Part II:Landscape Classification and Management Guidelines

5. LANDSCAPE CLASSIFICATION

INTRODUCTION

5.0.1 In this section of the report the landscape character of the Tayside Region is examined. In examining the principal influences on landscape character, and identifying the combinations of features or qualities which are critical in defining that character, a basis for future landscape planning and management is established.

SUMMARY METHODOLOGY

5.0.2 In analysing and describing the Tayside landscape, the approach recommended in the document '*Landscape Assessment: Principles and Practice*' published by the Countryside Commission for Scotland (Land Use Consultants, 1991) was broadly followed. The guidance issued by the Countryside Commission in their document '*Landscape Assessment Guidance*' (Countryside Commission, 1993) was also taken into account. The method comprised three principal stages.

(i) **Desk Study** wherein a range of information on geology, landform, land use, land cover and settlement are mapped and analysed to identify draft landscape character types and draft landscape character units which group together areas with similar attributes. The desk study stage of the assessment also included a review of other descriptions of the landscape and consultation with relevant parties.

(ii) **Field Survey** when the draft landscape types and units are tested on the ground and the character of the landscape recorded, using both written description and photographs.

(iii) **Analysis and reporting** when the desk and survey information are brought together to produce definitive descriptions of each landscape character type.

Subjective Assessment of Character

5.0.3 Landscape assessment uses a combination of objective appraisal (which records the presence or absence of particular features such as hedges or buildings) and subjective appraisal during field survey and subsequent analysis. The latter is designed to record the observer's perception of the landscape. The character of the landscape is described under a series of headings, which are explained below and are used to describe each of the landscape types in the rest of the report.

Views	Views are influenced by topographical and landcover factors. They may be **distant** where there is a large expanse of uniform foreground (e.g. heather moorland) and the focal point (e.g. mountain summits) are at some distance. Views may be **framed** where there are strong vertical and horizontal elements, such as woodland or steeply rising slopes either side of a bay. Views may be **intermittent** where the view is interrupted by landform features such as drumlins or woodland cover in the foreground or mid-ground. Views are **panoramic** where expansive, long distance views can be gained for a third or more of the field of view. Views are described as being **corridor** where they are linear in nature, for example within a valley or along a woodland ride.
Scale	Here the overall scale of the landscape must be assessed once the factors that define it have been assessed. These factors include the degree of enclosure by landform or woodland and the main positions from which the landscape is viewed. Scale increases with elevation and distance. The scale may range between **intimate** (perhaps in the vicinity of a waterfall or burn in a secluded hollow), through **small** (where a network of small fields might give the landscape a fine grain), **medium** (where the principal elements are of some size but do not overwhelm the observer) to **large** where the scale of the landscape is such as to make the observer feel dwarfed. It is not possible to place hard and fast rules on the dimensions which fall into each category.
Enclosure	Where elements are so arranged that they enclose space, this has an effect on the overall composition so that the space and mass become as one. It is also closely related to scale, due to the interaction of the height of enclosing elements and the distance between them. Enclosure may be defined as **confined** within a very small-scale landscape (e.g. within a ravine, or a clearing in dense woodland), **enclosed** where views are restricted to the immediate context (e.g., within a small to medium-sized valley), **semi-open** where the containment of the landscape is less and views to surrounding areas are more exposed (e.g.. within a shallow valley), **open** where there is little physical containment, but where features such as hedgerows, boundary trees or wall provide some sense of shelter, to **exposed** where there is no shelter and the observer feels exposed to the surrounding landscape and the weather.
Variety	This reflects the number and diversity of landscape features. On the one hand, a **complex** landscape will have very many elements (e.g. woods, fields, field boundaries, waterbodies, hills and hillocks, buildings and structures). On the other hand, a **simple** landscape will contain just one or two elements, such as heather moorland or outcrops of rock.

Texture	This varies according to scale of assessment but may be influenced by the underlying landform, the pattern of landcover and land use including size of fields, nature of boundaries and types of crop. For example, open chalk grassland may be described as **smooth**, an agricultural landscape of fields, hedges and hedgerow trees may be described as **textured**, a craggy area of heather moorland might be described as **rough** while an upland corrie or a section of cliff coast might be described as being **very rough**.
Colour	This simply records the contribution of colour in the landscape. In winter, a moorland landscape of heather and bog might be described as being **monochrome**, an area of unimproved pasture might be **muted**, an area of birch woodland **colourful** in spring and even **garish** in autumn. The assessment should take into account changes brought by different seasons and in different weather conditions.
Movement	Movement within the landscape may take a number of forms, reflecting levels of activity and land use, the physical movement of vehicles or people, or natural flows of the tides and falling water. This movement may be **remote** where it occurs on the fringes of the landscape, **vacant** where it is slight or absent altogether, **peaceful** where movement is in harmony with the character of the landscape or **active** where the movement stands out as an element in its own right.
Unity	The repetition of similar elements, balance and proportion, scale and enclosure all contribute to the sense of unity. The degree to which elements fit within their landscape context also contributes to the degree of unity. A major road through an otherwise unified landscape could result in a high degree of disunity. Degrees of unity include **unified** where the landscape shows common patterns of elements, management and use, **interrupted** where the otherwise unified landscape has been modified by moderately discordant elements such as insensitive residential development, **fragmented** where changes such as new transport infrastructure, or the decline of traditional forms of management mean that only some areas retain the historic character; or **chaotic** where unrelated landscape elements destroy any pre-existing character but fail to create a unified new landscape.
Naturalness	Naturalness reflects the apparent extent to which human activity has modified the landscape. It is usually used to describe common perceptions of the landscape. In other words, areas of semi-natural or managed landscape such as heather moorland are often described as **undisturbed**, while enclosed areas of glens may be described as **restrained** and lowland farmland described as **tamed**. Areas adversely affected by activities such as mineral working might be described as **disturbed**.

Scale of Assessment

5.0.4 It should be noted that landscape assessment can be undertaken at many different levels and that landscape types may be defined at very different scales. Whereas, at a regional scale, it may be appropriate to identify the principal Highland Glens, and to draw broad distinctions between upper, mid and lower glens, based on combinations of typical characteristics, a more detailed assessment might differentiate between river corridor, floodplain, and the lower, middle and upper valley slopes for each section of glen. It is important that assessments undertaken at a regional level are not applied at a locally specific level. The converse also applies.

ASSESSMENT HIERARCHY

5.0.5 This approach enabled the landscape to be described in a hierarchical framework which established the pattern of variation in the landscape. This framework is based upon the identification and description of Regional Character Areas. Landscape Types and Landscape Units (or Local Landscape Areas) are defined as follows:

(i) **Regional Character Areas** are recognisable as distinct landscape regions at a broad scale, based upon general characteristics such as landform, geology, soils, land use, ecological associations, historical associations and urban and industrial activity. The principal regional character areas are described later in this section.

(ii) **Landscape Types** are tracts of countryside which have a unity of character due to particular combinations of landform, landcover and a consistent and distinct pattern of constituent elements.

Differences in landscape character reflect both physical and historical or cultural influences including geology, drainage, landform, landcover and land use. Each of these landscape types has a distinct and relatively homogeneous character. There are, of course, subtle differences within each of the landscape types, some of which are referred to in the descriptions. It should be noted that the descriptions of landscape types are generalised and that the boundaries between types often indicate transitions rather than marked changes on the ground. This is particularly the case in lowland areas where changes in relief (often a major direct or indirect influence on landscape character) tend to be more subtle. The bulk of the analysis and description for this study related to landscape types. However, there is also reference, where appropriate, to landscape units (described in point (iii) below). Landscape types are usually given generic names reflecting their key characteristics (e.g. Upper Highland Glen). A given landscape type may occur in more than one regional character area, though one would expect regional factors to influence its character;

(iii) **Landscape Units** are discrete geographic areas of relatively uniform character, which fall within particular landscape types. In one regional character area, the same landscape type may occur in a number of different landscape units.

LANDSCAPE CLASSIFICATION

5.0.6 The following table sets out the hierarchy of regional character areas, landscape types and landscape units.

Table 5.1: Tayside Landscape Character Assessment: Landscape Classification

Landscape Type	Regional Character Area	Landscape Units
1 HIGHLAND GLENS		
1a) Upper Highland Glens	Mounth Highlands	Glen Mark
		Glen Lee
		Glen Effock
		West Water Valley
		Glen Clova
		Glen Prosen
		Glen Isla
		Glen Shee
		Glen Beag
		Glen Fearnach
		Glen Brerachan
		Glen Tilt
	West Highlands	Glen Garry
		Glen Quaich
		Glen Almond
1b) Mid Highland Glens	Mounth Highlands	Glen Esk
		West Water Valley
		Glen Clova
		Glen Prosen
		Glen Isla
		Glen Shee
		Strathardle
	West Highlands	Glen Errochty
		Dun Alastair

Landscape Type	Regional Character Area	Landscape Units
1b) Mid Highland Glens (continued)		Strathbraan
		Glen Lyon
		Glen Artney
1c) Lower Highland Glens	Mounth Highlands	Glen Shee
	West Highlands	Strath Tay
		Upper Strathearn
2 HIGHLAND GLENS WITH LOCHS		
2a) Upper Highland Glens with Lochs	West Highlands	Loch Ericht Loch Daimh Loch Lyon
2b) Mid Highland Glens with Lochs	West Highlands	Loch Rannoch Loch Tay Loch Earn
2c) Lower Highland Glens with Lochs	West Highlands	Loch Tummel
3 HIGHLAND SUMMITS AND PLATEAUX	West Highlands	Ben Vorlich and the Forest of Glenartney
		Ben Chonzie/Sròn Mhór/Meall nam Fuaran and Craigvinean Forest
		Ben Lawers and Beinn Heasgarnich Group
		Carn Gorm/Schiehallion Group
		Meall Tairneachan Group
		Talla Bheith and Craiganour Forest

Landscape Type	Regional Character Area	Landscape Units
3 HIGHLAND SUMMITS AND PLATEAUX (continued)	Mounth Highlands	Forest of Atholl
		Forest of Clunie
		Forest of Alyth
		Caenlochan Forest/Glen Doll Forest
		Muckle Cairn/Hill of Glansie/Hill of Wirren
		Hills of Saughs/Mount Battock
4 PLATEAU MOOR	West Highlands	Rannoch Moor
5 HIGHLAND FOOTHILLS	Mounth Highlands	Clunie Foothills
		Alyth Foothills
		Kirriemuir Foothills
		Menmuir Foothills
		Edzell Foothills
6 LOWLAND HILLS	Tayside Lowlands	Gask Ridge
		Keillour Ridge
		Logie Almond/ Bankfoot Plateau
7 LOWLAND RIVER CORRIDOR	Tayside Lowlands	Strath Tay Glen Almond
8 IGNEOUS HILLS	Tayside Lowlands	Sidlaws
		Ochils
9 DOLERITE HILLS	Tayside Lowlands	Lomond Hills
		Benarty Hill
		Cleish Hills

Landscape Type	Regional Character Area	Landscape Units
10 BROAD, VALLEY LOWLAND	Tayside Lowlands	Strathmore
		Strathearn
		Strathallan
11 FIRTH LOWLANDS		Braes of Gowrie
12 LOW MOORLAND HILLS	Tayside Lowlands	Forfar Hills
13 DIPSLOPE FARMLAND	Tayside Lowlands	SE Angus lowland
14 COAST		
14a) Coast with Sand	Tayside Lowlands	Barry Links
		Elliot
		Lunan Bay
		Montrose
14b) Coast with Cliffs	Tayside Lowlands	Carnoustie
		Auchmithie
		Usan
15 LOWLAND BASINS	Tayside Lowlands	Loch Leven Basin
		Montrose Basin

REGIONAL CHARACTER AREAS

5.0.7 As noted above, regional character areas are recognisable as distinct landscape regions at a national scale as result of the distinctive combinations of geology, landform, drainage, landcover, historical and ecological influences and settlement. Chapter 3 of this report demonstrated the key influence of geology within Tayside. The Highland Fault runs south-west to north-east across the region, marking a rapid transition from the Highlands, to the north-west, and lowlands to the south-east. This physiographic division has had a fundamental influence on landscape character reflected in contrasting patterns of landcover, land use, communication and culture.

5.0.8 The area to the north and west of the Highland Fault, often described simply as the Grampian Mountains, may be further divided, reflecting important differences between the Highlands to the west and east of Glen Garry and Drumochter. To the west lies the central mountain ridge that extends northwards from Ben Lomond to Ben Hope in

Sutherland. To the east lies the mountain chain extending from Drumochter eastwards along the southern side of the Dee valley, diminishing in size as it approaches the North Sea near Aberdeen. Historically, this area of highland has been referred to as the Mounth.

5.0.9 These three regional character areas - the Tayside Lowlands, the West Highlands and the Mounth - are described in the following paragraphs.

Tayside Lowlands

5.0.10 This regional character area covers all of the south-eastern part of the Tayside region. Its geology is dominated by a combination of Old Red Sandstone and volcanic lavas and tuffs. The former rocks are comparatively soft and were subject to erosion during periods of glaciation creating the lowland valleys of Strathmore, Strathearn and Strathallan, and the Firth of Tay, together with the distinctive basin of Loch Leven. The harder lavas and tuffs were more resistant to erosion, resulting in their survival as the Ochil and Sidlaw Hills. Although rising to 500 metres in places, these hills attain neither the scale nor the appearance of upland areas to the north of the Highland Boundary Fault. At a local level, glacial deposition, modified by fluvial and marine erosion, has an important influence on landform, land use and character throughout much of this regional character area. Eskers, kames, kettle holes and dry meltwater channels occur throughout the area.

5.0.11 The Tayside Lowlands are among the most fertile areas in Scotland, with much of the land falling into Land Capability Classes 2 and 3(1), meaning that it is suited to a wide range of crops including cereals, ley grassland and root crops such as potatoes. Consequently, much of the area is in intensive agricultural use and many of towns and villages provide markets for farm produce or provide processing, machinery or distribution services to farming enterprises. Extensive woodland is rare in this area, reflecting the importance of land for agriculture. Exceptions include the less fertile and more exposed areas on higher ground.

5.0.12 The Tayside Lowlands also share a distinctive history of settlement. The area represents the northern fringe of Roman occupation, and, as reflected in the pattern of place names, formed the boundary between the more anglicised parts of Scotland to the south, and Celtic areas to the north and west. Furthermore, the productivity of the area, its relative proximity to Stirling and Edinburgh, and its location at the junction of key communication routes (the Edinburgh to Inverness road and the Glasgow to Aberdeen road) are reflected in the large number of wealthy landed estates. The formal and informal woodland, together with the associated structure of field boundary trees has a significant influence on the character of the area. The contrast between the richness of the Tayside Lowlands and the poorness of neighbouring Highland areas generated considerable conflict over the centuries as bands of cattle thieves from the Highland glens plundered the lowland. The density of hill-forts, medieval castles and fortified manor houses reflects this turbulent history.

The West Highlands

5.0.13 The West Highlands form the north-western part of Tayside, bounded to the south by the Highland Boundary Fault between Glen Artney and Strath Tay near Dunkeld, and to the east by Drumochter-Glen Garry- Strath Tummel and Strath Tay. Geologically, the area has a structure similar to the Mounth Highlands to the east, dominated by the grits and schists of the Dalradian and Moine groups and outcrops of limestone. However, the pattern of faulting and ice movements have contributed to different patterns of glacial and fluvial erosion, and a different landscape has resulted. Glens tend to follow west to east fault lines, and are larger than the Angus Glens to the east. Several of the West Highland glens contain large lochs. Furthermore, the higher rates of precipitation in the western part of the region, caused a more rapid accumulation and movement of ice during periods of glaciation, resulting in the mountains gaining a sharper, craggier relief. The area was also more heavily dissected prior to the Ice Age and this was accentuated by glaciation.

5.0.14 Historically, settlement was influenced by the concentration of cultivable land within the principal glens, and by the existence of three major communication routes through the West Highlands towards the Atlantic coast. The first of these routes enters the Highlands at Comrie passes along the northern side of Loch Earn through Lochearnhead to Glen Ogle and beyond. The second route follows the Tay westwards to Aberfeldy and along Loch Tay. The third climbs past Loch Tummel and passes through Kinloch Rannoch to Rannoch Moor. The landscape is further influenced by the parklands and policy planting associated with the large houses and estates that occupy the lower sections of several glens. Examples include Blair Castle, Dunkeld House and Taymouth Castle. Large parts of the valley sides are clothed in coniferous woodland, while the expanses of highland between are under heather or grass shrub heath.

The Mounth Highlands

5.0.15 As noted above, the Mounth Highlands form a mountainous ridge extending eastwards from the West Highlands. The mountains form the north-eastern part of Tayside running from Drumochter-Glen Garry-Strath Tummel-Strath Tay eastwards to the Forest of Birse. The southern edge of the area is defined by the Highland Boundary Fault between Strath Tay near Dunkeld to Edzell in the east. Although dominated by the grits and schists of the Dalradian and Moine groups, there are also significant areas of granite (for example Ben Dearg) and areas of limestone. The landform has been substantially modified by glaciation, creating distinctive glaciated valleys and resulting in deposition of moraines within the glens. The lower accumulation of snow and ice in the drier Mounth, together with the preglacial landform, are reflected in the mountains having a more rounded and less craggy relief than those to the west. Along the Highland Fault the incidence of a range of different rock types, including volcanic lavas and tuffs, are reflected in the dissected pattern of hills and intervening glens which form the Highland foothills.

5.0.16 In contrast to the West Highlands, the glens along the southern side of the Mounth run from north-west to south-east, reflecting the natural fall of the land from the watershed. The glens tend to be smaller in scale, and shorter, with few providing modern routes through towards the Dee valley. Historically, however, many of the glens would have formed communication routes through the Mounth. The proliferation of castles and fortified houses at strategic points within the glens and at their mouths, reflected the need to control the movement of people and stock. Following the Highland Clearances, much of the Mounth was given over to deer hunting, a use indicated by the word 'forest' in the names of many of the upland areas. Commercial forestry has developed as an important land use in the middle and lower parts of the glens. The uplands themselves remain as expanses of dwarf heather moorland.

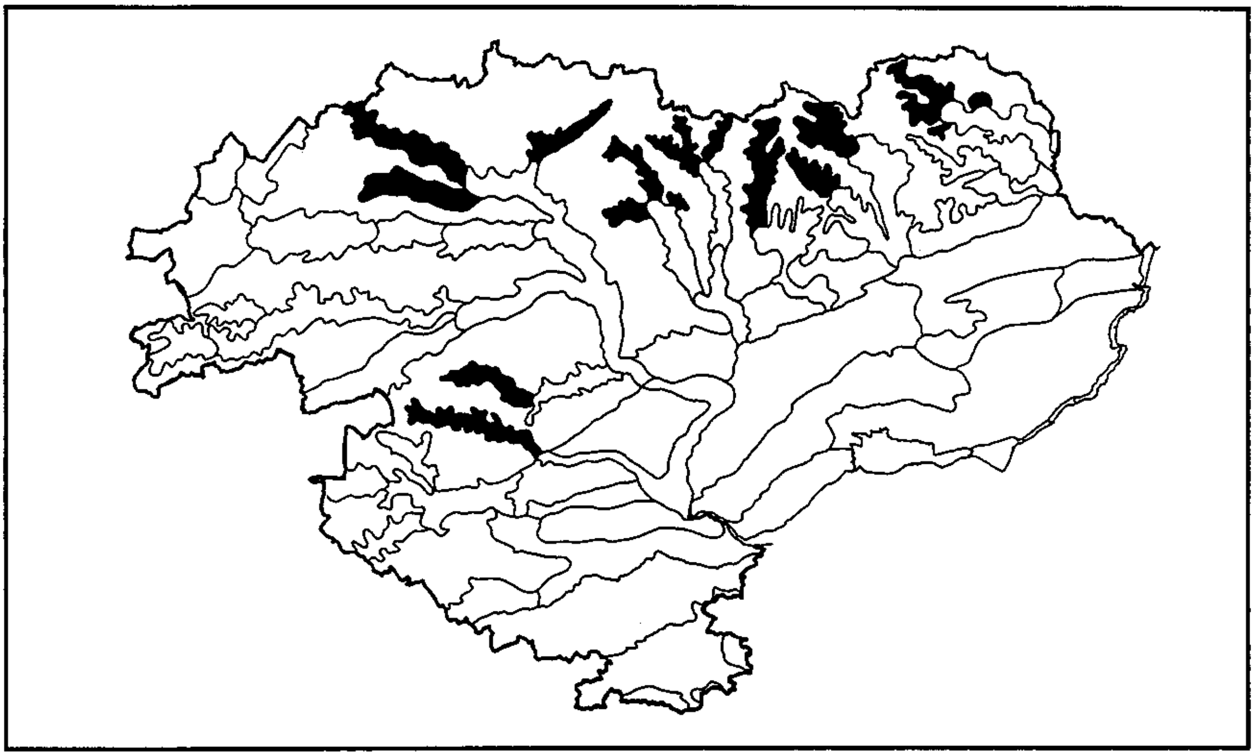
LANDSCAPE TYPE DESCRIPTIONS

5.0.17 The following sections of the report provide generalised descriptions of each of the landscape types identified by the landscape assessment. Reference is also made to the landscape units where these types occur. Where appropriate the variations in landscape character brought about by different regional character areas are described.

HIGHLAND GLENS (1)

5.1.1 Within that part of Tayside to the north of the Highland Boundary Fault, glens formed by the combination of glacial and river erosion provide one of the principal structural elements in the landscape. They also provide the focus for most human activity. In undertaking the landscape assessment, a distinction has been made between the upper, mid and lower sections of the glens. These are described below. It should be noted that those glens containing large lochs are described as a separate landscape type.

UPPER HIGHLAND GLENS (1A)



KEY CHARACTERISTICS

- *uppermost sections of principal Highland glens*
- *narrow*
- *dominated by the scale and proximity of enclosing mountains*
- *classic glaciated landforms and features*
- *sparse settlement and woodland cover*
- *upland, remote character*
- *in some areas the character has been weakened by recent development*

OBJECTIVE DESCRIPTION		Upper Highland Glens
Physical scale		1.5 kilometres wide at valley crest Valley floor 200-250 metres AOD Valley sides rise to 600-900 metres AOD
Woodland	broad-leaf	Virtually absent
	coniferous	Geometric plantations on valley floor and mid slopes, more natural shapes on upper slopes
Agriculture	arable	Absent
	pasture	Rough grazing on valley floor and slopes
	fields	Little or no enclosure
	field boundaries	Where they occur either dry-stone walls or post-and-wire fences
Settlement pattern		Predominantly unsettled. Scatter of isolated farms, lodges and cottages.
Building materials		Schists and granites with slate
Historic features		Castles, old routeways
Natural heritage features		Upland vegetation
Other landscape features		Rock outcrops, glacial features, hydro schemes
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium
Enclosure		Enclosed
Variety		Simple
Texture		Rough to very rough
Colour		Muted to monochrome
Movement		Remote
Unity		Unified/interrupted
'Naturalness'		Wild/slightly tamed

LOCATION

5.1.2 This landscape type comprises the uppermost sections of the most significant Highland Glens. They are distinct from the mid and lower sections of the valleys by their narrowness, the height and dominance of neighbouring mountains, the sparsity of settlement and the lack of enclosed or improved pastures on either the lower slopes or the valley floor. Within the Mounth Highlands, this landscape type occurs in Glen Mark, Glen Lee and Glen Effock (at the head of Glen Esk), the valley of the West Water, Glen Clova, Glen Prosen, Glen Isla, Glen Shee and Glen Beag (at the head of Glen Shee) and Glen Tilt. Within the West Highland mountains, it occurs at Drumochter Pass, and in Glens Quaich and Almond. In addition, there are many smaller glens within the Highlands which exhibit these characteristics, but equally form part of the upland landscape. These have not been identified separately.

PHYSICAL CHARACTERISTICS

5.1.3 While the glens in the West Highlands pass through Dalradian and Moinian grits and schists, within the Mounth the upper glens encounter a variety of different rock types including granites, limestones, quartzite and intrusive diorite. While these have local influences on topography (for instance forming the crags and scree slopes around Glen Doll, designated as an SSSI), it is glaciation that has had the most profound effect on this landscape type. Classic glaciated valley profiles, hanging valleys, corries and misfit rivers are all evident in these upper glens.

5.1.4 The upper glens are of comparatively small scale. With little or no floodplain, the valley sides rise steeply so that the glen as a whole is little more than 1 to 1.5 kilometres wide at the crest of enclosing hills. While valley floors are typically between 200 and 250 metres AOD, the enclosing mountains rise to between 600 and 900 metres. In the east, these summits are generally rounded. In the west they are craggier and more clearly defined. In both areas it is the mountains and the upland character that extends throughout the glen, that shapes perceptions and appreciation of the landscape.

5.1.5 These areas of upper glen are often of nature conservation importance, supporting a combination of moorland and lowland plant communities and fauna. The Dalradian limestone underlying Glen Tilt makes this of particular significance, supporting diverse calcareous and montane plant communities, and rare breeding birds. It is also of geological significance.

SETTLEMENT AND LAND USE

5.1.6 It is likely that, even before the Highland Clearances, the harsh environment of these upper glens would have discouraged settlement. However, many of the glens formed important routes through the highlands, particularly in the Mounth and, as a result, defensive castles (often northern outposts of larger castles or estates located in lower parts of the glen) were sited at strategic locations to control movements from the north. A good example is Invermark Castle, sited at the head of Glen Esk where three side valleys come together. A number of the old trackways through the Mounth survive as bridleways. In later centuries, these remote upland glens became popular for deer hunting and a significant number of large lodges were established.

5.1.7 Few areas of native woodland are found in the upper sections of the Highland Glens. More common are the areas of coniferous woodland established during this century by the Forestry Commission or major landowners. Within the Mounth, large plantations are found in the upper parts of Glen Clova and Glen Prosen. While conifer woods do not look out of place where they adopt 'natural' or organic shapes on the valley sides, the planting is less satisfactory where geometric shapes are imposed on the natural curves of the glaciated landform, or where plantations are established on the valley floor. The coniferous woodland around Glen Doll provides a range of examples. It is recognised that since these plantations were established, the Forestry Commission's approach to planting has changed substantially; however, as is inevitable in forestry, previous approaches endure over long periods.

5.1.8 The upper glens are at the same time accessible and remote. Roads along most of the glens provide access into the heart of the Highlands. Although sheltered within the confines of the valley, the dominance of the mountains and the undifferentiated nature of the vegetation across the glen give the landscape a distinctly upland character. Light and weather conditions can quickly reinforce this impression.

FORCES FOR CHANGE

5.1.9 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development. Although these areas have seen considerable change over past centuries as native woodland was cleared and the population removed, the upland glens retain a wild, untouched character. With little in the way of tree cover, views can be extensive within the glen and any development can intrude on this character.

5.1.10 **Transport.** For the most part, the Upper Highland Glens either have no roads at all or are served by minor roads, often ending in cul de sacs. Although visible in the open landscape, these roads tend to sit relatively easily in the landscape, following natural contours along the floor of the glen. It is important that the diminutive and low-key appearance of these roads is maintained and that minor improvements and signage do not compound to give an overly 'urban' effect. The principal exceptions to the above pattern are found in Glen Garry, where the A9 crosses the Drumochter Pass and Glen Beag (north of Glen Shee) where the valley is occupied by the A93. The A9 is a nationally important route which carries a substantial volume of heavy traffic. In the case of the A93, the two lane road is very visible at it climbs up towards the Cairnwell. In its lower sections the road follows the natural landform. Further up, comparatively recent improvements have created a road with a more even gradient, running up the hillside on a distinctive shelf. The remains of the old 'military road' are visible in the glen below. A programme of improvements along the A93 from Blairgowrie to the Cairnwell is planned. This is likely to increase the prominence of the road, particularly in its more exposed, upper sections. The effect of these roads, their traffic, and the development they have stimulated, demonstrates how easily the remote character of the Upper Glens can be changed.

5.1.11. **Development.** A lack of settlement is an important feature of these Upper Glens. For the most part, development is limited to a scatter of lonely cottages and lodges. Again, the exception to this is Glen Beag where comparatively good road access, possibly allied to the proximity to the Spittal of Glenshee and the ski area, has stimulated the recent development of a number of isolated houses. The houses stand prominently in the open glen and contribute to a weakening of its seemingly harsh upland character.

5.1.12. **Forestry and woodland**. As noted above, the Upper Highland Glens include several areas of coniferous woodland. In most cases, the plantations have been established to supply commercial timber. In others, the aim has been to provide shelter for game or livestock. The scale and form of the woodland varies accordingly. Commercial plantations tend to be larger in scale, occupying areas of the valley floor and the valley sides. Shelter plantations are smaller and often geometric in appearance. Perhaps the greatest range of plantation types may be found in Glen Clova/Doll where visually intrusive plantations on the valley floor, and in the form of small coverts, sit alongside more naturalistic forms on the valley sides. It is probably true to say that much of the commercial woodland that can be found in the Upper Highland Glens, if established today, would be planted very differently, if at all. Harvesting of this woodland provides an opportunity to review the best locations and designs for replanting. This is considered further within the management guidelines.

5.1.13 It is probable that, without management to favour deer and grouse, native woodland would regenerate on many of the valley slopes. This would form a transition from sparse birch and pine woods, through dwarf woodland to the open vegetation of the highland summits and plateaux.

5.1.14 **Recreation.** Many of the Upper Highland Glens are remote and seldom visited except by a comparatively small number of walkers and climbers. There are two principal exceptions to this rule - Glen Doll at the head of Glen Clova, and Glen Beag. Glen Doll is a popular walking and climbing centre with a Youth Hostel, car park, toilets, campsite and picnic site and a mountain rescue post. The facilities have been designed and implemented in a comparatively low-key way, focusing on the re-use of Glen Doll Lodge. While it would be sensible to accommodate any further growth in walking/climbing within Glen Doll, rather than encouraging wider use of the other, quieter, glens, the scale of development should not be allowed to undermine the essential character of this upland area.

5.1.15 At the head of Glen Beag lies the Cairnwell and the Glen Shee ski area. Although all the ski-runs are concentrated to the north of the Tayside boundary, some of the chairlifts can be seen on the ski-line from some way down the glen. Future expansion of the ski area may bring pressure to provide new runs on the southern side of the mountain watershed, bringing them into Tayside for the first time. The provision of new parking and uplift facilities could substantially modify the local landscape around the Devil's Elbow area. While, from a landscape point of view, it would be preferable to concentrate activity to the north, and to prevent the development spilling south to affect Glen Beag, the existing developed character of the glen (relative to other Upper Highland Glens), and the topographic screening provided by the turn in the glen, may reduce the significance of the impact. However, due to the sensitivity of the highland landscape, and the possibility that elements of the scheme would be visible over a considerable distance within this open landscape, a full visual impact assessment should be undertaken at the design stage.

5.1.16 **Tall structures.** The Upper Highland Glens are largely free from tall structures such as pylons and masts. An exception, mentioned previously, is the pylons associated with the lifts at the Glen Shee ski area. This landscape type would be very sensitive to any proposals for tall structures, be they pylons, masts or wind turbines, and be they within the glen itself or visible from within it. Such structures would undermine the wild, seemingly undeveloped character of the landscape.

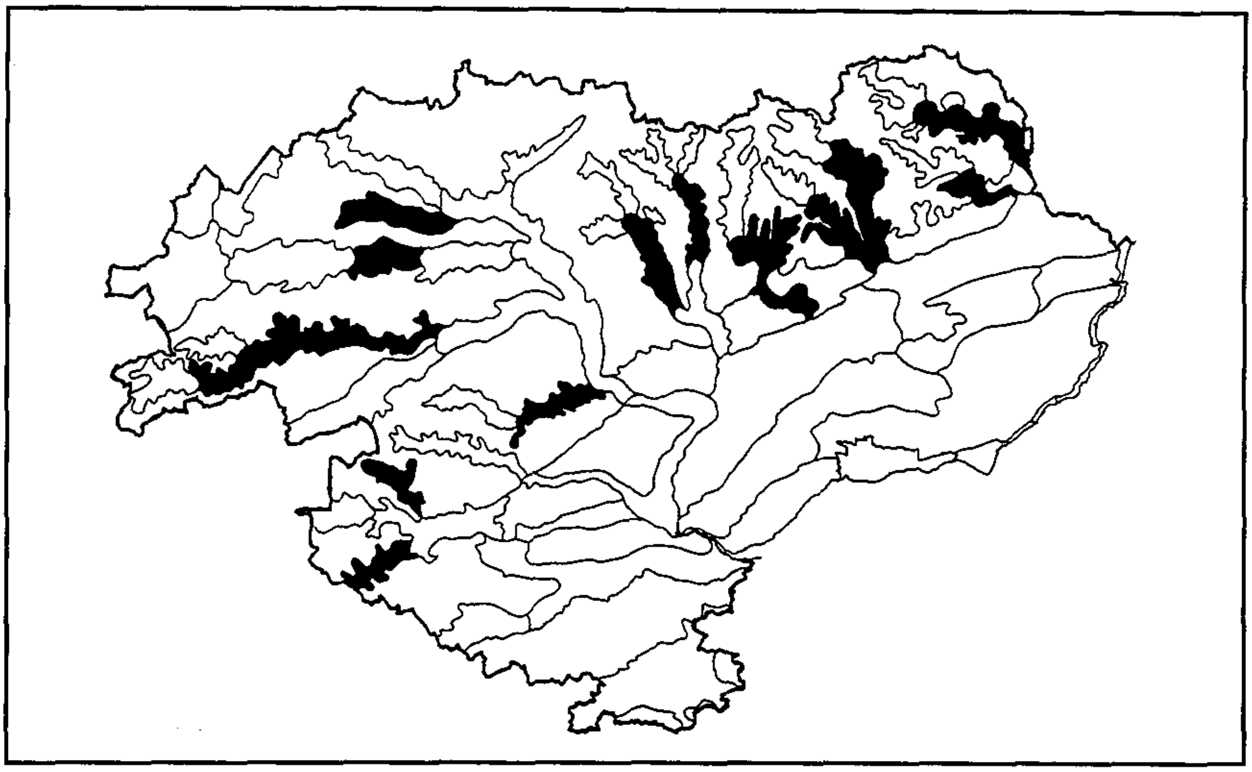
LANDSCAPE GUIDELINES

5.1.17 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristic upland landscape with its open, predominantly unsettled moorland vegetation and to maintain the contrast with the more settled lowland sections of the glens.

Agriculture	• Encourage the conservation of dry-stone dykes in local stone with an emphasis on roadside walls and others in highly visible areas.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, road paint or features such as concrete kerbing.
Development	• Discourage development in the Upper Highland Glens. • Where development is permitted, ensure that buildings are located so as to minimise their impact on the landscape (utilising any natural screening provided by the landform) and that they adopt vernacular styles, building materials and colours.
Forestry and woodland	• Encourage good landscape design and appropriate scale for any new woodland areas. • Encourage the removal of small, geometric plantations, allowing equal increases in planting in more appropriate locations elsewhere. • Support the removal of poorly designed plantations on the floor of glens.

(Forestry and Woodland contd.)	• With respect to the replanting of existing plantations on valley slopes: - encourage the rationalisation of woodland to avoid isolated, small- to medium-sized areas of plantation woodland which appear very prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes. • Explore opportunities to modify management practices to allow the regeneration of native woodlands on some valley slopes, to create the 'natural' transition from valley woodland, through dwarf alpine woodland to the vegetation of the highland summits and plateaux.
Recreation	• Focus recreation activities at existing centres. • Maintain low-key level of provision. • Ensure that proposals for expansion of facilities are subject to rigorous visual impact assessment adopting, for example, the approach set out in the guidance published by the Landscape Institute and the Institute of Environmental Assessment (1995). • Expansion of ski-facilities into this landscape type should only be permitted if it is clear that: - the visual and landscape impact is limited; - there is no scope to accommodate expansion to the north; - the economic need for the scheme is demonstrated. • Indirect effects including traffic and the proliferation of related facilities (ski-hire shops) should also be taken into account.
Tall structures	• Discourage proposals for aerials, masts or wind turbines because of their likely impact on the harsh, undeveloped character of the Upper Highland Glens. • Ensure that any proposals are subject to rigorous landscape impact assessment. • Where new power or telephone lines are proposed or required, ensure that operators adopt underground cable solutions.

MID HIGHLAND GLENS (1B)



KEY CHARACTERISTICS

- *middle sections of the principal Highland Glens*
- *concentration of agricultural activity on narrow, but distinct valley floor*
- *predominance of rough grazing, bracken, heather moorland on valley slopes*
- *rapids, gorges and waterfalls where bands of harder rocks occur*
- *glacial and post glacial features including morainic deposition*
- *native birch and oak woodland*
- *moderately settled*
- *proliferation of forts and castles*
- *substantial areas of commercial coniferous forestry*

OBJECTIVE DESCRIPTION		Mid Highland Glens
Physical scale		0.5 to 1 kilometre wide floodplain Valley floor 100-200 metres AOD Valley sides rise to 300-600 metres AOD Gorges and falls where harder rocks cross the glen
Woodland	broad-leaf	Native birch and oak woodland on steeper and poorer ground
	coniferous	Substantial areas of plantation
Agriculture	arable	Almost entirely absent
	pasture	Improved pasture on valley floor, rough pasture on lower/mid slopes
	fields	Small, irregular, reflecting landform
	field boundaries	Dry-stone dykes and post-and-wire fences
Settlement pattern		Scatter of farmsteads and small villages, located to avoid flooding and to maximise shelter/sunlight.
Building materials		Schists and granite with slates
Historic features		Castles, old farmsteads
Natural heritage features		Native woodlands, gorge vegetation
Other landscape features		Waterfalls, glacial deposition features
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium to small
Enclosure		Enclosed
Variety		Varied
Texture		Textured to rough
Colour		Colourful
Movement		Peaceful
Unity		Unified
'Naturalness'		Restrained

LOCATION

5.1.18 This landscape type comprises the middle sections of the most significant Highland Glens. These sections of glen are distinguished by the concentration of agricultural activity on the narrow valley floor, and the predominance of rough grazing, bracken and heather moorland on the valley slopes. Within the Mounth Highlands, this landscape type occurs in Glen Esk, the valley of the West Water, Glen Clova, Glen Prosen, Glen Isla, Glen Shee, Strathardle and Glen Tilt. Within the West Highland Mountains, it occurs at Glen Errochty, Dun Alastair (between Lochs Rannoch and Tummel), Strathbraan, Glen Lyon and Glen Artney.

PHYSICAL CHARACTERISTICS

5.1.19 While the Mid Glens pass through Dalradian and Moinian grits and schists, they also encounter a variety of different rock types including granites, limestones, quartzite and intrusive diorite. Where bands of harder rock cross the glen the valley often narrows to a gorge and the river tumbles over a series of waterfalls. One of the best examples of this is found at Linn in Glen Isla, a narrow gorge 120 feet in depth. In just a short distance, the river descends some 80 feet. A similar gorge is found above Fortingall as the River Lyon descends to join the Tay. However, as with the upper glens, it is glaciation that has had the most profound effect on this landscape type. Classic glaciated valley profiles, hanging valleys, corries and misfit rivers are all evident in these sections of glens. Equally significant, particularly at the local scale, are the glacial deposits found along the valley sides and across the valley floor. Formed as the retreating glaciers dropped their load of scoured rock and soil, and modified by temporary meltwater channels, these deposits often create a hummocky landscape of drumlins and eskers. Misfit rivers meandering across the floodplains cut through the deposits, creating incised meanders.

5.1.20 While the surrounding mountains still have an influence on the mid sections of the glens, they are more open than their upper sections. There is now a well-defined valley floor ranging between 0.5 and 1 kilometres in width. In places, the river has cut a steep-sided inner valley, often cutting down into the glacial deposits (sometimes in response to the general uplift of the Highlands following the melting of glaciers and icesheets). Valley floors are typically between 100 and 200 metres AOD and the enclosing valley slopes rise more gently to between 300 and 600 metres. As before, these summits are generally rounded in the east and craggier and more clearly defined in the west. Within the West Highlands, the northern valley slopes (effectively dipslopes) tend to be gentler than those to the south (eroded escarpments).

5.1.21 Many of the Mid Glens are ecologically important, containing stands of native oak and birch woodland on steeper valley slopes and on poorer land on the valley floor. Much of this is semi-natural and long-established, and active management to exclude grazing is required to encourage regeneration. In places (e.g. near Gallin in Glen Lyon) sparse remnants of Caledonian pine woodland survive. More extensive are the native birchwoods that are found within Glens Prosen and Esk. Much of this is now over-mature and is not regenerating due to high levels of grazing. In addition, policy woodland is found in Glen Clova. Within the deeper gorges the cool, damp and shady conditions favour mosses, liverworts and some rare higher plants and invertebrate species. The upper valley slopes generally comprise a mosaic of heather moorland and grassland which, together with rock outcrops and scree slopes, creates a textured and varied landcover.

SETTLEMENT AND LAND USE

5.1.22 The mid sections of the glens are more settled than the upland sections. Stone farmsteads, often whitewashed with slate roofs, are sited in the lee of spurs or small hillocks, or are associated with small farm woodlands. Solitary cottages are found throughout the Mid Glens. Fields are generally enclosed within networks of stone dykes, supplemented by post-and-wire fencing. Abandoned enclosures on the valley slopes are surrounded by crumbling walls and have been invaded by bracken and rough grassland. Improved pasture, ley grassland even arable crops are found on flatter fields and along the floor of the glen. Within the West Highland glens, settlement and farmland is often concentrated on the northern side of the valley, benefiting from a southern aspect and gentler slopes. Periods of clan warfare are once again reflected in a proliferation of castles and forts. Near Cashlie there are the remains of the ancient forts of Glen Lyon, while further down the glen, Meggernie Castle stands as an important hunting lodge. Modern development is scarce, limited to a handful of hydroelectric schemes and their associated pylons.

5.1.23 In addition to the semi-natural birch and oak woodland which makes a significant contribution to the landscape character, a substantial amount of commercial woodland is found within the Mid Glens. In many cases coniferous species have been mixed, integrated with surrounding broad-leaf woodland and designed to fit with the natural flow of the landscape. A good example is found along the southern slopes of Glen Errochty where larch, sitka and other species are mixed, creating a more natural, mottled appearance, and where broadleaves along field boundaries and burns push up into the plantations. These woodlands do need to be seen in the wider context however. Even in Glen Errochty there is an imbalance created by the concentration of woodland on the southern slopes and the retention of pastures and open moorland on the northern slopes. Older plantations are generally less well-integrated into the landscape, often comprising geometric blocks apparently unrelated to landform. Within some of the larger valleys, such as Glen Lyon, the presence of estates is signalled by policy woodlands and by the regular lines of trees along field boundaries.

5.1.24 These sections of the West Highlands and Mounth glens provide a transition between the upper and lower parts of the valleys. The presence of the mountains is still the dominant influence on landscape character and it is only on the narrow valley floor that agriculture has been able to bring the land into productive use. Despite the size of the mountains, the narrowness of the glens means that these are relatively small-scale landscapes. Settlement has generally taken the form of a scatter of buildings constructed from local materials. More substantial development, such as pylons, are very evident.

FORCES FOR CHANGE

5.1.25 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.1.26 **Agriculture.** As described above, most agricultural activity in the Mid Highland Glens is concentrated on the valley floor. In a few places the level ground created by valley terraces or morainic deposits also provides suitable land. For the most part, however, the valley sides are dominated by rough grazing, grading into craggy heather or grass moorland. Pastures dominate, with a variety of livestock grazed on the floor of the glen. In a few places, typically on higher, better drained and sunnier land along the northern side of the glen, root crops or other vegetables are grown. Where this occurs, the bright green leaves of the crop, or the brown of the tilled soil, contrasts with the more subdued browns and greens in other parts of the glen. In other places, the quality of pasture in the glens has been improved by the provision of drainage, reseeding and the application of fertilisers. Again, this creates an intensity of green which appears out of place in this semi-upland landscape.

5.1.27 **Transport.** For the most part, the middle parts of the highland glens are served by minor roads. These generally sit easily in the landscape, following natural contours along the floor of the glen, winding their way between drumlins and marking the boundary between the rough valley sides and the grazed floor of the glen. As in the upper glens, it is important that the diminutive and low-key appearance of these roads is maintained and that minor improvements and signage do not compound to give an overly 'urban' effect. Several glens, notably Glen Shee, Strathardle and Strathraan, contain main roads, bringing with them larger volumes of traffic and a greater amount of development.

5.1.28 **Development.** With significantly more farmsteads, cottages and houses than the upper highland glens, this landscape type is still comparatively sparsely settled. As noted above, older buildings tend to be sited so as to maximise shelter and sunlight. More recent buildings seem to be located more with access to the road in mind. Shelter and (to a degree) screening is often provided by conifers planted around the boundary of the property. In an otherwise open landscape, the screening itself draws attention to the building. While older buildings often share a vernacular of stone walls (sometimes whitewashed) and slate roofs, newer buildings adopt more ubiquitous designs and materials which hinder their integration into the landscape still further. A more effective approach would be to encourage new development to consolidate existing villages, hamlets or even groups of farm buildings, adopting designs which respond to their setting. There may also be some scope for the sensitive conversion of traditional farm buildings.

5.1.29 **Forestry and woodland.** The Mid Highland Glens exhibit a pattern of commercial forestry that is similar to that of the upper parts of the glens. Commercial plantations tend to be large in scale, occupying areas of the valley sides. Shelter plantations and coverts are smaller and often geometric in appearance. Many of the plantations were established following very different planting principles to those employed today. In places this has resulted in geometric blocks of even-aged, single-species woodland which appear as impositions upon the natural form of the landscape. Harvesting of this woodland provides an opportunity to review the best locations and designs for replanting. This is considered further within the management guidelines. It is also true to say, however, that well-designed commercial woodland in the middle parts of the highland glens is significantly less intrusive than in the upper sections. In part this reflects the larger scale and more open character of the landscape (wider glens with lower hills) and the greater extent of human settlement and land use. There may be additional scope for commercial woodland in these glens, particularly in the lower, more wooded, sections.

5.1.30 The Mid Highland Glens are also characterised by areas of native birch woodland, concentrated particularly on steeper valley slopes and on less productive areas of drumlins. The birch woods have had a varied history with periods of regeneration and expansion (typically during wartime periods when grazing declined), followed by decline and even dereliction. Many of the woods that survive today are in a very poor condition, overmature and unable to regenerate due to the level of grazing within or around them. There is an urgent need to facilitate the regeneration of these woodlands, an aim which is being pursued by the Tayside Native Woodlands Initiative.

5.1.31 Moving beyond the survival of these woods, there is an opportunity to allow their expansion and growth through the glens and up the valley slopes so as to re-create the more natural patterns of woodland that would have characterised the glens before intensive management for deer and grouse dominated. Better management of the birch woodland could result in the creation of a marketable crop of high quality timber.

5.1.32 **Recreation.** Other than fairly low-key, informal recreation, there are few pressures within these middle sections of glen.

5.1.33 **Tall structures.** The Mid Highland Glens are largely free from tall structures such as pylons and masts. Although better able to absorb development than the simpler and smaller upper glens, this landscape type would be quite sensitive to any proposals for tall structures, be they pylons, masts or wind turbines, either within the glen itself or visible from within it.

LANDSCAPE GUIDELINES

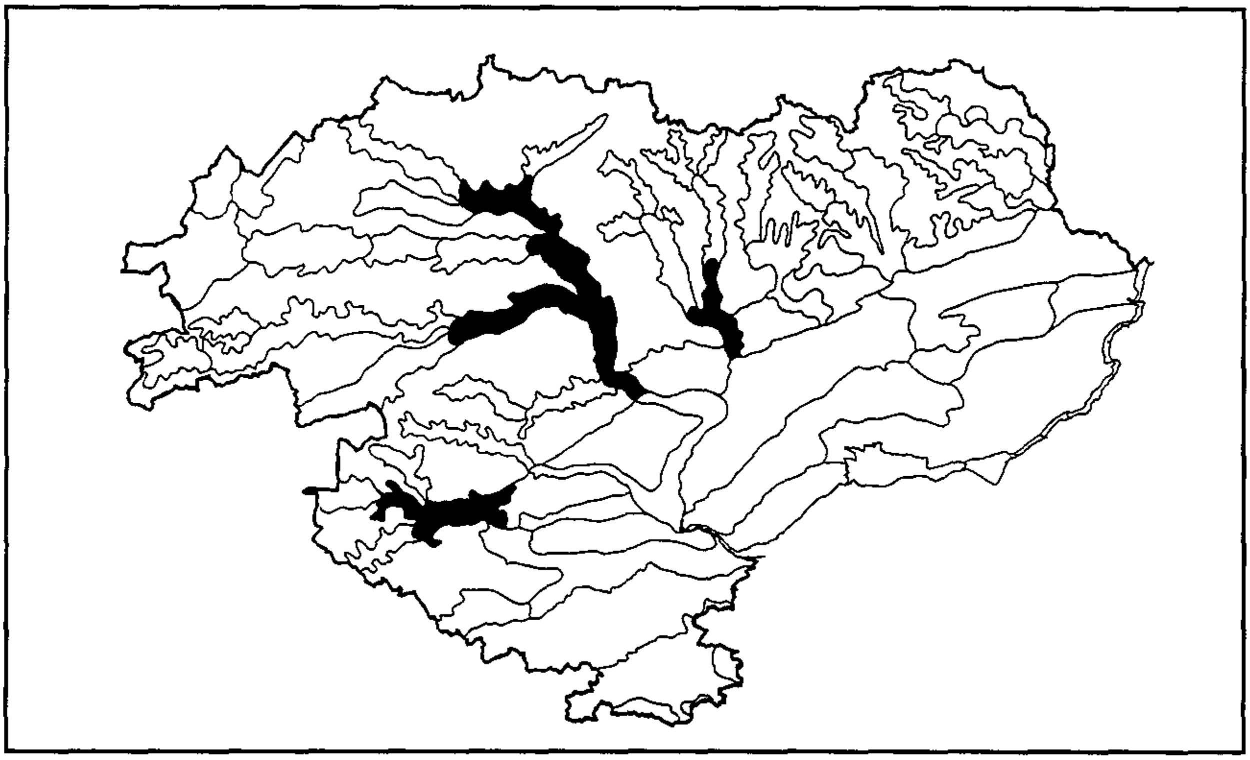
5.1.34 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristically lightly settled landscape with agriculture on the valley floor enclosed by moorland-covered valley slopes. These areas provide a transition from the simple landscape of the upper glens to the richer lower sections - this role should be respected.

Agriculture	• Discourage further improvement of pastures and expansion of cultivation within the Mid Glens. • Encourage the conservation of dry-stone dykes in local stone with an emphasis on roadside walls and others in highly visible areas. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.

Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, road paint or features such as concrete kerbing.
Development	• Discourage isolated developments in the open landscape. • Where development is permitted, encourage construction to consolidate existing villages, hamlets or groups of farm buildings, and favour sheltered locations. • Do not rely on screening where the screening itself becomes a prominent landscape feature. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles.
Forestry and woodland	• Support the removal of poorly designed plantations where they occur on the floor of glens. • With respect to the replanting of existing plantations on valley slopes: - encourage the rationalisation of woodland to avoid isolated, small to medium sized areas of plantation woodland which appear very prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes. • Manage grazing levels in and around birch woodland to allow regeneration and expansion. • Explore opportunities to modify management practices to allow the regeneration of native woodlands on some valley slopes, to create the 'natural' transition from valley woodland, through dwarf alpine woodland to the vegetation of the highland summits and plateaux.
Recreation	• Maintain low level of formal provision for recreation.

Tall structures	• Discourage proposals for aerials, masts or wind turbines because of their likely impact. • Ensure that any proposals are subject to thorough landscape impact assessment. • Where new power or telephone lines are proposed or required, encourage operators to adopt underground cable solutions.

LOWER HIGHLAND GLENS (1C)



KEY CHARACTERISTICS

- *lower sections of the principal Highland glens*
- *comparatively large-scale landscapes*
- *combinations of upland and lowland attributes*
- *broad floodplains, often with meandering rivers, interspersed with narrower, gorge-like sections where harder rocks cross the glens*
- *the most settled parts of the glens*
- *farmland on valley floor and slopes*
- *substantial and varied woodland cover*
- *influence of large estates, castles and Victorian development*

OBJECTIVE DESCRIPTION		Lower Highland Glens
Physical scale		0.5 to 1 kilometre wide floodplain Valley floor 50-200 metres AOD Valley sides rise to 500 metres AOD Gorges and falls where harder rocks cross glen.
Woodland	broad-leaf	Extensive: comprising semi-natural woodland on steeper slopes and managed estate woodland
	coniferous	Extensive: on valley sides and associated with estates
Agriculture	arable	Lower/mid valley sides and drained valley floor
	pasture	Valley floor and upper slopes
	fields	Large and rectilinear on valley floor, medium and rectilinear on gentler valley slopes
	field boundaries	Shelterbelts and post-and-wire fences on floodplain, hedges, trees and walls on valley slopes
Settlement pattern		Well settled with villages and large estates, some planted villages
Building materials		Transitional - granite, schist, slate and some sandstone
Historic features		Castles, lodges and estate features
Natural heritage features		Native woodlands, gorge vegetation
Other landscape features		Waterfalls, glacial deposition features
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium to large
Enclosure		Enclosed to semi-enclosed
Variety		Varied
Texture		Textured
Colour		Colourful
Movement		Peaceful
Unity		Unified
'Naturalness'		Managed

LOCATION

5.1.35 This landscape type comprises the lower sections of the most significant Highland Glens. These sections of glen are distinguished by their comparatively large scale, and the particular combination of upland and lowland attributes. Most of the glens within the Mounth Highlands change rapidly from upper and mid glen to the lowland and foothills, so this landscape type only occurs in Strathardle. Within the West Highland mountains, however, it occurs in Glen Garry around Blair Atholl, joining with the Strath Tummel and Strath Tay between Aberfeldy and Dunkeld.

PHYSICAL CHARACTERISTICS

5.1.36 The Lower Glens share the same geological structure as other parts of the highlands in Tayside. The area is dominated by Dalradian and Moinian grits and schists but there are also significant outcrops of other rocks. A broad band of Atholl limestone runs north-eastwards from the western end of Loch Tummel, across Glen Garry at Blair Atholl towards Beinn A'Ghlo. These softer rocks account for the broadening of the valley in the vicinity of Blair Atholl. The limestone is quarried on the western side of the glen. A little to the south, the glen is crossed by bands of harder quartzite rocks, this time resulting in the narrowing of the valley to form a dramatic gorge with waterfalls at Killiecrankie. While glaciation has had a significant effect on these Lower Glens, the valleys lack many of the classic features found higher up. Rivers tend to be larger, either meandering across broad, often level floodplains or flowing through narrow, incised channels. The valley floor lies typically at between 50 and 200 metres AOD, while the neighbouring hills rise to about 500 metres AOD. Where floodplains occur, they are generally about a kilometre wide.

SETTLEMENT AND LAND USE

5.1.37 These are the most settled parts of the Highland Glens. Historically, they provided important communication routes through the Highlands. Traces of General Wade's Military Road can be found in many of the glens (e.g. Glen Garry and Strath Tay at Aberfeldy where he constructed a grand bridge over the river) while the railway and A9 and A93 routes follow the same corridors. Other significant bridging points include the Bridge of Cally, Dunkeld and Tummel Bridge. As with the upper sections of the glens, the strife between highlanders and lowlanders, and the need to control movement through the glens resulted in the construction of many castles and fortified manor houses. Perhaps the best example is Blair Castle at Blair Atholl which is believed to date back as far as 1269. The clan warring reached its height during the 17th century at the Battle of Killiecrankie.

5.1.38 However, perhaps the most significant phase of settlement occurred during the 18th and 19th centuries as a result of growing wealth and the accessibility brought by railways. The dramatic nature of the landscape within the Lower Glens, particularly where they narrowed to enclose gorges and waterfalls, was favoured by followers of the picturesque and sublime. Historic estates such as Blair Castle and Craighall were remodelled to emphasise and accentuate the natural landscape. The creation of extensive parkland, including large areas of woodland on many of the steeper valley slopes contributes much to the landscape that we see today. New estate villages such as Blair Atholl were built to a uniform style and layout. Smaller estates with their own distinctive landscape and architecture (e.g. Findynate and Derulich) were also created in Strathtay. In the 19th century the Tay Valley became known as 'little Switzerland' and attracted many visitors and travellers, resulting, in turn, in the growth of towns such as Pitlochry and Dunkeld. Visits by writers, poets, artists and members of the Royal Family underline the popularity of the area among the Victorians. Twentieth century development has continued this pattern of settlement, accelerated by the upgrading of the A9.

5.1.39 In contrast to the upper parts of the glens, these valleys include large areas of relatively fertile farmland. It is most productive on the floodplain alluvium but also extends much further up the valley slopes. The influence of large estates is often visible in the form of lines of hedgerow trees (e.g. along lower Strathardle) giving the valley a well-wooded and structured appearance. Within the Tay Valley, however, farmland is concentrated on the valley floor in large fields, often divided only by post-and-wire fences. Above Aberfeldy the floodplain is structured by bands of woodland running across the valley. Between these, fields are divided by wire fences.

5.1.40 Woodland is a vital element of the Lower Highland Glens landscape type. Broad-leaf woodlands, some ancient and semi-natural, clothe many of the steeper hill slopes, surround some of the lodges and estate houses, and trace the course of rivers along the glens. Coniferous woodland such as the larch plantations around Blair Atholl, or the woods on the crags around Dunkeld, further emphasise the landform and contribute to the sense of enclosure within the glens. With the bare summits which rise beyond, these coniferous plantations help create a dramatic upland atmosphere in a relatively lowland area. The combination of this woodland and the pattern of large estates, Victorian settlements and productive farmland gives this landscape type a rich yet dramatic character which contrasts both with the harsher upland areas, and with the more open lowland areas to the south.

FORCES FOR CHANGE

5.1.41 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.1.42 **Agriculture.** While agricultural activity in the Lower Highland Glens is concentrated on the valley floor, there are also many areas where pastures and even arable fields extend up the more shallow valley slopes. The network of walls, hedges and hedgerow trees is an essential element of this landscape, underlining its relationship with lowland areas, and adding texture and variety to the landscape of the glens. However, in some areas, this structure is in decline with once dense lines of trees becoming gappy and fragmented, and hedges and fences being replaced by 'invisible' post-and-wire fencing. Field boundaries on the broad floodplains, where they occur, are often marked by fences, though sometimes boundaries across the valley are marked by shelterbelts or lines of trees.

5.1.43 **Transport.** A number of Lower Highland Glens have provided important communication routes for centuries and today accommodate roads such as the A93 in Glen Shee, the A827 through the middle part of Strath Tay and, most significantly, the A9 through Glen Garry and the lower part of Strath Tay. For the most part, these roads and their traffic are relatively well-absorbed by the often well-wooded landscape of the Lower Glens. However, the A9, which has been improved as dual carriageway or high quality single carriageway along much of its length, is a much more prominent feature with its rock cuttings, embankments and overbridges. At points such as Killicrankie, the present road is considerably higher up the side of the glen than previous routes, meaning that the road structure is more visible, and the traffic moving along it has a much wider impact.

5.1.44 A little more subjective, perhaps, is the effect that a fast road has on a traveller's perception of the landscape. Parts of Strathtay around Blair Atholl and Dunkeld, for example, were remodelled during the 19th century to create a sublime landscape in which key vistas and the experience of travelling slowly through the landscape would have been particularly important. Today many people pass through at high speed, their attention focused within a narrow road corridor.

5.1.45 **Development.** Facilitated by better communication, more suitable land and access to the lowlands, this part of the Highlands has traditionally accommodated the greatest amount of settlement. Old market and bridging settlements such as Comrie, Aberfeldy and Pitlochry expanded during the 19th century as the area was opened up by the railways, and again during the 20th century as motoring brought the area within commuting distance of Perth. Generally, the growth of these towns has respected their original form. Pitlochry and Crieff for example have expanded up the valley slopes. In the case of Pitlochry, the historic linear settlement, represented by the main street, has expanded eastwards into the gentle bowl created by a tributary of the Tay. Twentieth century suburban development had its precedents in the form of grand Victorian hotels which were established with commanding views high on the hillside. This pattern of expansion is preferable to growth onto the Tay floodplain, or along the edges of the valley. Nevertheless, the elevation of much of the development means that it is more visible than it might otherwise have been.

5.1.46 At Comrie, which historically comprised two settlements, one each side of the bridge over the River Earn, recent growth has been concentrated on the Dalginross side. More recent development, however, has sometimes comprised low density, speculative estates of similar or identical dwellings which are crudely grafted onto the edge of these towns. The stark designs (often lacking any reference to vernacular designs or material) are usually unmitigated by planting, screening or landscaping, while the infrastructure of internal roads, footways, drives etc. appears over-engineered and overly suburban in this rural area. The growth of smaller settlements has been more limited, retaining the impression of a settled, rural landscape with a scattering of farmsteads and hamlets.

5.1.47 **Forestry and woodland**. Woodland is an essential component of this landscape type, comprising a combination of semi-natural woodland, commercial forestry, farm woodland and field boundary trees, policy and estate woodland. The characteristic interplay of woodland, farmland and areas of designed landscape is particularly important.

5.1.48 Several areas of Lower Glen are identified by the Tayside Indicative Forestry Strategy as having potential for new planting (Tayside Regional Council, 1997a). While there is scope for additional woodland in these areas, it is important to maintain the overall balance of unplanted and planted areas and to conserve key views. It is also important to conserve landscape features such as field systems where these contribute to the grain and texture of the landscape. As elsewhere, there is scope to enhance the appearance of existing plantations as they come forward for harvesting and replanting.

5.1.49 **Recreation.** The high landscape quality, allied to the area's accessibility and the presence of a number of towns, means that tourism and recreation are important activities in the Lower Highland Glens, making important contributions to the area's economy. Generally, this development pressure has been steered towards existing settlements with, for example, the expansion of tourism facilities at Pitlochry. There are a handful of exceptions to this, the most notable being a major tourism facility at Bruar, north of Blair Atholl. Opinions about this particular scheme are mixed since, although its design attempts to reflect Scottish Baronial influences, the accompanying signage, car parking etc. indicates the presence of a more modern development. Furthermore, located close to the point where the southbound traveller leaves the sparse, dramatic landscape of the upper glen and enters the rich landscape of the lower glen, the new development reduces the positive visual impact of Blair Castle, a few kilometres to the east.

5.1.50 **Tall structures.** The Lower Highland Glens are subject to a range of pressures for tall structures such as pylons and masts, reflecting the more settled nature of these areas, and their suitability as routes for electricity transmission cables. Particular concerns relate to the provision of mobile communication infrastructure along routes such as the A9 which can result in the proliferation of telecommunications masts.

5.1.51 Within this landscape type there is unlikely to be significant pressure for wind turbine construction. However, the effect of proposals on higher ground which are visible from within the glens (particularly some of the more historic areas of designed landscape) should be considered carefully.

LANDSCAPE GUIDELINES

5.1.52 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristically settled landscape of farmland, woodland and designed landscapes.

Agriculture	• Encourage the conservation of dry-stone dykes in local stone with an emphasis on roadside walls and others in highly visible areas. • Discourage improvements which result in further loss of field boundaries or field boundary trees. • Encourage farmers and landowners to replant trees along field boundaries, initially along roads, but also between fields. Species to include oak, maple, beech and ash. Use incentives to compensate for lower yields where mature trees are retained.

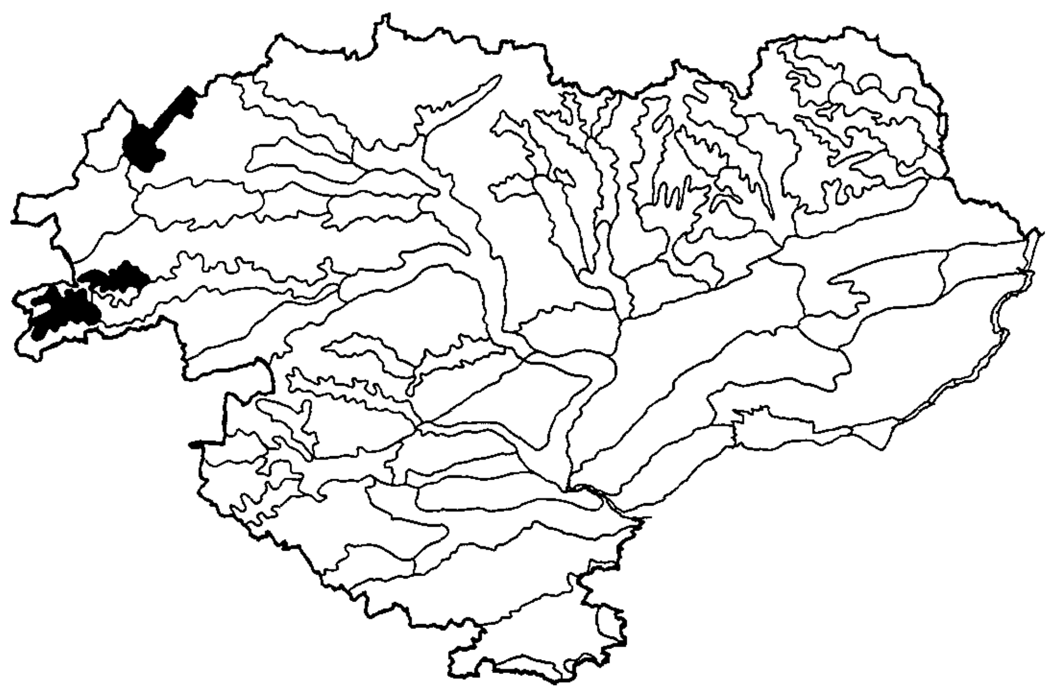
	• Explore the opportunities to increase woodland cover by creating new woodland belts, particularly where there is a need to screen development. • Explore development of market for hardwood from field boundary trees. • Discourage over-concentration of oil seed rape and similar crops. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, or features such as concrete kerbing. • Explore opportunities for additional on- and off-site screening to reduce the impact of existing sections of improved road.
Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the rural character of other parts of the Lower Highland Glens. • Discourage the simplistic grafting of housing estates onto the edge of settlements. Encourage more imaginative schemes which respond to the existing patterns of layout, structure, massing and scale. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Consider positive ways of addressing the interface between settlements and the surrounding countryside. These could include: - screening; - new buildings which address surrounding areas; - key vistas and views; - landmark features; - gateways and approaches.
Forestry and woodland	• With respect to the replanting of existing plantations on valley slopes: - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen;

(Forestry and woodland contd.)	- discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes. • Consider opportunities for new woodland planting in terms of: - the overall balance of woodland and open space; - the relative importance of different areas of existing woodland (e.g. commercial plantation versus policy woodland) and how this would be influenced by an increase in woodland cover; - the importance of key views and features within the landscape; - opportunities for provide screening within the Lower Glens; - opportunities to link isolated areas of woodland.
Recreation	• Concentrate tourist facilities within existing settlements. • Influence the design and provision of associated signage. • Influence the design of new tourism facilities, particularly where it is permitted in previously undeveloped areas. While modern and innovative design may be appropriate, it should respect local building styles, scales, materials and locations. Features such as signage and car parking should be designed to minimise the impact on the local and wider landscape.
Tall structures	• Assess proposals for aerials, pylons or masts in terms of their visual and landscape impact on the local landscape of the hills and surrounding areas. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Ensure that any proposals are subject to thorough landscape impact assessment. • Where new power or telephone lines are proposed or required, encourage operators to adopt underground cable solutions.

HIGHLAND GLENS WITH LOCHS (2)

5.2.1 Lochs are an important feature of many Highland Glens. In undertaking the landscape assessment the influence of such lochs upon landscape character was considered carefully. In some cases (for example Loch Lee at the head of Glen Esk) the lochs are sufficiently small as to have a relatively minor effect on the overall appearance of the landscape. In others, the presence of the loch (most obviously in the cases of the largest lochs such as Loch Rannoch, Loch Tummel and Loch Tay) has a very significant influence on character. The latter cases justified inclusion as a landscape type in their own right. Again, the landscape classification draws a distinction between the upper, mid and lower sections of the glens.

UPPER HIGHLAND GLENS WITH LOCHS (2A)



KEY CHARACTERISTICS

- *geological and physical structure similar to Upper Highland Glens*
- *visual dominance of lochs, enlarged to provide hydroelectric power*
- *the expanse of water, changing its appearance according to the weather, adds to the sense of exposure, remoteness and desolation*

OBJECTIVE DESCRIPTION		Upper Highland Glens with Lochs
Physical scale		1.5 kilometres wide at valley crest Loch surface at 300-450 metres AOD Valley sides rise to 600-900 metres AOD
Woodland	broad-leaf	Virtually absent
	coniferous	Geometric plantations on mid slopes, more natural shapes on upper slopes
Agriculture	arable	Absent
	pasture	Rough grazing on valley slopes
	fields	No enclosure
	field boundaries	Not applicable
Settlement pattern		Predominantly unsettled; hydroelectric infrastructure (dams, turbine houses, pylons etc.)
Building materials		Not applicable
Historic features		Old routeways
Natural heritage features		Upland vegetation
Other landscape features		Rock outcrops, glacial features, hydro schemes
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium
Enclosure		Enclosed
Variety		Simple
Texture		Rough to very rough
Colour		Muted to monochrome
Movement		Remote
Unity		Unified/interrupted
'Naturalness'		Wild/slightly tamed

LOCATION

5.2.2 A number of the upper glens within the West Highlands contain lochs. Where these lochs are of a sufficient size, they have a significant influence on the landscape character of these upper glens. Examples of the Upper Highland Glens with Lochs landscape type include Loch Errochty, Loch Daimh, Loch Lyon and Loch Ericht.

PHYSICAL CHARACTERISTICS

5.2.3 The geological and physical structure of the Upper Highland Glens with Lochs is very similar to that described above in relation to Upper Highland Glens. The geology is dominated by grits and schists of the Dalradian and Moinian groups and the landscape has been highly modified by glacial erosion, creating typically glaciated valley cross sections, hanging valleys and corries. The lochs have been created where the ice sheets overdeepened the glens or where morainic material deposited during their retreat impounded water within the valley. Each of the lochs has been modified by the addition of dams, thereby increasing the available head of water for hydroelectric power generation.

5.2.4 The expanse of water, often disturbed by wind and rain, adds to the sense of exposure, remoteness and desolation experienced within these upper glens. Even the engineering structures associated with power generation are dwarfed by the scale and sweep of the enclosing mountains. The landscape is dominated by low moorland vegetation, with woodland limited to sheltered side glens or a handful of geometric coniferous plantations. In fine weather these glens form part of the dramatic upland landscape. In poor light or inclement weather, the atmosphere is less hospitable and can even seem threatening.

FORCES FOR CHANGE

5.2.5 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development. Although these areas have seen considerable change over past centuries as any native woodland was cleared and the population removed, the upland glens retain a wild, untouched character. With little in the way of tree cover, views can be extensive within the glen and any development can intrude on this character.

5.2.6 **Transport.** For the most part, the Upper Highland Glens with Lochs either have no roads at all or are served by minor roads, often ending in cul de sacs. Although visible in the open landscape, these roads tend to sit relatively easily in the landscape, following natural contours along the floor of the glen. It is important that the diminutive and low-key appearance of these roads is maintained and that minor improvements and signage do not compound to give an overly 'urban' effect.

5.2.7 **Development.** A lack of settlement is an important feature of these upper glens. For the most part, development is limited to a scatter of lonely cottages and lodges.

5.2.8 **Forestry and woodland.** The Upper Highland Glens with Lochs include areas of coniferous woodland, though these tend to be more limited than in those glens without lochs. In most cases, the plantations have been established to supply commercial timber while in others, the aim has been to provide shelter for game or livestock. The scale and form of the woodland varies accordingly. Commercial plantations tend to be larger in scale while shelter plantations are smaller and often geometric in appearance. Harvesting this woodland will provide an opportunity to review the best locations and designs for replanting. This considered further within the management guidelines.

5.2.9 It is probable that, without management to favour deer and grouse, native woodland would regenerate on many of the valley slopes. This would form a transition from sparse birch and pine woods, through dwarf woodland to the open vegetation of the highland summits and plateaux.

5.2.10 **Recreation.** Many of the Upper Highland Glens with Lochs are remote and seldom visited except by a comparatively small number of walkers and climbers.

5.2.11 **Tall structures.** The Upper Highland Glens with Lochs are comparatively free from tall structures. The exception occurs where power lines serve the hydro installations located adjoining the dams that impound the lochs. This landscape type would be sensitive to proposals for further tall structures, be they pylons, masts or wind turbines, either within the glen itself or visible from within it.

LANDSCAPE GUIDELINES

5.2.12 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristic upland landscape of open, predominantly unsettled moorland vegetation. Maintain the contrast with the more settled lowland sections of the glens.

Agriculture	• Encourage the conservation of dry-stone dykes in local stone with an emphasis on roadside walls and others in highly visible areas.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, road paint or features such as concrete kerbing.
Development	• Ensure any woodland expansion complies with the principles of good forest design. • Where development is permitted, ensure that buildings are located so as to minimise their impact on the landscape (utilising any natural screening provided by the landform) and that they adopt vernacular styles, building materials and colours.

<table>
<tr><td>Forestry and woodland</td><td>

Discourage the creation of additional areas of coniferous forestry within the upland glens.
Encourage the removal of small, geometric plantations, allowing equal increases in planting in more appropriate locations elsewhere.
With respect to the replanting of existing plantations on valley slopes:
- encourage the rationalisation of woodland to avoid isolated, small to medium sized areas of plantation woodland which appear very prominent in an otherwise open landscape;
- adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags;
- create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen;
- discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line;
- employ more varied species mixes;
- vary the size of felling coupes, with smaller areas on lower slopes.
Explore opportunities to modify management practices to allow the regeneration of native woodlands on some valley slopes, to create the 'natural' transition from valley woodland, through dwarf alpine woodland to the vegetation of the highland summits and plateaux.
</td></tr>
<tr><td>Recreation</td><td>

Maintain low-key level of provision.
</td></tr>
<tr><td>Tall structures</td><td>

Discourage proposals for aerials, masts or wind turbines because of their likely impact on the character of the Upper Highland Glens with Lochs.
Ensure that any proposals are subject to rigorous landscape impact assessment.
Where new power or telephone lines are proposed or required, ensure that operators adopt underground cable solutions.
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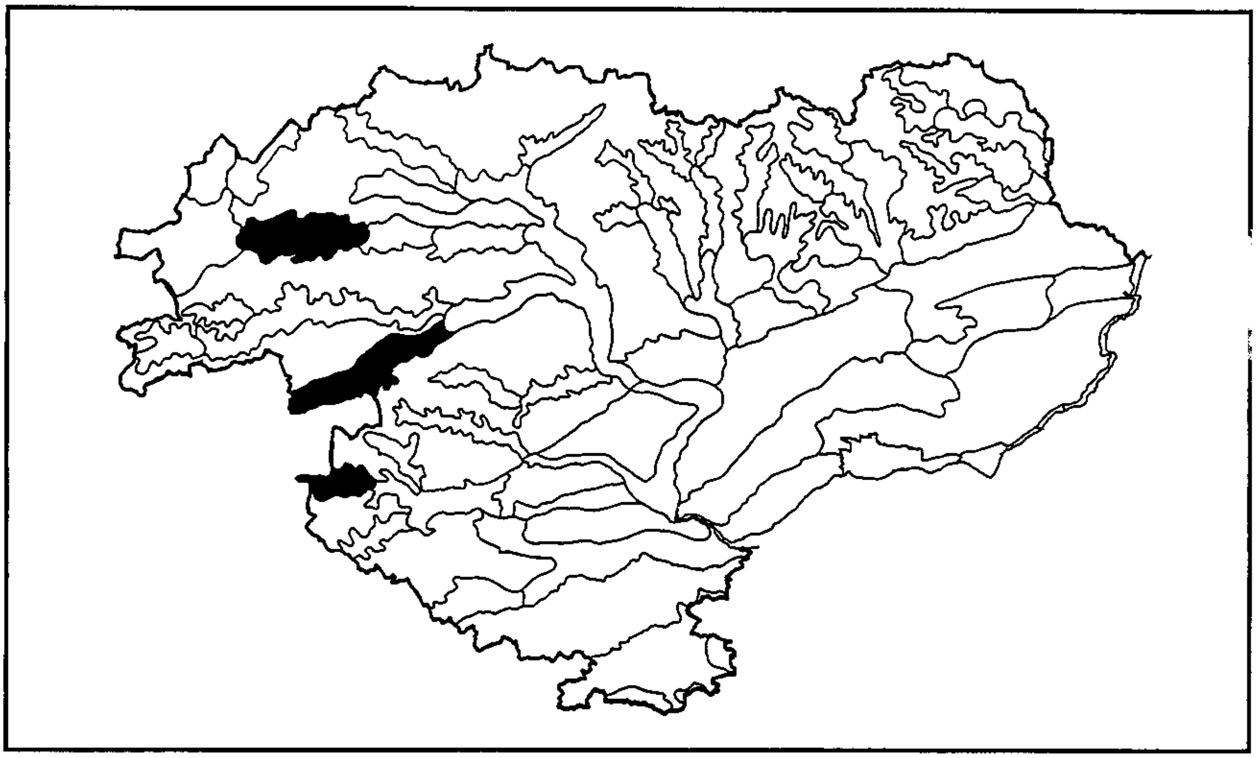
MID HIGHLAND GLENS WITH LOCHS (2B)



KEY CHARACTERISTICS

- *geological and physical structure similar to Mid Highland Glens*
- *large-scale landscape created by the combination of expansive lochs and large enclosing mountains*
- *concentration of settlement and farming activity on lower slopes and at the ends of the lochs*
- *extensive woodland on lower slopes*
- *extensive corridor views*
- *clear transition from lower pastures through heather midslopes to bare upper summits*

OBJECTIVE DESCRIPTION		Mid Highland Glens with Lochs
Physical scale		1 to 1.5 kilometre wide loch. Loch surface at 120-200 metres AOD Valley sides rise to 300-600 metres AOD Lochs between 50 and 100 metres deep
Woodland	broad-leaf	Native birch and oak woodland on steeper and poorer ground
	coniferous	Substantial areas of plantation
Agriculture	arable	Absent
	pasture	Rough pasture on lower/mid slopes
	fields	Regular fields on smooth valley slopes
	field boundaries	Dry-stone dykes and post-and-wire fences
Settlement pattern		Scatter of farmsteads along shore of loch; greater concentration on sunnier, south-facing slopes
Building materials		Schists and granite with slates
Historic features		Old farmsteads, castles/estates concentrated on lower ground at each end of lochs
Natural heritage features		Native woodlands
Other landscape features		Mills, historic settlement sites
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium to large
Enclosure		Enclosed to semi-enclosed
Variety		Varied
Texture		Smooth to textured
Colour		Colourful
Movement		Peaceful
Unity		Unified
'Naturalness'		Restrained

LOCATION

5.2.12 Glacial overdeepening along faultlines in the West Highlands created a number of substantial lochs between 50 and 100 metres deep. Several of these occupy the middle sections of glens. Examples include Loch Rannoch, Loch Tay and Loch Earn.

PHYSICAL CHARACTERISTICS

5.2.13 The geology and landform of the Mid Highland Glens with Lochs landscape type are very similar to those already described in respect of Mid Highland Glens. The geology is dominated by grits and schists of the Dalradian and Moinian groups. Again, the landscape has been modified by glacial erosion, creating relatively straight, glaciated valley cross sections.

SETTLEMENT AND LAND USE

5.2.14 The lack of valley floor means that human activity has been pushed on to the lower slopes of the glen, or concentrated on alluvial deposits at either end of the loch. Small farmsteads tend to be located at fairly regular intervals along the northern and southern shores of the lochs, with access both to the more sheltered, often less steep, lower slopes, and the rough grazing provided at higher altitudes. The pattern is particularly well-developed along Loch Tay where, along the northern side of the loch, farms are found every kilometre or so. The remains of old farmsteads are very obvious here. Many of these would have formed part of a transhumance economy, with sheep and cattle being moved to the mountain pastures and shielings during the summer months. Settlement tends to cluster at points where the larger burns enter the loch. The water in these burns once powered mills - up to a dozen are said to have been built along the Lawers Bum, north of Loch Tay. A line of woodland along the lochside gives way to a band of pastures which extend a short way up the hillside. Each of the lochs also has substantial areas of woodland (broad-leaf, coniferous or mixed) along the lower slopes. One of the most significant of these is the Black Wood of Rannoch which survives as the largest areas of Caledonian pine forest in the area.

5.2.15 Each loch is encircled by roads, the more major of the two being along the northern side (reflecting the sunnier aspects of these slopes). The lochs would have formed important links in historic communication routes between the central lowlands and the west coast. This is reflected in a range of defensive structures found along these sections of glen including crannogs (e.g. Eilean nam Breaban on Loch Tay), forts (e.g. Dundurn Fort at the eastern end of Loch Earn) and castles. Numerous other historic sites such as stones, tumuli and crosses point to the historic importance of the lochs. During the Victorian era, loch steamers were popular with piers at Kenmore, Killin and other places.

5.2.16 Today, human activity is still focused on the lochs. The growth of tourism and recreation is reflected in the development of hotels, timeshare schemes, and a number of caravan and log-cabin sites. The lochs attract further activities such as sailing, powerboating, water-skiing and jet-skiing. This tends to be particularly the case on Lochs Tay and Earn, where activity is focused at either end of the loch. Loch Rannoch is much less intensively used, partly in response to stricter polices governing recreation development, and partly because of its remoteness. The lochs also form part of a major hydroelectric power generating scheme, as signalled by the presence of high voltage power lines and power stations such as the one on the northern side of Loch Rannoch. Served by minor roads, the southern sides of the lochs are less developed and in places show signs of decline and abandonment.

5.2.17 These are amongst the largest scale landscapes in Tayside. The scale of the enclosing mountains and the expanse of open water creates a vast sense of space that belittles features such as farms or woods. Equally, however, it is an open landscape where intrusive features would be visible over a considerable distance.

FORCES FOR CHANGE

5.2.18 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.2.19 **Agriculture.** Most agricultural activity in the Mid Highland Glens with Lochs is concentrated in a narrow band on the valley slopes above the loch. Higher ground is dominated by rough grazing, grading into craggy heather or grass moorland. Pastures dominate. The pattern of farmsteads, pastures and hedgerow trees is an important feature of this landscape. However, the physically constrained location of these farms means there is little room to expand and there are several examples of derelict farm buildings and even apparently abandoned fields. In other cases, farm holdings have diversified into tourism, accommodating log cabin developments or static caravan parks. The decline of agriculture, and the deterioration of farm buildings, appears most pronounced on the lochsides served by minor roads (e.g. the southern side of Loch Tay).

5.2.20 **Transport.** Each of the lochs is encircled by roads. The main roads tend to be along the northern side of the glen and the more minor roads along the southern side. This distinction is reflected in the relative prosperity of the two sides of the loch and the degree of settlement and development. Along both sides of the lochs, it is important that the roads continue to be relatively minor features within the large-scale landscape. Improvements such as widening, realignment, lighting or the provision of more extensive signage should be resisted.

5.2.21 **Development.** Although with significantly more farmsteads, cottages and houses than the Upper Highland Glens, this landscape type is still comparatively sparsely settled. Older buildings often share a vernacular of stone walls (sometimes whitewashed) and slate roofs. Victorian buildings, concentrated within settlements found at the heads of the lochs and along roads leading out along the lochside, tend to continue use of local building material, providing interesting interpretations of vernacular styles. Newer buildings adopt more ubiquitous designs and materials which hinder their integration into the landscape. Developers of new buildings should be encouraged to select designs which respond to their location, both in terms of the landscape and the vernacular style. There may be some scope for the sensitive conversion of traditional farm buildings, particularly where these have become redundant or derelict.

5.2.22 **Forestry and woodland.** The Mid Highland Glens with Lochs have a mixture of semi-natural woodland, often marking the edge of the loch and extending up the hillside, and areas of coniferous plantation. The latter tend to be larger in scale, occupying higher areas of the valley sides. While the majority of these plantations sit comfortably within the wider landscape, sometimes the dominance of single species can be locally oppressive. Harvesting of this woodland provides an opportunity to review the best locations and designs for replanting. This is considered further within the management guidelines.

5.2.23 The Mid Highland Glens with Lochs also have some areas of semi-natural woodland, concentrated particularly on steeper valley slopes and on less productive areas along the lochside. Many of the woods that survive today are in very poor condition, overmature and unable to regenerate due to the level of grazing within or around them. There is an urgent need to facilitate the regeneration of these woodlands, an aim which is being pursued by the Tayside Native Woodlands Initiative.

5.2.24 Moving beyond the survival of these woods, there is an opportunity to allow their expansion and growth through the glens and up the valley slopes so as to re-create the more natural patterns of woodland that would have characterised the glens before intensive management for deer and grouse dominated.

5.2.25 **Recreation.** The Mid Highland Glens with Lochs are subject to a range of recreation pressures. This is particularly the case in relation to Lochs Tay and Earn. The remoteness and policy context means that pressures are far less on Loch Rannoch.

5.2.26 Recreation issues fall into two categories. Firstly there are those concerning the development of facilities. While most hotels, guest houses and bed and breakfast establishments are concentrated within, or on the edge of settlements such as Kenmore or St Fillans, there has been considerable historic development of static and mobile caravan parks within woodland along the lochside. There is a particularly large number of sites, both formal and informal, along the southern shores of Loch Earn. While individual static caravans sit within the woodland, some of the larger sites are more intrusive and are visible over a longer distance. There is an obvious concern that the use of mobile homes does not result into the gradual development of holiday cottages or other more permanent structures.

5.2.27 The second type of issue that affects both Loch Earn and Loch Tay is recreation activities such as watersports and walking or climbing. Both lochs have watersports centres (at Lochearnhead and Kenmore, respectively) and a number of smaller facilities along the waterside. The growth of motorcraft use, particularly powerboats and jet-skis, has led to concerns about the impact on the comparatively peaceful landscape of the lochs. Local authorities have pursued a policy which seeks to control the provision of additional motorised watersports facilities and which concentrates activity at the more developed ends of the lochs. As pressures and adverse effects continue to grow, the introduction of bylaws governing the use of the lochs is being considered.

5.2.28 Walkers and climbers generally have a much lower level of impact on the landscape. Problems may emerge, however, at popular locations (e.g. Ardvorlich, at the foot of Ben Vorlich) where there may be concentrations of parked cars. The most well-used routes may also suffer erosion resulting in local landscape and ecological impacts.

5.2.29 **Tall structures.** Each of the Mid Highland Glens with Lochs has a line of pylons running along the northern shore, linking components of the Tummel hydro scheme and serving settlements in the area. These pylons tend to run parallel to the road corridor and are often seen against a backdrop of rising hills. Their impact within the large-scale landscape of the lochs is therefore comparatively limited.

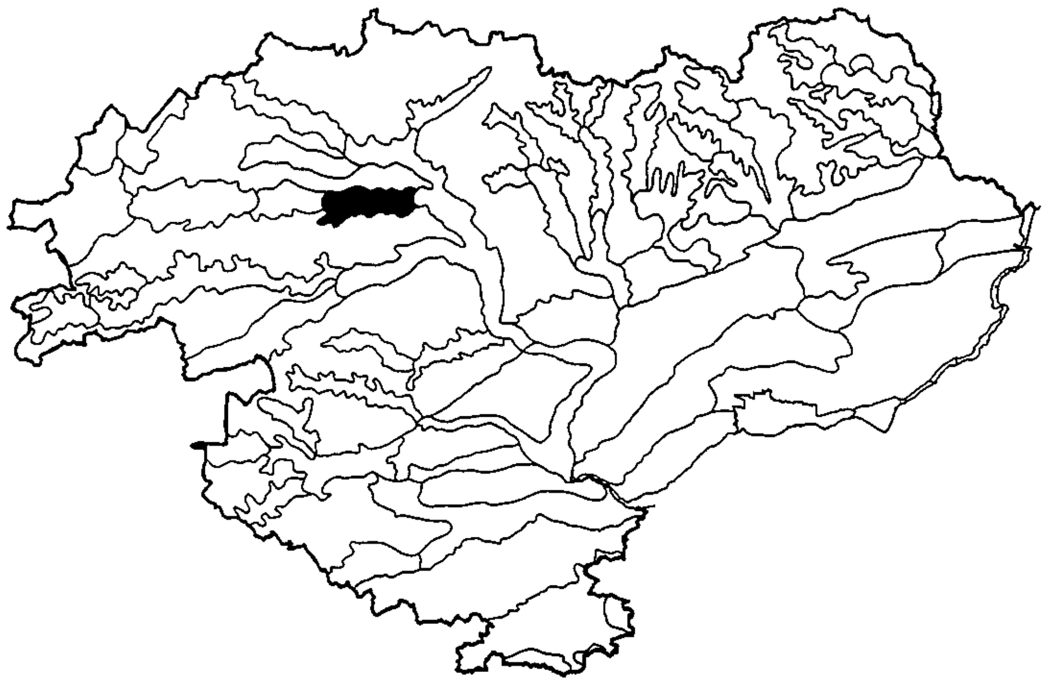
LANDSCAPE GUIDELINES

5.2.30 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristic pattern of farmland, woodland and settlement around the fringes of the lochs, maintaining the tranquil nature of these large-scale landscapes.

Agriculture	• Support farming activities along loch fringes. • Encourage management of farm woods, hedges and hedgerow trees. • Encourage maintenance of farm buildings and structures.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, or features such as concrete kerbing.
Development	• Discourage isolated developments in the open landscape. • Where development is permitted, encourage construction to consolidate existing villages. • Do not rely on screening where the screening itself becomes a prominent landscape feature. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Support the appropriate conversion of agricultural buildings where they have become redundant.
Forestry and woodland	• With respect to the replanting of existing plantations on valley slopes: - encourage the rationalisation of woodland to avoid isolated, small to medium sized areas of plantation woodland which appear very prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes;

(Forestry and Woodland contd.)	- vary the size of felling coupes, with smaller areas on lower slopes. • Manage grazing levels in and around semi-natural woodland to allow regeneration and expansion. • Explore opportunities to modify management practices to allow the regeneration of semi-natural woodlands on some valley slopes, to create the 'natural' transition from valley woodland, through dwarf alpine woodland to the vegetation of the highland summits and plateaux.
Recreation	• Restrict the creation of additional caravan parks and chalets. • Encourage more effective screening of caravan parks, consider use of alternative colours in most prominent areas. • Prevent upgrading of static caravans to more permanent structures. • Continue to restrict noisy watersports at the loch-ends. • Monitor levels of watersports activity and degree and extent of disturbance and bring forward byelaws to effect controls. • Monitor car parking patterns and erosion levels in areas popular among walkers and climbers.
Tall structures	• Where new power or telephone lines are proposed or required, encourage operators to adopt underground cable solutions.

LOWER HIGHLAND GLENS WITH LOCHS (2C)



KEY CHARACTERISTICS

- *geological and physical structure similar to Lower Highland Glens*
- *combination of lowland and upland attributes*
- *rich woodland enclosing the loch and providing a transition to upper slopes*
- *significant cultural and historic associations*
- *recreation and other development pressures*

OBJECTIVE DESCRIPTION		Lower Highland Glens with Lochs
Physical scale		0.5 to 1 kilometre wide floodplain Surface of loch at 140 metres AOD Valley sides rise to 500 metres AOD
Woodland	broad-leaf	Extensive: comprising semi-natural woodland on steeper slopes and managed estate woodland
	coniferous	Extensive: on valley sides and associated with estates
Agriculture	arable	Absent
	pasture	Mid slopes
	fields	Medium irregular on valley slopes
	field boundaries	Trees and walls on valley slopes
Settlement pattern		Well settled with villages and large estates.
Building materials		Transitional - granite, schist, slate and some sandstone
Historic features		Castles, lodges and estate features
Natural heritage features		Native woodlands.
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium to large
Enclosure		Enclosed to semi-enclosed
Variety		Varied
Texture		Textured
Colour		Colourful
Movement		Peaceful
Unity		Unified
'Naturalness'		Managed

LOCATION

5.2.31 The Lower Highland Glens with Lochs landscape type is confined to the area around Loch Tummel. Although sharing many of the characteristics of the Mid Highland Glens with Lochs, the area around Loch Tummel is subtly different. In part this is due to the lower hills (generally 500-600 metres AOD, compared with 600-1000 metres) and slightly shallower slopes. It also reflects the pattern of woodland since there is a higher proportion of broad-leaf woodland, and the cultural associations of Queen's View on Loch Tummel's northern side. The rich character of this area has more in common with the rich wooded valley to the east (Glen Garry and Killiecrankie) than with the more exposed areas to the west.

FORCES FOR CHANGE

5.2.32 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.2.33 **Agriculture.** Most agricultural activity in the Lower Highland Glens with Lochs is concentrated in a narrow band on the valley slopes above the loch. Higher ground is dominated by rough grazing, grading into craggy heather or grass moorland. The pattern of farmsteads, pastures and hedgerow trees is an important feature of this landscape, allied to rich policy and semi-natural woodland. As in the case of the Mid Highland Glens with Lochs, the physically constrained location of these farms means there is little room to expand and there are several examples of abandoned fields. In other cases, farm holdings have diversified into tourism, accommodating log cabin developments or caravan parks.

5.2.34 **Transport.** Loch Tummel, like the other large lochs is encircled by roads. The main road is along the northern side of the glen and the more minor road along the southern side. This distinction is reflected in the relative prosperity of the two sides of the loch and the degree of settlement and development. Along both sides of the loch, it is important that the roads continue to be relatively minor features within the large-scale landscape. Improvements such as widening, realignment, lighting or the provision of more extensive signage should be resisted.

5.2.35 **Development.** This landscape type is more wooded and less settled than the Mid Highland Glens with Lochs. Where they occur, older buildings often share the vernacular of stone walls and slate roofs. Victorian buildings tend to continue use of local building material, providing interesting interpretations of vernacular styles. Newer buildings adopt more ubiquitous designs and materials which hinder their integration into the landscape.

5.2.36 **Forestry and woodland.** Woodland is an essential component of this landscape type, comprising a combination of semi-natural woodland, commercial forestry, farm woodland

and field boundary trees, policy and estate woodland. The characteristic interplay of woodland and farmland with rough moorland above is particularly important.

5.2.37 Coniferous plantations tend to be medium to large in scale, occupying higher areas of the valley sides. While the majority of these plantations sit comfortably within the wider landscape, sometimes the dominance of single species can be locally oppressive. Harvesting of this woodland provides an opportunity to review the best locations and designs for replanting. A particular aim should be the visual integration of areas of broad-leaf woodland with the existing areas of coniferous plantation. These issues are considered further within the management guidelines.

5.2.38 The Lower Highland Glens with Lochs also have some areas of semi-natural woodland, concentrated particularly on steeper valley slopes and on less productive areas along the lochside. Some have generated on areas of former farmland. Some of the woods that survive today are in poor condition. There is a need to facilitate the regeneration of these woodlands, an aim which is being pursued by the Tayside Native Woodlands Initiative.

5.2.39 **Recreation.** Loch Tummel has attracted visitors at least since Victorian times, and a number of tourism facilities are found along its northern side. A particular example is the visitor centre and forest walks at Queen's View. Hotels, a lochside caravan site and other forms of visitor accommodation, including groups of log cabins are also found here. Although some of these facilities are locally incongruous, their impact on the wider landscape is generally more limited, partly due to the level of woodland cover. The principal exception to this is the caravan site located on a lochside promontory just to the west of Queen's View. This is a prominent and unscreened feature which detracts from the view out over the loch from Queen's View in particular.

5.2.40 **Tall structures.** Loch Tummel has a line of pylons running along the northern shore, linking components of the Tummel hydro scheme. These pylons run along the lower slopes and are seen against a backdrop of rising hills. Their impact within the large-scale landscape of the lochs is therefore comparatively limited. However, the linear nature of the power lines is emphasised by the very straight corridors that are cut through woodlands to accommodate them.

5.2.41 Within this landscape type there is unlikely to be significant pressure for wind turbine construction. However, the effect of proposals on higher ground which are visible from within the glen should be assessed and considered carefully.

LANDSCAPE GUIDELINES

5.2.42 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the rich landscape of loch, woodland and farmland, and to minimise the intrusion of recreation facilities and activities upon it.

Agriculture	• Support farming activities along loch fringes. • Encourage management of farm woods, hedges and hedgerow trees. • Encourage maintenance of farm buildings and structures.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, or features such as concrete kerbing.
Development	• Discourage isolated developments in the open landscape. • Where development is permitted, encourage construction to consolidate existing villages. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Support the appropriate conversion of agricultural buildings where they have become redundant.
Forestry and woodland	• With respect to the replanting of existing plantations on valley slopes: - encourage the rationalisation of woodland to avoid isolated, small to medium sized areas of plantation woodland which appear very prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes. • Manage grazing levels in and around semi-natural woodland to allow regeneration and expansion. • Explore opportunities to modify management practices to allow the regeneration of semi-natural woodlands on some valley slopes, to create the 'natural' transition from valley woodland, through dwarf alpine woodland to the vegetation of the highland summits and plateaux.

Recreation	• Maintain policy of concentrating tourist facilities within existing settlements. • Influence the design and provision of associated signage. • Encourage the re-location and/or screening of intrusive recreation provision.
Tall structures	• Where new power or telephone lines are proposed or required, encourage operators to adopt underground cable solutions. • Ensure that any proposals for aerials, pylons or masts are subjec' to thorough landscape impact assessment in terms of their visual and landscape impact, both on the local landscape of the loch and on surrounding areas. • Consider any proposals for wind turbines or other tall structures in surrounding areas in terms of their impact on key views and vistas from Loch Tummel and the valley sides.

UPPER HIGHLAND GLENS
Glen Beag, north of the Spittal of Glen Shee. A landscape dominated by the enclosing Highlands and the moorland vegetation.

MIDDLE HIGHLAND GLENS
Glen Shee. Improved pastures on the valley floor, grading into rough grazing, woodland and moorland on the valley slopes.

LOWER HIGHLAND GLENS
Strathardle near the Bridge of Cally - a rich landscape of dense woodland, hedgerow trees, pastures and arable fields, backed by rising hills.

UPPER HIGHLAND GLENS WITH LOCHS
Most of the lochs in the harsh landscape of the upper glens have been impounded by dams to generate hydroelectricity.

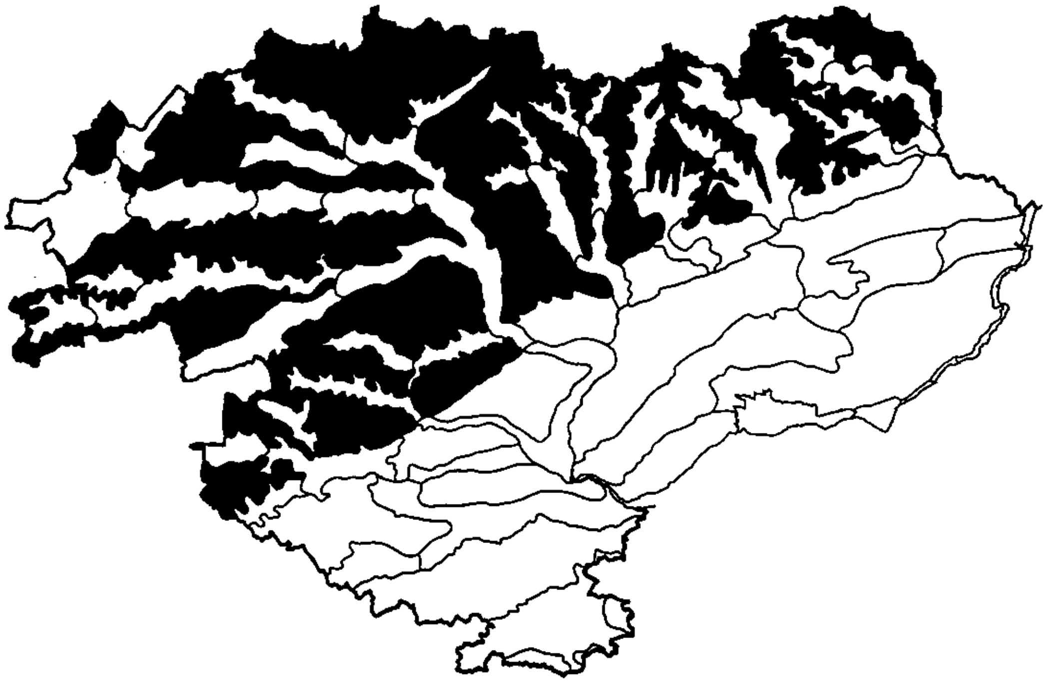
Photo: SNH

MIDDLE HIGHLAND GLENS WITH LOCHS
Loch Tay. A string of farms along the steep lower slopes, with exposed moorland rising above.

FIGURE 13

LANDSCAPE CHARACTER TYPES

HIGHLAND SUMMITS AND PLATEAUX (3)



KEY CHARACTERISTICS

- *areas of upland separating the principal glens*
- *West Highlands comprise distinct summits and ranges, separated by fault line lochs; the hills are sharply defined and often craggy*
- *Mounth Highlands comprise a more extensive area of upland with spurs extending southwards; the hills are more rounded than those to the west and rock outcrops are fewer*
- *vegetation patterns closely reflect altitude and exposure and include heather, grassland, blanket bog and arctic alpine plant communities; variations reflecting the underlying geology*
- *most of the area managed as open moorland*
- *little or no settlement*
- *some extensive plantations*
- *one of the remotest and wildest landscapes in the UK*

OBJECTIVE DESCRIPTION		Highland Summits and Plateaux
Physical scale		400 to 1000 metres AOD, forming individual groups of mountains or extensive upland tracts
Woodland	broad-leaf	A few areas of semi-natural woodland up to 600 metres AOD. Generally cleared by burning, cutting and grazing
	coniferous	Plantations up to about 450 metres
Agriculture	arable	Absent
	pasture	Rough and unimproved
	fields	Unenclosed
	field boundaries	Not applicable
Settlement pattern		Unsettled
Building materials		Not applicable
Historic features		Ancient routeways, former shielings
Natural heritage features		Rich arctic-alpine flora and fauna
Other landscape features		Rock outcrops, glacial features, expansive views
SUBJECTIVE DESCRIPTION		
Views		Panoramic
Scale		Large
Enclosure		Exposed
Variety		Simple to uniform
Texture		Rough
Colour		Muted
Movement		Distant
Unity		Unified
'Naturalness'		Undisturbed to managed

LOCATION

5.3.1 This landscape type comprises the areas of upland separating the principal glens, to the north of the Highland Boundary Fault. As with the glens described above, a broad distinction can be drawn between the West Highlands to the west of Glen Garry/Drumochter, and the Mounth Highlands to the east. While the hills generally reach similar heights, those in the west tend to be craggier and those in the east more rounded. This reflects the higher rates of erosion in the west due to the more rapid accumulation of snow and ice during period of glaciation and the pre-glacial landform. The West Highlands are more heavily dissected than the Mounth. The latter therefore includes more extensive areas of upland plateau. Furthermore, as noted above, east-west fault lines have determined the orientation of western glens while north-south valleys in the Mounth reflect the inclination of the massif.

West Highlands

5.3.2 The West Highlands can therefore be described as a series of comparatively discrete hills or ranges, as follows:

- Ben Vorlich and the Forest of Glenartney, south of Loch Earn;
- Ben Chonzie/Sròn Mhór/Meall nam Fuaran and Craigvinean Forest between Strathearn and Loch Tay/Strath Tay;
- Ben Lawers and Beinn Heasgarnich range south of Glen Lyon;
- Carn Gorm/Schiehallion range between Glen Lyon and Loch Rannoch;
- Meall Tairneachan Group between Strath Tay and Loch Tummel;
- Talla Bheith and Craiganour Forest between Lochs Rannoch and Tummel and Glen Garry.

Mounth Highlands

5.3.3 The Mounth Highlands form a more continuous area of upland with a series of spurs extending southwards towards Strathmore. The principal areas can be summarised as follows:

- Forest of Atholl north of Glen Garry;
- Forest of Clunie west of Strathardle;
- Forest of Alyth between Glen Shee and Glen Isla;
- Caenlochan Forest/Glen Doll Forest between Glen Shee and Glen Clova;
- Muckle Cairn/Hill of Glansie/Hill of Wirren between Glen Clova and Glen Esk;
- Hills of Saughs/Mount Battock, north and east of Glen Esk.

5.3.4 The rest of this section describes the whole of the Highland Summits and Plateaux landscape character type. It draws examples from within both the West Highlands and Mounth Highlands, as appropriate, but also highlights key differences between them, where they occur.

PHYSICAL CHARACTERISTICS

5.3.5 The geology of these Highland areas has already been described in relation to the intervening glens. Dalradian and Moinian grits and schists dominate, forming broad bands running south-west to north-east, parallel to the Highland Boundary Fault. These rocks were once the sediments of limestones, sandstones and shales, metamorphosed by heat and pressure to form huge schist mountains which, over millions of years, were reduced to the mountains we see today. The area also has significant intrusions of other rock forming parallel bands. These rocks include granites, limestones, quartzites and intrusive diorite. These differing rock types can have an important influence on local landform. Harder rocks result in outcrops, softer rocks result in eroded basins. They also influence vegetation patterns. Barytes has been quarried in parts of this area and further proposals for mineral extraction may come forward in the future.

5.3.6 Vegetation on the schists varies with altitude and exposure. On the moorland slopes below 600 metres, the land cover tends to be dominated by heather, mixed with sedge, rush, bog asphodel, cotton grass, and purple moor grass. On some of the shallower plateau slopes (for example on the Atholl upper moors) blanket bog has developed, with peat lying a metre or more deep. Heather is particularly extensive on drier moorland slopes, such as those in Glen Clova, turning the hillsides purple and pink in late August and September. Grass tends to dominate in the western part of the Highlands. At between 600 and 900 metres there is a pronounced transition from heather and grass moorland to the arctic alpine zone with many screes, rock outcrops and, where topography and soil accumulation allows, a low growth of blaeberry and crowberry, and sometimes a mat of prostrate heather. Otherwise, it is lichens which predominate in this exposed, often inhospitable environment. Periglacial features produced by freeze-thaw processes, are also evident in the higher areas.

5.3.7 Vegetation patterns vary with the underlying rock, however. Perhaps the most common of these variations occurs where calcareous schists and limestone rocks occur. Particular plant communities associated with these rocks are found on Ben Lawers, Carn Gorm, Beinn A'Ghlo and Schiehallion among others. A number of these summits are protected as SSSIs, while Ben Lawers, regarded by some as one of the finest examples of arctic alpine flora, is designated as a National Nature Reserve (NNR). Caenlochan is also a NNR.

5.3.8 Most of the vegetation of the Highlands is managed for grouse, deer and sheep. Tree and scrub growth is prevented by burning, grazing and tree-cutting. Although there are a few patches of semi-natural woodland on slopes up to about 600 metres, the tree roots and stumps that are sometimes visible in areas of bog point to the former extent of woodland on these moors. In other countries, where similar sub-arctic conditions occur, land uses have allowed the growth of vegetation such as dwarf birch and willow, forming a transition from lower habitats to the ground vegetation of the arctic-alpine zone.

5.3.9 The Highland areas support a variety of habitats. Notable species of birds found in the area include ptarmigan, dotterel, dunlin and golden plover on the higher ground and peregrine falcon, red and black grouse, snipe, curlew, hen harrier, siskin, lesser redpoll and capercaillie on the lower moors and in the remaining areas of woodland. Red squirrel, mountain hare and wild cat are not uncommon, while much of the area is inhabited by both red deer and roe deer.

SETTLEMENT AND LAND USE

5.3.10 Human activity is specialised in the upland areas. Long managed by the large estates for hunting and shooting (hence the term 'forest' which is used extensively throughout the area), the upland areas also once provided areas of summer grazing when transhumance (the seasonal movement of sheep and cattle between the lowland and upland pastures) was a common practice. The remains of the old shielings, often sited in the most sheltered parts of the upland, can still be found today, for example on the southern and eastern slopes of Ben Lawers above Loch Tay. Historically, there would also have been many tracks and paths through the uplands, providing links with areas to the north or west. Many of these were important droving routes, used when moving stock to and from market. Some of the best examples of these old routes are found at the head of the 'cul-de-sac' glens of the Mounth. Jock's Road, for example climbs out of Glen Doll, crossing a bealach south of the White Mounth before dropping down towards Braemar. Few modern roads follow these old routes, one of the exceptions being the A93 through Glen Shee which crosses the Mounth at Cairnwell. While these historic tracks, together with more recent stalkers' paths and footpaths, are an important recreational resource, the creation of additional tracks and paths could have a local landscape impact and could undermine the special character of these areas.

5.3.11 Other signs of human activity are generally limited to the patterns created by heather burning, and the comparatively small number of upland conifer plantations. Large coniferous woodlands on the upland plateaux (for example above Glen Garry) are less intrusive than within the glens or where the scale of the landscape is less expansive. Here they appear as a thin layer which does not upset the scale or drama of the highlands. The hills are largely free from tall structures with the exception of pylons serving hydroelectric schemes, particularly in the West Highlands. Depending upon the angle of view, the season and the light, these pylons can appear as light grey structures against an otherwise sombre landscape of browns and greens.

5.3.12 In summary, therefore, despite active management which favours heather moorland over other forms of sub-arctic vegetation, the Highland Summits and Plateaux comprise one of the wildest landscapes in the UK. Dramatic mountains, sweeping moorlands, extensive views throughout southern Scotland and constant exposure to changing, often extreme weather conditions, all shape perceptions of the landscape. Hidden from view are the more sheltered, fertile and settled glens. Remoteness is another important factor. With just a few roads climbing out of the glens onto the high moorland, these are relatively inaccessible areas requiring commitment on the part of those visiting them.

FORCES FOR CHANGE

5.3.13 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.3.14 **Transport.** For the most part, the highland summits and plateaux are inaccessible, served only by rough tracks or stalkers' paths. The highland massifs are comparatively dissected so many roads follow lowland routes. There are comparatively few highland passes, and these are generally minor in their impact on the upland landscape.

5.3.15 **Forestry and woodland.** The highland summits and plateaux contain relatively little commercial forestry. Notable exceptions include Craigvean Forest between Aberfeldy and Pitlochry and areas around Glen Isla.

5.3.16 The wider landscape impact of these woods is comparatively limited. In part this is because of the high ratio of open moorland to plantation. It also reflects the grand scale of the landscape, and the appearance of the woods as little more than dark shapes on an already sombre landform. This perception could change if the scale of woodland increased significantly so as to replace the mottled appearance of the heather moorland with more uniform areas of conifers. It is unlikely that such proposals will come forward since the regional Indicative Forestry Strategy describes much of the area as being 'unsuitable for tree crops'.

5.3.17 Much of the Highland Summits and Plateaux are managed for deer and grouse, preventing the natural regeneration of woodland where this could occur. To that extent, the upland landscape that we see today is highly managed and closely allied to the historic pattern of estate management and economy. Appropriate grazing management, supported by appropriate funding mechanisms, could help develop opportunities for natural regeneration of dwarf and other woodland on the lower and mid slopes.

5.3.18 **Recreation.** The management of the Highland Summit and Plateau landscape for game has been noted above. With the exception of this, recreation pressures are relatively few on this remote, harsh landscape type. The principal exceptions are the more popular peaks such as Ben Lawers, Schiehallion and Ben Vorlich where substantial numbers of walkers and climbers can cause local problems of erosion. The creation of new paths and tracks in this mountain environment should be avoided. There may be additional pressures for ski development, particularly at the head of Glen Beag where there are proposals to expand the existing facilities southwards. This would extend the zone of visual influence associated with the ski area. Elsewhere, there may be pressure to expand cross-country skiing, with the provision of cross-country routes in areas such as Ben Lawers.

5.3.19 **Tall structures.** The Highland Summits and Plateaux are comparatively free from tall structures such as pylons and masts. There are, however, a number of electricity pylons lines which link hydroelectric plants and which climb out of the highland glens to cross the exposed upland. Examples include the pylons between Tummel Bridge and Glen Garry, and the pylons between Appin of Dull and Glen Quaich. Though the lines of pylons are relatively small when set within the expansive uplands, they are a modern and functional intrusion into the highland landscape. Opportunities to bury these cables should be taken should they arise. Additional pylons should be resisted.

LANDSCAPE GUIDELINES

5.3.20 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristic upland landscape of open, unsettled moorland vegetation and to maintain the contrast with the more settled and wooded glens and lowlands.

Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, or features such as concrete kerbing.
Development	• Discourage any development on the Highland Summits and Plateaux.
Forestry and woodland	• Ensure any new woodland proposals comply with the agreed standards of good forest design. • Encourage the removal of small, geometric plantations, allowing equal increases in planting in more appropriate locations elsewhere. • With respect to the replanting of existing plantations: - encourage the rationalisation of woodland to avoid isolated, small to medium sized areas of plantation woodland which appear prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes.

(Forestry and woodland contd.)	• Explore opportunities to modify management practices to allow the regeneration of native upland treecover in some areas.
Recreation	• Maintain low-key level of provision. • Avoid creation of new mountain tracks and paths. • Expansion of ski facilities into this landscape type should only be permitted if it is clear that: - the visual and landscape impact is limited; - there is no scope to accommodate expansion to the north; - the economic need for the scheme is demonstrated. • Indirect effects including traffic and the proliferation of related facilities (ski hire shops) should also be taken into account.
Tall structures	• Discourage proposals for aerials, masts or wind turbines or additional pylons because of their likely impact on the harsh, undeveloped character of the Highland Summits and Plateaux. • Ensure that any proposals are subject to rigorous landscape impact assessment. • Where new power or telephone lines are proposed or required, ensure that operators adopt underground cable solutions.

Photo: SNH

LOWER HIGHLAND GLENS WITH LOCHS
Loch Tummel - a richly wooded landscape enclosing the enlarged loch; settled and modified by designed landscapes.

Photo: SNH

HIGHLAND SUMMITS AND PLATEAUX
Exposed, craggy uplands along Glen Lyon, punctuated by surviving Scots pines.

Photo: SNH

PLATEAU MOOR
Lochans, blanket bog, granite boulders and grey tree stumps characterise the desolate landscape of Rannoch Moor

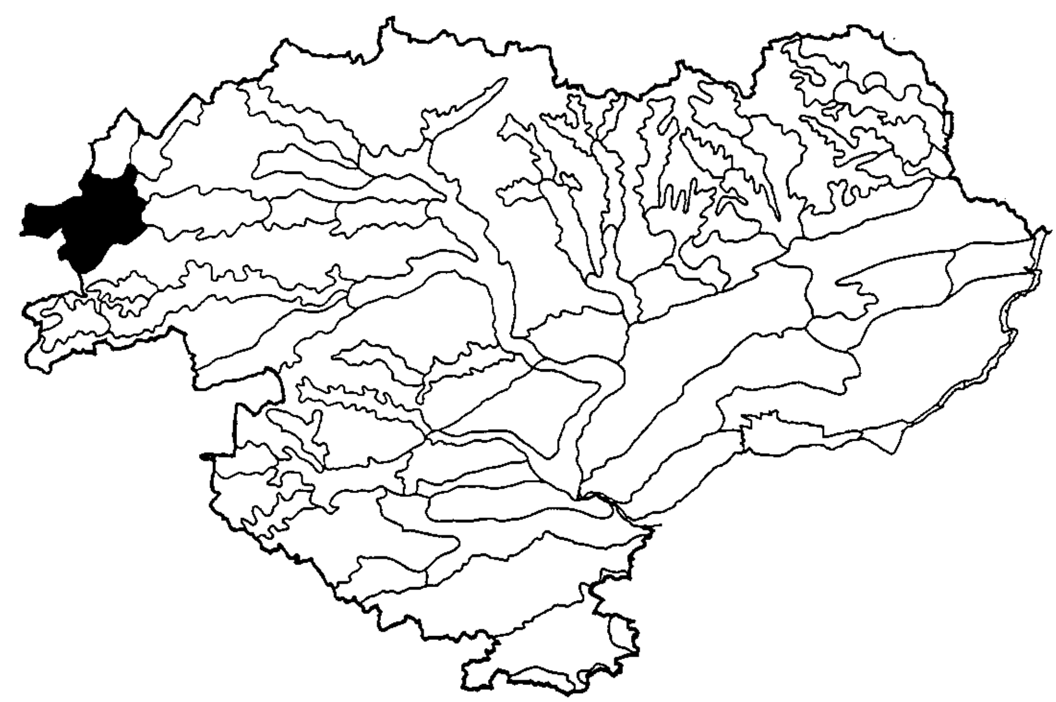
HIGHLAND FOOTHILLS
A complex landscape of interlocking, ridge-like hills and intervening valleys - here close to White Caterthun Fort.

LOWLAND HILLS
The rounded upland character of the hills south of Comrie.

FIGURE 14

LANDSCAPE CHARACTER TYPES

PLATEAU MOOR: RANNOCH MOOR (4)



KEY CHARACTERISTICS

- *highly eroded granite basin overlain with glacial deposits*
- *mosaic of lochans, mires, hillocks and boulders*
- *extensive coniferous woodland to the south*
- *modern development prominent but fails to tame the landscape*
- *wild, exposed and remote*

OBJECTIVE DESCRIPTION		Plateau Moor
Physical scale		300 metres AOD, 25 kilometres in diameter
Woodland	broad-leaf	Scattered trees where shelter/grazing permit
	coniferous	Extensive plantation to the south
Agriculture	arable	Absent
	pasture	Very rough
	fields	Absent
	field boundaries	Not applicable
Settlement pattern		Unsettled with the exception of buildings at Rannoch Station
Building materials		Granite and slate
Historic features		No notable features
Natural heritage features		Rich wetland ecology
Other landscape features		Linear features - railway and pylons; enclosing mountains
SUBJECTIVE DESCRIPTION		
Views		Panoramic
Scale		Large
Enclosure		Exposed
Variety		Simple
Texture		Very rough
Colour		Muted
Movement		Remote
Unity		Unified
'Naturalness'		Undisturbed

LOCATION

5.4.1 At the western end of Loch Rannoch, the Dalradian and Moinian schists which are ascendant throughout much of the Highlands give way to an extensive basin of intrusive granite covering an area about 25 kilometres in diameter. At an altitude of about 300 metres, this is Rannoch Moor.

PHYSICAL CHARACTERISTICS

5.4.2 The moor's landform belies its geological structure. Granite usually comprises the most resistant rocks, remaining as upland when softer rocks around have been eroded away. However, Rannoch Moor formed the epicentre of the ice sheets that were formed during successive periods of glaciation. The elevated rates of accumulation and ice movement resulted in rapid and sustained scouring and erosion on the moor, and along the principal routes emanating from it (including the glens of Loch Rannoch, Loch Ericht and Glencoe and Glen Etive). This accentuated the erosion resulting from chemical weathering of the granite in the pre-glacial era. When the ice sheets melted, the area was left as undulating plateau of morainic deposits punctuated by hundreds of small lochans and a handful of larger lochs.

5.4.3 The vegetation that subsequently developed represents the most extensive area of western blanket mire in Great Britain. Plants include ling, bog myrtle, a variety of grasses and sphagnum mosses. The blanket bog grew under the cool post-glacial conditions that have prevailed since the last Ice Age, sustained by high levels of rainfall. Where shelter is greatest, a scatter of deciduous trees survives, remnants of what would once have been extensive native woodland. The stumps of many trees are preserved in the peat bogs on the moor.

SETTLEMENT AND LAND USE

5.4.4 Though wild and remote, signs of human activity are not absent from Rannoch Moor. Protected by snow fences and sheds, the West Highland railway crosses the moor with a halt at Rannoch Station, 10 kilometres west of Loch Rannoch. Loch Eigheach has been dammed and enlarged to generate hydroelectricity, and a line of grey pylons serving the power station marches defiantly across the moorland landscape. Finally, an extensive area of coniferous plantation (about 50 square kilometres) covers the moor to the south of Rannoch Station.

5.4.5 Like the Highland Summits and Plateaux, the Plateau Moor landscape type comprises one of the wildest areas and, for many, most forbidding landscapes in Scotland. Treacherous mires, boulder-strewn moorland, a complete lack of shelter, and exposure to winds and rain make this an inhospitable environment. Enclosing summits such as Sgor Gaibhre often disappear into the swirling clouds that often descend onto the moor. It is a constantly changing landscape, transforming itself according to the light, the weather and the season. Though these qualities are valued by many, most people prefer to hurry through, travelling along the West Highland railway line, or the A82 further to the west.

FORCES FOR CHANGE

5.4.6 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.4.7 **Forestry and woodland.** Though much of Rannoch Moor comprises a mosaic of lochans, bog and boulder strewn moorland, large areas were planted with conifers in the earlier part of the 20th century. These woods have matured and now comprise monocultures of even-aged trees which hide much of the variety of the underlying landscape. Since they were planted, opinions have changed. On the one hand, the wilderness of Rannoch Moor is now more valued as a landscape resource. On the other hand, as has been described in preceding sections, forestry practices have progressed to the extent that comprehensive, large-scale afforestation has been abandoned in favour of a more sensitive approach which takes into account more fully the importance of landscape. The challenge at Rannoch Moor is to decide how replanting, when it occurs, should create a more natural form. Much has to do with the nature of the woodland edge, the ratio of open space to woodland, the size and shape of planting and felling coupes and the degree of integration with native and semi-natural woodland.

5.4.8 Rannoch Moor includes a few areas of remnant native woodland. It is likely that grazing and other forms of management are preventing natural regeneration outside of fenced areas. There may be opportunities to change management practices so as to encourage regeneration, particularly where this allows integration with commercial forestry.

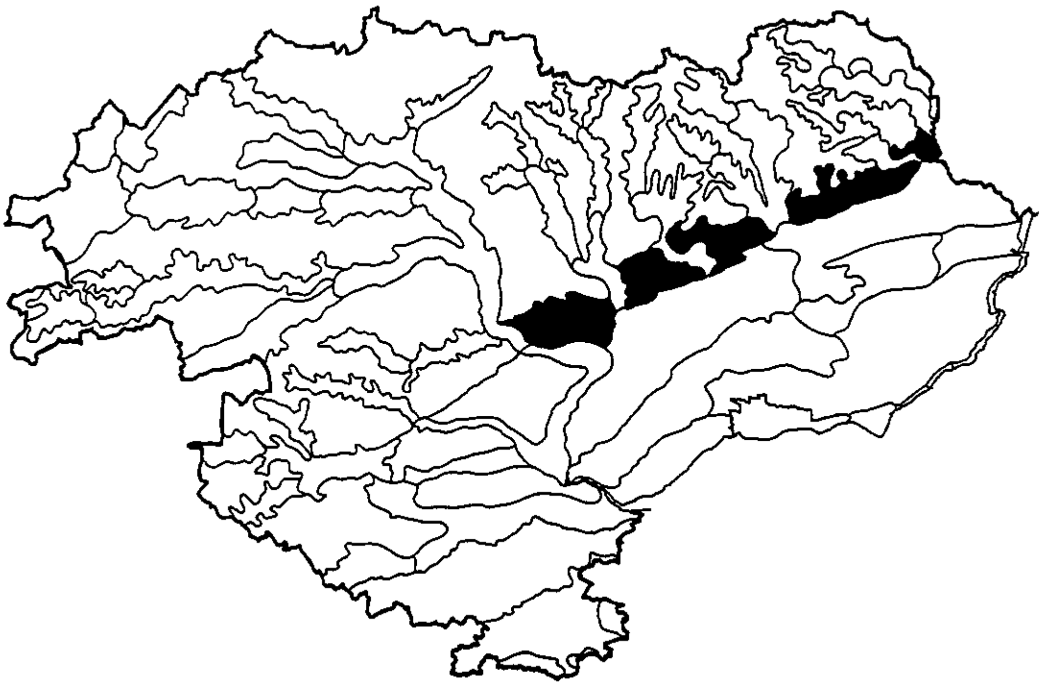
5.4.9 **Tall structures.** Rannoch Moor is currently comparatively free from tall structures such as pylons and masts. There is, however, a line of pylons which follows the road to Rannoch Station before turning south to follow the railway line. The grey of the pylons makes them stand out against the dark green of the conifer plantations. Though the line of pylons is relatively small when set within the expansive moorland, it is a modern and functional intrusion into the landscape. Opportunities to bury these cables should be taken should they arise. Additional pylons should be resisted.

LANDSCAPE GUIDELINES

5.4.10 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the exposed upland character of the moor and to reduce the impact of modern features such as commercial woodland and electricity pylons.

Forestry and woodland	• Ensure any proposals for further woodland expansion are rigorously tested by environmental assessment and comply with the principles of good forest design. • With respect to the replanting of existing plantations: - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins; - integrate conifers with native species; - employ more varied species mixes; - vary the size of felling coupes. • Explore opportunities to modify management practices to allow the regeneration of native upland treecover in some areas, particularly where this can provide a transition to commercial woodland.
Tall structures	• Discourage proposals for aerials, masts or wind turbines or additional pylons because of their likely impact on the harsh, undeveloped character of the moor. • Where new power or telephone lines are proposed or required, ensure that operators adopt underground cable solutions. • Explore options for burying existing cables, and for alternative colours for pylons to reduce their prominence in the landscape.

HIGHLAND FOOTHILLS (5)



KEY CHARACTERISTICS

- *complex geological structure resulting from their position along the line of the Highland Boundary Fault*
- *glacial deposits*
- *steep whale backed hills and south-west to north-east valleys*
- *winding, gorge-like main river valleys*
- *gateway to the Angus Glens with a rich historic heritage*
- *building materials reflecting geological transition*
- *complex, sometimes disorientating landscape with glimpses of Highland and lowland*

OBJECTIVE DESCRIPTION		Highland Foothills
Physical scale		Climbing from about 100 metres at their southern edge to summits between 300 and 400 metres AOD
Woodland	broad-leaf	Scattered areas of woodland
	coniferous	Small to medium sized coniferous plantations, often geometric in form
Agriculture	arable	On gentler, lower slopes, particularly along northern edge of Strathmore
	pasture	Extensive areas of pasture
	fields	Medium, regular shaped where landform permits
	field boundaries	Hedges, sometimes heathy in character and some dry-stone walls
Settlement pattern		Settlement concentrated on low ground, particularly where rivers have cut corridors through to the lowland
Building materials		Combination of hard rocks from the north and sandstones from the south
Historic features		Very rich in defensive sites, hill-forts, castles and fortified manor houses
Natural heritage features		Mainly confined to intervening valleys and gorges
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Intermittent
Scale		Small to medium
Enclosure		Semi-enclosed
Variety		Varied
Texture		Smooth/rough
Colour		Muted
Movement		Peaceful
Unity		Fragmented
'Naturalness'		Tamed

LOCATION

5.5.1 Along the Highland Boundary Fault, at the foot of the Mounth Highlands, a series of foothills mark the transition to the lowland of Strathmore. Dissected by the rivers that flow out of the highland glens, the Highland Foothills landscape type forms a series of units running eastwards from Dunkeld to Edzell.

PHYSICAL CHARACTERISTICS

5.5.2 The geology of this area is mixed, comprising areas of schist to the north-west and Old Red Sandstone to the south-east, separated in places by a variety of resistant conglomerates, intrusive and extrusive rocks including slates, lavas and tuffs. Superimposed upon this structure is a mass of glacial moraine, deposited as the ice sheets retreated into the glens. The complexity of the geology is reflected in a landscape of steep, whale-backed hills and intervening valleys, generally orientated on an east-west axis. Many of the Highland Boundary rocks are harder than those to the north and south, and rivers flowing off the highlands have been forced to find the least resistant route. Each turns north-eastwards before turning to the south once again. The hills are most distinct in the east. In the west, the hills between Dunkeld and Blairgowrie are less well-defined, though there are many signs of glacial deposition.

SETTLEMENT AND LAND USE

5.5.3 Much of the Highland Foothills landscape type is under intensive agricultural use, comprising a mixture of fertile grasslands and, on the more level, better drained land, arable fields. A small number of coniferous plantations are found on the foothills, while broad-leaf woodland is concentrated on steeper slopes, particularly along the narrow river valleys, or dens, that cut through the hills. Many of these valleys are ecologically important, supporting ancient woodland and the cool damp conditions favouring ferns and mosses. Many of the valleys are designated as SSSIs.

5.5.4 Historically, this area represented the gateway to the glens, the boundary between the highland and lowland glens, and the limit of Roman occupation. It is not surprising, therefore, that the Highland Foothills have a rich heritage of archaeological sites, ranging from sculptured stones and crosses, through hill-forts and Roman camps to dramatic medieval castles and fortified manor houses. Particularly significant examples of prehistoric hill-forts are found at Brown Caterthun and White Caterthun. A number of large houses, for example The Burns near Edzell, are located in this landscape type. Modern settlement echoes the past importance of the glens, most towns and villages of any size being sited close to one of the valleys emanating from the foothills. Building materials reflect the geological transition, comprising a mixture of grey schists and granites and the more colourful lowland red sandstones.

5.5.5 In contrast to the apparent simplicity of lowland Strathmore and the clear structure of the Mounth Highland and glens, this is a confusing, almost disorientating landscape. The hills and their intervening valleys mean that it is relatively well-contained, with only occasional glimpses to the heath moorland above, or open lowland below. Valleys appear to run in all directions, twisting up into the Highlands, running along the fault line and leading down to Strathmore.

VARIATIONS IN LANDSCAPE CHARACTER

5.5.6 The Highland Foothills are most pronounced, but also narrowest in the east. Here the whale-backed hills are sharpest in relief, enclosing a narrow valley running parallel to the Highland Boundary Fault to the north. Further west, the foothills are less pronounced, and their width increases to over 5 kilometres. There is a gradual transition in character and the area of foothills between Rattray and Dunkeld, which includes a series of small kettle hole lochs along the course of the Lunan Burn, is quite different in appearance from those areas near Edzell. The waterbodies are of considerable nature conservation importance, adding further interest to this landscape.

FORCES FOR CHANGE

5.5.7 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.5.8 **Agriculture.** The transitional nature of the Highland Foothills is reflected in the pattern of agriculture. Many farms straddle the transition, combining sheep and cattle rearing on the uplands with arable cultivation on the lowlands. This pattern of mixed farming means that farms have the opportunity to vary the extent of arable cultivation or grazing to reflect prevailing market conditions. The support mechanisms for cereal production in particular may have encouraged farmers to extend arable cultivation from the lowlands into parts of the foothills, in places weakening the contrast between the hills and the lowland strath. On the other hand, the Highland Foothills mark the approximate boundary of the Less Favoured Area which covers much of the Highlands, providing support for hill farming. This scheme offers income stability for sheep and cattle farmers on higher ground. However, as with all forms of support, it makes the economy potentially vulnerable to changes in national or European policy.

5.5.9 Many farms in the Highland Foothills have constructed modern agricultural buildings such as sheds and barns. These are generally of a smaller scale than those found in the lowland straths. Furthermore, the more complex landform provides a much greater degree of screening.

5.5.10 **Transport.** The Highland Foothills are laced with a network of minor roads, often bordered by hedgerows (sometime comprising gorse) or contained within steep banks. The circuitous nature of many of these roads emphasises the complicated nature of the landform. It is important that the small scale and rural character of these roads is retained. Hedges and hedgerow trees should be conserved and signage and 'improvements' such as widening or kerbing resisted.

5.5.11 **Development.** Though relatively close to the string of small towns and villages located at the mouths of the Angus Glens, development within the foothills is very limited, generally comprising little more than a scatter of farmsteads and a few small hamlets. While further residential development could be accommodated without major impacts on the wider landscape, the effect on the local landscape could be significant. Although there may be some scope for residential conversions where traditional farm buildings have become redundant, generally new development should be focused outwith this landscape type.

5.5.12 **Forestry and woodland.** The Highland Foothills have a limited amount of woodland, in some places hidden within the complex of hills, in others crowning the hills overlooking the lowland straths. While much of this woodland is commercial in nature, some has been planted to provide shelter for game, stock or crops. The Tayside Indicative Forestry Strategy categorises much of the Highland Foothills landscape type as being 'preferred' or 'potential' areas for new planting. Taking a regional perspective it is evident that the foothills are relatively free from the constraints associated with the most productive agricultural land and the sensitive highland areas. At a more local level, there is obviously a concern that the scale of any new planting should not be such as to change significantly the landscape character of the foothills. Key factors to be considered include:

- scale of new planting relative to the landform and the proportion of unplanted land;
- species composition;
- relationship with existing semi-natural or planted woodland;
- retention of key views within and outwith the foothills;
- size of felling coupes;
- factors such as agricultural viability, nature conservation and historic sensitivities.

5.5.13 These issues are addressed by Forestry Authority woodland design guidance (see section 4.19.), and are summarised in the landscape guidelines presented at the end of this section.

5.5.14 **Recreation.** Access to the Highland glens, the proliferation of castles and other historic sites, and the particular nature conservation interest of areas such as the Lunan Valley, means that the Highland Foothills are popular for recreation and tourism. A number of caravan parks are found within or immediately adjoining the foothills. While these generally have a limited impact on the wider landscape, it is possible, however, that there may be pressure to expand these sites or create new ones. There may also be pressure for chalet developments or timeshare schemes. Where they are permitted, such developments should be located in less prominent lowland locations, exploiting the natural screening provided by the topography and existing woodland. Additional impacts on the landscape, including traffic levels on narrow roads, signage, an increase in the loss of tranquillity, should also be taken into account.

5.5.15 **Tall structures.** The Highland Foothills remain comparatively free of tall structures. The principal exception is the high voltage electricity transmission line which climbs into the foothills near Airlie before running north-eastwards through the hills. Given the comparatively small scale of the foothills and the intervening valleys, this line of pylons is a substantial feature in the landscape, conflicting with the area's otherwise rural character.

The effect is particularly significant where the pylons run across hilltops or along ridgelines, or where they run along narrow glens such as that of the Paphrie Burn.

5.5.16 Masts and aerials are largely absent from these hills. Given the growth of telecommunications and the position of the foothills overlooking the lowland straths, however, it is possible that proposals for new masts may come forward. Where possible, these should be resisted, but operators should be encouraged to develop a strategy that reflects the local and strategic landscape effects of masts. Given the density of hill-forts, castles and other significant sites, there must also be concern about the potential effect on the historic component of the landscape, and on people's enjoyment of historic sites in their wider context.

5.5.17 Wind turbines represent a further potential development pressure. Though wind speeds are likely to be significantly lower than in more elevated parts of the Highlands or the Sidlaws/Ochils, it is possible that the lower level of perceived constraint, together with the proximity to the existing electricity distribution network, could favour this area. This would be even more likely if the efficiency of wind turbines continues to improve, thereby making areas with lower wind speeds viable. It is acknowledged that development here could avoid the need to locate turbines in even more sensitive upland areas, or in less sensitive, but more populated areas closer to settlements. It would also mean that, from a distance, turbines would be viewed against a backdrop of higher ground. However, the insensitive development of wind turbines in this area would conflict with the small scale, historic and deeply rural character of the landscape. It would also weaken and confuse the area's role of providing a transition from the unsettled uplands to the fertile and settled lowland.

LANDSCAPE GUIDELINES

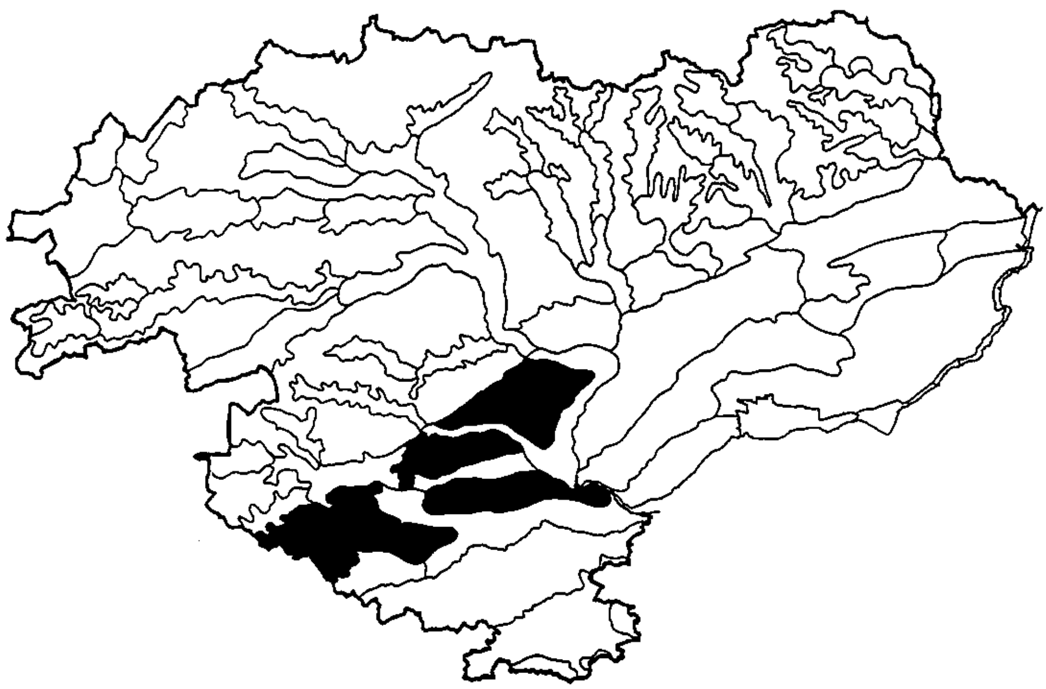
5.5.18 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the small-scale, rural and historic character of the Highland Foothills, recognising their importance in providing a transition zone between the highlands and the lowlands.

Agriculture	• Maintain the distinction between lowland cereals and highland grazing areas. • Encourage farmers and landowners to maintain and replant trees and farm woodlands. Species to include oak, maple, beech and ash. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.

Transport	• Where road improvement schemes take place, ensure that hedges and hedgerow trees are reinstated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives. • Develop a road use hierarchy as a basis for management.
Development	• Discourage significant development in the Highland Foothills. Instead, encourage new development to reinforce the existing settlement pattern in surrounding areas, particularly within the lowland straths. • Where small-scale development is permitted, encourage developers to use local building materials and to adopt local vernacular in respect of density, massing, design, colour and location. Avoid standard designs and layouts. Assess and adopt existing traditional layouts. Consider the preparation of design guides as supplementary planning guidance. • Encourage the appropriate conversion of redundant farm buildings. Guidance should be provided on the way buildings should be converted (including the provision of drives, gardens etc.) to prevent the suburbanisation of the countryside.
Forestry and woodland	• New planting should conform to the Forestry Authority's design guidelines. In particular, it should respond to the small-scale nature of the landscape, complex topography, the importance of views within and out of the hills, and historic and ecological values. • Use new woodland planting to enhance the landscape and nature conservation value of the foothills. New woodland could link existing plantations and semi-natural woodlands in the foothills and lower parts of the Highland glens. • The broad principles of new woodland could include: - overall planting strategy that emphasises the transitional character of the foothills; - expansion/regeneration of native woodlands from highland glens into foothill glens; - mixture of broad-leaf (oak and ash) and conifer species; - small coupes to reflect the small scale of the landscape; - concentration of new woodland on steeper slopes, around the lower slopes of whale backed hills and through small glens towards highlands and lowlands; - retention of key views out from foothills.

Recreation	• Concentrate recreation and tourism developments, including caravan sites, chalet developments and timeshare schemes, in well-screened locations within valleys and glens. Secondary effects resulting from signage, traffic and activity levels should also be taken into account.
Tall structures	• Assess proposals for aerials, pylons or masts in terms of their visual and landscape impact on the local landscape of the Highland Foothills, and the broader landscape of the lowland straths and Highlands. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape. • Encourage the development of a regional strategy for renewable energy, including wind power, in order that the most appropriate types of development and areas come forward.

LOWLAND HILLS (6)



KEY CHARACTERISTICS

- *low ridges and hills separating lowland straths and adjoining the nearby uplands*
- *composed of soft, red sandstones*
- *transitional character with pastures on lower slopes, giving way to rough grazing and even open moorland*
- *evidence of several phases of historic settlement*
- *extensive woodland, including forestry plantations*
- *influence of modern development*

OBJECTIVE DESCRIPTION		Lowland Hills
Physical scale		Broad ridges and rounded hills rising to between 150 and 600 metres AOD
Woodland	broad-leaf	Small farm woods and woodland along sheltered burns
	coniferous	Extensive areas of plantation
Agriculture	arable	Limited to lower slopes and some sheltered, gentler upper slopes
	pasture	Improved pasture dominant, giving way to rough grazing and moorland on upper slopes
	fields	Medium, rectilinear where landform allows
	field boundaries	Hedges on lower slopes and walls on upper slopes
Settlement pattern		Sparse scatter of farmsteads. Also masts, roads
Building materials		Sandstone and harder schists and granites
Historic features		Prehistoric, Roman, medieval and later influences
Natural heritage features		Moorland areas
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Panoramic/framed
Scale		Medium
Enclosure		Open to semi-enclosed
Variety		Varied to simple
Texture		Textured to rough
Colour		Muted
Movement		Still
Unity		Interrupted
'Naturalness'		Tamed to restrained

LOCATION

5.6.1 Between Strathallan and the Strath Tay at Dunkeld lies a series of low ridges and hills, separating the lowland valleys. The principal examples include the Gask Ridge west of Perth, the Keillour Forest south of Glen Almond, the Bankfoot Hills between Glen Almond and Dunkeld, and what we have termed the Knaik Hills lying to the south of Glen Artney.

PHYSICAL CHARACTERISTICS

5.6.2 Unlike the Highland Foothills (described above) which have a complex geological structure, the Lowland Hills lie to the south of the Highland Boundary Fault, entirely on the broad band of Old Red Sandstone which runs south-west to north-east across the region. A series of quartz-dolerite dykes run through several of the hills, however, contributing to their greater resistance to erosion. One such dyke runs westwards from Perth along the Gask Ridge to the River Earn near Crieff.

5.6.3 These Lowland Hills form the transition between the Highlands to the north and west and the lowlands to the south and east. They vary in height, the highest being the Knaik Hills which rise to over 600 metres AOD, and the lowest being the Gask Ridge which rises to just 150 metres AOD. In contrast to the areas of true upland to the north, these hills are generally smooth and well-rounded. Small valleys cut easily into the sandstone creating a series of convex ridges and valleys to the north of the lower part of Glen Almond.

5.6.4 The transitional nature of the hills is reflected in landcover and vegetation. Pastoral and even arable fields on the lower slopes give way to rough grazing and then to open moorland as height is gained. This is particularly evident on the Knaik Hills which, because of their scale and height, have a particularly upland character. Even on the low Gask Ridge, where farmland extends onto the summit line, and the land is quite fertile, the greater exposure contributes to the transitional character. There is a considerable amount of coniferous forestry in this landscape type, though this is concentrated where less fertile glacial till occurs. Large plantations are found on the lower slopes of the Knaik Hills, along the Gask Ridge and in the Keillour Forest. Smaller plantations are found along the valleys which drain the Bankfoot Hills. In places, stands of conifers are extremely geometric. Particular examples are found east of the A822 above Crieff where narrow bands of conifers extend up the hillside from the floor of the glen, pushing over the summit and beyond.

SETTLEMENT AND LAND USE

5.6.5 With the exception of their most elevated parts, the landscape of these hills shows evidence of thousands of years of settlement and land use. The hills are rich in prehistoric remains including standing stones (for example on the lower slopes of Dunruchan Hill south of Comrie, and in the vicinity of Fowlis Wester in the Keillour Forest), cairns, stone circles and hut circles. Roman occupation is equally well-represented by forts (e.g. at Braco and west of Buchanty at the head of lower Glen Almond), roads (e.g. along the Gask Ridge) and signal stations. The hills' location close to several 'gateways' to the Highlands is reflected in the number of castles and fortified houses. Examples include Huntingtower, Keillour and Drummond Castles. Many of these became transformed into landscaped estates over subsequent centuries. Today, agriculture predominates. There are, however, signs of modern development including the busy A9 corridor where it climbs over the Gask Ridge to the west of Perth, the lines of pylons which fan out from the highland glens carrying power to the lowlands, and a number of telecommunication masts (e.g. on Kirton Hill near Perth) exploiting the hills' proximity to settled lowland. Large areas of the Knaik Hills are reserved for military use.

FORCES FOR CHANGE

5.6.6 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.6.7 **Agriculture.** The transitional nature of the Lowland Hills (like the Highland Foothills) is reflected in the pattern of agriculture with arable on some of the lower slopes giving way to enclosed pastures and eventually, in the case of the more exposed areas, to rough moorland grazing. As in the case of the Highland Foothills, the nature of this transition may vary according to market conditions and the level of support. In particular, it is likely that cereal production has extended uphill from the lowland straths onto parts of the lowland hills such as the Gask Ridge. This does not, however, seriously weaken the contrast between lowland, lowland hills and the highlands.

5.6.8 Many farms in the foothills have constructed modern agricultural buildings such as sheds and barns. These are generally of a smaller scale than those found in the lowland straths.

5.6.9 **Transport.** The Lowland Hills have a network of main and minor roads. These are generally small-scale and fit with the grain of the landscape. The exception is the A9 corridor which crosses the eastern part of the Gask Ridge and the Bankfoot Hills to the north of Perth. Existing coniferous woodland, together with cuttings provide a degree of screening. However there are a number of sections (particularly the length climbing onto the Gask Ridge from Strathearn) which have a much wider landscape impact.

5.6.10 **Development.** Development within the Lowland Hills is very limited, generally comprising little more than a scatter of farmsteads and a few small hamlets. Small, stone settlements such as Fowlis Wester and Findo Gask characterise the lower parts of this landscape type. Along the A9 corridor, particularly to the north of Perth, there has been some more recent residential settlement, in particular expanding villages such as Bankfoot. In others, such as Methven for example, land has been allocated for further housing development. There is scope to accommodate further development in the dissected lower parts of the Bankfoot Hills without major impacts on the wider landscape. The Perth Area Local Plan (Perth and Kinross District Council, 1996) indicates that the possibility of establishing a new village in the vicinity of Moneydie is the subject of early discussions between interested parties. The impact of housing developments in these Lowland Hill areas would have as much to with their layout, scale, variety, materials and vernacular, as with their location within the landscape. Housing developers should be encouraged to adopt layouts and designs which integrate new dwellings into existing settlements, rather than simply grafting suburban estates onto the edge of villages and hamlets. There may also be some scope for sensitive residential conversions where traditional farm buildings have become redundant.

5.6.11 **Forestry and woodland.** The elevation, soils and prevailing climate of the Lowland Hills makes them well-suited to commercial forestry. This is reflected in the Tayside Indicative Forestry Strategy which categorises much of this landscape type as being 'preferred' or 'potential' areas for new planting. The area already includes a considerable number of coniferous plantations, particularly along the low ridges between Glen Almond and Strathearn. Taking a regional perspective it is evident that the Lowland Hills, like the Highland Foothills, are relatively free from the constraints associated with the most productive agricultural land and the sensitive Highland areas. At a more local level, there is obviously a concern that any additional planting should not be such as to change significantly the landscape character of the hills. Some areas already have about 50% planting, while others (particularly the Knaik Hills and the western part of the Bankfoot Hills) have an open, upland character that could be affected by new planting. Key factors to be considered include:

- scale of new planting relative to the landform and the proportion of unplanted land;
- species composition;
- relationship with existing semi-natural or planted woodland;
- retention of key views within and outwith the foothills;
- size of felling coupes;
- factors such as agricultural viability, nature conservation and historic sensitivities.

5.6.12 These issues are addressed by Forestry Authority woodland design guidance (see section 4.19), and are summarised in the landscape guidelines presented at the end of this section.

5.6.13 There is also a need to address the character of existing plantations, many of which were established many decades ago. A particular concern relates to the hillside shelterbelts to the east of the A822 between Crieff and Glen Almond. Here narrow, geometric strips of woodland run vertically up the hillside, one even crossing the hilltop and descending the other side. While such plantations may provide valuable shelter for stock or game, their landscape impact is high. Consideration should be given to removing them, in due course, and perhaps creating new woodlands elsewhere in compensation. Elsewhere, harvesting and replanting will provide an opportunity to remodel some of the more geometric plantations to create more naturalistic and sensitive woodland forms.

5.6.14 **Tall structures.** The Lowland Hills are comparatively free of tall structures. The principal exceptions are the high voltage electricity transmission lines which cross the area, and the masts that are sited on high ground overlooking Perth (e.g. near Methven and on Kirton Hill). It is possible that there may be pressure for additional masts as telecommunications traffic grows.

5.6.15 At a small scale, wind power has been important in this area for many decades, being harnessed by wind pumps to raise water. With the development of modern wind turbines to generate power, it is possible that this area may come under pressure for wind farm development. Though wind speeds are likely to be significantly lower than in more elevated parts of the Highlands or the Sidlaws/Ochils, it is possible that the lower level of perceived constraint, together with the proximity to the existing electricity distribution network, could favour this area. This would be even more likely if the efficiency of wind turbines continues to improve, thereby making areas with lower wind speeds viable. It is acknowledged that development here could avoid the need to locate turbines in even more sensitive upland areas, or in less sensitive, but more populated areas closer to settlements. It would also mean that, from a distance, and from some directions, turbines would be viewed against a backdrop of higher ground. However, the insensitive development of wind turbines in this area could conflict with the small-scale, historic and deeply rural character of the landscape. It would also weaken and confuse the area's role of providing a transition from the unsettled uplands to the fertile and settled lowland.

LANDSCAPE GUIDELINES

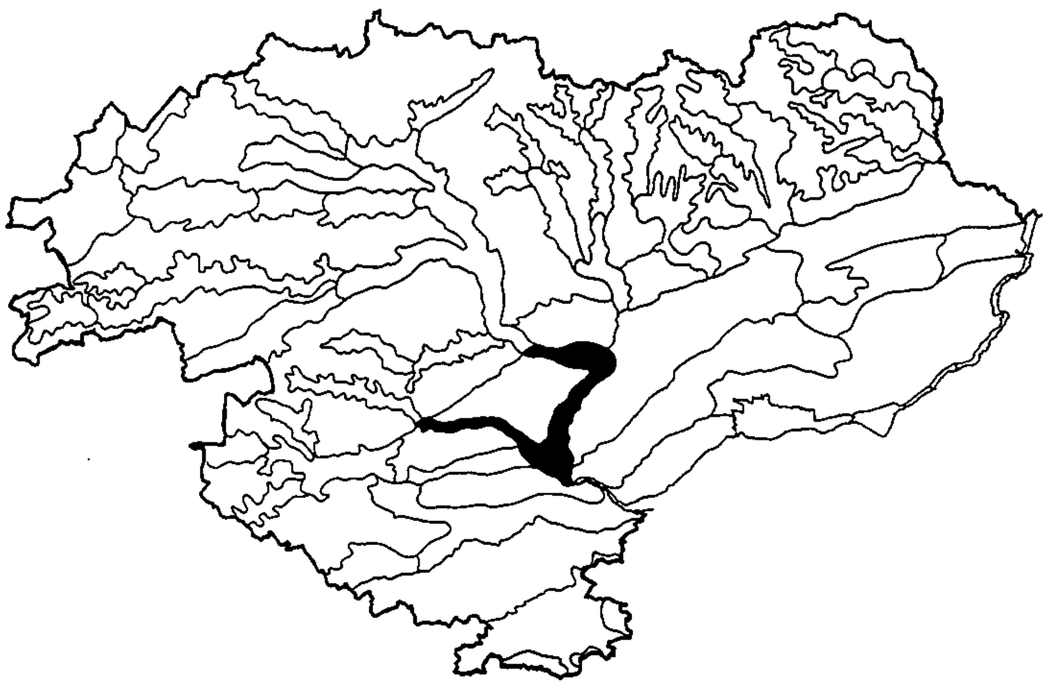
5.6.16 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the small-scale, rural and historic character of the Lowland Hills, recognising their importance in providing a transition zone between the Highlands and the Lowlands.

Agriculture	• Maintain the distinction between lowland cereals and highland grazing areas. • Encourage farmers and landowners to maintain and replant trees and farm woodlands. Species to include oak, maple, beech and ash. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.
Transport	• Where necessary, explore opportunities to provide additional on and off-site screening of major roads. • Where more minor road improvement schemes take place, ensure that hedges, hedgerow trees, gates and other features are re-instated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives. • Develop a road use hierarchy as a basis for management.

Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the rural character of other parts of the lowland glens. • Discourage the simplistic grafting of housing estates onto the edge of settlements. Encourage more imaginative schemes which respond to the existing patterns of layout, structure, massing and scale. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Consider positive ways of addressing the interface between settlements and the surrounding countryside. These could include: - screening; - new buildings which integrate surrounding areas; - key vistas and views; - landmark features; - gateways and approaches. • Where small-scale development is permitted, encourage developers to use local building materials and to adopt local vernacular in respect of density, massing, design, colour and location. Avoid standard or suburban designs and layouts. Assess and adopt existing traditional layouts. Consider the preparation of design guides as supplementary planning guidance. • Encourage the appropriate conversion of redundant farm buildings. Guidance should be provided on the way buildings should be converted (including the provision of drives, gardens etc.) to prevent the suburbanisation of the countryside.
Forestry and woodland	• New planting should conform to the Forestry Authority's design guidelines. In particular, it should respond to the small-scale nature of the landscape, complex topography, the importance of views within and out of the hills, and historic and ecological values. • The broad principles of new woodland could include: - overall planting strategy that emphasises the transitional character of the Lowland Hills; - focus new planting in lower areas, retaining more open, upland character of areas nearer the Highland Boundary Fault; - consider scope for regeneration of native woodlands on higher ground to provide a transition to more heavily wooded areas;

(Forestry and woodland contd.)	- favour a mixture of broad-leaf (oak and ash) and conifer species; - vary the size of planting and felling small coupes to reflect the scale of the local landscape. • With respect to the replanting of existing plantations: - encourage the removal of small, geometric plantations, allowing equal increases in planting in more appropriate locations elsewhere; - encourage the rationalisation of woodland to avoid isolated, small to medium-sized areas of plantation woodland which appear very prominent in an otherwise open landscape; - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes.
Tall structures	• Assess proposals for aerials, pylons or masts in terms of their visual and landscape impact on the local landscape of the foothills, and the broader landscape of the lowland straths and Highlands. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape. • Encourage the development of a regional strategy for renewable energy, including wind power, in order that the most appropriate types of development and areas come forward.

LOWLAND RIVER CORRIDORS (7)



KEY CHARACTERISTICS

- *well-defined river corridors in broader lowland landscapes*
- *meandering, often incised course through softer sandstones*
- *semi-natural woodland on steeper slopes*
- *rapids, weirs and mills where harder rocks cross the valley*

OBJECTIVE DESCRIPTION		Lowland River Corridors
Physical scale		Narrow corridors up to 3 km wide, containing rivers incised by up to 40 metres; falls and rapids where river crosses bands of harder rocks
Woodland	broad-leaf	Semi-natural woodland on steep incised slopes
	coniferous	A few areas where plantations or policy woodlands extend to the river edge
Agriculture	arable	On higher ground either side of river
	pasture	On higher ground either side of river, on gentler slopes and on a few areas of level floodplain
	fields	Within inner valley, size and shape determined by topography; on higher, level ground, larger and more geometric fields
	field boundaries	Hedges and post-and-wire fences
Settlement pattern		A number of mill settlements sited close to rapids and weirs. Also historic houses and designed landscapes enjoying riverside location
Building materials		Red sandstone
Historic features		Historic houses and designed landscapes, castles and mills
Natural heritage features		Hanging woodlands, rapids
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Small to medium
Enclosure		Semi-enclosed
Variety		Varied
Texture		Textured
Colour		Colourful
Movement		Peaceful
Unity		Unified
'Naturalness'		Undisturbed to tamed

LOCATION

5.7.1 Two Lowland River Corridors stand out as having distinctly different characters from the surrounding landscape. The first is the River Tay corridor between the Highland Boundary fault and the Firth of Tay at Perth. The second, which is of a much smaller scale, is the lower section of Glen Almond from the Highland Boundary fault eastwards to Perth.

PHYSICAL CHARACTERISTICS

5.7.2 Unlike their upper reaches where both rivers are constrained within glens cut through the hard schists and grits, south of the Highland Boundary Fault they flow onto the softer Old Red Sandstones. Here the rivers have been able to meander more freely, though rising land levels following the end of the last Ice Age have resulted in both rivers developing incised channels. Where the more resistant igneous dykes cross the rivers, rapids and cataracts occur.

5.7.3 After crossing the Highland Boundary Fault near Murthly, the Tay swings in a series of broad meanders across a wide, flat floodplain. As it flows south the meanders tighten and the river enters an inner valley up to 40 metres deep. Within this incised channel, there is little or no floodplain and the fertile haughs found upstream are absent. Many of the steep slopes are clothed in deciduous woodland, further increasing the sense of enclosure which cuts the river off from the wider landscape. South of Stormontfield, the Tay valley broadens once more, forming the broad basin with river terraces occupied by Perth and Scone. However, encountering the hard igneous rocks of the Sidlaws, the river has cut a narrow valley, turning eastward to the Carse of Gowrie.

SETTLEMENT AND LAND USE

5.7.4 The River Tay has stimulated several phases of settlement. In prehistoric times, it is likely that the fertile haughs of the river attracted hunter-gatherers and the earliest settlers. However, as with other locations close to gateways into the Highlands, the defensive structures of Roman and subsequent eras have left a more lasting mark on the landscape. The strategic importance of Strath Tay, leading both north and west through the uplands is reflected in the presence of a Roman fort at Inchtuthill south of Spittalfield, and a series of smaller castles such as those near Kinclaven and Stanley. Medieval settlement was focused at Perth, a strategic location in the Tay gap, and at the lowest bridging point. The landscape quality of the river corridor contributed to the later development of landscaped estates associated with historic houses such as Murthly, Meikleour and Scone. The series of rapids that are found along the River Tay stimulated the development of watermills, powering Perthshire's textile industry during the industrial revolution. Mills were constructed at several places, most spectacularly at Stanley. Here the river turns through a tight meander, enclosed within a 40 metre deep gorge. A tunnel was built through the neck of the meander, leading water away from a weir to power mills further downstream.

5.7.5 The River Almond has some striking similarities with the Tay, reflecting its proximity to the Highlands and its common geological structure. Most notable perhaps is the deep, gorge-like valley that the river has cut through the sandstone and glacial deposits.

Although flowing in a meandering course, the river is entrenched within a valley 40 metres deep until it enters the open floodplain of the Tay above Perth. Many of the slopes are too steep to farm and are clothed in broad-leaf woodland. In the upper part of the glen, the river corridor is relatively unsettled, farms and hamlets clustering along roads on more level ground to the north and south. Fields along the northern side of the valley have a dense network of field boundary trees. The site of a Roman Fort at the western end of this part of the glen and the presence of large houses and institutions such as Glenalmond College, echo the pattern of development seen along the Tay. Furthermore, the River Almond also provided a series of mill sites along its lower reaches, where the river cuts through a series of igneous dykes. Here mills and associated houses are perched alongside the river, concealed from the wider landscape.

FORCES FOR CHANGE

5.7.6 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.7.7 **Agriculture.** Agricultural activity within these river corridors is concentrated on higher ground either side of the entrenched river. The network of hedges and hedgerow trees is an essential element of this landscape, extending the texture and variety of the straths up towards the lowland hills. In some areas, however, this structure is in decline with once dense lines of trees becoming gappy and fragmented, and hedges and fences being replaced by 'invisible' post-and-wire fencing. This is noticeable, for example, along the northern side of Glen Almond. Field boundaries on the broad floodplains, where they occur, are often marked by fences, though sometimes boundaries across the valley are marked by shelterbelts or lines of trees.

5.7.8 **Transport.** Main roads have tended to avoid the steep-sided and tortuous river corridors, favouring more level routes elsewhere. Where access to the river corridors is possible, it is usually gained by steep narrow roads which serve mills or riverside farms. The steep, twisting nature of these roads is a characteristic of the area and should be conserved where practical.

5.7.9 **Development.** The proximity of these areas to Perth, and their attractive, sheltered landscape (the Tay valley is designated as an Area of Great Landscape Value) means that there is some pressure for residential settlement. This is particularly the case to the north of Perth where villages such as Luncarty and Stanley lie close to the A9. Over-development in these areas could undermine the quality of the landscape, and development plans for the area seek to steer additional housing towards existing settlements. Almondbank, Luncarty and Stanley all include areas allocated for future residential development. Furthermore, the Perth Area Local Plan (Perth and Kinross District Council, 1996) raised the possibility of a 'new settlement' (termed Almond Valley Village) between Almondbank and Huntingtower on the north-west edge of Perth. This would result in the Perth Urban Area extending into the Almond Valley.

5.7.10 The alignment of the ring road/motorway, and steeply rising ground to the south-west and east broadly defines the physical extent of Perth and contains it within a section of the Tay valley which is relatively concealed within the wider landscape. A somewhat more ambiguous area lies to the north where development has been permitted to the north of the ring road but south of the River Almond. The latter is hidden in woodland, so for people travelling along the A9 there is no obvious physical boundary to the northern part of the town.

5.7.11 Concerns about the potential impact of new residential development reflect the patterns of recent growth. Often this has comprised low density, speculative estates of similar or identical dwellings which are crudely grafted onto the edge of these towns. The stark designs (often lacking any reference to vernacular designs or material) are usually unmitigated by planting, screening or landscaping, while the infrastructure of internal roads, footways, drives etc. appear over-engineered and overly suburban. The impact of additional housing in these river corridor areas would have much to do with their layout, scale, variety, materials and vernacular, as well as their location within the landscape. Housing developers should be encouraged to adopt layouts and designs which integrate new dwellings into existing settlements, rather than simply grafting suburban estates onto the edge of villages and hamlets. There is a role for design guides and imaginative design briefs. There may also be further scope for sensitive residential conversions where traditional farm buildings have become redundant, though this will do little to meet the demand for housing in the area as a whole. Again, guidance on the most appropriate means of conversion will be important.

5.7.12 **Forestry and woodland.** Woodland is an essential component of this landscape type, comprising a combination of semi-natural woodland, commercial forestry, farm woodland and field boundary trees, policy and estate woodland. The characteristic interplay of woodland, farmland and areas of designed landscape is particularly important.

5.7.13 Several areas of river corridor are identified by the Tayside Indicative Forestry Strategy as having potential for new planting. While there may be some scope for additional woodland in these areas, it is important to maintain the overall balance of unplanted and planted areas and to conserve key views into and along the river corridor. It is also important to conserve landscape features such as field systems where these contribute to the grain and texture of the landscape. As elsewhere, there is scope to enhance the appearance of existing plantations as they come forward for harvesting and replanting.

5.7.14 **Tall structures.** With the exception of the lines of pylons that cross Glen Almond at two points, this landscape type is relatively free from tall structures. There is unlikely to be significant pressure for wind turbine construction. However, the effect of any proposals on higher ground which are visible from within the river valleys (for example on the Lowland Hills) should be considered carefully. Development of small-scale hydro schemes at former mill sites could reduce pressure for wind turbine development in the wider area.

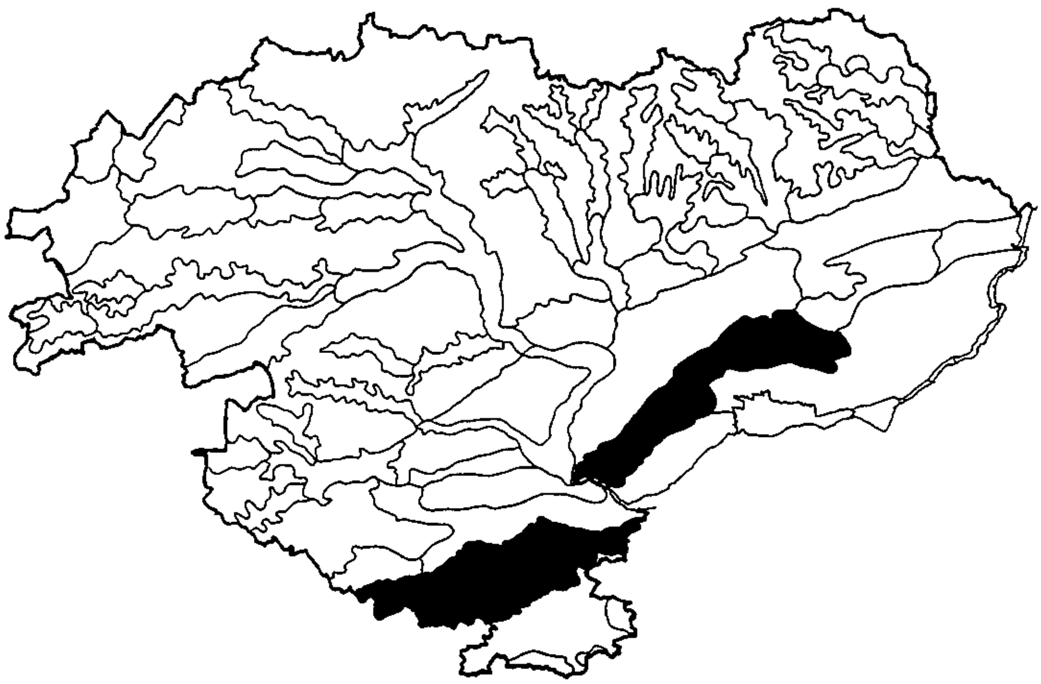
LANDSCAPE GUIDELINES

5.7.15 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the characteristically settled landscape of farmland, woodland and designed landscapes and to ensure that new development is designed to minimise adverse impacts on the landscape.

Agriculture	• Discourage improvements which result in further loss of field boundaries or field boundary trees. • Encourage farmers and landowners to replant trees along field boundaries, initially along roads, but also between fields. Species to include oak, maple, beech and ash. Use incentives to compensate for lower yields where mature trees are retained. • Explore development of market for hardwood from field boundary trees. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.
Transport	• Minimise upgrading or improvement of roads particularly where this involves the creation of cuttings and embankments, or the introduction of additional signage, or features such as concrete kerbing.
Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the rural character of other parts of the lowland glens. • Discourage the simplistic grafting of housing estates onto the edge of settlements. Encourage more imaginative schemes which respond to the existing patterns of layout, structure, massing and scale. Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Consider positive ways of addressing the interface between settlements and the surrounding countryside. These could include: - screening; - new buildings which address surrounding areas; - key vistas and views; - landmark features;

(Development contd)	- gateways and approaches. • Explore the development of Almond Valley Village as a means of addressing the ambiguous pattern of development to the north and north-west of Perth by firming up the distinction between urban and rural and providing clear gateways to the town.
Forestry and woodland	• With respect to the replanting of existing plantations on valley slopes: - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes. • Consider opportunities for new woodland planting in terms of: - the overall balance of woodland and open space; - the relative importance of different areas of existing woodland (e.g. commercial plantation versus policy woodland) and how this would be influenced by an increase in woodland cover; - the importance of key views and features within the landscape; - opportunities for provide screening; - opportunities to link isolated areas of woodland; - agricultural, ecological and historical sensitivities.
Tall structures	• Assess proposals for tall structures in terms of their visual and landscape impact on the local landscape of the river corridors. • Explore the scope for small-scale hydro schemes as an alternative to wind power projects. • Where new power or telephone lines are proposed or required, encourage operators to adopt underground cable solutions.

IGNEOUS HILLS (8)



KEY CHARACTERISTICS

- *the Sidlaw and Ochil hills, comprising hard volcanic rocks*
- *short burns and rivers flowing from short steep glens*
- *a few large glens through the hills*
- *often distinctive scarp and dipslopes*
- *generally open landscapes of almost conical summits dominated by grass moorland*
- *some areas of extensive forestry*
- *many modern influences*

OBJECTIVE DESCRIPTION		Igneous Hills
Physical scale		Ochils up to 600 metres AOD, about 10 km wide and 40 km long; Sidlaws up to 300 metres AOD, about 5 km wide and 30 km long
Woodland	broad-leaf	Very limited, confined to woodland on steep slopes (e.g. along the Braes of the Carse), in more sheltered sections of glen (e.g. Glen Eagles) and along lower level field boundaries
	coniferous	A few isolated pines; more common are extensive areas of coniferous plantation (e.g. in the Ochils south of Dunning and the eastern part of the Sidlaws)
Agriculture	arable	A few areas of arable cultivation on gentler slopes, particularly in the southern and western part of the Sidlaws
	pasture	Pastures common on steeper slopes and on rougher and more exposed areas of hilltop.
	fields	Generally large and regular shaped
	field boundaries	Combination of stone dykes and post-and-wire fences; occasionally marked by isolated Scots pine in upper areas and deciduous species in more sheltered parts
Settlement pattern		Largely unsettled; farms and hamlets concentrated in main glens such as Glen Devon
Building materials		Locally won hard rock and some sandstone
Historic features		Old field systems, burial sites, hill-forts and later castle sites
Natural heritage features		No notable features
Other landscape features		Masts and aerials are already prominent features
SUBJECTIVE DESCRIPTION		
Views		Intermittent
Scale		Medium
Enclosure		Semi-enclosed to open
Variety		Simple
Texture		Smooth
Colour		Muted
Movement		Peaceful
Unity		Interrupted
'Naturalness'		disturbed

LOCATION

5.8.1 To the south and east of the Old Red Sandstone lies a band of hard volcanic rocks. More resistant than the surrounding beds, these rocks survive as the Ochil Hills which run from the boundary with Fife as far as Perth, and the Sidlaw Hills which run from Perth north-east towards Forfar. The Ochils and Sidlaws represent two parts of the same geological structure. Once a broad arch of volcanic rocks would have extended over the area occupied by the lower part of Strathearn and the Firth of Tay. Weakened by compression, the crest of this arch was eroded away, revealing the softer rocks beneath. The resulting landforms comprise a pair of scarp slopes (in the Ochils facing north, in the Sidlaws, south) and a pair of dipslopes (in the Ochils facing south, in the Sidlaws, north).

The Ochils

5.8.2 **Physical characteristics.** The Ochils are the larger of the two hill ranges, rising to over 500 metres and extending up to 12 kilometres in width in places. The hills are drained by a large number of short burns and small rivers, flowing northwards into Strathearn and Strathallan and southwards into the Loch Leven Basin. Most glens are short and steep. The principal exception to this is the pass formed by Glen Eagles to the north and Glen Devon to the south. This corridor was enlarged during the Ice Age when ice sheets in Strathearn pushed into Glen Eagles, lowering the watershed between the two glens by over 200 metres. Ice sheets also had the effect of truncating the Ochils' northern spurs, thereby increasing the drama of the scarp along the southern side of Strathearn and Strathallan.

5.8.3 **Settlement and land use.** Though there are areas of improved pasture and even some cultivation within the more sheltered glens, the land is generally of low fertility (classified as Class 5 or 6) and the bulk of the agricultural land takes the form of unimproved rough grazing. The Ochils also have a considerable amount of coniferous forestry. Along the lower slopes in Strathallan, this generally takes the form of geometric plantations and shelterbelts which are prominent in this open, large-scale landscape. Further west, in Strathearn, the woodland is less formal. However, the most extensive woodlands are located in the heart of the eastern Ochils, particularly on Innerdouny Hill where a large expanse of Sitka spruce covers a series of upper catchments. The effect is to transform the sparse, open landscape of the Ochil summits, and to create a sense of enclosure which is absent elsewhere on the hills. New planting is more sensitive, incorporating broad-leaf fringes and better reflecting the natural flow of the landform. Nevertheless, it will result in a significant change in the upland landscape.

5.8.4 The natural defences provided by the steep slopes overlooking lowland routes are reflected in a large number of hill-forts. There is a particular concentration of such sites along the northern escarpment of the Ochils and along key routes through the hills. Later castles occupy positions lower down the slopes and in the glens themselves. Several of the glens show signs of past prosperity. In Glen Devon the structure of abandoned field boundaries is visible as a series of low grassy banks. More recent settlement is limited to a scatter of farmsteads, concentrated in the less-steep eastern part of the Ochils. Glen Devon now accommodates a range of tourism and recreation facilities while some of the more prominent hilltops are crowned with telecommunications masts.

The Sidlaws

5.8.5 **Physical Characteristics.** The Sidlaws are lower and less extensive than the Ochils. They are most distinct at their southern end where the south-east facing scarp (the Braes of the Carse) rises almost vertically to tower over the Carse of Gowrie, and where the shallower, north-facing dipslope meets the Strath Tay near Scone. Even here the hills are barely 5 kilometres wide. Further north the hills subside, particularly along their south-eastern side, gradually merging into the farmland plateau. From the north, however, the hills continue to present a distinctive profile of smooth rounded hills which contain the views within Strathmore. The lower elevation of the Sidlaws is reflected in more productive agricultural land. While grass and some heather moorland predominate on the upper parts of the hills, it is not uncommon to find arable and improved grassland fields, enclosed by stone dykes, in the more sheltered open basins that occur in the Sidlaws. Such a concentration is found around Milton of Ogilvie, to the south of Glamis. Broad-leaf woodland is limited to steep slopes (such as the southern scarp face) and river valleys.

5.8.6 **Settlement and land use.** Though elevated and often exposed, the landscape of the Sidlaws reflects many hundreds of years of settlement. Many Stone Age hill-forts can be found, exploiting the natural defences provided by the steep hills. Bronze Age burial mounds occupy other key locations on prominent ridges overlooking the lowland. There are few Roman or Pictish remains, but several medieval castles and mottes are located to defend routes through the hills. An example is Pitcur Castle, sited at the mouth of Glen Cott, south of Coupar Angus. Several follies are found through the hills. The most notable of these includes the series of towers built along the top of the south-facing cliffs overlooking the Carse of Gowrie and apparently designed to recreate the landscape of the Rhine Valley in Germany. Another example is the tower on Kinpurney Hill. More recent development has taken the form of coniferous plantations which are less extensive than in the Ochils, and the telecommunication masts which have been built at the summit of a number of hills. A number of existing and disused quarries are found in the Sidlaws, reflecting the value of the hard volcanic rocks that occur there.

FORCES FOR CHANGE

5.8.7 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.8.8 **Agriculture.** Much of the Ochils and Sidlaws are given over to pastoral uses, and in places the land is so poor it supports little more than rough grazing. This pattern of agricultural land use sits comfortably with the Igneous Hills' upland, exposed character and contrasts effectively with more fertile areas of lowland to the north and south. In a few areas better soils and a degree of shelter allow arable cultivation to take place, often at some altitude. It may be appropriate to consider the use of incentive payments to encourage reversion to grassland in some of these areas. As in other areas, the influence of estate ownership is evident in the maintenance of the farming landscape.

The area falling within the Gleneagles Estate can be determined from less well-maintained areas around.

5.8.9 **Transport.** The Ochils and Sidlaws are crossed by a number of minor roads, often bordered by dry-stone dykes. The alignment of many of these roads reflects the gradient of the landform and the presence of glens and passes through the hills. It is important that the small-scale and rural character of these roads is retained. Walls should be conserved and signage and 'improvements' such as widening or kerbing resisted. Similarly, main roads through the hills should be maintained so as to retain their rural character. The eastern part of the Tayside Ochils is cut by the M90 motorway. Despite its scale and nature, the road alignment is relatively sympathetic to the landscape, following a sinuous glen through the hills. However, the movement, noise and pollution associated with moving traffic, together with the presence of over-bridges, cuttings and other structures determine that the motorway has a considerable impact on the local landscape.

5.8.10 **Development.** The elevation and exposure of the Ochils and Sidlaws, and the presence of nearby lowland settlements means that the Igneous Hills are very sparsely settled. The principal exception to this is the gentler southern slopes of the Sidlaws near Dundee. Here there has been a limited amount of building in the open countryside, creating a few lines of south facing suburban houses extending from farmsteads or existing hamlets. This has a suburbanising influence on the Sidlaws' landscape.

5.8.11 **Minerals.** The hard volcanic rocks of the Ochils and Sidlaws are valued for road construction among other uses. However, there are very few operational quarries and only a handful of small-scale disused quarries. Existing quarries are generally well-concealed and do not have a significant impact on the wider landscape. Collace Quarry in the Sidlaws is comparatively well-hidden in the wider landscape, though it has a more local setting on the hill-fort of Dunsinane. Should the number, or scale of quarries increase in response to demand, mineral working could have quite a significant impact on this generally open landscape.

5.8.12 **Forestry and woodland.** Woodland makes an important contribution to the landscape of the Ochils and Sidlaws, clothing many of the steepest slopes and lining some of the more sheltered valleys and glens. However, a number of commercial woodlands, planted in the first half of the 20th century, have had a significant adverse effect on the landscape. Extensive ranks of sitka spruce and Douglas fir cover large areas of the Ochils in particular in an even aged monoculture of conifers. Such plantations have created a uniform, enclosing landscape where before there would have been an open and varied landscape of pastures, burns and small glens. The negative effect of these early plantations has tainted attitudes towards commercial forestry in these areas even though forestry practice has long since moved on. As the existing plantations reach maturity, there will be opportunities to implement a phased programme of felling and replanting which will allow a more varied and 'natural' woodland form to be created, with a much more varied species and age mix, and a higher proportion of open space.

5.8.13 The low fertility of the Igneous Hills, and the suitability of their climate to tree growing means that there is still some interest in establishing new woodlands within the Ochils and Sidlaws. The Tayside Indicative Forestry Strategy suggests that areas to the south and east of Auchterarder fall into the 'preferred' category for new planting, together with smaller areas in the eastern Sidlaws.

5.8.14 The current policy is to promote multi-purpose woodlands which can, if appropriately located, consolidate and expand existing semi-natural and planted woodland along the glens, which include a proportion of broad-leaves (particularly on lower ground and in more sheltered locations) and native pine woodland (particularly on higher ground). New woodland should also provide the opportunity to create new habitats, and establish new areas for informal recreation.

5.8.15 **Recreation.** The proximity of the Ochils and Sidlaws to a number of centres of population means that there is an opportunity to facilitate countryside and informal recreation, thereby taking the pressure off other more sensitive areas to the north. While some areas of public access already exist, commercial woodlands, reservoirs and even archaeological sites offer potential for recreation and interpretation.

5.8.16 Formal recreation provision within the area is comparatively limited. However, within Glen Devon a number of commercial developments have been established, announcing their presence with large signs. This contrasts with other, less developed parts of the Ochils.

5.8.17 **Tall structures.** The elevation of the Ochils and Sidlaws and their proximity to centres of population makes them technically well-suited as locations for telecommunications masts and aerials. Several of the hilltops are crowned with one or more masts, introducing strong vertical and industrial structures into the upland landscape. The masts are frequently visible over a considerable distance. It is possible that the growth of the telecommunications industry will be reflected in pressure for additional masts and aerials. Operators should be encouraged to develop a strategy that takes into account the landscape implications of masts and which seeks to share masts where this is appropriate and where this can be achieved without increasing the overall level of landscape impact. Additional masts on undeveloped hilltops or ridges should be avoided.

5.8.18 The government's commitment to the stabilisation of carbon dioxide emissions, and the resulting emphasis on developing a market for renewable energy is likely to result in more proposals for wind turbines. At a regional level, suitable sites will be influenced by the presence of adequate wind speeds and proximity to the electricity grid. These operational requirements are likely to favour upland areas fairly close to centres of population. Potential areas therefore include the parts of the Highland Summits and Plateaux within reach of the principal glens, or close to existing hydro schemes, the Highland Foothills, the Ochils and Sidlaws, and other lowland hills. From an environmental perspective, such areas need to be evaluated in terms of the sensitivity of the landscape and its capacity to absorb development. There is a strong argument in favour of steering such schemes away from sensitive upland landscapes and towards areas where human influences are already much more marked. For this reason, it is likely that, wind characteristics permitting, the Sidlaws and Ochils may be the most suitable areas for wind turbine development in Tayside.

LANDSCAPE GUIDELINES

5.8.19 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to restore and enhance the landscape of the Ochils and Sidlaws, addressing the effects of past development and land use and ensuring that future changes do not lead to further deterioration in landscape quality.

Agriculture	• Maintain the distinction between lowland cereals and highland grazing areas. • Encourage farmers and landowners to maintain and replant hedgerow trees. Consolidate areas where native pines have been used in the past. • Encourage the conservation of dry-stone dykes in local stone with an emphasis on roadside walls and others in highly visible areas. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.
Transport	• Where road improvement schemes take place, ensure that hedges and hedgerow trees, together with other features such as milestones, finger posts and gates are reinstated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives.
Development	• Encourage new development to reinforce the existing settlement pattern, focused on market towns and smaller villages outwith this landscape type. Discourage development in the open countryside. • Encourage the appropriate conversion of redundant farm buildings. Guidance should be provided on the way buildings should be converted (including the provision of drives, gardens etc.) to prevent the suburbanisation of the countryside.
Forestry and woodland	• Ensure the current Forestry Authority approach to the restructuring of existing plantations is followed. Replanting should conform to Forestry Authority design guidance and should result in a varied age and species structure, woodland forms which more closely reflect the underlying landform and a greater proportion of open space. • New planting should conform to the Forestry Authority's design guidelines. In particular, it should respond to the small to medium scale nature of the landscape, the importance of views within and out of the hills, and historic and ecological values.

(Forestry and woodland contd.)	• Use a new planting framework to absorb earlier development in the open countryside and other visually intrusive features. • Ideally link new woodlands to lowland shelterbelts, glen woods and farm woodlands, providing broad-leaf lower margins. • Use new woodland planting to enhance the landscape and nature conservation value of the hills. New woodland could link existing plantations and semi-natural woodlands. • New planting should respect historic features, routes and viewlines between them. • The scale and nature of planting should be varied to reflect local differences in topography. In areas of subdued relief (e.g. on the south-eastern side of the Sidlaws), new planting could be used to highlight more subtle variations.
Recreation	• Encourage greater provision of informal recreation within the Ochils and Sidlaws, focus on existing and new woodlands, reservoirs and historic sites. • Encourage providers of formal recreation and tourism facilities to respect the setting of their developments.
Tall structures	• Restrict the development of tall structures to those absolutely essential for operational reasons. • Encourage operators to share masts and sites. • Avoid new masts on undeveloped hilltops and ridges. • Where possible, encourage masts and other tall structures to achieve 'backclothing', particularly for associated infrastructure and buildings so that sky-line features are minimised. • Explore the potential to steer wind farm developments away from exposed and steep ridgelines and summits and from locations where their visual influence would extend both north and south. Consider potential areas with shallow bowls and valleys away from ridges. Maximise the amount of backclothing provided by the natural landform. Consider steering development to areas already affected by masts, roads or forestry. • Assess proposals for aerials, pylons or masts in terms of their visual and landscape impact on the local landscape of the hills and surrounding areas. • New infrastructure (e.g. access roads) should be minimised by locating any new facilities close to existing roads. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact.

(Tall structures contd.)	• Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape. • Encourage the development of a regional strategy for renewable energy, including wind power, in order that the most appropriate types of development and areas come forward.

IGNEOUS HILLS
Coniferous woodland and rounded, open moorland in the Ochils.

LOWLAND RIVER CORRIDOR
The River Tay flows through a narrow wooded valley to the south of Dunkeld.

BROAD VALLEY LOWLAND
The distinctive arable landscape of Strathmore. Remaining hedgerow trees make an important contribution to landscape character.

Photo: SNH

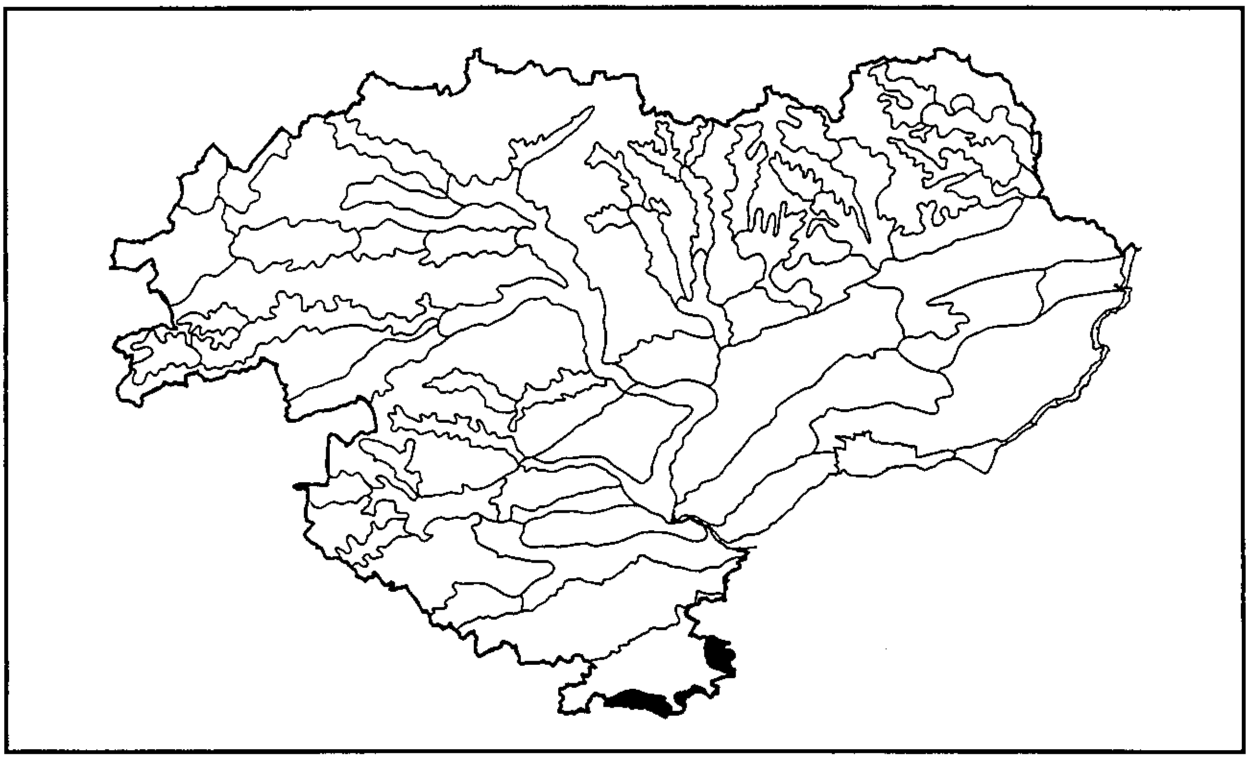
DOLERITE HILLS
The steep western slopes of the Lomond Hills.

FIRTH LOWLANDS
Rich farmlands along the estuarine reaches of the River Tay between Perth and Dundee.

FIGURE 15

LANDSCAPE CHARACTER TYPES

DOLERITE HILLS (9)



KEY CHARACTERISTICS

- *hard quartzite hills enclosing the Loch Leven Basin*
- *steep slopes*
- *predominance of rough grazing*
- *some areas of coniferous forestry*
- *fine views to the north and south*

OBJECTIVE DESCRIPTION		Dolerite Hills
Physical scale		Hills ranging in height from 300m AOD to 450 m AOD
Woodland	broad-leaf	Limited to a small area on the western slopes of Lomond Hills
	coniferous	Extensive plantations (c33% by area)
Agriculture	arable	Absent
	pasture	Rough grazing
	fields	Largely unenclosed
	field boundaries	Stone walls and post-and-wire fences
Settlement pattern		Unsettled
Building materials		Not applicable
Historic features		Forts and castles
Natural heritage features		No notable features
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Panoramic
Scale		Medium to large
Enclosure		Open to exposed
Variety		Simple
Texture		Rough to very rough
Colour		Muted
Movement		Remote
Unity		Unified
'Naturalness'		Restrained

LOCATION

5.9.1 A series of hills rise along the southern boundary of Tayside, enclosing the Loch Leven basin. These are fragments of landscape character areas which extend beyond the region in Fife. The hills divide into three groups, the Lomond Hills to the east, and Benarty Hill and the Cleish Hills to the south.

PHYSICAL CHARACTERISTICS

5.9.2 The Dolerite Hills share a common geology comprising a core of intrusive quartz dolerite overlying carboniferous limestone which, in turn overlies Old Red Sandstone. Bishop Hill (the one Lomond Hill in Tayside) has a steep, west facing scarp slope, rising to 460 metres, and a shallower east facing scarp slope. Only the northern and western slopes of Benarty Hill lie in Tayside. These slopes are also steep, climbing to 350 metres. The Cleish Hills are less steep, but more extensive, forming a rolling line of hills of up to 380 metres along the southern edge of the Loch Leven basin. The north facing slopes are heavily gullied. The hills are dominated by brown forest soils, supporting a combination of rough grazing and coniferous plantation. The latter are most extensive along the Cleish Hills and on the eastern slopes of Bishop Hill.

SETTLEMENT AND LAND USE

5.9.3 Like many other areas of upland in the region, a number of forts are sited among these hills. Later fortifications, such as Cleish Castle are found on the lower slopes. Other signs of human settlement and land use include several small quarries which were worked in the past to obtain hard rock. Relatively accessible to nearby urban populations, these hills provide fine views north and westwards over Loch Leven and southwards towards the Firth of Forth.

FORCES FOR CHANGE

5.9.4 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.9.5 **Agriculture.** The prevailing upland character of these hills means that agricultural activity is dominated by rough grazing with better pastures on the lower slopes. Provided that support mechanisms remain and no significant market changes occur, this activity appears to be relatively stable. Landscape change is therefore unlikely.

5.9.6 **Development.** The Loch Leven Basin is characterised by a series of small villages strung along the roads that encircle the loch. Several of these lie at the foot of the Lomond Hills and comprise little more than groups of stonebuilt houses. The principal exception to this is Kinnesswood which experienced substantial suburban expansion during the 1970s and 1980s. Much of the more recent development occurred on the slopes of the Lomond Hills, resulting in a significant landscape impact. While the local plan envisages further housing development here, it will be concentrated on the less sensitive lower slopes.

5.9.7 **Minerals.** There is some evidence of small-scale quarrying having taken place in the past, for example in the eastern part of the Cleish Hills. There does not appear to be any prospect of mineral working in the future.

5.9.8 **Forestry and woodland.** Much of the coniferous plantation woodland present in the Dolerite Hills landscape type was established in the 1960s and 70s under very different circumstances and with more narrow objectives than would be considered appropriate today. Modern forestry practices would prevent the geometric, even aged monocultures that are found particularly within the Cleish Hills. Harvesting of this woodland provides an opportunity to review the best locations and designs for replanting. This is considered further within the management guidelines.

5.9.9 **Tall structures.** With the exception of the lower slopes of Benarty Hill, which are currently crossed by a line of electricity pylons, the hills are currently free from tall structures. Masts are found, however, further south in the Cleish Hills, beyond the regional boundary.

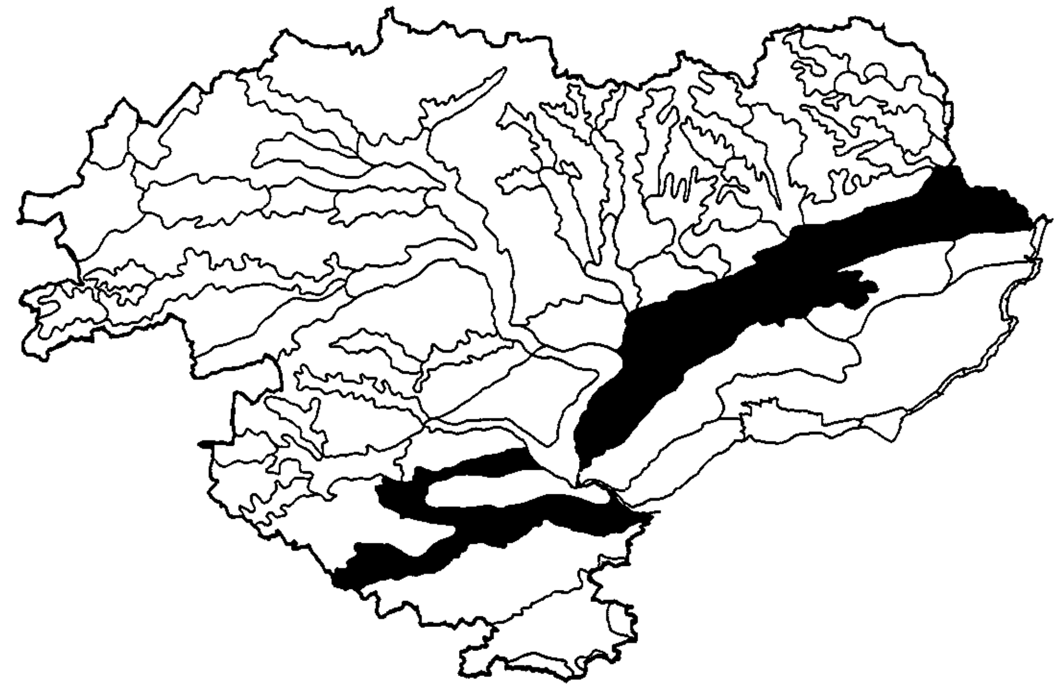
5.9.10 The summits of Benarty Hill and the Lomond Hills are particularly sensitive to structures such as masts, pylons or wind turbines. Not only do they provide the immediate setting to Loch Leven, but they are visible from a considerable distance to the north (e.g. from the Sidlaws) and south (into Fife and even Lothian). The lower, more fragmented Cleish Hills are less sensitive, though any development here would still need to pay regard to the impact on the wider landscape.

LANDSCAPE GUIDELINES

5.9.11 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve and restore the landscape of the bare uplands of the Dolerite Hills, addressing the effects of past development and land use and ensuring that future changes do not lead to further deterioration in landscape quality.

Agriculture	• Maintain the distinction between lowland cereals and highland grazing areas.
Development	• Prevent further uphill expansion of settlements on the lower slopes of the Lomond Hills.
Forestry and woodland	• Ensure the Forestry Authority's approach to the restrictions of single species even-aged blocks is implemented. Implement a phased programme of felling, redesign and replanting of existing plantations to reduce the adverse impact on the environment. Replanting should conform to Forestry Authority design guidance and should result in a varied age and species structure, woodland forms which more closely reflect the underlying landform and a greater proportion of open space: - adopt a more naturalistic appearance, responding to the landform and features such as burns, gullies and crags; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line; - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes.
Tall structures	• Prevent the development of tall structures on the sensitive Lomond and Benarty Hills. • Assess carefully any proposals for tall structures within the Cleish Hills to determine the visual and landscape impact on the local and wider landscape.

BROAD VALLEY LOWLANDS (10)



KEY CHARACTERISTICS

- *broad straths formed by glacial erosion*
- *undersized, misfit rivers*
- *complex local topography caused by glacial deposition*
- *distinctive red soils and red building stone*
- *influence of large estates, particularly in terms of woodland and policies*
- *dominance of arable and root crops*
- *tree loss weakening landscape character*

OBJECTIVE DESCRIPTION		Broad Valley Lowlands
Physical scale		In the case of Strathmore, up to 10 km wide and 30 km long; Strathallan and Strathearn up to 5 km wide
Woodland	broad-leaf	Extensive broad-leaf woodland limited to inner policy woodland and a few areas of unimproved land
	coniferous	Coniferous plantations on areas of poorer land, especially on valley sides; geometric plantation in Strathallan
Agriculture	arable	Dominant agricultural land uses - cereals, potatoes and oil seed rape
	pasture	Limited
	fields	Medium size, regular, some enlarged; most dating back to parliamentary enclosure
	field boundaries	Characteristically hedges with high density of mature hedgerow trees.; pattern weakened as trees felled. Strathallan fewer hedges and trees
Settlement pattern		Small, often planted, villages, small market/processing towns, and larger market towns
Building materials		Red sandstone
Historic features		Comparatively limited, reflecting intensity of agricultural use
Natural heritage features		Fluvial-glacial landforms. Ecological interest limited to a few unimproved areas
Other landscape features		Large, modern agricultural buildings; dominance of estates and historic houses
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium
Enclosure		Open
Variety		Varied to simple
Texture		Textured to smooth
Colour		Colourful
Movement		Active
Unity		Interrupted
'Naturalness'		Tamed

LOCATION

5.10.1 South of the Highland Boundary Fault lie 5 broad lowland valleys or straths. These share a range of common characteristics which set them apart from other valleys and glens. There are, however, significant variations in landscape character within this type, and these are described below. The five areas of Broad Valley Lowlands are:

- Strathmore;
- Strathearn;
- Strathallan;
- the lower South and North Esk river valleys;
- the Pow Water Valley between the Gask Ridge and Keillour Forest.

PHYSICAL CHARACTERISTICS

5.10.2 These areas share a common geological structure, based on the broad band of Old Red Sandstone that runs south-west to north-east through the heart of Tayside. Bounded by harder schists and grits to the north and lavas and tuffs to the south, and already lowered by downfaulting, this soft rock was easily eroded by the ice sheets which extended across the region during period of glaciation. These created much wider and deeper valleys than the scale of existing rivers might suggest. At the end of the last Ice Age, retreating ice sheets deposited a considerable amount of drift within these valleys, much of which was further modified by meltwater flows below or around the ice. This created the complex local topography of outwash terraces, eskers and dry valleys that occur in many places today. Much of the glacial material was locally derived and have given rise to the distinctive red soils that are visible when fields are ploughed. Brighter reds tend to be found further north and east.

SETTLEMENT AND LAND USE

5.10.3 While surviving standing stones and other monuments point to the prehistoric use of these areas, most of the present landscape has been substantially modified since medieval times. Valleys such as Strathmore had comprised extensive areas of rough grazing, scrub woodland and unproductive wetland. The process of draining and improving the land was begun in the 10th century when groups of monks came to the area. One of the principal centres was Coupar Angus where a major Cistercian Abbey was founded in 1164, and many of the moors and mires were brought into agricultural use over subsequent centuries. The process of improvement entered a new phase with the parliamentary enclosure of the 18th and 19th centuries, creating the structure of rectilinear fields that are evident today. A characteristic of this period of enclosure was the planting of many trees (oak, beech, chestnut and ash) along field boundaries. These would have given shelter and provided a source of building timber and firewood. Up to 200 years later, where they survive these mature (or even over-mature) trees make a critical contribution to the rich character of the Broad Valley Lowlands. The large estates, with their baronial mansions and castles, designed landscapes, pleasure grounds, ornamental woodlands, avenues and policies make an equally important contribution.

5.10.4 The 19th century also saw the rationalisation of estates, including the creation of new villages to accommodate farm workers, and the arrival of the railways. Market towns such as Kirriemuir, Coupar Angus and Forfar experienced growth during this period, reflected in their inner suburbs of Victorian terraces and villas. Agriculture has continued to develop. More and more land has been brought into production. Flood defences have been constructed along rivers, allowing arable cultivation to spread onto the floodplain. The fertility of the soil, allied to favourable climatic conditions have favoured the cultivation of cereals, oil seed rape, soft fruit and potatoes.

VARIATIONS IN LANDSCAPE CHARACTER

5.10.5 It is in Strathmore that the distinctive character of the landscape is most evident. From a distance, the area appears as a very broad, flat-bottomed valley enclosed by the Highland Foothills to the north and the rising sweep of the Sidlaws' north-facing dipslope to the south. Where estate planting survives, for example around Glamis, the strath landscape is rich and textured and particularly colourful during spring and autumn. Where the trees have been lost, it is an open and expansive landscape of rectangular fields punctuated with a scatter of large farmsteads. The landscape of the strath contrasts strongly with neighbouring areas of upland, particularly where the woodland structure has survived.

5.10.6 Strathearn, extending from Crieff eastwards to the Bridge of Earn has a similar structure to Strathmore. To the south it is enclosed by the steep slopes of the Ochils, while to the north the Gask Ridge separates it from the valley of the Pow Water. There are a number of significant differences, however. The first is scale. Strathearn is considerably narrower and less extensive. Furthermore, the River Earn is a more evident feature in the landscape, its broad meanders swinging back and forth across the floodplain. The strath also accommodates a railway and the main A9 dual carriageway. Where the woodland structure is thin, the road and its traffic are very visible. Overall, however, the strath retains a rich, well-wooded agricultural landscape, particularly towards the east.

5.10.7 Strathallan extends from Greenloaning towards Auchterarder. Although the scale is similar to that of Strathearn, the landscape is very much more open, forming a shallow valley between the lowland hills to the north and the smooth, largely unwooded slopes of the Ochils to the south. Arable cultivation predominates and woodland is generally limited to dense, geometric blocks of conifers. In this large-scale, open landscape, this woodland appears sculptural, almost comparable to fields of crops. Along the floor of the strath, the local topography is complex, resulting from extensive fluvio-glacial deposits. Drumlin fields create a landscape of hummocks and small basins. Areas of glacial sands and gravels have been quarried, leaving a network of small lochs.

5.10.8 The Pow Water valley, lies between the Gask Ridge and the lowland hills of the Keillour Forest. It is a shallow, small-scale agricultural valley, with field and woodland patterns similar to those of the larger lowland valleys. Much of the valley floor has been drained to provide pastures and arable land.

5.10.9 The valleys of the Rivers South Esk and North Esk form a broad area of lowland to the south of the Highland Boundary Fault and enclosed to the south by the high ground to the east of Forfar. Although sometimes included within the broad definition of Strathmore to the west, this area drains eastwards and is separated from Strathmore by a low watershed around Kirriemuir. More significantly, perhaps, this area is distinguished by its smaller scale, higher proportion of woodland (both broad-leaf and coniferous) and by the well-defined river corridors of the two Esks. The rivers are identified by lines of riverside trees, and by inner terraces. They are separated by a low ridge. Like other straths, the valleys are in both pastoral and arable use.

FORCES FOR CHANGE

5.10.10 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.10.11 **Agriculture.** Reflecting the dominance of agriculture within this landscape type, it is changing farming practices which have brought the most significant changes to the areas of Broad Valley Lowlands. The principal agents of change have included:

- intensification of arable production;
- concentration on potato growing;
- introduction of 'new' crops and forms of production.

The landscape effects of these changes are described below.

5.10.12 Over recent decades the national policies, allied to the Common Agricultural Policy (CAP), encouraged the expansion of arable production. This was achieved by greater mechanisation, the more extensive use of inputs such herbicides and fertilisers, and a range of capital improvements designed to maximise the area under cultivation. These improvements included some hedgerow removal to create larger fields. Allied to this was a tendency not to replace the once-dense network of hedgerow trees where they resulted in uneven patterns of cereal growth or ripening as a result of shading or water demand. Field boundary trees are also regarded as a liability as they become over-mature and drop branches or suffer wind blow. New techniques also allowed the more intensive use of land throughout the year with the introduction of a wider range of winter crops.

5.10.13 Although the pattern of change has been uneven within the Broad Valley Lowlands, with some estates deliberately conserving the structure of fields, boundaries and boundary trees, and the emphasis of agricultural policies has shifted towards a stabilisation or reduction in cereal production, in some areas the landscape has been denuded of its tree-cover, creating a prairie-like appearance. This weakens the otherwise rich and textured character of many of these lowland areas and dilutes the contrast between the productive, well-treed lowlands and the harsher highlands. It also renders other landscape features such as roads, traffic and buildings much more visible.

5.10.14 Allied to cereal production has been the expansion of potato growing, particularly within Strathmore. Growth and harvesting of this crop sits easily within the farming landscape. There has, however, been a significant increase in the number and scale of agricultural buildings as a result. After harvesting, potatoes are typically stored until market conditions favour selling some months later. Many farms in the straths now include a number of very large modern sheds which overtower the older farm buildings and which are often visible over a considerable distance. They are frequently painted white.

5.10.15 Recent decades have also seen a diversification of arable production with the introduction of new crops, principally oil seed rape. The vivid yellow of this crop during flowering creates a very visible and often extensive feature in the landscape. While opinions are mixed about the nature of this impact, it is comparatively short-lived. Other changes in agricultural practice include the move towards free-range stock keeping, particularly of pigs in areas of lighter soils. The animals are typically brought onto cereal fields after harvesting and are allowed to roam within areas delineated by electric fences. While many welcome the more humane treatment of such animals, the landscape impact of over-grazed fields and the scatter of metal pig arcs could be of concern if this practice expands significantly.

5.10.16 **Transport.** Several of the Tayside straths incorporate major roads which enjoy comparatively level routes through the Broad Valley Lowlands. The A9 primary route, which is dual carriageway for much of its length, runs along Strathallan and Strathearn, while the A94 runs through Strathmore. The large scale of the straths means that the impact of these major roads is less than it might otherwise have been. The broad curves and sinuous alignments seem to echo the generous proportions of the landscape. Having said that, the road structures (including embankments, cuttings and overbridges) are clearly impositions upon the lowland agricultural landscape. There appears to have been little attempt to use either roadside or off-site planting to integrate the roads into the broader structure of the landscape.

5.10.17 The noise and movement of traffic using these routes have a major influence on the character of the local landscape in areas adjoining the roads. Such roads also result in an increase in pressure for development, particularly around junctions and where pockets of land are trapped between settlements and the road corridor. The future impact of the roads is likely to increase as traffic grows and there is pressure to upgrade junctions to provide grade separated access.

5.10.18 More minor roads also raise concerns, including:

- the landscape impact of village bypasses (e.g. the A94 at Glamis) both in terms of the road itself and the view of the settlement from the road;
- the failure to re-establish hedges and hedgerow trees where widening schemes have been implemented;
- the increasingly common practice of including concrete kerbing along the edges of minor rural roads, introducing a suburbanising influence into the countryside.

5.10.19 **Development.** Most development within the lowland straths is concentrated within existing settlements. These include historic market towns such as Rattray, Forfar and Brechin, which have grown at the crossroads of important routes and which often provide gateways to upland areas, and a series of smaller agricultural villages, many of which were established in the 18th and 19th centuries following enclosure, agricultural improvement and the arrival of the railways. Many of these settlements are closely associated with the surrounding landscape, both in terms of the materials that are used (typically red sandstones among older buildings) and their market function. Development outside these settlements is comparatively limited, confined to farmsteads and a scatter of agricultural dwellings.

5.10.20 As noted elsewhere in this report, older settlements make use of local building materials and reflect local building vernacular. More recent developments on the edge of settlements (for example that to the south of Glamis) tend to owe little to local tradition, often comprising low density estates of houses built in a style that can be found throughout the UK. Future decades are likely to see continued demand for residential development, potentially increasing the impact of new development on the landscape. There may be scope to focus new development within some of the 19th century 'planted' villages, many of which never reached their anticipated size. Alternatively, there may be potential to echo the Victorian movement and create a small number of new villages in key locations.

5.10.21 **Minerals.** The lowland straths include substantial deposits of fluvio-glacial material, some of which has been exploited to provide material for building. Sites currently being worked include those to the west of Auchterarder in Strathallan (where a series of lochans have been formed in worked-out areas) and near Kingsmuir, immediately to the east of Forfar. Although such workings inevitably have a local landscape impact, their broader effect is limited. This would change if it proved viable to expand mineral working more broadly.

5.10.22 **Forestry and woodland.** The fertile nature of these lowland areas, and the consequent dominance of agriculture, means that woodland is limited in extent. The exceptions include:

- the rich legacy of hedgerow trees, many of which are up to 200 years old;
- the less fertile Strathallan where geometric plantations of conifers are found;
- the policy woodlands associated with major estates;
- the native birch woodland found on the pockets of unimproved land within the straths.

5.10.23 The issue of hedgerow trees is closely allied to agricultural change and, as such, has been discussed above. However, it is worth noting that even where such trees survive, they are now reaching maturity or are even over-mature. Phased replanting and felling will be required if the stock of trees is not to dwindle further.

5.10.24 As noted above, the large-scale and rectilinear landscape of Strathallan means that it is one of the few parts of Tayside where rigidly geometric conifer plantations do not appear out of place. Policy woodland is an important aspect of a landscape where woodland cover is decreasing. Retention and management should be encouraged. The fragments of native birch woodland should be conserved for their natural heritage value and because of the insight they provide as to the landscape which would have prevailed prior to enclosure.

5.10.25 **Tall structures.** Tall structures such as masts or wind turbines are unlikely to present a significant threat to the landscape within the Broad Valley Lowlands. However, it is possible that further proposals may come forward for developments on higher ground adjoining the valleys. These could have an impact on the character of the straths. It is also possible that proposals for additional power lines may come forward over time, particularly since this would avoid more exposed upland areas and would achieve 'backclothing' of pylons against the hills.

LANDSCAPE GUIDELINES

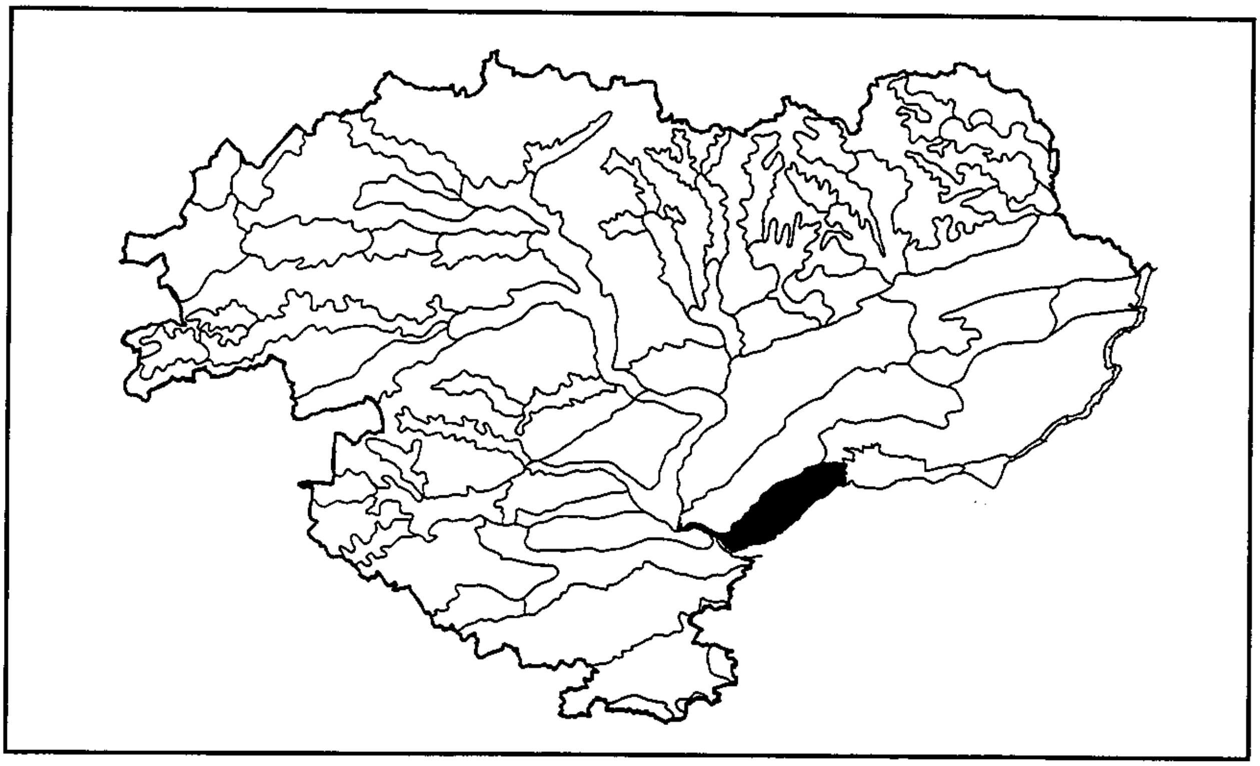
5.10.26 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve and restore the characteristic landscape of hedged fields, hedgerow trees, avenues and policy woodlands. It is important to maintain the contrast between the rich lowland landscapes and the neighbouring areas of harsh upland and enclosed glen.

Agriculture	• discourage improvements which result in further loss of field boundaries or field boundary trees; • encourage farmers and landowners to replant trees along field boundaries, initially along roads, but also between fields; species to include oak, sycamore, beech and ash; use incentives to compensate for lower yields where mature trees are retained; • explore the opportunities to increase woodland cover by creating new woodland belts, particularly where there is a need to screen development; • explore development of market for hardwood from field boundary trees; • discourage over-concentration of oil seed rape and similar crops; • monitor growth of open air pig keeping; • use the agricultural development notification scheme to influence the design, materials, screening and location of new farm buildings; explore the use of planning conditions attached to new buildings to re-establish hedgerow trees.

Transport	• Encourage on-site and off-site planting to better integrate major roads into the landscape and to provide screening of traffic. • Ensure that further proposals for improvements such as dualling or the provision of grade separated junctions are assessed in terms of their wider landscape impact. Where major, unmitigatable impacts exist, explore alternative solutions including traffic management and traffic calming. • Where new bypasses are proposed, consider the severing effect of the road on its setting. Consider also the view of settlements from the new road. • Where road improvement schemes take place, ensure that hedges and hedgerow trees, together with other features such as milestones, finger posts and gates are reinstated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives.
Development	• Encourage new development to reinforce the existing settlement pattern, focused on market towns and smaller villages. • New residential development should respond to the morphology of existing settlements (e.g. nucleated market settlements, grid-iron 19th century new villages). Explore the need and scope for a small number of new villages, echoing those established in the 19th century. • Encourage developers to use local building materials and to adopt local vernacular in respect of density, massing, design, colour and location. While red sandstones predominate, there are local variations which reflect subtle changes in the character of the local geology. Avoid standard designs and layouts. Consider the preparation of design guides as supplementary planning guidance.
Minerals	• Monitor future demand for mineral working. Ensure that any schemes that come forward are restoration-led and are located so as to minimise landscape impacts during operation.
Forestry and woodland	• As a matter of urgency, encourage a phased programme of replanting, managing and, where necessary, felling hedgerow trees, so as to maintain and restore the historic legacy of strath trees. • Maintain, where appropriate, the rectilinear woodland areas in Strathallan. Elsewhere, discourage significant and extensive new afforestation. • Retain and manage surviving pockets of native birch woodland. • Examine the potential to create an integrated pattern of new small woodlands and woodland belts in the most open areas.

Tall structures	• Assess proposals for aerials, masts or wind turbines in terms of their visual and landscape impact on the lowland straths. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape. • Underground cable solutions should be considered in preference to pylon lines across the arable landscape.

FIRTH LOWLANDS (11)



KEY CHARACTERISTICS

- *predominantly flat, fertile area*
- *enclosed by the steep Sidlaws escarpment to the north and bounded by the Firth of Tay to the south*
- *estuarine reed-beds and mudflats*
- *large rectangular fields*
- *decaying structure of hedges and hedgerow trees*
- *well-settled with some urban influences*

OBJECTIVE DESCRIPTION		Firth Lowlands
Physical scale		Relatively flat area bordering Firth of Tay, lying at between about 10 and 50 metres AOD
Woodland	broad-leaf	Trees mainly limited to field boundaries, shelterbelts and policy woodlands; historically an orchard area
	coniferous	Limited to a few areas of policy woodland
Agriculture	arable	Extensive areas of arable land
	pasture	Relatively little pasture land
	fields	Large and rectilinear
	field boundaries	Gappy hedges, post-and-wire fences and wet ditches; decaying structure of hedgerow trees
Settlement pattern		Nucleated settlements on higher ground and a scatter of large farmsteads on tracks leading from principal roads
Building materials		Red sandstone and harder igneous rocks from Sidlaws
Historic features		Castles, historic houses and designed landscapes
Natural heritage features		Reed-beds and mudflats
Other landscape features		Communication corridors, disused airfield etc.
SUBJECTIVE DESCRIPTION		
Views		Corridor
Scale		Medium
Enclosure		Open
Variety		Simple to varied
Texture		Smooth
Colour		Colourful
Movement		Active
Unity		Fragmented to interrupted
'Naturalness'		Tamed

LOCATION

5.11.1 Along the northern side of the Firth of Tay, between Perth and Dundee lies an area of estuarine lowland known as the Carse of Gowrie. Bounded to the north by the steep escarpment of the Sidlaw Hills, the area forms one of the most fertile parts of Scotland.

PHYSICAL CHARACTERISTICS

5.11.2 The Carse of Gowrie is underlain by Upper Old Red Sandstone and a smaller area of Carboniferous limestone which occurs in the vicinity of Errol. The bedrock, however, is buried beneath a thick capping of superficial deposits, laid down by retreating ice sheets, and by the estuarine and marine deposition. Though the area would once have been subject to frequent tidal flooding, the upward movement of the land mass following the melting of ice sheets means that this no longer occurs. The area averages about 10 metres AOD, rising to a maximum of 50 metres AOD at Errol. The edge of the estuary is often marked by a distinct bank before extensive reed-beds and mudflats are reached. In this flat landscape the sky forms an important part of the landscape and the character can change with the pattern of cloud cover the nature of the light.

SETTLEMENT AND LAND USE

5.11.3 This is a well-settled area, with a number of villages and a scatter of farmsteads and hamlets. Some of the more historic settlements are sited on low hills or slight rises in the otherwise level landscape. A number of castles (e.g. Castle Huntly and Megginch Castle) point to the need to defend the area in the past. The designed landscapes and policies of Castle Huntly and Errol Park also contribute to the landscape. The subdued topography of the area presents no obstacle to communications and roads and railways generally follow straight or geometric lines. Minor roads feed off the main routes at ninety degrees. The area has a history of apple growing with blossoms from surviving orchards characterising the area during the spring. Other past activities include the manufacture of bricks and pipes from local clay at Errol.

5.11.4 The Carse of Gowrie is principally an agricultural area and the landscape is dominated by large, geometric fields. Field boundaries within parcels of land are often absent, the distinction between different fields being marked by drainage ditches or simply by changes in crop. Hedges and hedgerow trees are more common along roads and tracks, though even here many hedges, though trimmed, have become gappy, and lost trees have not been replaced. Historically, the area was an important orchard area but much of this has disappeared though locally important remnants remain. The reed-beds near Errol are one of the largest commercial sources of thatching reeds in the UK.

FORCES FOR CHANGE

5.11.5 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.11.6 **Agriculture.** Farming on the Carse of Gowrie has long been dominated by arable cultivation. Over the years, much of the land has been drained and many fields enlarged to allow the use of modern machinery. Those hedges that remain are often sparse and gappy, with only a few remnants of what would once have been an extensive population of hedgerow trees. The remnant orchard areas, particularly around Errol, contribute a splash of blossom in springtime.

5.11.7 **Transport.** Comprising the only area of flat land linking Perth and Dundee, the area has developed as a transport corridor accommodating the A90(T) - which has been upgraded to dual carriageway standard - and a railway line. The A90, in particular, has a significant impact on this landscape, partly because of the large-scale and unscreened nature of the road itself, and partly because of the large volume of fast-moving traffic moving along it. The further upgrading of the road to include a number of grade separated junctions (Glendoick, Inchmichael and Inchture), while improving safety, is likely to result in increased landscape impacts and may lead to the development of roadside service facilities.

5.11.8 A further detracting feature is the disused airfield to the east of Errol. Options considered for this site include mixed industrial, business and aviation uses and a new settlement expansion for Errol. Out of necessity, these potential uses are being proposed in response to the presence of a derelict site rather than the character of the surrounding landscape. It appears inevitable that the redevelopment of this site will contribute to the increase in urban influences within this landscape type. Even if development is screened from view it is likely to result in traffic generation, altering the character of country roads in the area.

5.11.9 **Development.** The location of this landscape type between Perth and Dundee means that there has been considerable pressure for housing development. While some of this pressure has been accommodated within settlements such as Inchture, Errol and St Madoes, elsewhere it has resulted in a dispersed pattern of development (e.g. around Grange) and the growth of some ribbon developments (e.g. Walnut Grove). As noted above, the disused airfield near Errol is being considered as a potential new settlement location. While this could allow dereliction on the site to be addressed, it would comprise a significant increase in the level of development in this traditionally rural area.

5.11.10 **Forestry and woodland.** Commercial forestry is absent in this productive agricultural area and woodland cover is confined to a declining population of hedgerow trees and shelterbelts and policy woodlands associated with the Errol estate. As noted above, the survival of hedgerow trees and remnant orchards is a particular concern.

5.11.12 **Tall structures.** The area is crossed by two lines of electricity pylons, adding further to the urban influences along the Firth Lowlands.

5.11.13 **Climate change.** Changing sea levels could have an impact on the Firth Lowlands landscape in the medium term. The extent of mudflats and reed-beds could be squeezed as low water levels rise, but productive farmland is protected by tidal defences. In the longer term, there may need to be a choice between expensive flood defences and 'managed retreat'. The latter accepts that the frequency and extent of tidal inundation is likely to increase and modifies land uses accordingly. Within the Firth Lowlands the density of settlement, even on land below 10 metres AOD, and the productivity of the land, are likely to preclude this approach.

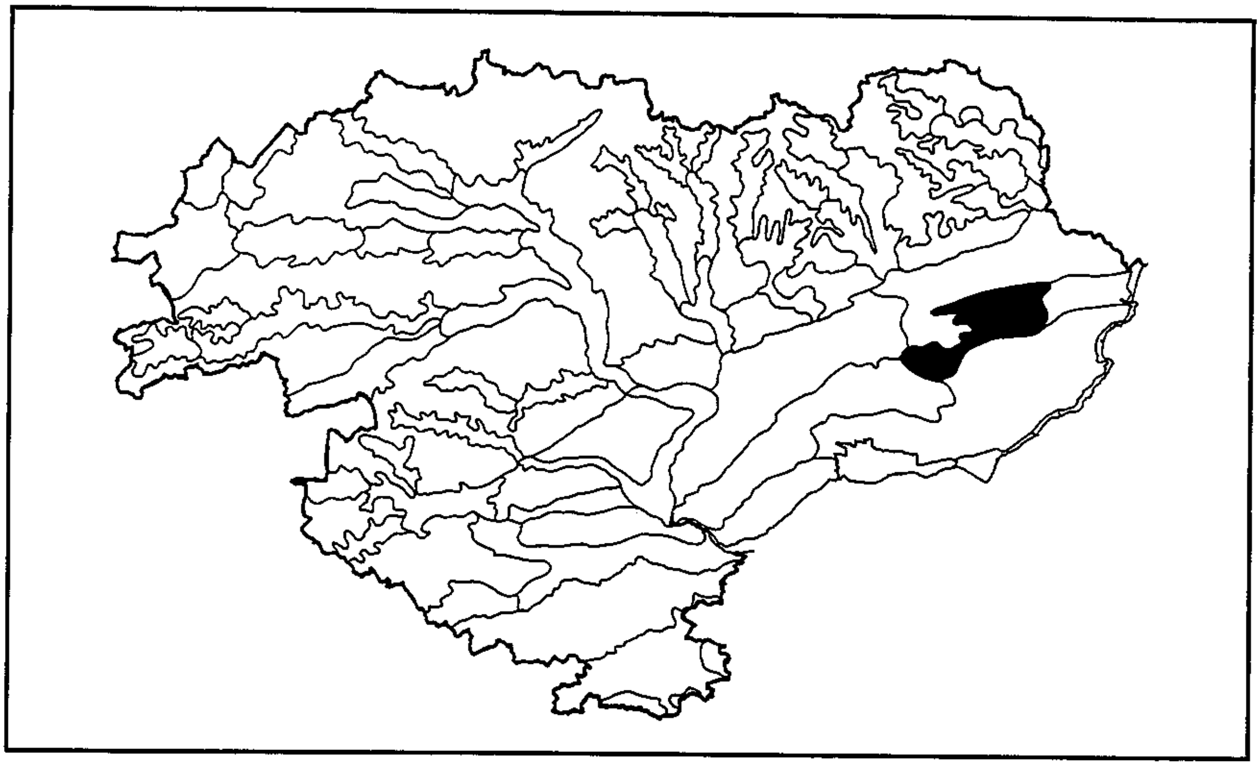
LANDSCAPE GUIDELINES

5.11.14 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve and restore the characteristic landscape of hedged fields, hedgerow trees, avenues and policy woodlands. The rural character of the Firth Lowlands should be restored by addressing inappropriate developments and land uses that have taken place in the past.

Agriculture	• Discourage improvements which result in further loss of field boundaries or field boundary trees. • Encourage farmers and landowners to replant trees along field boundaries, initially along roads, but also between fields. Species to include oak, sycamore, beech and ash. Use incentives to compensate for lower yields where mature trees are retained. • Explore the opportunities to increase woodland cover by creating new woodland belts, particularly where there is a need to screen development. • Encourage the maintenance of the remnant orchards in the Carse for their historic importance and local landscape significance. • Use the agricultural development notification scheme to influence the design, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to re-establish hedgerow trees.

Transport	• Encourage on-site and off-site planting to better integrate major roads into the landscape and to provide screening of traffic. • Ensure that further proposals for the provision of grade separated junctions are assessed in terms of their wider landscape impact. Where major, unmitigatable impacts exist, explore alternative solutions including traffic management and traffic calming. • Where road improvement schemes take place, ensure that hedges and hedgerow trees, together with other features such as milestones, finger posts and gates are reinstated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives.
Development	• Encourage new development to reinforce the existing settlement pattern, focused on market towns and smaller villages. • New residential development should respond to the morphology of existing settlements. Examine how a new settlement could be accommodated within the existing landscape, road network and settlement hierarchy. • Encourage developers to use local building materials and to adopt local vernacular in respect of density, massing, design, colour and location. Avoid standard designs and layouts. Consider the preparation of design guides as supplementary planning guidance.
Forestry and woodland	• Introduce incentives to retain and regenerate the existing orchard remnants. • As a matter of urgency, encourage a phased programme of replanting, managing and, where necessary, felling hedgerow trees, so as to maintain and restore the historic legacy of trees.
Tall structures	• Assess proposals for aerials, masts or wind turbines within and around the Firth Lowlands, in terms of their visual and landscape impact. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape.
Climate change	• Monitor long-term changes in climate so as to anticipate and plan for any implications for the landscape.

LOW MOORLAND HILLS (12)



KEY CHARACTERISTICS

- *eastern outliers of the Sidlaws*
- *combination of low, rounded hills and craggy, ridged upland*
- *moorland character evident in areas of heather and gorse*
- *some areas of extensive woodland*
- *rich historic heritage*
- *scattered modern settlement*

OBJECTIVE DESCRIPTION		Low Moorland Hills
Physical scale		Series of east-west ridge-like hills with sharply defined northern edge and gentler eastern slopes; hills rise to 200 to 250 metres AOD
Woodland	broad-leaf	Very limited
	coniferous	Extensive plantation at Montreathmont Forest
Agriculture	arable	Some arable on gentler and lower eastern slopes
	pasture	Extensive pastures, much of it rough and heathy in character on the upper slopes
	fields	Medium-sized, rectilinear where topography allows
	field boundaries	Hedges with some stone walls and post-and-wire fences
Settlement pattern		Scatter of isolated farmsteads, no villages
Building materials		Red sandstone
Historic features		Hill-forts, Pictish stones
Natural heritage features		No notable features
Other landscape features		Masts and pylons
SUBJECTIVE DESCRIPTION		
Views		Panoramic
Scale		Medium
Enclosure		Open
Variety		Simple
Texture		Rough to very rough
Colour		Muted
Movement		Remote
Unity		Interrupted
'Naturalness'		Restrained

LOCATION

5.12.1 To the east and south of Forfar lie a series of hills, forming low, eastern outliers of the Sidlaws. We refer to these as the Forfar Hills. The hills can be divided into two sub-groups. Firstly there is a series of isolated, rounded hills. These include Dunnichen Hill and Fothringham Hill. Secondly there is the more continuous area of upland centred on Montreathmont Moor, which culminates in sharp ridges overlooking Forfar.

PHYSICAL CHARACTERISTICS

5.12.2 These hills comprise a combination of the more resistant components of the Old Red Sandstone series and areas of volcanic rocks. The resistant sandstone is clearly visible where crags form outcrops on the Hill of Finavon and Turin Hill. Elsewhere, however, the landform is rounded and smooth. Along the southern side of the River South Esk the northern boundary of the resistant lavas is visible as a steep, straight escarpment running west from the coastal cliffs south of Montrose towards Farnell. Rescobie Loch and Balgavies Loch, both of which are of importance for nature conservation, lie in a narrow valley between Turin Hill and Dunnichen Hill. These lochs feed the Lunan Water which flows eastwards to the coast.

SETTLEMENT AND LAND USE

5.12.3 Although lying just 100-150 metres above the surrounding lowland farmland, these hilltops have a very different character, in part reflecting their more recent reclamation and improvement. In agricultural terms, the ridges of the Dunnichen Hill, Hill of Finavon and Turin Hill are categorised as Class 6(2) compared with the surrounding farmland which falls into Classes 3 or even 2. The poorer nature of the eastern part of these hills is reflected in their heathy character (including the survival of gorse and bracken along field boundaries), the existence of large areas of coniferous woodland (other lowland is regarded as being too productive to put into woodland) and the presence of wetland areas. Place names such as Muirton, Muirside, Mostonmuir and Rossie Moor all point to the past or current heathland character.

5.12.4 Settlement on the Low Moorland Hills is limited to a dispersed pattern of farmsteads on the unforested part of Montreathmont Moor. However, there is extensive landscape evidence of earlier phases of human activity. This includes the dramatic Iron Age hill-forts sited on the craggy summits of the Hill of Finavon and Turin Hill. Nearby, at Aberlemno, are some of the finest examples of Pictish sculptured stones and crosses in southern Scotland. Also near Aberlemno stands Melgund Castle, a 16th century, four storey stronghold. The concentration of these sites, spanning two millennia, points to the significance of these hills, marking the divide between the lowland route of Strathmore and the coastal lowlands to the south. Modern encroachments onto these hills are limited to a handful of telecommunications masts. Extensive sand and gravel working takes place at the western foot of Turin Hill, and there were recent proposals to extract igneous rock from Dunnichen Hill. The hilltops provide fine viewpoints looking northwards across the valley lowland to the Highland Foothills and the Highlands themselves.

FORCES FOR CHANGE

5.12.5 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.12.6 **Agriculture.** The poorer nature of the soils of the Low Moorland Hills is reflected in the pattern of agriculture with arable on some of the lower slopes giving way to enclosed pastures and eventually, in the case of the more poorly drained areas, to rough moorland grazing. Historically, it is likely that improvements brought by drainage, reseeding and the application of fertilisers has resulted in a reduction in the extent of rough moorland and an increase in the area of enclosed pasture and arable land. This, allied to the effects of afforestation, means that only fragments of the former landscape survive.

5.12.7 On lower slopes, this landscape type shares the structure of hedgerows and hedgerow trees that is found in the Broad Valley Lowlands and elsewhere. As in these areas, the population of trees is declining as replanting is not undertaken.

5.12.8 Many farms in the foothills have constructed modern agricultural buildings such as sheds and barns. These are generally of a smaller scale than those found in the lowland straths but can have a visual and landscape impact where the screening effect of woodland is absent.

5.12.9 **Transport.** The moorland hills have a network of main and minor roads. Although often very straight, these generally fit with the grain of the landscape. Existing coniferous plantations provide a degree of screening.

5.12.10 **Development.** Development within the Low Moorland Hills is very limited. It has been concentrated instead in lowland settlements such as Forfar, Letham and Friockheim.

5.12.11 **Minerals.** There have been proposals in the past to establish quarries at Dunnichen Hill. The proposals were withdrawn in response to local opposition, but it is possible that modified plans may come forward in the future. If mineral working is permitted it should be subject to the following terms:

- full environmental assessment to address, in particular, issues to do with landscape impact and the cultural environment;
- advance on and off-site planting to provide adequate screening around the site;
- full restoration proposals, re-creating the existing landform, and landscape features such as hedges and woodland.

5.12.12 **Forestry and woodland.** The elevation, soils and prevailing climate of the Low Moorland Hills makes them well-suited to commercial forestry. This is reflected in the Tayside Indicative Forestry Strategy which categorises parts of this landscape type as being 'preferred' or 'potential' areas for new planting. The area already includes an extensive area of plantation woodland at Montreathmont Forest and Moor. Taking a regional perspective it is evident that these hills are relatively free from the constraints associated with the most productive agricultural land and the sensitive highland areas. Furthermore, the plateau-like summit of the hills means that often it is only the edge of the existing plantation woodland that is seen, concealing its true extent. While there is scope for new planting, this needs to take into account:

- the scale of new planting relative to the landform and the proportion of unplanted land;
- species composition;
- relationship with existing semi-natural or planted woodland;
- retention of key views within and outwith the hills;
- opportunities to conserve or recreate areas of low moorland within the woodland;
- size of felling coupes;
- factors such as agricultural viability, nature conservation and historic sensitivities.

5.12.13 These issues, together with concerns regarding the restocking of existing woods, are addressed by Forestry Authority woodland design guidance, and are summarised in the landscape guidelines presented at the end of this section.

5.12.14 **Tall structures.** The Low Moorland Hills have a number of tall structures, principally a series of masts on Fothringham Hill, Dunnichen Hill, Hill of Finavon and Montreathmont Moor, and the line of electricity pylons running from north of Forfar towards Brechin. There is also pressure for additional masts to serve the cellular telephone industry, particularly along the A90.

5.12.15 With the development of modern wind turbines to generate power, it is possible that this area may come under pressure for wind farm development. Though wind speeds are likely to be significantly lower than in more elevated parts of the Highlands or the Sidlaws/Ochils, it is possible that the lower level of perceived constraint, together with the proximity to the existing electricity distribution network, could favour this area. This would be even more likely if the efficiency of wind turbines continues to improve, thereby making areas with lower wind speeds viable. It would be worth examining the scope for accommodating wind turbines within forested (and serviced) areas such as Montreathmont Forest.

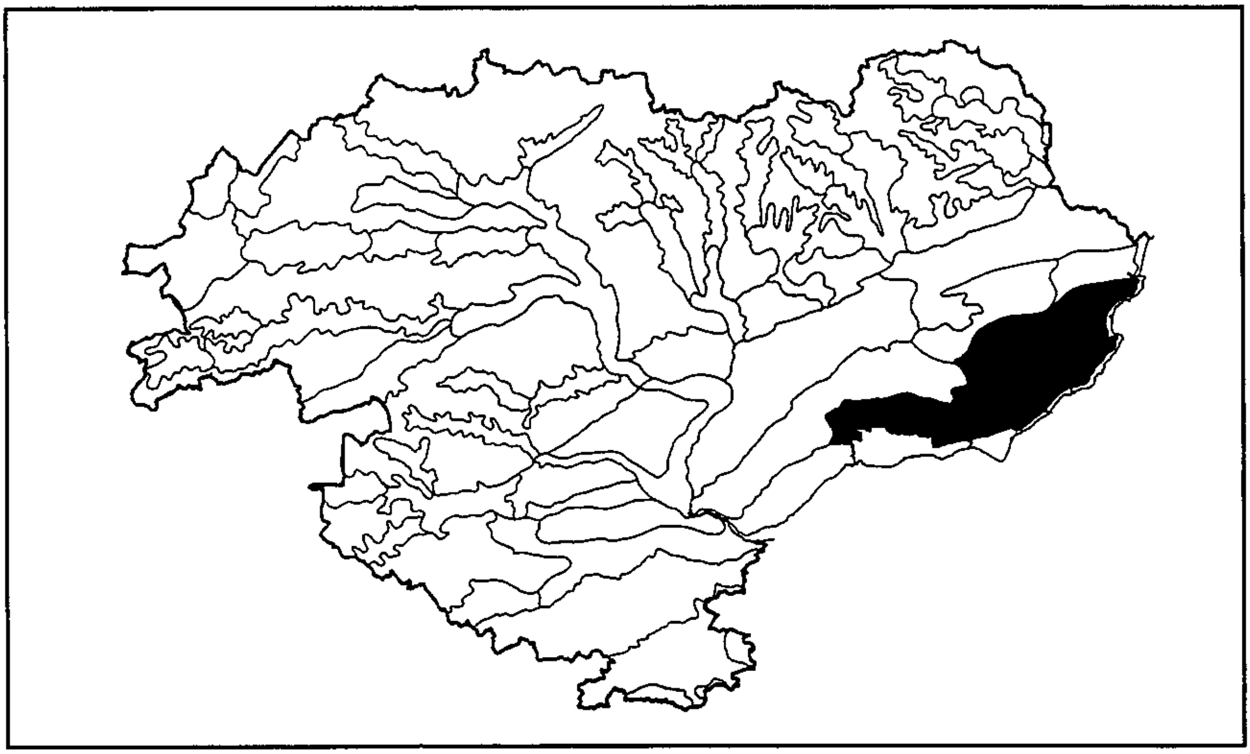
LANDSCAPE GUIDELINES

5.12.16 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the semi-moorland character of these hills, maintaining the contrast with more fertile lower lying areas.

Agriculture	• Encourage farmers and landowners to maintain and replant trees and farm woodlands. Species to include oak, maple, beech and ash. • Use the agricultural development notification scheme to influence the design, colour, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to provide screening where appropriate.
Transport	• Where more minor road improvement schemes take place, ensure that hedges, hedgerow trees, gates and other features are re-instated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives. • Develop a road use hierarchy as a basis for management.
Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the rural character of other parts of the lowland glens. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Encourage the appropriate conversion of redundant farm buildings. Guidance should be provided on the way buildings should be converted (including the provision of drives, gardens etc.) to prevent the suburbanisation of the countryside.
Minerals	• Ensure that proposals for mineral working are subject to thorough environmental assessment and that they are accompanied by full restoration proposals. • Ensure adequate on and off-site screening during the operation of any sites that are granted consent.

Forestry and woodland	• New planting should conform to the Forestry Authority's design guidelines. In particular, it should respond to the small-scale nature of the landscape, complex topography, the importance of views within and out of the hills, and historic and ecological values. • With respect to the replanting of existing plantations: - adopt a more naturalistic appearance, responding to the landform and features such as burns and small valleys; - create graded and irregular margins at the top and bottom of the slope, allowing views of upper slopes from within the glen; - discourage straight lateral edges - do not plant up to the edge of a land holding where this creates a strong and geometric vertical line;. - employ more varied species mixes; - vary the size of felling coupes, with smaller areas on lower slopes; - retain open heathy glades within the woodland.
Tall structures	• Assess proposals for aerials, pylons or masts in terms of their visual and landscape impact on the local landscape, including historic sites, and the broader landscape. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape. • Encourage the development of a regional strategy for renewable energy, including wind power, in order that the most appropriate types of development and areas come forward.

DIPSLOPE FARMLAND (13)



KEY CHARACTERISTICS

- *extensive area of land, generally sloping from the north-west to the south-east*
- *dominated by productive agricultural land*
- *low woodland cover, except on large estates and along river corridors*
- *variety of historic sites*
- *dispersed settlement pattern, including some suburban development*
- *limited visual impact of Dundee and Arbroath*

OBJECTIVE DESCRIPTION		Dipslope Farmland
Physical scale		Extensive area of land sloping towards the coast from north-west to south-east; range in height from about 150 metres to 50 metres AOD
Woodland	broad-leaf	Shelterbelts and hedgerow trees
	coniferous	Shelterbelts, policy woodlands and areas of woodland associated with designed landscapes; highly variable cover
Agriculture	arable	Extensive arable production - very fertile land
	pasture	Limited pastureland
	fields	Medium to large, rectilinear
	field boundaries	Many field boundaries absent, others marked by hedges or post-and-wire fences
Settlement pattern		Scatter of hamlets and farmsteads
Building materials		Traditional use of sandstones and harder stone from the Sidlaws
Historic features		Souterrains, castles, mills, historic houses and designed landscapes
Natural heritage features		No notable features
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Intermittent
Scale		Medium
Enclosure		Semi-enclosed to open
Variety		Simple
Texture		Textured to smooth
Colour		Colourful
Movement		Peaceful
Unity		Interrupted
'Naturalness'		Tamed

LOCATION

5.13.1 To the south-east of the Sidlaws and the Forfar Hills lies an extensive area of farmland sloping gently towards the Angus coast.

PHYSICAL CHARACTERISTICS

5.13.2 The area is dominated by Lower Old Red Sandstone, though there are patches of igneous rocks, forming low outliers of the Sidlaws. The area falls from up to 180 metres in the north-west to about 50 metres along the coastal strip. The dipslope blends almost imperceptibly into the southern slopes of the Sidlaws and Montreathmont Hills.

SETTLEMENT AND LAND USE

5.13.3 This is one of the most fertile and productive agricultural areas in Scotland, with much of the land being categorised as Classes 1 or 2. It is not surprising, therefore, that intensive agriculture, based on cereals, is the dominant land use. Fields tend to be large and rectilinear. Woodland cover is low or even absent in some areas, particularly closest to the coast, creating an open, exposed landscape in places. Elsewhere, particularly on some of the larger estates more extensive woodland survives, comprising a mixture of shelterbelts (for example stands of Scots pine or beech) and hedgerow trees. Where these survive, the landscape is enclosed and structured. Often the trees are wind-trimmed and bent slightly away from the coast. Semi-natural woodland is limited to steeper valley sides, for example along the Lunan Water.

5.13.4 Despite the intensive pattern of agriculture, the area has a range of archaeological and historic sites. These include Bronze Age burial sites such as that at Dickmountlaw just to the north of Arbroath, a number of souterrains (for example at Grange of Conon near Redford and in Arbroath), Roman sites such as the camp at Kirkbuddo near Whigstreet, and medieval castles including Braikie Castle and Gardyne castle near Friockheim and Colliston Castle to the south. Designed landscapes are also important in this area. A dense scatter of more recent farmsteads is supplemented by a number of isolated houses, reflecting the proximity to Dundee and Arbroath. Both settlements are, however, relatively well-hidden in this otherwise open landscape. Dundee is screened from the north by a ridgeline running parallel to the Firth of Tay, while Arbroath occupies lowland at the mouth of a shallow valley.

FORCES FOR CHANGE

5.13.5 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.13.6 **Agriculture.** The fertile and productive nature of this area is reflected in the dominance of agriculture, particularly cereal production and the low level of woodland cover. Many fields have been enlarged and the structure of hedges and hedgerow trees, as elsewhere, is declining. Many farms in the foothills have constructed modern agricultural buildings such as sheds and barns and, while these are generally of a smaller scale than those found in the lowland straths, the reduction in woodland cover means that they are often visible over a considerable distance.

5.13.7 **Transport.** The Dipslope Farmland has a network of main and minor roads. These are generally small-scale and fit with the grain of the landscape. The exception is the A90(T) corridor which runs north from Dundee. The road and its traffic has a considerable landscape and aural impact.

5.13.8 **Development.** The Dipslope Farmland landscape type has few settlements of any size, since most tend to be located along the coast. However, as noted above, the proximity to Dundee and Arbroath is reflected in the number of isolated modern dwellings or groups of dwellings that are found throughout the area. Many of these are associated with existing farm buildings or hamlets. However, designs are usually suburban in character, and their sites chosen to maximise the view rather than minimise landscape impact. Planning policies in Angus have allowed a certain amount of development in the open countryside as a means of stabilising and reversing economic and social decline. A similar policy applied in part of Dundee prior to local government reorganisation in 1996. By way of contrast, the urban edges of Dundee and Arbroath, while abrupt, are comparatively well-screened by the landform and have little impact on the wider landscape.

5.13.9 **Forestry and woodland.** As noted above, woodland cover within this landscape type is limited, comprising small copses (often located on pockets of less productive land), surviving hedgerow trees, and the shelterbelts and policies of estates and designed landscapes. The area is similar to the lowland straths in that the influence of individual estates on woodland management is evident. Some areas retain structural woodland, creating landscape rooms, and providing screening for development in the countryside while others are almost completely open. The importance of restoring tree cover in the latter areas was recognised by the Dundee Rural Areas Local Plan (City of Dundee District Council, 1994) which encouraged woodland planting particularly in the Tealing Area. The Rural Angus Local Plan (Angus District Council, 1991) contained similar policies. Agricultural factors suggest that large-scale afforestation is unlikely to happen in this area.

5.13.10 **Tall structures.** This low-lying area is comparatively free from tall structures with the exception of the electricity transmission lines which serve Dundee and Arbroath. It is possible that there may be pressure for additional masts, particularly in the vicinity of major roads, as telecommunications traffic grows.

LANDSCAPE GUIDELINES

5.13.11 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve and restore the rural character of the Dipslope Farmland landscape type, and to reduce the range of urban influences upon it.

Agriculture	• Discourage improvements which result in further loss of field boundaries or field boundary trees. • Encourage farmers and landowners to replant trees along field boundaries, initially along roads, but also between fields. Species to include oak, sycamore, beech and ash. Use incentives to compensate for lower yields where mature trees are retained. • Explore the opportunities to increase woodland cover by creating new woodland belts, particularly where there is a need to screen development. • Explore development of market for hardwood from field boundary trees. • Discourage over-concentration of oil seed rape and similar crops. • Use the agricultural development notification scheme to influence the design, materials, screening and location of new farm buildings. Explore the use of planning conditions attached to new buildings to re-establish hedgerow trees.
Transport	• Where necessary, explore opportunities to provide additional on- and off-site screening of major roads. • Where more minor road improvement schemes take place, ensure that hedges, hedgerow trees, gates and other features are re-instated. • Avoid the use of suburban features such as concrete kerbing in a rural setting unless absolutely necessary. Explore more appropriate alternatives. • Develop a road use hierarchy as a basis for management.

Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the rural character of other parts of the lowland glens. • Discourage the simplistic grafting of housing estates onto the edge of settlements. Encourage more imaginative schemes which respond to the existing patterns of layout, structure, massing and scale. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles. • Where small-scale development is permitted, encourage developers to use local building materials and to adopt local vernacular in respect of density, massing, design, colour and location. Avoid standard or suburban designs and layouts. Assess and adopt existing traditional layouts. Consider the preparation of design guides as supplementary planning guidance. • Encourage the appropriate conversion of redundant farm buildings. Guidance should be provided on the way buildings should be converted (including the provision of drives, gardens, etc.) to prevent the suburbanisation of the countryside.
Forestry and woodland	• New planting should help restore field boundary trees and establish woodland belts (see above). • Encourage new woodland where this would help enhance relatively low quality agricultural landscape.
Tall structures	• Assess any proposals for aerials or masts in terms of their visual and landscape impact. • Encourage telecommunications companies to share facilities where it is evident that this would reduce the overall landscape impact. • Encourage telecommunication companies to develop a strategy for mast provision which reflects the sensitivity of the local landscape.

LOW MOORLAND HILLS

Craggy hill tops and ridges near Hill of Finavon above Forfar.

DIPSLOPE FARMLAND

A settled landscape of farmland and small woods.

COAST WITH SAND

The broad sandy beach at Lunan Bay, backed by a complex of sand dunes.

COAST WITH CLIFFS

The former fishing village of Auchmithie perches above the soft red sandstone cliffs.

Photo: SNH

LOWLAND BASIN

An open, simple landscape dominated by the expanse of water and surrounding gently sloping farmland.

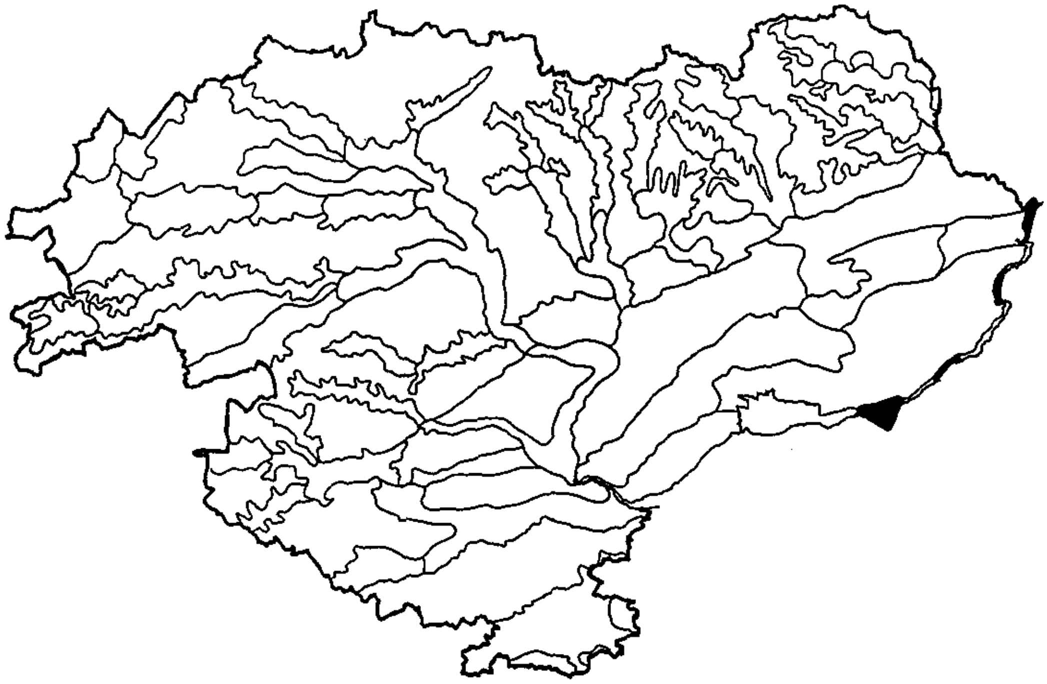
FIGURE 16

LANDSCAPE CHARACTER TYPES

COAST (14)

5.14.1 The combination of distinct physical characteristics and a strong coastal influence on the landscape distinguishes a comparatively narrow band of land along the Angus coast. Here, the sense of exposure, the presence of the sea, the influence of the tides and the expanse of sky create a very different landscape character than that of inland areas. A distinction has been made between the sandy and cliff sections of the coast.

COAST WITH SAND (14A)



KEY CHARACTERISTICS

- *areas of marine alluvium and windblown sand along lower sections of coast*
- *sand dunes inland*
- *ever-changing landscape of shifting sands, erosion and deposition and tidal fluctuation*
- *golf courses*
- *limited settlement*

OBJECTIVE DESCRIPTION		Coast
Physical scale		Low-lying sections of coast ranging from 0 to 5 metres AOD
Woodland	broad-leaf	Confined to hedgerow trees on farmland adjoining the coast
	coniferous	Confined to shelterbelts on farmland adjoining the coast
Agriculture	arable	Along coastal strip
	pasture	On dune slack and along lower sections of river valleys
	fields	Medium and rectilinear where topography allows
	field boundaries	Hedges and walls, supplemented by fences
Settlement pattern		Limited settlement
Building materials		Red sandstone
Historic features		Castles, fishing station
Natural heritage features		Dune systems are of ecological and geological interest
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Distant
Scale		Medium
Enclosure		Exposed
Variety		Simple
Texture		Smooth to rough
Colour		Colourful
Movement		Active
Unity		Unified
'Naturalness'		Undisturbed to tamed

LOCATION

5.14.2 Sections of coast with sand occur between Broughty Ferry and Carnoustie, south of Arbroath, at Lunan Bay and at Montrose.

PHYSICAL CHARACTERISTICS

5.14.3 The origins of these areas differ, falling into two main groups. Firstly, there are sections of coast where blown sand and marine alluvium have created substantial deposits. Particular examples include Barry Links, where a rounded peninsula of sand dunes extends southwards into the Firth of Tay, and the spit of land occupied by Montrose at the mouth of the River South Esk. Secondly, there are sections of coast where rivers such as the Lunan have lowered the level of the land and broad bays are now filled with sand. In both cases, the sandy beach is often backed by sand dunes, some of which are relatively level and are used for grazing.

5.14.4 Several of the links are of ecological and geological importance. Barry Links for example is a designated SSSI, notified because of its range of characteristic plant communities, including some rare species, as well as important mosses, invertebrates and breeding birds. It is regarded as an excellent example of coastal deposition, including the well-developed complex of parabolic dunes. Although there is a golf course on the northern part of the links, much of the area is reserved for military live firing.

SETTLEMENT AND LAND USE

5.14.5 Comparatively little has survived from earlier periods in this ever-changing coastal landscape. Exceptions include Broughty Castle, originally built in the 15th century but refortified in the 19th century, and Red Castle which stands, ruined, above Lunan Bay. Also at Lunan Bay are the remains of an earlier commercial fishing station, including the ruin of an icehouse constructed to store the catch. Today, many of the beaches are popular destinations when the weather is good. A number of golf courses are found among the dunes.

FORCES FOR CHANGE

5.14.6 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.14.7 **Agriculture.** Low intensity grazing can be quite important in maintaining the stability of vegetated parts of the dune systems. Overgrazing could result in the loss of vegetation and an increase in erosion.

5.14.8 **Transport.** Vehicular access to much of this coastal area is limited. Even at Lunan Bay it is limited to a minor farm road which leads to a small and informal car park which has been created in the lee of the sand dunes. This low level of access is an asset, underlining the low level of development along the coast.

5.14.9 **Development.** There is also very little development on the sections of sandy coast. The principal exceptions are found at Barry Links (which is used for military training and also has a golf course) and the Links of Montrose (also used as a golf course). While these land uses hinder more general access to the coast, they are low-key in nature and do assist in the conservation of the natural heritage.

5.14.10 **Forestry and woodland.** Commercial woodland is absent from this landscape type. However, semi-natural woodland is found along the river valleys that emerge in places such as Lunan Bay and on some of the more stable areas of sand dune.

5.14.11 **Recreation.** While, for most of the year, these beaches and dune systems are deserted, during period of fine weather, particularly at weekends and holiday times, they can attract considerable numbers of people. This can result in erosion around key access points, reducing the overall stability of the dunes. At Lunan Bay, where these pressures are high, boardwalks and other management measures have been implemented to minimise damage.

5.14.12 **Tall structures.** Many of these sections of coast are free from signs of modern development and retain an almost timeless character. The erection of masts in areas visible from these areas (for instance in cliff-top locations) or the development of shore-line or off-shore wind power schemes could have an adverse effect on this character. Any proposals should be assessed carefully in these terms.

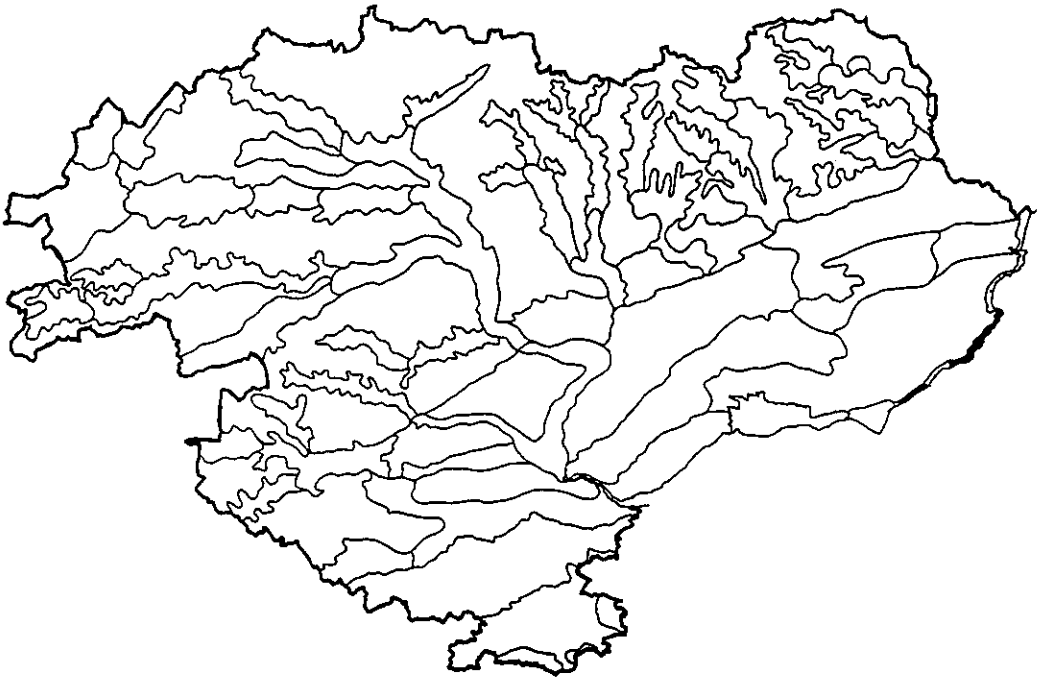
5.14.13 **Climate change.** It is possible that climate change brought about by global warming could result in an increase in storminess and changes in sea levels. Both could have serious implications for the stability and survival of these sections of dune coast. Further monitoring of any changes should be undertaken. If the stability of the coast is threatened, a comprehensive assessment options (including the do-nothing scenario) for managing this change should be undertaken.

LANDSCAPE GUIDELINES

5.14.14 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the natural and, at times, remote character of these sections of coast.

Agriculture	• Encourage the continuation of appropriate levels of grazing on the vegetated dunes and dune slack areas.
Transport	• Maintain the low level and informal character of vehicular access.
Development	• Restrict development in these areas. • Should the military training area at Barry Links become redundant, encourage the restoration of the natural dune landscape rather than disposal for development.
Forestry and woodland	• Discourage planting except within sheltered river valleys. • Facilitate natural colonisation on established dune areas (where this does not conflict with natural heritage interests).
Recreation	• Maintain low level of formal recreational provision. • Monitor erosion and other effects in areas subject to highest pressure, implementing management measures as necessary.
Tall structures	• Assess any proposals for tall structures in terms of their visual and landscape impacts.
Climate change	• Monitor the effects of climate change on the stability of the sandy coast. • Assess any options for coastal management in a comprehensive way (e.g. through a Shoreline Management Plan) reflecting the dynamic and interdependent nature of the processes of erosion and deposition along the coast.

COAST WITH CLIFFS (14B)



KEY CHARACTERISTICS

- *more resistant sandstones and intrusive rocks*
- *cliffs, arches, inlets, bays and rocky reefs*
- *defensive coast with castles*
- *fishing settlements*
- *windswept and exposed*
- *minimal tree cover*
- *productive farming up to cliff edge*

OBJECTIVE DESCRIPTION		Coast with Cliffs
Physical scale		Red sandstone cliffs rising up to 30 metres
Woodland	broad-leaf	Absent except on field boundaries along the coastal strip
	coniferous	Absent except for shelterbelts along the coastal strip
Agriculture	arable	Along coastal strip
	pasture	Absent
	fields	Medium and rectilinear where topography allows
	field boundaries	Hedges and walls, supplemented by fences
Settlement pattern		Fishing villages
Building materials		Red sandstone, often highly weathered
Historic features		Castles, fishing stations
Natural heritage features		Cliffs of ecological and geological interest
Other landscape features		No notable features
SUBJECTIVE DESCRIPTION		
Views		Distant
Scale		Medium
Enclosure		Exposed
Variety		Simple
Texture		Rough to very rough
Colour		Colourful
Movement		Active
Unity		Unified
'Naturalness'		Undisturbed to restrained

LOCATION

5.14.15 Sections of rocky coast with cliffs occur north of Carnoustie, between Arbroath and the southern end of Lunan Bay, and between Lunan Bay and Montrose.

PHYSICAL CHARACTERISTICS

5.14.16 The cliffs fall into two groups, reflecting variations in their geology. To the south, Old Red Sandstones are predominant, forming an indented coastline of dark red cliffs up to 30 metres high. Here the relatively soft rock is eroded into a series of small bays and inlets. Arches and caves reflect the erosive power of the sea. Further north, enclosing Lunan Bay and extending northwards to the southern edge of the Montrose Basin is an area of volcanic lavas and tuffs, of the same origin as the Sidlaws and Ochils. This has created a more resistant coastline of promontories, low cliffs and a rocky shore line.

5.14.17 The rocky coast is also of ecological and geological interest, much of it being designated as SSSIs. The cliffs support a range of important nesting seabirds and overwintering waders including kittiwake, puffin, razorbill, turnstone and purple sandpiper, along with rare grassland and rock-ledge communities. Perched saltmarsh and species-rich grassland also occur along the northern, igneous coastline. Most of this section of coastline provides good exposures of sandstones and lavas, providing considerable potential for the study of the geological structure and origins of the Midland Valley.

SETTLEMENT AND LAND USE

5.14.18 In addition to a number of castles sited about one kilometre inland (e.g. Ethie Castle), several clifftop forts are found along this section of coast. At least six (including Maiden Castle, Castle Rock and Prail Castle) are known to have existed between Arbroath and Lunan Bay. The indented coastline also provided natural harbours for fishing villages. Auchmithie, perched at the top of the sandstone cliffs comprises a cluster of low cottages in the shelter of a shallow bay. Many of the buildings and walls show signs of weathering with the red sandstone sculpted into curious shapes. Stimulated by the arrival of the railways which provided access to markets as far away as Billingsgate in London, many commercial fishing stations developed along the coast. This is exemplified at Usan where, in the 18th and 19th century, the landowner rebuilt the existing villages around salmon fisheries, with the result that one of them is known as 'Fishtown of Usan'. The remains of ice houses and saltpans can still be seen. While these villages are closely related to the surrounding landscape, other more recent settlements such as Carnoustie are not, simply comprising expanded residential suburbs of Dundee.

5.14.19 Despite the exposed, sometimes windswept character of the this coastal landscape, the natural fertility of the soils (much of the area falling into Class 2) means that agriculture dominates inland, with arable fields often running up to the edge of the cliffs. Tree cover is minimal.

FORCES FOR CHANGE

5.14.20 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.14.21 **Agriculture.** The fertile nature of the soils in this area means that in many places farmland extends right up to the cliff edge. In some places networks of shelterbelts, together with field boundary trees emphasise the exposed coastal location, the trees' branches and canopies are windbent and trimmed. In other areas woodland cover is absent, having declined over decades or having been cleared to allow field enlargement. In the latter case, modern farm buildings can be particularly prominent.

5.14.22 **Transport.** The network of roads, which is often geometric in structure, reflecting the presence of rectangular fields, is complemented by a network of unpaved roads, often contained between high dry-stone dykes, constructed from the local red sandstone. The rough character of these tracks should be retained.

5.14.23 **Development.** Settlement along the sections of cliff coast is concentrated in a number of fishing villages and a scatter of farmsteads. As the fishing industry has declined, some of the villages have declined, or have become remote 'suburban' outposts of Arbroath or Montrose. There is little other development along these sections of coast.

5.14.24 **Forestry and woodland.** Commercial woodland is absent from this landscape type. Woodland is confined to the shelterbelts and field boundaries described above.

5.14.25 **Recreation.** Access to the coast and areas of beach is often difficult and there are comparatively few recreational pressures.

5.14.26 **Tall structures.** Many of these sections of coast are free from signs of modern development and retain an almost timeless character. The erection of masts in cliff-top locations or the development of shore-line or off-shore wind power schemes could have an adverse effect on this character. Any proposals should be assessed carefully in these terms.

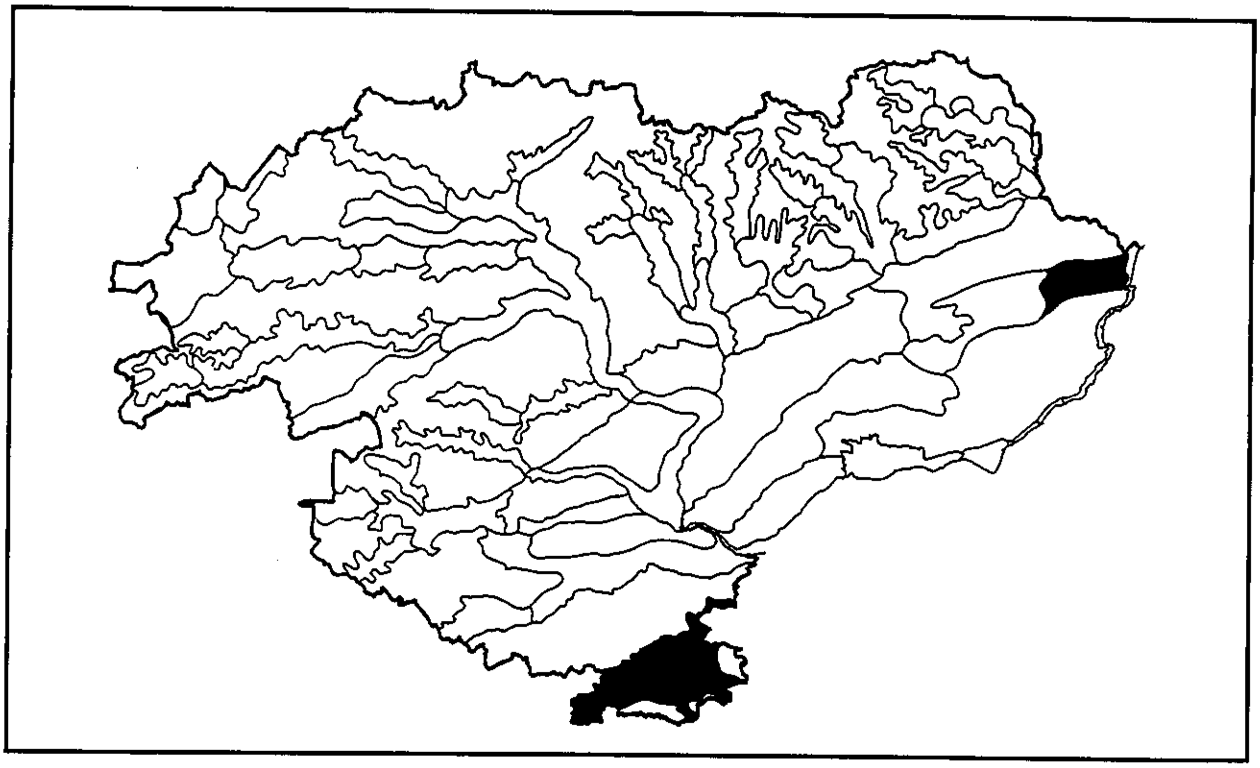
5.14.27 **Climate change.** It is possible that climate change brought about by global warming could result in an increase in storminess and changes in sea levels. Both could have implications for the pattern of erosion and deposition along the cliff coast. The red sandstone is comparatively soft, and increases in erosion could affect natural coastal features and the security of coastal settlements. Monitoring of any changes should be undertaken and if the stability of the coast is threatened, a comprehensive assessment of options (including the do-nothing scenario) for managing this change should be carried out.

LANDSCAPE GUIDELINES

5.14.28 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the natural and, at times, remote character of these sections of coast.

Agriculture	• Encourage the maintenance of shelterbelts and field boundary trees and their restoration where appropriate. • Encourage the maintenance of the network of dry-stone dykes.
Transport	• Maintain the low level and informal character of vehicular access, in particular, conserving the network of unsurfaced roads.
Development	• Focus any residential development within existing coastal settlements. • Ensure that development adopts appropriate designs, materials and scale.
Forestry and woodland	• Discourage extensive planting.
Recreation	• Maintain low level of formal recreational provision.
Tall structures	• Assess any proposals for tall structures in terms of their visual and landscape impact.
Climate change	• Monitor the effects of climate change on the stability of the cliff coast. • Assess any options for coastal management in a comprehensive way reflecting the dynamic and interdependent nature of the processes of erosion and deposition along the coast.

LOWLAND BASINS (15)



KEY CHARACTERISTICS

- *broad basins formed where sandstones have been eroded away leaving harder enclosing rocks*
- *extensive mudflats*
- *rich natural heritage, particularly migratory and wading birds*
- *historic associations*
- *dominance of water, sky and distant shores*

OBJECTIVE DESCRIPTION		Lowland Basins
Physical scale		Loch Leven Basin lies at about 110 metres AOD, rising to about 150 metres in places; the Montrose Basin lies close to sea level, rising to 10 or 20 metres
Woodland	broad-leaf	Semi-natural and plantation woodland around the fringes of the basins, particularly on steeper land
	coniferous	Little coniferous woodland - limited to a small number of shelterbelts
Agriculture	arable	Extensive arable land within Loch Leven basin
	pasture	Some pastures on lower lying and poor land
	fields	Generally large and regular shaped
	field boundaries	Combination of stone walls extending down from surrounding higher ground, and hedges
Settlement pattern		Settlement along roads encircling Loch Leven, concentrated to the west at Kinross and Milnathort; settlement around the Montrose Basin concentrated in Montrose
Building materials		Mixture of sandstone, harder volcanics and, at Kinross, pantiles
Historic features		Kinross House, Loch Leven Castle, millsites and drainage/water management infrastructure
Natural heritage features		Both basins are very rich in nature conservation interest
Other landscape features		Kinross telecommunications installation
SUBJECTIVE DESCRIPTION		
Views		Framed
Scale		Medium
Enclosure		Enclosed
Variety		Simple
Texture		Smooth
Colour		Muted
Movement		Peaceful
Unity		Unified
'Naturalness'		Restrained to natural

LOCATION

5.15.1 Two flooded basins have formed where softer, Upper Old Red Sandstone deposits, enclosed by hard volcanic or carboniferous rocks, have been eroded away. The first of these is occupied by Loch Leven, in the extreme south of Tayside, enclosed by the Lomond and Cleish Hills to the east and south, and by the Ochils to the north. The second of these is the Montrose Basin, a broad tidal estuary cut off from the sea by the spit of land occupied by the town of Montrose, and enclosed by harder volcanic rocks to the north and south.

Loch Leven Basin

5.15.2 **Physical characteristics.** Loch Leven was formed at the end of the last Ice Age as retreating icesheets, which had scoured a hollow between the Lomonds, Cleish Hills and the Ochils, deposited a mass of sand and gravel, impounding a shallow loch surrounded by extensive areas of marsh and wetland. In the first half of the 19th century, the level of the loch was lowered by 1.5 metres in order to ensure a steady supply of water to mills along the River Leven and to increase the amount of rentable farmland. Surrounding areas of marsh were drained and improved to provide the basis of the landscape that we see today. Inland, a shallow basin extends towards the Crook of Devon, drained by a network of minor burns. Downstream, the River Leven has been canalised in a straight channel and the surrounding floodplain drained by a network of ditches. Water levels in the loch fluctuate, revealing extensive mudflats during the late summer and early autumn. The overall impression is of a very broad, shallow basin within which, particularly at the eastern end, water and sky, together with the enclosing hills are the dominant landscape elements.

5.15.3 Despite the changes brought by the lowering of water levels and the drainage of the marshes, Loch Leven retains a rich ecology. It is particularly important for birds, accommodating thousands of ducks, migratory geese, swans and waders. The loch's fish stocks have been exploited for over 650 years, the brown trout being particularly well-known. Mammals around the loch include otters, roe deer and foxes. The area has a range of natural and planted woodland with Scots pine growing in the drier areas and birch, willow and alder in wetter areas. The loch is designated as an SSSI and an NNR.

5.15.4 **Settlement and land use.** Historically Loch Leven has been a focus for human settlement and land use. The earliest signs of settlement included a crannog which was destroyed during the 19th century. Loch Leven has a number of other historic sites including Kinross House, Loch Leven Castle on Castle Island and the Priory on St Serf's Island. Several villages and hamlets grew around the fringes of the loch, their industries of weaving, paper making and fishing reliant on the supply of water. The largest of these settlements, particularly Kinross, Milnathort and Kinnesswood have expanded over the last century, the latter pushing up the slopes of the Lomond Hills.

Montrose Basin

5.15.5 Physical characteristics: The Montrose Basin is a large, rounded estuarine basin formed near the mouth of the River South Esk. Unlike Loch Leven, the basin is tidal, revealing extensive mudflats at low tide. An area of low-lying, drained farmland extends inland, while the basin is separated from the sea by the town of Montrose, located on a low peninsula spit of land less than two kilometres wide. There have been attempts to drain the basin to provide farmland in the past, the most notable effort leaving Dronner's Dyke which is revealed at low tide. Like the Loch Leven Basin, this area is shallow and open. The expanse of mudflats, water, distant shores and sky all shape the character of the surrounding landscape.

5.15.6 The Montrose Basin also has a rich natural heritage. Its mudflats provide important feeding grounds for birds, supporting internationally important numbers of geese, wigeon and redshank and nationally important numbers of eider, oystercatcher, knot and mute swan. A number of salt-loving plants, including rare grasses, occur on the mudflats. The variety of saline, brackish and freshwater marshes have a great variety of plant communities. The area is also of geological importance.

5.15.7 **Settlement and land use.** Outwith the physically constrained town of Montrose, settlement is limited to a scatter of farmsteads, generally located on slightly higher ground along the A934 and A935 to the south and north of the basin. The western end of this landscape unit is occupied by Kinnaird Park with its deer park and extensive estate woodlands. A number of historic mills are sites along the non-tidal section of the River South Esk, above the Bridge of Dun. Some land has been reclaimed at the inland edge of the basin. There is also a series of raised beaches which demonstrate the series of sea level changes that occurred during the later stages of the last Ice Age and in the post-glacial period.

FORCES FOR CHANGE

5.15.8 This section contains a description of the principal types of change that have affected this landscape type in the recent past or which are likely to affect it in the future. Changes may be positive or negative in terms of their effect on the landscape. The aim of this section is to gain a clear understanding of the nature and direction of change and its likely impact on the essential character and quality of the landscape. This analysis provides the basis for management guidelines to assist other organisations develop more detailed policies for agriculture, forestry and development.

5.15.9 **Agriculture.** Both basins include considerable areas of arable and grazing land around the fringes of the waterbodies. This is generally of a semi-open character, enclosed by hedges. There appear to be few pressures acting upon agriculture in these areas.

5.15.10 **Transport.** Both basins are encircled by roads, several of them of A road status. In addition, the M90 passes close to the western side of Loch Leven and, at Montrose, a new inner relief road has been constructed along the north-eastern side of the basin. These roads means that there is often a considerable amount of traffic movement and noise in these otherwise tranquil locations.

5.15.11 **Development.** Historically, both the Loch Leven and Montrose Basins have been a focus for settlement. In the case of Loch Leven, a number of suburban settlements have developed around the loch principally at Kinross, Milnathort and Kinnesswood (the latter is discussed in relation to the Dolerite Hills landscape type, above). Some of the more recent development at Kinross is particularly prominent in the landscape as a result of the building materials that have been employed (white walls and orange pantiles - reflecting the styles more commonly found in Fife to the south) and the lack of screening around the urban edge. Development at Montrose has been concentrated on the constrained spit of land occupied by the town itself. Expansion has occurred northwards, away from the basin.

5.15.12 **Forestry and woodland.** Commercial woodland is absent from this landscape type. However, semi-natural woodland is found around the edges of the waterbodies.

5.15.13 **Recreation.** The natural heritage importance of the Lowland Basins is reflected in the presence of interpretation facilities. Otherwise, access and recreation is limited.

5.15.14 **Tall structures.** The Loch Leven Basin includes a ball-like radio installation west of the Kinross junction on the M90. Although visible from a number of areas it is not an unduly prominent feature. More serious would be the development of tall structures on the hills that enclose the basins. This is discussed elsewhere, but could have a significant impact on the landscape character and quality of the basins.

5.15.15 **Climate change.** It is possible that climate change brought by global warming could result in an increase in storminess and changes in sea levels. Both could have serious implications for the future of the Montrose Basin in particular. Rising sea levels could result in the inundation of areas of surrounding farmland, or the erection of tidal defences which would result in a decrease in the extent of exposed mudflats and inevitable implications for birds. Monitoring, and an integrated strategy to manage any changes are therefore essential.

LANDSCAPE GUIDELINES

5.15.16 The following guidelines reflect the sensitivities of the landscape and the pressures for change acting upon it. They are intended to provide a broad basis for the development of more detailed management strategies. The overall aim of such strategies should be to conserve the natural and at times remote character of these sections of coast.

Transport	• Explore opportunities to provide more on- and off-site screening to reduce the visual and aural impacts of principal roads.
Development	• Focus new development in existing towns and villages so as to reinforce the historic pattern of settlements and to protect the area's tranquil character. • Discourage the simplistic grafting of housing estates onto the edge of settlements. Encourage more imaginative schemes which respond to the existing patterns of layout, structure, massing and scale. • Encourage the wider use of vernacular designs, materials and colours, while allowing for modern interpretations of traditional styles.

(Development contd.)	• Consider positive ways of addressing the interface between settlements and the surrounding countryside. These could include: - screening; - new buildings which address surrounding areas; - key vistas and views; - landmark features; - gateways and approaches.
Forestry and woodland	• Encourage appropriate woodland planting where this can contribute to positive land management to reduce eutrophication at Loch Leven. • Encourage management of hedges and semi-natural woodland.
Recreation	• Maintain low level of formal recreational provision.
Tall structures	• Assess any proposals for tall structures in terms of their visual and landscape impact.
Climate change	• Monitor the effects of climate change and assess any options for flood defence in a comprehensive and balanced way.

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Appendices

APPENDIX A

HISTORICAL ASSESSMENT

The Study Brief required the study to incorporate historic aspects of the landscape into the assessment and for a short statement to be prepared describing how this had been achieved. A comprehensive historic landscape assessment would require a substantial input to the study from archaeologists and historians in order to translate the mass of detailed historic information (for instance that contained in Sites and Monuments Records) into broader historic landscape types. Having undertaken similar studies elsewhere in the country, it was recognised that such an analysis lay outwith the scope of the present study. However, it was agreed with the Study Steering Group to draw upon existing information sources to provide as full a picture of historical influences on the modern landscape as possible.

This report has, therefore, sought to integrate consideration of the historic landscape throughout the report. Rather than limiting discussion to a self-contained chapter at the beginning of the report, the report has deliberately described those historical features which are characteristic of the region, or parts of it, and which make an important contribution to the landscape. At the same time, there is an analysis of the pattern of historic sites and landscapes found within each of the landscape character types, including a brief description with examples in the written descriptions in Chapter 5. This complements similar information on geology, natural heritage and modern development. It is believed that this approach has worked well in Tayside where the sharp topographical contrasts have had a profound influence on historic patterns of settlement, land use, farming, communication and even clan warfare.

APPENDIX B

OTHER LANDSCAPE ASSESSMENTS

The Study Brief for the Tayside Landscape Assessment Project required the project team to review a range of other landscape assessments covering parts of the study area, or surrounding areas. It stated that 'the consultants will need to ... ensure consistency in their classification of landscape character areas and types'. Accordingly, the principal landscape assessments were reviewed and the following conclusions drawn.

Figure B1 shows the landscape classifications of **Kinross-shire** and **Dunfermline** prepared by David Tyldesley and Associates (1995) overlaid on the landscape classification produced during the Tayside Landscape Assessment. It is evident that the Kinross-shire and Dunfermline assessments were undertaken at a much finer scale, representing district or local level landscape assessments as opposed to a regional scale assessment. There is broad correspondence between the different levels of assessment.

Figure B2 shows the classification produced by the Turnbull Jeffrey Partnership as part of the **Cairngorms Landscape Assessment** (1996). In contrast to the Kinross-shire and Dunfermline assessments, it is evident that this study adopted a larger scale approach than the Tayside Landscape Assessment, incorporating highland glens and intervening hill ranges in single landscape types for example. There is less correspondence between Cairngorm and Tayside landscape assessments.

Figure B3 shows the landscape classifications of the **Central Region Landscape Assessment** (ASH, 1999) and the **Loch Lomond and the Trossachs Landscape Assessment** (TJP, unpublished report to SNH). It is evident that these studies adopted a scale of assessment similar to that of the Tayside Landscape Assessment. Furthermore, many of the landscape character areas identified during the Tayside study, are continued across the regional boundary into Central Region and the Trossachs area.

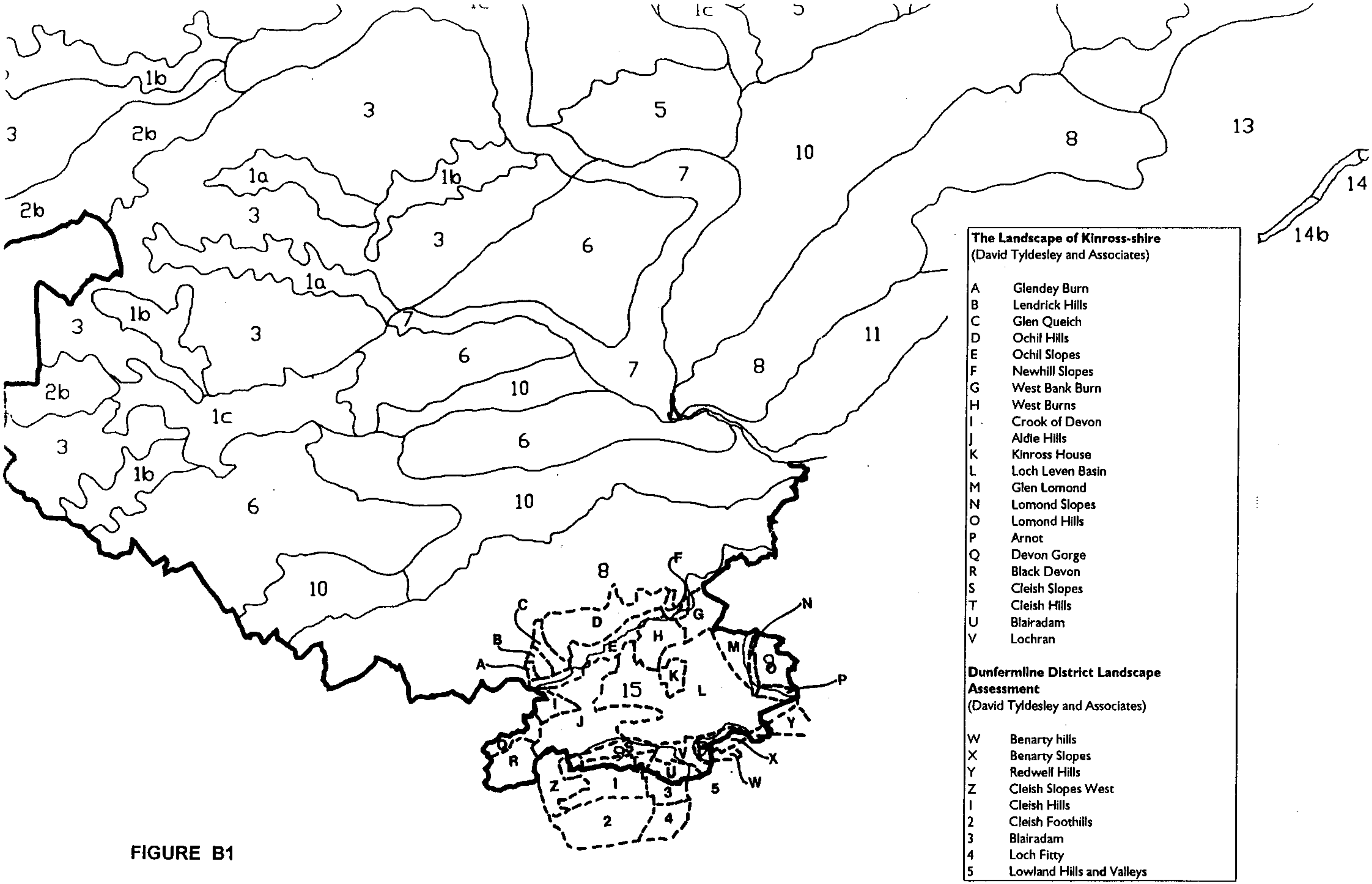
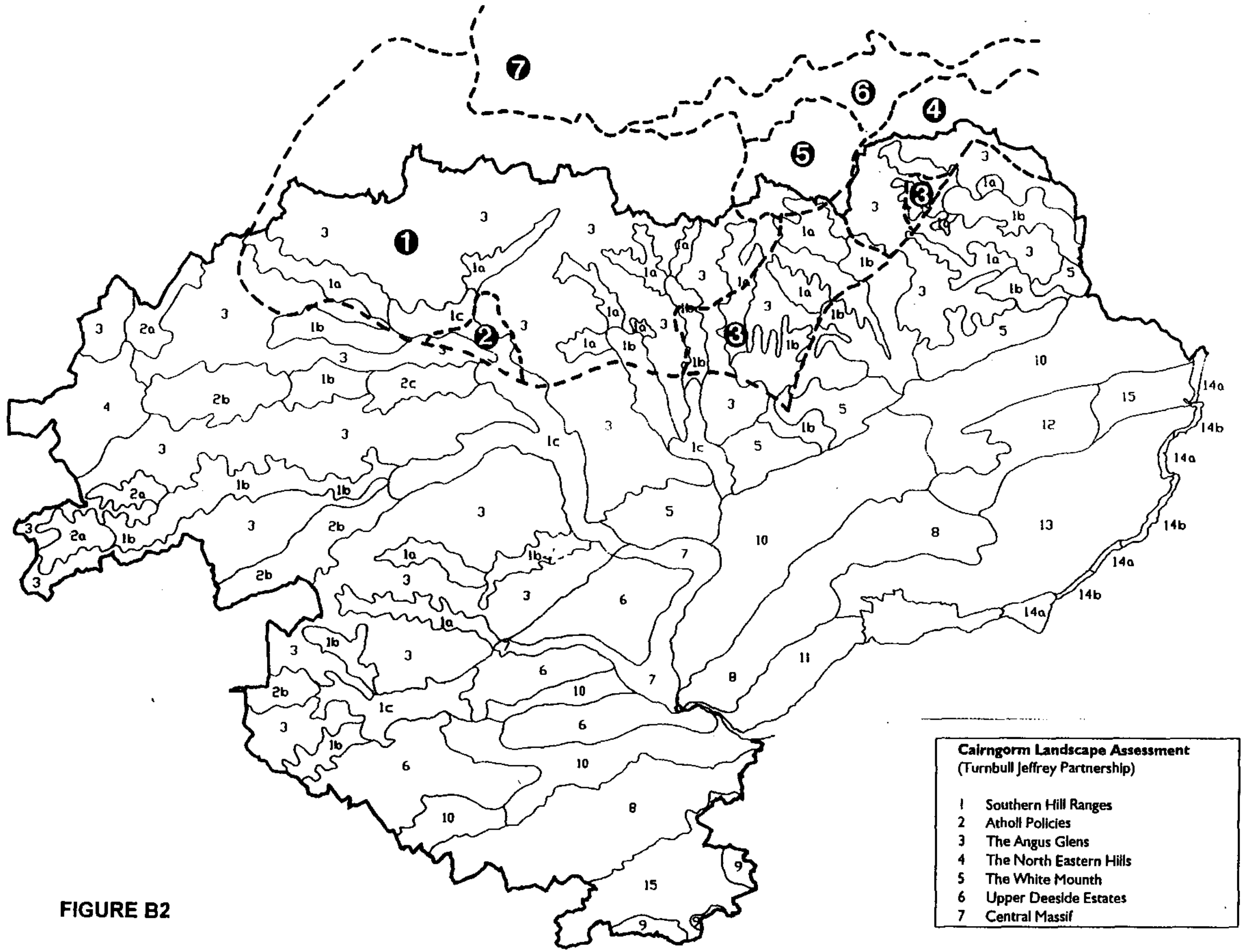

The Landscape of Kinross-shire
(David Tyldesley and Associates)
A Glendey Burn
B Lendrick Hills
C Glen Queich
D Ochil Hills
E Ochil Slopes
F Newhill Slopes
G West Bank Burn
H West Burns
I Crook of Devon
J Aldie Hills
K Kinross House
L Loch Leven Basin
M Glen Lomond
N Lomond Slopes
O Lomond Hills
P Arnot
Q Devon Gorge
R Black Devon
S Cleish Slopes
T Cleish Hills
U Blairadam
V Lochran
Dunfermline District Landscape Assessment
(David Tyldesley and Associates)
W Benarty hills
X Benarty Slopes
Y Redwell Hills
Z Cleish Slopes West
1 Cleish Hills
2 Cleish Foothills
3 Blairadam
4 Loch Fitty
5 Lowland Hills and Valleys
1a
1b
1c
2b
3
5
6
7
8
10
11
13
14
14b
15

FIGURE B1

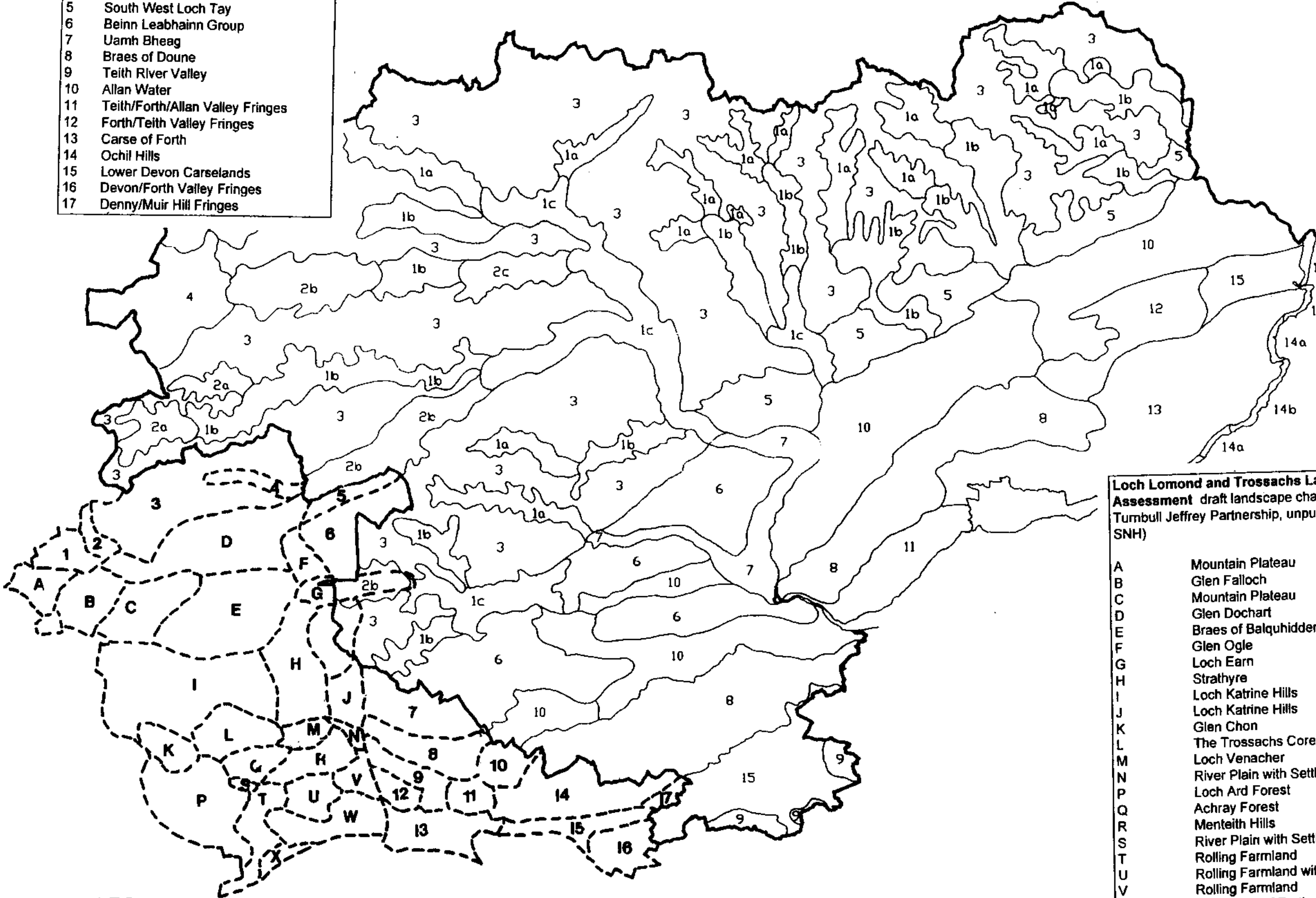


Cairngorm Landscape Assessment
(Turnbull Jeffrey Partnership)
1 Southern Hill Ranges
2 Atholl Policies
3 The Angus Glens
4 The North Eastern Hills
5 The White Mounth
6 Upper Deeside Estates
7 Central Massif

FIGURE B2

Central Region Landscape Assessment
(ASH) - relevant landscape character areas

1	Ben Lui Group
2	Strath Fillan
3	Glen Lochay Group
4	Glen Lochay
5	South West Loch Tay
6	Beinn Leabhainn Group
7	Uamh Bheag
8	Braes of Doune
9	Teith River Valley
10	Allan Water
11	Teith/Forth/Allan Valley Fringes
12	Forth/Teith Valley Fringes
13	Carse of Forth
14	Ochil Hills
15	Lower Devon Carselands
16	Devon/Forth Valley Fringes
17	Denny/Muir Hill Fringes



Loch Lomond and Trossachs Landscape Assessment draft landscape character areas (from Turnbull Jeffrey Partnership, unpublished report to SNH)

A	Mountain Plateau
B	Glen Falloch
C	Mountain Plateau
D	Glen Dochart
E	Braes of Balquhidder
F	Glen Ogle
G	Loch Earn
H	Strathyre
I	Loch Katrine Hills
J	Loch Katrine Hills
K	Glen Chon
L	The Trossachs Core
M	Loch Venacher
N	River Plain with Settlement
P	Loch Ard Forest
Q	Achray Forest
R	Menteith Hills
S	River Plain with Settlement
T	Rolling Farmland
U	Rolling Farmland with Estate Policies
V	Rolling Farmland
W	The Carse of Forth

FIGURE B3

APPENDIX C

WIND POWER GUIDANCE

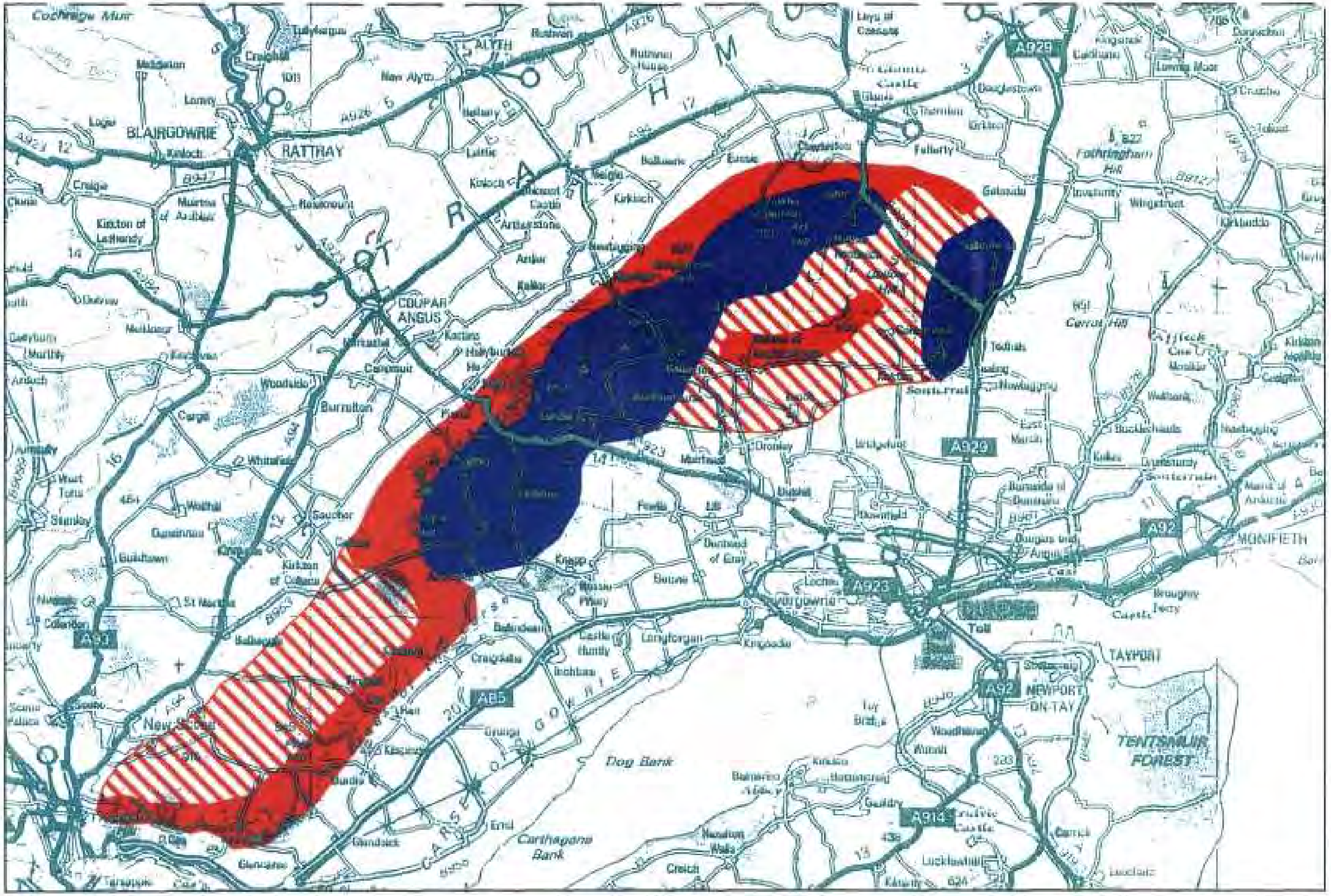
Chapter 4 of this report deals in some detail with the issue of wind power and the possible landscape effects associated with the development of wind farms.

It was recognised that pressure for wind farm development may occur in the Highland Summits and Plateaux areas, in the Highland Foothills and within the Ochils and Sidlaws. The relative merits and constraints associated with each of these landscape types are discussed in some detail in Chapter 4. The approach to planning and assessing such proposals is also outlined.

It was agreed that it would be helpful to provide indicative guidance for one area to illustrate more clearly the broad sensitivities and principals which should be respected in bringing forward proposals for wind farms. The Sidlaws were selected as a suitable area.

Figure C1 provides guidance on the siting of wind turbines within the Sidlaws. It should be emphasised that this guidance is indicative only, and has been prepared on the basis of a regional scale landscape assessment. Much more detailed landscape assessment and landscape impact appraisal would be required to confirm the suitability of these areas in relation to specific planning proposals. Furthermore, it should be emphasised that no areas are entirely free from landscape constraints and that decisions should be made in the light of a regional renewable energy strategy, and in the context of a range of other factors (including technical and operational factors). The indicative wind farm strategy does not necessarily represent the views of Scottish Natural Heritage.

Figure C1 identifies areas of lowest constraint, medium constraint and highest constraint. The most prominent ridgelines and areas visible from both the Firth of Tay and Strathmore fall into the first category. The areas of lowest constraint include the shallow bowls lying to the south of the main Sidlaws ridge and are, in places, associated with existing development such as road corridors.



TAYSIDE REGION

LANDSCAPE CHARACTER ASSESSMENT

FIGURE C1

WIND FARM LOCATION ANALYSIS

= Areas of lowest constraint for windfarm development

= Areas of medium constraint for windfarm development

= Areas of highest constraint for windfarm development

Scale:
0km — 10 km

APPENDIX D

LANDSCAPE PLANNING AND MANAGEMENT SUMMARY MATRIX

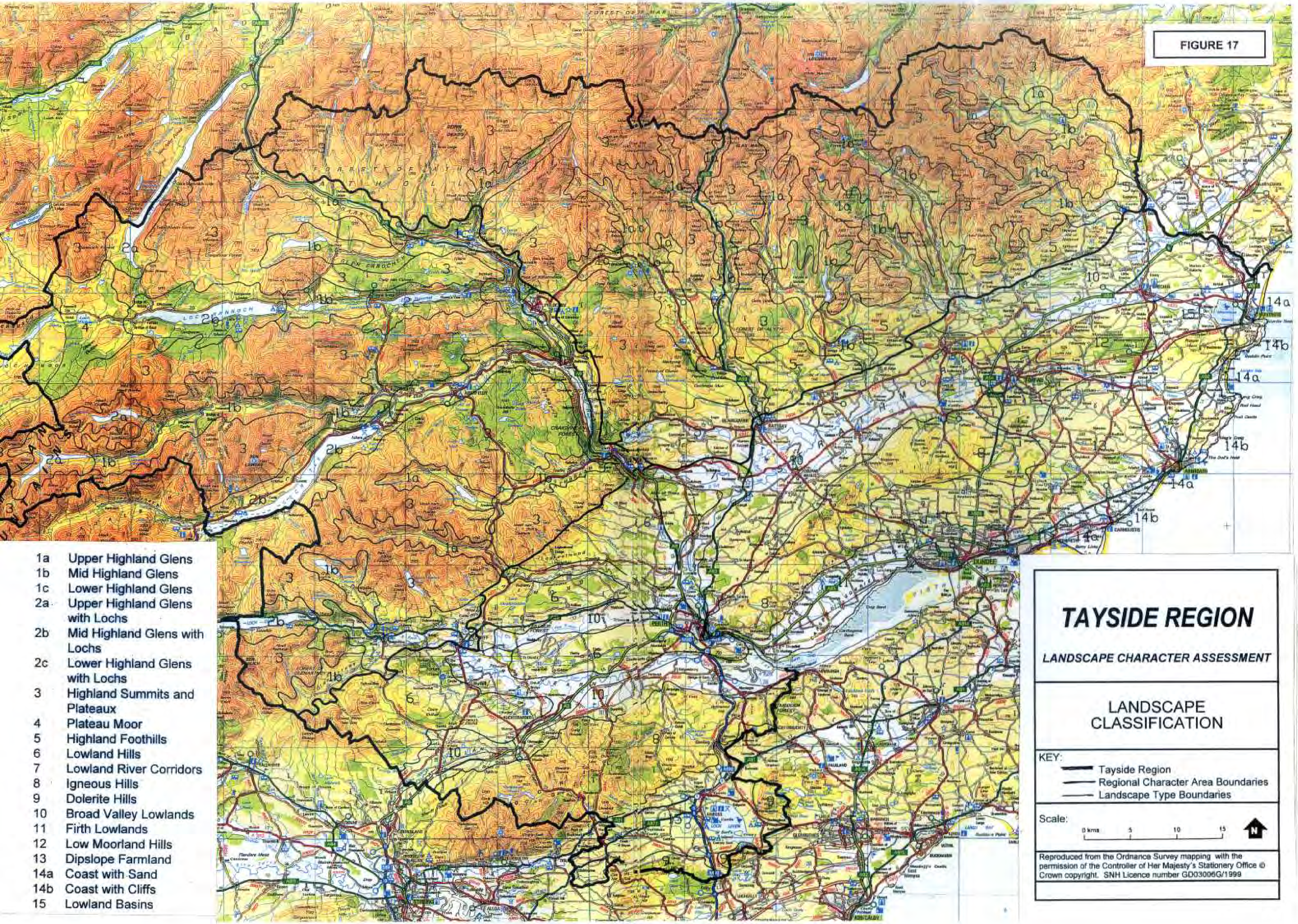
Issue	Management Approach	Upper Highland Glens	Middle Highland Glens	Lower Highland Glens	Upper Highland Glens with Lochs	Middle Highland Glens with Lochs	Lower Highland Glens with Lochs	Highland Summits and Plateaux	Plateau Moor	Highland Foothills	Lowland Hills
Agriculture	Conserve field boundaries	★	★	★	★	★	★			★	★
	Replant boundary trees			★		★	★			★	★
	New woodland belts			★						★	★
	Discourage agricultural improvement	★	★		★	★		★	★		
	Discourage over concentration of oil seed rape			★							
	Design of new buildings		★	★		★	★			★	★
	Retain agriculture						★	★			
	Maintain upland/lowland distinction		★			★				★	★
	Conserve traditional buildings		★	★		★	★			★	★
Transport	Minimise upgrading of roads	★	★	★	★	★	★	★	★	★	★
	Mitigate impact of new roads	★	★	★	★	★	★			★	★
	Restore roadside features									★	★
	Mitigate impact of existing roads			★							★
Development	Discourage development	★			★			★	★		
	Steer development to existing centres		★	★		★	★			★	★
	Encourage use of vernacular		★	★		★	★			★	★
	Improve urban edge			★			★				★
Forestry	Discourage new plantations	★			★			★	★		
	Explore potential for new plantations			★			★			★	★
	Improve existing conifers	★	★	★	★	★	★	★	★	★	★
	Favour native woodlands	★	★	★	★	★	★	★	★		

Recreation	Focus activity at existing centres	★			★	★	★				
	Low-key provision	★	★		★	★		★	★		
	Restrict additional caravan parks					★	★				
	Mitigate existing caravan parks					★	★				
	Influence design of facilities			★			★				
	Monitor visitor pressures	★				★	★	★			
Tall structures	Discourage	★	★		★	★		★	★		
	Encourage sharing of facilities		★	★		★	★			★	★
	Potential for sensitive wind farms									★	★
Climate change	Monitor and plan										
Minerals	Restoration issues										
	Ensure screening										

Issue	Management Approach	Lowland River Corridor	Igneous Hills	Dolerite Hills	Broad Valley Lowlands	Firth Lowlands	Low Moorland Hills	Dipslope Farmland	Coast with Sand	Coast with Cliffs	Lowland Basins
Agriculture	Conserve field boundaries	★	★		★	★	★	★		★	★
	Replant boundary trees	★	★		★	★	★	★		★	★
	New woodland belts				★	★		★		★	
	Discourage agricultural improvement										
	Discourage over concentration of oil seed rape				★			★			
	Design of new buildings	★	★		★	★	★	★			
	Retain agriculture										
	Maintain upland/lowland distinction		★	★							
	Conserve traditional buildings	★	★		★	★		★		★	
Transport	Minimise upgrading of roads	★	★	★	★	★	★	★	★	★	★
	Mitigate impact of new roads				★	★					
	Restore roadside features		★		★	★	★	★			
	Mitigate impact of existing roads				★	★		★			
Development	Discourage development								★		
	Steer development to existing centres	★	★	★	★	★	★	★		★	★
	Encourage use of vernacular	★	★	★	★	★	★	★		★	★
	Improve urban edge	★		★	★	★		★			★
Forestry	Discourage new plantations			★					★	★	★
	Explore potential for new plantations	★	★		★		★				
	Improve existing conifers	★	★	★			★				
	Favour native woodlands	★	★	★	★						★

Recreation	Focus activity at existing centres										
	Low-key provision		★						★	★	★
	Restrict additional caravan parks										
	Mitigate existing caravan parks										
	Influence design of facilities										
	Monitor visitor pressures								★		
Tall structures	Discourage			★					★	★	
	Encourage sharing of facilities	★	★		★	★	★	★			★
	Potential for sensitive wind farms		★				★				
Climate change	Monitor and plan					★			★	★	★
Minerals	Restoration issues				★		★				
	Ensure screening				★		★				

FIGURE 17



TAYSIDE REGION
LANDSCAPE CHARACTER ASSESSMENT
LANDSCAPE CLASSIFICATION
KEY:
Tayside Region
Regional Character Area Boundaries
Landscape Type Boundaries
Scale:
0 kms 5 10 15
N
Reproduced from the Ordnance Survey mapping with the permission of the Controller of Her Majesty's Stationery Office © Crown copyright. SNH Licence number GD03006G/1999
1a Upper Highland Glens
1b Mid Highland Glens
1c Lower Highland Glens
2a Upper Highland Glens with Lochs
2b Mid Highland Glens with Lochs
2c Lower Highland Glens with Lochs
3 Highland Summits and Plateaux
4 Plateau Moor
5 Highland Foothills
6 Lowland Hills
7 Lowland River Corridors
8 Igneous Hills
9 Dolerite Hills
10 Broad Valley Lowlands
11 Firth Lowlands
12 Low Moorland Hills
13 Dipslope Farmland
14a Coast with Sand
14b Coast with Cliffs
15 Lowland Basins

Visual Assessment of Windfarms: Best Practice

Report No. F01AA303A

For further information on this report please contact:

Nigel Buchan
Scottish Natural Heritage
2 Anderson Place, Edinburgh EH6 5NP
NIGEL.BUCHAN@snh.gov.uk

This report should be quoted as:

University of Newcastle (2002) Visual Assessment of Windfarms Best Practice. *Scottish Natural Heritage Commissioned Report* F01AA303A.

SCOTTISH NATURAL HERITAGE

COMMISSIONED REPORT
Summary

Visual Assessment of Windfarms: Best Practice
Report No: F01AA303A
Contractor : University of Newcastle

BACKGROUND

The development process for many windfarms requires formal environmental impact assessment (EIA) and the incorporation of the results into an environmental statement (ES). SNH's experience is that there can be a great deal of variation in the way that visual impact assessment (VIA) is dealt with in EIA. This project involved: a review of relevant guidance, research and development work on visibility, visual impact and significance; an investigation of the visibility of eight existing Scottish windfarms; a comparison between as-built visibility and estimates of visibility in the ESs; evaluation of Zone of Visual Influence (ZVI) and other assessment tools; and generation of Best Practice Guidelines for VIA of windfarms.

MAIN FINDINGS

- Many guidelines on windfarm development appear to be based on first generation windfarms and need to be revised for second and third generation turbines.
- There is some research and a wide and diverse range of guidance and opinion on the detailed issues of ZVI, distance, visibility and significance for windfarms, explained by the complexity and the subjectivity of the issues, the desire of one set of windfarm interests to minimise the political, professional and public perception of the visual (and landscape) effects of windfarms and an opposing desire by another set of interests to maximise these perceptions.
- The magnitude or size of windfarm elements, and the distance between them and the viewer, are basic physical measures that affect visibility, but the key issue is human perception of visual effects, and that is not simply a function of size and distance.
- The influences on apparent magnitude are reviewed, including factors that tend to increase it and factors that tend to reduce it. A new conceptual model and schema for assessing visual effects is provided.
- Based on survey work at eight sites - Beinn An Tuirc, Beinn Ghlas, Deucheran Hill, Dun Law, Hagshaw Hill, Hare Hill, Novar and Windy Standard - an overall analysis is provided of the effects on visibility of the Size and Scale of the Development, Proportional Visibility, Lighting, Movement and Orientation, Distance, Colour and Contrast, Contrast, Skylining and Backclothing, Elevation of Windfarm and Human Receptor and Colour and Design.
- Zones of Visual Influence (ZVI) are never wholly accurate and other tools such as photomontage are never wholly realistic. Suggestions are made of ways to address these issues.

For further information on this project contact :
Nigel Buchan, Scottish Natural Heritage, 2 Anderson Place, Edinburgh EH6 5NP.
For further information on the SNH Research & Technical Support Programme contact ascg@snh.gov.uk

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1 INTRODUCTION

1.1 Concern for the landscape, visual and other environmental effects of tall, industrial or technological structures in the landscape is not new (e.g. Goulty, 1990). In the case of windfarms, however, there is universal acknowledgement that the potential landscape and visual effects are among the most important and to some extent the most intractable issues for obvious and well-rehearsed reasons (e.g. Coles & Taylor, 1993; Lindley, 1994).

1.2 Strategic approaches to the siting of windfarms are advocated through the use of tools such as Geographical Information Systems (GIS) (e.g. Sparkes & Kidner, 1996) and there are commercial software packages such as WindFarmer (Garrad Hassan, no date), WindPRO (EMD, no date) and WindFarm (ReSoft, no date) that combine GIS with procedures for calculating Zones of Visual Influence (ZVI) and producing photomontages. It is not clear if such software is in widespread use in the UK. Ultimately, however, the assessment of all but the smallest individual development project for a windfarm requires formal environmental impact assessment (EIA) and the incorporation of the results of that assessment into an environmental statement (ES).

1.3 Under the EIA Regulations, effects on landscape must be assessed. Established guidance (LI-IEA, 1995 and LI-IEMA, 2002) makes a distinction between landscape effects and visual effects, the latter being considered a specific subset of the former. *"Landscape effects derive from changes in the physical landscape which may give rise to changes in its character and how this is experienced. This may in turn affect the perceived value ascribed to the landscape. … Visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity"* (LI-IEMA, 2002). In this report the focus is mainly on the visual effects for the reasons discussed below.

1.4 Scottish Natural Heritage's (SNH) experience is that there can be a great deal of variation in the way that assessment of both visual impact and the significance of visual impact are dealt with in EIA documents, including the appropriate distance for Zone of Visual Influence (ZVI) surveys. The latter attracts a degree of contention amongst some developers and landscape professionals. There is therefore a need for some independent opinion on all these aspects.

1.5 The brief for the current study (Appendix 4) therefore required that it address the following aims:

- to identify any relevant work on visibility, visual impact and significance
- to investigate visibility of existing windfarms
- to compare as-built visibility with estimates of visibility in ESs
- to draw conclusions about appropriate distances for ZVI in different circumstances

1.6 A series of research questions has therefore been posed in order to address these aims:

- What research, policy, guidance and opinions exist on issues related to the assessment of the magnitude and significance of the visual effects of windfarms?
- Is this literature consistent, and if not, what are the sources of and details of any differences?
- What are the key factors that affect visual effects and the assessment of those effects?
- What is the visibility of existing windfarms, and is this real-life visibility as predicted by the literature and as predicted in EIA? If not, why not?

- Based on the answers to those questions, can recommendations be made for best practice with regard to visual impact assessment within EIA?

1.7 This report is divided into six main sections as follows:

- The methodology and approach used for the study are described in section 2.
- Background research is described in section 3.
- Survey and analysis of eight case-study sites are described and analysed in section 4.
- An analysis of the overall survey is described in section 5.
- Discussion of the overall findings of the study appears in section 6.
- Recommendations for Best Practice Guidelines are summarised in section 7.

Table 1: Case Study Windfarms

Windfarm *	Local Planning Authority	SNH Office	OS Sheet/ Grid Reference	Location
(1) Beinn an Tuirc, Kintyre (2001)	Argyll & Bute Council	Argyll & Stirling	68/NR 753361	Centre/East of Kintyre
(2) Beinn Ghlas, Oban (1999)	Argyll & Bute Council	Argyll & Stirling	49/NM 980257	5km south of Taynuilt, 10 km east of Oban
(3) Deucheran Hill, Kintyre (2001)	Argyll & Bute Council	Argyll & Stirling	62/NR 760440	Centre/East of Kintyre
(4) Dun Law (Soutra Hill), Borders (2000)	Scottish Borders Council	Forth & Borders	66/NT 465575	South of Soutra and north west of Lauder
(5) Hagshaw Hill, Douglas (1995)	South Lanarkshire Council	Strathclyde & Ayrshire	71/NS 790307	4km west of Douglas
(6) Hare Hill, Ayrshire (2000)	East Ayrshire Council	Strathclyde & Ayrshire	71/NS 655098	Near New Cumnock
(7) Novar, Dingwall (1997)	The Highland Council	East Highland	20/21/NH 555715	6km north west of Evanton
(8) Windy Standard, Galloway (1996)	Dumfries & Galloway Council	Dumfries & Galloway	77/NS 615015	9km north east of Carsphairn and east of Loch Doon

* The date given is when the windfarm was built and/or commissioned.

2 METHODOLOGY

2.1.1 The project has followed the requirements and guidance of the brief in all key respects and proceeded as follows (Figure 1).

2.2 Background Research

2.2.1 Both published and grey literature[1] on relevant topics was reviewed. The World Wide Web was searched for access to a wide range of unpublished guidance, opinion and comment. Although the primary focus was on Visual Impact Assessment (VIA), there are many other sources concerning renewable energy or wind energy that refer indirectly to technical detail concerning VIA and these have been included wherever relevant.

Figure 1: Project Methodology

Background Research

Including published, refereed and "grey" literature, via systematic searches of bibliographic data-bases and using search engines.

To include ZVI, visual impacts of windfarms, distance-visibility-perception issues, selection of viewpoints, distance-significance issues, "Guidelines" and Environmental Statements for windfarms.

Consultation

Request for information using short telephone questionnaire to SNH regional-local offices.

↓

Case Study Windfarms

(1) Beinn an Tuirc, Kintyre (2) Beinn Ghlas, Oban (3) Deucheran Hill, Kintyre (4) Dun Law, Borders (5) Hagshaw Hill, Douglas (6) Hare Hill, Ayrshire (7) Novar, Highland (8) Windy Standard, Galloway

↓

Review of Environmental Statements

For the selected windfarms, to include evaluation of methods used (ZVI, wireframe, photomontage), definitions of significance, methods of determining significant viewpoints, and predictions of visibility and significance.

↓

Survey of Windfarms

Site visits to compare predictions made in ES with results on site. Two visits to be made to each site, to capture diverse weather-visibility conditions. Visits to be to selected key viewpoints for each site. Time constraint will restrict assessment to accessible viewpoints (by car or short distances on foot i.e. excluding remote vantage points on e.g. Southern Upland Way or the islands). Identification of any visibility issues omitted (based on site visit supplemented by advice from SNH).

↓

Analysis

Of accuracy of ES predictions, including evaluation of significant factors:
Observer factors - sight, perception, opinion
Windfarm factors – size, number of turbines, movement-flicker effects
Landscape factors – topography, land-cover
Meteorological factors – season, light, weather
Other factors – intervisibility, cumulative impacts

↓

Conclusions & Recommendations

Regarding "Best Practice Guidelines" for developers (and others) on the environmental assessment of the visibility and visual impacts of windfarms.

2.3 Case Study Sites

2.3.1 The character of the landscape, weather and other environmental effects are important and so the study was required to focus mainly on Scotland. Selection of case study sites was iterative. A first short list was compiled from those windfarms built and operating in Scotland (Appendix to Brief), concentrating on the larger windfarms (in terms of numbers of turbines). Next, the age of the windfarms, the landscape character and the availability of Environmental Statements were examined. A final selection of eight sites was chosen, all in Scotland (Table 1). The ES for each windfarm was obtained through SNH[2] (Appendix 1).

2.4 Case Study Survey and Analysis

2.4.1 An identical survey and analytical procedure has been used at each case study site. First, the Environmental Statement and related or supplementary documents (Appendix 1) were analysed to extract basic information (if present) on the ZVI, viewpoints, visualisations (including photomontages) and terms used to define visual significance. The main focus was on the key elements of the Visual Impact Assessment (VIA) and not on the broader Landscape (including landscape character) Assessment.

2.4.2 Next, a contact within SNH (including some advisors who have since left the organisation) was telephoned to ask about the process of environmental assessment for each case study and to discover information not available from the ES, such as whether a public inquiry was held. Although we began asking for detailed recollection from each contact (for example: Did SNH advise on the precise radius of the ZVI? Were all viewpoints identified by SNH included or were any excluded?), this proved an unrealistic expectation. Contacts quite reasonably could not recall case details from several years previous and were only able to give general comments and recollections. Whilst case details could be extracted from archived SNH files, we did not pursue this due to time constraints. The contacts were able to comment on changes made between the windfarm *"as assessed"* and *"as built"*, but again could not provide site-specific details on turbine re-locations and similar adjustments. In some cases there are significant differences between *"as assessed"* and *"as built"* that have affected our ability to test the accuracy or otherwise of the ES.

2.4.3 Finally, site visits were made during which as many viewpoints as practicable were visited and a comparison made between the appearance of the windfarm on site and the verbal description and photomontage (if any) presented in the ES. Records of the weather, time of day, light levels, visibility etc were made. The site survey protocol was devised and field tested at Dun Law windfarm by all three surveyors, and then revised and refined before being applied at the remaining seven sites. Each site was visited by one of the professional landscape surveyors accompanied by an assistant. The numbers of visits to each viewpoint are noted in Section 4.

2.5 Timetable

2.5.1 Site visits to the case study sites were made on the dates shown in Table 2. Two visits were made to each windfarm, except at Novar where one visit was made.

2.6 Limitations

2.6.1 The study was constrained by time, and by time of year, and these factors must be borne in mind in the interpretation of the results. The whole project was executed over a short period of approximately 8 weeks. Field work was completed during January and February 2002 and so was not able to compare visibility or visual effects over four seasons and during a wide range of light and weather conditions. Although most sites were seen in contrasting weather conditions, it was not possible to ensure that every viewpoint at every case study site was observed in contrasting conditions (for example, overcast and clear skies).

Table 2: Fieldwork Timetable

DATE	DAY	KES	SPJ	JFB
30 Jan	Wednesday	Dun Law	Dun Law	Dun Law
3 Feb	Sunday	Beinn Ghlas		
4 Feb	Monday	Deucheran Hill Beinn An Tuirc		
6 Feb	Wednesday		Hare Hill Hagshaw Hill	
7 Feb	Thursday		Windy Standard	
9 Feb	Saturday			Novar
13 Feb	Wednesday		Windy Standard	
14 Feb	Thursday		Hare Hill Hagshaw Hill	Dun Law
17 Feb	Sunday	Deucheran Hill Beinn An Tuirc		
18 Feb	Monday	Beinn Ghlas		

2.6.2 It was not practical to visit every viewpoint in every ES; inaccessible or remote viewpoints (such as on islands, at the tops of mountains or hills or in remote walking terrain) were in general omitted from the study. Particular case study site limitations are mentioned in section 4 and may affect the comprehensiveness of the diagnosis for individual windfarms. Adverse weather conditions were a significant constraint in Kintyre. However, overall the study team assessed 70 viewpoints and made 113 individual viewpoint assessments; the more generalised diagnoses and conclusions from these pooled results are therefore more robust, limited only by the seasonal constraints.

3 BACKGROUND RESEARCH

3.1 Guidelines on Windfarm Development

3.1.1 We have reviewed a range of guidelines on windfarm development. There is universal acknowledgement that visual effects are important, that they depend on distance, size, visibility and other factors, and on both landscape and visual receptors. Whilst there is some evidence to suggest a degree of professional landscape consensus on VIA and significance, there is extremely diverse and subjective opinion among other stakeholder groups. Some guidelines quote specific distances for recommended ZVI or for the relative impacts (and by implication significance) of visual effects in relation to distance. Some guidance appears to be re-cycling guidance from other sources and justification for any specific distances quoted in these documents is rare. In most cases any distance-effect guidance is not related directly to or varied with the size or height of turbine towers, but appears to be based on first-generation windfarms with tower heights (to hub/nacelle) of 25-30 m approximately (40 – 55 m overall).

3.1.2 The latest version of National Planning Policy Guidance 6: Renewable Energy Development (Scottish Executive, 2001) sets out broad policy but contains no detailed technical advice concerning the assessment of landscape or visual effects (but see below). Similarly, Department of the Environment (1993)(Planning Policy Guidance 23) is generic but non-specific, although it does recommend light grey/white colours as most suitable for towers, nacelles and blades in Northern Europe. Department of the Environment (1995) quotes as an example that the zone of visual influence for a particular windfarm development in Britain has been calculated to be approximately 10 miles (16 km), but without any detail. Scottish Executive (2002)(Planning Advice Note 45) offers the following general guide (Table 3) to the effect that distance has on the perception of a windfarm development in an open landscape (without relating this to tower height, but having earlier referred to turbines of tower height >70m and rotor diameters of >80m):

Table 3: General Perception of a Wind Farm in an Open Landscape

	Perception
Up to 2 kms	Likely to be a prominent feature
2-5 kms	Relatively prominent
5-15 kms	Only prominent in clear visibility – seen as part of the wider landscape
15-30 kms	Only seen in very clear visibility – a minor element in the landscape

Source: PAN 45 (revised 2002): Renewable Energy Technologies.

3.1.3 A similar table appeared in the Draft NPPG6 Consultation Document (2000), and the comments made on that Draft are of interest. For example, the British Wind Energy Association (BWEA) asked for the term *"impact"* to be replaced by *"effect";* argued that the table of perceptions of impact was prejudicial and asked for its removal; and offered that *"significant visual effects of wind turbines are only experienced within 5 km; beyond 15 km wind turbines can generally only be seen in very clear visibility and even when visible are likely to be a minor element in the landscape"* (Powergen Renewables made essentially the same argument).

3.1.4 Other consultees referred to the fact that turbines are increasing in size; that the Novar windfarm is clearly visible at 30 km; preferred a recommendation of semi-matt to matt surfacing for towers; and raised the issue of cumulative effects. Several consultees referred to the Sinclair-Thomas Matrix (see section 3.7 and Table 4) without identifying its source, pedigree or publication. As a result of these consultations, almost all reference to particulars was removed from the final version of NPPG6. Some details do however reappear in PAN45, but the word *"dominant"* which appeared in the table in NPPG6 Consultation Draft is changed to *"prominent"* in the table in PAN45 (above).

3.1.5 Scottish Natural Heritage (2001) is the most detailed of any statutory agency guidance available or published. Whilst it contains detailed information on issues of siting and design, and the processes of site planning, it also contains a specific recommendation that a ZVI should usually extend to at least 25 km. The Countryside Council for Wales (1999) specifies a ZVI of at least 10 km from the site (for wind turbine proposals) and up to 20 km on the fringes of National Parks and Areas of Outstanding Natural Beauty (AoNB) and in areas likely to be seen from such distances. Countryside Commission (1991) suggests an outer limit of 10 – 15 km for ZVI. There is no up-to-date Countryside Agency guidance in existence but we understand it is in preparation.

3.1.6 It is likely that much local government guidance exists, but a comprehensive review would have required letters or questionnaires to each organisation; a small selection available on the www is noted here. Cornwall County Council (no date) is general development guidance and is based on Landscape Institute - Institute of Environmental Assessment (LI-IEA)(1995). It combines the concepts of impact magnitude and receptor sensitivity (both *"landscape"* and *"viewer"* for landscape and visual respectively) and then offers two matrix tables for evaluating landscape and visual significance.

3.1.7 Specifically for windfarms, Moray Council (2001) recommends the use in EIA of a ZVI map and viewpoint analysis based on wireline diagrams and photomontage without specifying any distance or technical detail for these. Cornwall County Council (1996) (Appendix A: Visual Impact Assessment of Delabole Wind Farm) describes how this project (which began operation in December 1991, comprising 10 No 400 kW turbines, each 40.4 m high inclusive), was assessed using a ZVI of 7.5 km and based on the nacelle height only (32 m).

3.1.8 South Norfolk District Council (2000) (Supplementary Planning Guidance) is more explicit, and contains the following specific guidance (extract)(although the South Norfolk topography and landscape character are very different to much of Scotland): *"The following seven general principles … should be met if the visual impact of any proposal is to be minimised: … ii) Where a proposal lies within 5km of the Broads Authority Executive Area boundary, it would only be acceptable if it was demonstrably capable of locating without visual intrusion to the Broads; … vi) Proposals should be spaced at not less than 5km intervals from each other in order to prevent substantial adverse cumulative impacts which might exceed the capacity of the landscape to accommodate wind developments; …".* The SPG also recommends that any visual assessment is made on a 20km radius of the proposed large turbines in its zone of visual influence.

3.1.9 Cumbria County Council (1999) is the most detailed local government guidance we have identified. It is based on turbine heights to a maximum of 60 m and recommends a basic ZVI of 20 km and the visualisation of key viewpoints within 10 km. It also addresses cumulative effects, recommending such assessment for windfarms within 20 km of each other, and contains a range of further detailed guidance on both landscape and visual impact assessment.

3.1.10 The British Wind Energy Association (1994) suggests that the ZVI should be defined within a radius agreed with the local planning authority but contains no specifics concerning ZVI or other visual assessment tools.

3.1.11 The Campaign for the Protection of Rural Wales (CPRW)(1999) draws attention to the progressive increase in installed capacity and size of individual towers between 1991 to 1998 of from around 300 kW (41.5 m) to 600 kW (60 m) and notes that future increases will come from higher capacity machines of 1.5 MW (c 95 m) or more and that due to their extended threshold of visual intrusion, their impact would not be correspondingly diminished and would be considerably intensified at closer range. CPRW has argued that 95 m turbines could be visually intrusive at a 12 km radius and readily discernible at 22 km (Sinclair, 2001, discussed further at sections 3.7 and 6.2) so that CPRW recommend a *"radius of visual impact analysis of 30 km compared with 20 km for the current typical 55 m turbines".* They note the potential siting of turbines offshore and call for this to be at non-intrusive distances from the coast (more than 10 km and preferably 15 km). CPRW state that 60 m turbines can be visually significant within a 15 km radius and forecast 20 km for 95 m turbines. Thomas (1996) argues for 20 km or more (ZVI) for large-scale developments and the landscape terrain of the Mid Wales upland plateaux.

3.1.12 Although the project has not been able to review international guidance, we did note that guidance from New Zealand (EECA, 1995) explicitly omits detailed recommendations for assessing visual effects and argues that *"each development will need to be considered on its merits in terms of site and locality-specific considerations such as distance, back-drop, landscape scale and number of potential viewers".*

3.2 Research and Development Studies

3.2.1 Reference to ZVI and visual significance is contained in several national, supra-national and international research and development reports, some focused on wind power and some considering renewables in general.

3.2.2 AEA Technology plc (AEAT)(1998) is part of a study attempting to produce an overall valuation (or cost-benefit analysis) for the whole wind fuel cycle, including monetary estimates of the aggregate visual amenity damage of windfarms. It offers an *"Impact Pathway for Visual Intrusion"* and refers to the *"visual burden"* and the *"objective impact*" of that burden, and then contrasts this with the *"perceived impact"* which is influenced by attitudes and the existing land form and scenery. It refers to ZVI as zones of visual intrusion and notes that *"It can be concluded that there is unlikely to be any significant visual impact at a range of greater than 6 km",* although this conclusion is not justified.

3.2.3 The International Energy Agency (IEA)(1998) uses similar language to AEAT (1998), emphasising the difference between the visual burden (comprised of the height, shape, form, colour and number of turbines themselves) and human responses to it. It goes on to state that beyond 20 km the turbines will not be visible to the human eye (apparently based on towers of *"40 m height with the blades adding another 20 m*") and that in practice there are very small or negligible effects on visual amenity beyond 12 km. *"Between 6-12 km, the towers are indistinct and the rotor movement will be visible only in good conditions. Therefore, the visual amenity effects are generally concentrated within 6 km of the wind farm"* (the latter conclusions appear to be based on Eyre, 1995).

3.2.4 The European Commission (EC)(1997) (also based extensively on Eyre, 1995) states that *"a 1.5 MW turbine looks little different from a 500 kW machine, so the continuing trend towards larger wind turbines may, paradoxically, reduce the subjective visual effect of a given installed capacity".* Although not explained, this may be a reference to the suggestion that any enlargement is very difficult to perceive if there are few comparable scale indicators in the landscape, although this ignores the effect of height on the visibility distance and also ignores the effects of magnitude near to a tower. It notes that *"two bladed rotors appear to tilt with respect to the horizon whereas three bladed rotors appear to revolve and are therefore more calm and pleasant to view"* but it makes no reference to distance effects.

3.2.5 Soerensen & Hansen (2001) focus on offshore windfarms and note that it is assumed that the visual impact to viewers at sea level is negligible when the farms are located more than 8 km from shore. With distances larger than 45 km, the visibility will be almost zero due to the curvature of the earth's surface. These distances will be greater where there are elevated viewpoints but may also be severely reduced depending on the atmospheric clarity. They quote a study in Germany where visual impact would not be regarded as a problem at all if the farms were placed 15 km from shore. CADDET (2001) reports briefly on studies for two offshore windfarms in Denmark. The Horns Rev windfarm (eighty 2 MW turbines in a grid pattern 14-20 km offshore) *"will be visible from shore on a very clear day"* but *"the dominance of the windfarm in the landscape as viewed from the shore will be so modest that the impact is likely to be minimal".*

3.2.6 Quantitative research on ZVI, distance and visual impacts appears less common. Hull & Bishop (1988) examined the effects of electricity pylons on the landscape and in particular the relationship between distance and scenic impact. Based on the use of photographs and a rating of *"scenic beauty"* on a ten-point scale, they found that the visual impact decreases rapidly as distance increases. Most of the impact occurred in the 100 m to 1 km range, and the impact at 500 m was about 25% of the maximum, whilst at 1km it was 10%. The tower's scenic impact was also influenced by the landscape surrounding the tower. It appeared that towers had less impact in more complex scenes, especially at larger distances, presumably because the tower becomes less of a focal point and the observer's attention is diverted by the complexity of the scene.

3.2.7 Recent research by Bishop (in press) used animated computer simulations in paired comparisons of scenes, with and without a wind turbine, to test the ability of respondents (students) to first detect, then recognize, and then judge the impact of the turbine in relation to distance, contrast and atmospheric conditions (drawing on detailed equations from Shang & Bishop, 2000). The test turbine was 63 m in height (to rotor tip). His key conclusions (drawn from a Draft report by the Windfarm Steering Committee, Victoria, Australia, supplied by Nigel Buchan) are that:

- Recognition was only made by 5% of respondents at 30 km distance
- Recognition was only made by 10% of respondents at 20 km distance
- The most significant drop in recognition rates occurred at 8-12 km in clear air
- The most significant drop in recognition rates occurred at 7-9 km in light haze
- Visual impact drops rapidly at approximately 4 km and is <10% at 6 km in clear air
- Visual impact in light haze is not greatly different. A rapid decrease in visual impact begins at under 4 km and is <10% at 5 km
- Low contrast in light haze reduces the distance thresholds by 20%
- High contrast can dramatically increase the potential impact of white towers
- Ratings are highly sensitive to changing atmospheric conditions.

Given the size of the test turbine, these controlled and simulated findings are not dissimilar to the empirical results reported in Stevenson & Griffiths (1994) and Turnbull Jeffrey Partnership (1997)(Appendix 5), discussed below.

3.2.8 Research has been carried out, mainly in the USA and Denmark, into observer attitudes to the symbolism and meaning of wind energy (e.g. Thayer & Freeman, 1987; Wolsink, 1989, 1990), and into design issues such as scale, visibility, dominance, coherence, diversity, and the effects of site layouts (e.g. Bergsjo et al, 1982), but this research does not contain details that would inform the present study. For example, in some research smaller turbines appeared to have a lower effect than larger turbines, but this was a small preference compared to the effect of the number of units, so that people preferred fewer larger turbines. One potentially contradictory piece of research evidence is that on the one hand people find moving rotors more attractive than static ones, so that motion has been equated with lower perceived visual impact by some commentators, whilst elsewhere there appears to be agreement that movement makes the turbines more conspicuous than they would otherwise be.

3.2.9 Atkins Planning (1986) carried out a scoping study for the Energy Technology Support Unit on the visual impact of large wind turbines (up to 50 m high), which contains a range of sound, general observations and conclusions, although the penetration of such commissioned reports into wider circulation and practice is less clear. For example, we found no reference to that report, or Stevenson & Griffiths (1994), discussed below, in any of the ESs examined for the current study (except for an indirect reference to Stevenson & Griffiths in the Dun Law ES).

3.2.10 Stevenson & Griffiths (1994) carried out a comprehensive post-development audit of eight windfarms in England and Wales, visiting each windfarm on up to four occasions throughout the year. Six viewpoints were analysed at each site at distances up to 20 km, although in practice topography and visibility restricted views from 10 km and prevented views beyond 16 km for all sites. Photographs used a medium format camera (image area 4.5 x 6 cm) and a 80 mm focal length lens *"to provide an image closest to that of the human eye"*. The case study sites included turbines ranging in maximum height from 40.0 to 61.5 (but six were within the range 40.0 – 43.5 m) and in a variety of landscape settings.

3.2.11 Drawing on previous literature, and their own judgements, they devised an impact-zoning schema as follows:

> *"i) Visually dominant – the turbines dominate the field of view and appear large scale. The character of the immediate area is substantially altered and the movement of the rotor blades is obvious.*
>
> *ii) Visually Intrusive – The turbines appear fairly large in scale, and an important element in the landscape. However, they do not necessarily dominate the field of view. Blade movements are clearly visible and can attract the eye.*
>
> *iii) Noticeable – The turbines are clearly visible but not intrusive. The windfarm is noticeable as an element in the landscape. Movement is visible in good visibility but the turbines appear small in the overall view. Some change to the landscape setting is likely.*
>
> *iv) Element within Distant Landscape – Turbines are indistinct and form minor insignificant elements within a broader landscape. Movement of blades is generally indiscernible. The apparent size of the turbines is very small".*

3.2.12 Their main conclusions are that

- *In most situations turbines dominated the view up to a distance of 2 km (zone (i)).*
- *Turbines appear visually instrusive at distances between 1 and 4.5 km in average to good visibility (zone (ii)).*
- *Turbines are noticeable, but not intrusive, at distances between 2 and 8 km, depending on atmospheric conditions and other factors (zone (iii)).*
- *Turbines can be seen as indistinct elements within the distant landscapes at distances of over 7 km (zone (iv)).*

3.2.13 They also include further analysis and discussion concerning the effects of atmospheric conditions and seasonal variations, before analysing a number of VIA techniques. For ZVI, they recommend 10 km as suitable in most conditions. For photomontages, they make a number of straightforward recommendations, but in particular note that the size of the original photograph will affect the apparent size of the turbine image, stating that *“where photographs smaller than A3 are used, the turbines on the photomontage appear smaller than in reality”* and *“An A3 size print viewed from approximately 8 “ [20 cm] gives an accurate rendition of scale”.*

3.2.14 A recent study on ZVI, distance and visibility has been carried out at Hagshaw Hill windfarm for Scottish Power plc, as part of the preparation of the Beinn an Tuirc ES (Turnbull Jeffrey Partnership, 1997). Although we have not been able to examine the full report, we have reproduced a summary of it in Appendix 5 (from Scottish Power, 1997) because it covers similar issues to the present study.

3.2.15 It is evident that there is some research and a wide range of guidance and opinion on the detailed issues of ZVI, distance, visibility and significance for windfarms. Some of the differences identified might be explained by much of the early work having been based on first generation windfarms of a maximum height of from 40 to 55 m. Other differences can be attributed to both the complexity and the subjectivity of the issues, especially concerning visibility, perception and significance. A final influence is probably the desire of one group of windfarm interests to seek to minimise the political, professional and public perception of the potential visual (and landscape) effects of windfarms, and an opposing desire by another group of interests to maximise these perceptions. In practice, those differences must be resolved and decisions made.

3.3 Visual Effects and Design Issues

3.3.1 IEA (1998) notes that stroboscopic effects are minimised by keeping rotation rates below 50 rpm for three-bladed machines (75 rpm for two-bladed machines). The flicker effect (from the effect of sunlight streaming past the rotating turbine blades) has only a short potential duration each day and depends on a number of other criteria. In any event, effects should be minimal at distances greater than 300 m. It also states that *“Visual impacts are only normally important for residents and tourists up to a distance of about 10 km, with the main effects on amenity being concentrated within a few kilometres of the wind farm”.*

3.3.2 The Danish Wind Industry Association (2000) offers some simple suggestions regarding design issues, similar to but much less comprehensive than SNH (2001). SNH (no date) remarks that *“experiments in blade colour have shown that pale blue, brown and grey rather than white appear to be more recessive, whilst a matt surface reduces the amount of glint”*, whilst Stanton (1996) argues that the colour used should be white rather than off-white or grey, arguing that this (white) represents a forthright design statement, rather than off-white or grey which may be seen as a form of deception. Stanton argues that white is associated with purity and neutrality, whilst grey appears technically primitive, linked with other industrial elements. Gipe (1995) reviews public opinion surveys and a range of design guidance, based on North American and European experience, to arrive at conclusions not dissimilar to the guidance contained in SNH (2001).

3.3.3 A recent study (European Wind Energy Association, 2000) has examined the colour issue afresh and has explored a wide range of colours, combinations and design approaches – including camouflage, blending and articulation – but the work was restricted to explorations using photomontage and we are not aware of any field testing of different colour combinations. *“The overall conclusion was that graduated colour schemes worked well in all situations, especially helping to "root" the turbines in their setting. In terms of actual colours, "earthy" colour schemes - browns, greens and oranges – were found to tie the turbines to their surroundings more effectively than "airy" blues and greys. Schemes using a range of different grey shades on different turbines in a group, and an idea for "false shadows" – three or four shades of grey in vertical irregular stripes up the tower - were both* *considered visually confusing".* It is not clear from this report whether the issue of visibility and perception in relation to distance was included in this study of colour.

3.4 Visibility and Perception

3.4.1 Viewed by the human eye 1.8 m from the ground across a *"flat"* surface such as the sea, the horizon will be of the order of 6 km distant, due to the curvature of the earth. Viewed at an elevation of 60 m, the horizon will be of the order of 32 km distant and from the top of a 1000 m mountain the horizon will be at a distance of approximately 113 km. A tall structure standing above the horizon would of course increase these distances significantly; for example, for an observer at 1.8 m who is viewing a man-made structure 50 m tall, the effective distance to the horizon is 34 km and for a 100 m structure the distance is 46 km (Miller & Morrice, no date).

3.4.2 However, actual human perception is affected by the acuity of the human eye. In good visibility (visibility is meteorologically defined as the greatest distance at which an object in daylight can be seen and recognised), a pole of 100 mm diameter will become difficult to see at 1 km and a pole of 200 mm diameter will be difficult to see at 2 km. In addition, mist, haze or other atmospheric conditions may significantly affect visibility (Hill et al, 2001). Assuming this relationship is linear, and assuming absolute clarity of view, this suggests that the outer limit of human visibility in clear conditions of a pole (e.g. a notionally cylindrical wind turbine tower) 5000 mm (5 m) in diameter (a representative figure for a 60+ m high tower) will be of the order of 50 km; and the absolute limit of visibility imposed by the limit of the horizon viewed across a flat plane is similar at approximately 46 km.

3.4.3 Although there is frequent reference in ESs to the effect of reduced visibility caused by atmospheric or weather effects, data is rarely used to quantify this effect (the Hare Hill ES is an exception among the case study sites, and Stevenson & Griffiths (1994) also use such data). Such data is available from the Meteorological Office.

3.4.4 Physical visibility is not, of course, the only issue. Human perception is equally important in considerations of if and how a windfarm will be seen. Whole branches of medicine, ophthalmology, psychology and many applied sciences are concerned with perception. Numerous text books provide illustrations of the complexity of perception, including many familiar optical illusions. These issues are critically important in areas such as the design of roads and signage, in the training of airline pilots, the analysis of accidents and the design of machinery. Whilst the thrust of much research is concerned with how people can be deceived or make perceptual misjudgements, there are several key points that we believe may be material to VIA for windfarms.

3.4.5 People perceive size, shape, depth and distance by using many cues, so that context is critically important. When people see partial or incomplete objects, they may mentally *"fill in"* the missing information, so that partial views of turbines may have less effect than imagined. Although people may be able to physically *"see"* an object, inattentional *"blindness"* caused by sensory overload, or a lack of contrast or conspicuousness, can mean they fail to *"perceive"* the object. In a contrary way, large size, movement, brightness and contrast, as well as new, unusual or unexpected features, can draw attention to an object. In all these effects, issues such as experience, familiarity and memory may have an important role to play. Therefore, perception depends on experience, the visual field, attention, background, contrast and expectation, and may be enhanced or suppressed.

3.4.6 Two important issues, depth perception and size constancy, deserve further discussion. At least six monocular cues (cues dependant on one eye only, compared to binocular cues that require both eyes) are recognized as being used in the perception of depth and relative distance. These include (i) interposition (one object partially obscuring another appears nearer), (ii) the relative size of the retinal image (an object of known size is perceived to be further away if the image is smaller), (iii) the height of an object relative to other objects (an object at a lower level is perceived to be nearer), (iv) objects that appear clearly visible are judged to be nearer than others which are less clear, (v) linear perspective (converging lines in the landscape can create this effect), and (vi) movement cues (fast movement is judged nearer than slow movement by a stationary observer). We can therefore surmise that these phenomena will act to increase or decrease the apparent distance of a windfarm from the observer in the landscape.

3.4.7 Constancy is the phenomenon in which the properties of familiar or well-known objects appear to be constant and stable irrespective of the circumstances in which they are viewed. In size constancy, objects are perceived as the same size even when viewed from different distances. This is often illustrated using photographs containing people, but applies with any familiar object – the perception of the size of the people is quite different to their actual size on the photograph. This effect appears to be based on factors such as the relative size of other objects, textures and familiarity (the phenomena of shape, colour and brightness constancy are also well-recognised). We can therefore surmise that on viewing a windfarm in the landscape, a human observer could perceive the turbines to be the same size over a potentially long distance range as their familiarity increases, even if the image sizes (on either the retina or a photographic film) are very different.

3.4.8 The general conclusions to be drawn are that the magnitude or size of windfarm elements, and the distance between them and the viewer, are basic physical measures that affect visibility, but the real issue is human perception of visual effects, and that is not simply a function of size or distance. We say more on factors that we believe increase perception of *"apparent size",* and factors that decrease it, in sections 5 and 6.2.

3.5 Zone of Visual Influence[3] (ZVI)

3.5.1 The visibility of a windfarm is of course also affected by topography. The concept of the ZVI[4] in professional landscape work originated in the 1970s. Typically, topographic sections would be plotted and sight lines analysed at, say 10^0, intervals. This manual process was and is crude, slow and laborious. Faster and more refined manual techniques were developed using contour maps and templates or overlays. By the mid-1980s, Jarvis (1985) is describing the use of custom-written computer programs to produce ZVI and related visual assessment tools, but one is a program that takes six hours to execute 100,000 sections checking intervisibility; he gives an example of a ZVI covering 20 km^2 based on a 150 m grid.

3.5.2 The rapid development of computing power and capacity, and a parallel decline in relative costs, is of course familiar, so that a typical desk-top personal computer today might have many times the power of the Jarvis machine. However, the programs needed for calculating visual or landscape impacts over large areas have fallen into a no-man's land between Computer Aided Design (CAD) and GIS so that some companies such as TJP Envision (Turnbull Jeffrey Partnership, 1995; McAulay, 1997) have invested much in-house research and development effort in this area. The results are that today such ZVI calculations can be executed rapidly and relatively cheaply in terms of program costs and computing time (although it should be noted that program running times for ZVI calculations are counted in hours, not minutes, and these times increase linearly with the number of turbines and by the square (or worse) as the area of the ZVI increases).

3.5.3 The basic modules needed to calculate a ZVI are now an increasingly standard feature of much GIS software and integrated links to programs for producing wireframes and photomontages are commonplace. Use of a 50m grid, producing greater refinement and resolution, now appears common and standard. However, the rapid changes in the technology and tools that have taken place during the last 10 years inevitably means that some of the early ZVI in windfarm assessment (including the case study sites) are not as sophisticated or extensive as those appearing in current assessments, and this needs to be borne in mind in assessing aspects of the case study sites analysed later.

3.5.4 Hankinson (1999) describes three possible stages or components of a ZVI. First, a desktop study during which an experienced assessor can usually read the local contours from a 1:25,000 or 1:50,000 plan and gain a good idea of the likely extent of visibility. Next, an analysis (computer based) using a digital terrain model (DTM), cross-sections etc is carried out. Finally, site evaluation. She emphasises the distinction to be made between the ZVI (from the desk study and site evaluation) and what she terms the Zone of Theoretical Visibility (ZTV) derived from computer modelling (Hankinson, Box 16.7, page 367). There are two main sources of error in any ZTV.

3.5.5 First, data errors built into the computer program used include the contour intervals in the baseline data, which affect the degree of interpolation used in the program; and the accuracy and reliability of that data (other error refinements include whether the program takes account of the curvature of the earth etc)(Hankinson, Box 16.8, page 369). For example, a ZTV derived from a DTM based on 1:50,000 contour information (10 m contour interval) may be interpolated and rounded to the nearest metre in the program. The *"1 m interpolation"* assumes a straight-line slope between two contours and cannot take account of rocky terrain that can vary by up to 9.9 m without appearing on the 10 m contour base. Purchased data (from Ordnance Survey) and data digitised in-house also all contain inaccuracies or errors.

3.5.6 The second source of error arises because the ZTV is theoretical, that is it usually assumes a perfectly bare and smooth terrain unencumbered by houses, buildings or other structures, vegetation, hedges, woodland and forests. The site evaluation is the opportunity to take account of landform features that do not appear on the ZTV and landscape features that affect visibility such as trees, hedgerows, fences and buildings. Some programs are being developed that allow the introduction of surface features such as tree cover into the computation of ZVI (e.g. Turnbull Jeffrey Partnership, 1995 and illustrated in the Beinn An Tuirc ES). The key conclusion offered by Hankinson is that users and readers of ZTV/ZVI in environmental statements need to be alert to and explicit about the inherent sources of error, assumptions and limitations of the tools.

3.5.7 Current EIA DTM and ZVI calculations appear to be based on the use of Ordnance Survey (OS) topographic information, which is available for commercial and business use as Land-Form PROFILE (from 1:10,000 scale) or Land-Form PANORAMA (from 1:50,000 scale). The degree of detail, error and cost (at February 2002) of these products are significantly different. PANORAMA is available as 20 km x 20 km tiles (812 tiles cover Great Britain) that cost £10 each. Hence the digital or contour data for a windfarm in the centre of a tile might cost only £10 (to produce a 20 x 20 km ZVI), or £40 in the event that the proposed site fell at the corner of a tile. However, it should be noted that contour intervals are at 10 m and the error is ± 3 m, with a 50 m cell size. When details are stated in the case study ESs, the data set most commonly used is 1:50,000.

3.5.8 PROFILE has contour intervals at 5 m (±1 m) or 10 m (±1.8 m)(cell size 5 m) but each tile only covers 5 x 5 km and more than 10,000 tiles cover Great Britain. The cost per tile varies depending on quantity (e.g. decreasing from £100 - £70 - £42 - £25 per tile). The result is that 9 tiles cover an area 15 x 15 km, 16 tiles cover 20 x 20 km, 25 tiles cover 25 x 25 km and 36 tiles cover 30 x 30 km. The raw data costs are then, respectively, £900 - £1120 - £1750 - £2520. The practical result of this is that we are not aware that PROFILE data is used in ZVI for windfarms.

3.6 The Accuracy of ZVI Predictions

3.6.1 Fisher (1995) has analysed the effects of data errors on viewsheds calculated by GIS programs and shown that the calculations are extremely sensitive to small errors in the data, and to the resolution of the data and errors in viewer location and elevation. Other studies have shown that a viewshed calculated using the same data but with eight different GIS programs can produce eight different results. The direction of such errors – to either over or underestimate the ZVI – is unclear and is not obviously unidirectional. Such errors and effects are well researched and familiar in the detailed GIS technical literature but may not be highlighted in commercial programs or reported in practice reports, which reinforces the conclusion that the ZVI reported in most studies should be described as the Zone of Theoretical Visibility or the *"probable viewshed"*[5], and be subject to subsequent field testing and verification.

3.6.2 Prediction is at the heart of EIA and the general scarcity of detailed post-development audits by which the accuracy of impact predictions might be judged is surprising and regrettable, although some studies are now appearing. A general study by Wood et al (2000) across a range of project types and all (EU Directive) impact categories found that for landscape and visual effects, 40% of predictions were accurate, almost 40% were nearly accurate and approximately 20% were inaccurate.

3.6.3 Wood (1999) has made a detailed audit of the accuracy of a number of EIA predictions, including a ZVI for a clinical waste incinerator in Leeds. He discovered that for the incinerator stack, the ZVI overestimated the spatial extent of project visibility, due mainly to the use of a worst-case and simple topographic model that took no account of the heterogeneous and complex natural and man-made elements in the surrounding landscape.

3.6.4 In a further study (Wood, 2000) he audited the ZVI for four developed projects, including the Ovenden Moor windfarm near Halifax (ES dated 1991) in which the ZVI was determined by desk-study and not by the use of a topographic model or DTM. Overall he found a relatively close match between the predicted and actual ZVI, but including many errors of detail (large discrepancies were revealed for the other projects he analysed). He attributes the detailed errors in part to the fact that the ZVI was based on the tower height excluding the rotors, so that there was systematic under-prediction of visibility at the fringes of the ZVI; however, the general accuracy achieved using a coarse technique based on terrain only is probably due to the homogeneous landscape of the windfarm, dominated by open moorland with virtually no screening vegetation or buildings.

3.7 Visual Effect, Distance and Impacts

3.7.1 The most explicit and structured recommendations on the specific issue of the potential visual impact of wind turbines in relation to distance appears to be the self-styled Sinclair-Thomas Matrix (CPRW, 1999; Sinclair, 2001). This has its origins in a table produced in 1996 by a planning officer of Powys County Council (Thomas) and since revised and updated by a consultant (Sinclair). Assuming unimpeded, good visibility, Thomas defined 9 distance bands (A-I) and classified these with a visual impact rating from *"dominant"* (A) to *"negligible"* (I). This initial table was devised based on the 25 and 31 m hub machines built at Cemaes and Llandinam (Wales) in 1992. At that time, Thomas concluded that *"15 km is considered to be the appropriate radius distance for study"* and according to Sinclair, this became recognised as the norm for ZVI in EIA (apparently irrespective of turbine size).

3.7.2 Sinclair repeated the analysis, concluded that the Thomas distance bands were *"rather conservative",* and revised them upwards. Sinclair then extended the approach to viewpoints around other windfarms, including larger (72 m) turbines at Great Eppleton (Durham), and also projected or extrapolated the recommendations to encompass 90-100 m turbines. Both authors acknowledge that the Matrix is a general guide, especially at the margins of each band, and recognise the important influences of local conditions, viewing direction, turbine angle and the scale and nature of the landscape context. The resulting Sinclair-Thomas Matrix is reproduced in Table 4 (from Sinclair, 2001)(it is repeated in slightly different form in CPRW, 1999).

3.7.3 We have not been able to determine if this Matrix is in widespread use, or if it has been accepted, challenged or revised at public inquiries (although we are aware that it has been presented and used at public inquiries). It is not referred to in any ES we have examined (although many of these pre-date production of the Matrix) and it is not referred to in any of the literature we have examined, barring its citation in CPRW (1999) and Sinclair (2001) and mention in the consultation responses to Draft NPPG6.

3.7.4 Our initial diagnosis is that the Matrix raises several issues and difficulties of interpretation, including the fact that it is based on the professional (if experienced) opinion of two people, and that it sometimes conflates two separate points – magnitude and significance – for example in using the value-laden word *"intrusive"* in Band C. Such

Table 4: The Thomas and Sinclair-Thomas Matrices

THE THOMAS AND SINCLAIR-THOMAS MATRICES (section A) to estimate the potential visual impact of different sizes of wind turbines					
Overall height of turbines (m) >>>		41-45	41-48	53-57	72-74
Descriptors	Band	Thomas Matrix		Sinclair-Thomas Matrix	
		Original	Revised		
		Approximate distance range (km)			
Dominant impact due to large scale, movement, proximity and number	A	0-2	0-2	0-2.5	0-3
Major impact due to proximity: capable of dominating landscape	B	2-3	2-4	2.5-5	3-6
Clearly visible with moderate impact: potentially intrusive	C	3-4	4-6	5-8	6-10
Clearly visible with moderate impact: becoming less distinct	D	4-6	6-9	8-11	10-14
Less distinct: size much reduced but movement still discernible	E	6-10	9-13	11-15	14-18
Low impact, movement noticeable in good light: becoming components in overall landscape	F	10-12	13-16	15-19	18-23
Becoming indistinct with negligible impact on the wider landscape	G	12-18	16-21	19-25	23-30
Noticeable in good light but negligible impact	H	18-20	21-25	25-30	30-35
Negligible or no impact	I	20	25	30	35
Suggested radius for ZVI analysis		15	At least Junction of Band F and Band G; extended to reflect local circumstances or if cumulative impact may be involved		

THE SINCLAIR-THOMAS MATRICES (section B) Potential visual impact matrix for wind turbines of 72-74m overall height (field observation) and 90-100m (extrapolated). Distances in km					
Band		72-74m	90-100m	Magnitude	Significance
				(subject to other factors)	
A	Dominant impact due to large scale, movement, proximity and number	0 - 3	0 - 4	High	Potential for independent significant impact
B	Major impact due to proximity: capable of dominating landscape	3 - 6	4 - 8	Medium/High	
C	Clearly visible with moderate impact: potentially intrusive	6 - 10	8 - 13	Medium	Potential for contributory significant impact
D	Clearly visible with moderate impact: becoming less distinct	10 – 14	13 - 18		
E	Less distinct: size much reduced but movement still discernible	14 – 18	18 - 23	Low/Medium	Potential for ancillary non-significant impact: only becoming significant if numerous or cumulative with other installations
F	Low impact, movement noticeable in good light: becoming components in overall landscape	18 – 23	23 - 30	Low	
Approximate recommended threshold for ZVI analysis					
G	Becoming indistinct with negligible impact on the wider landscape	23 –30	30 - 38	Negligible	
H	Noticeable in good light but negligible impact	30 -35	38 - 45		
I	Negligible or no impact	35+	45 +		

Source: Sinclair (2001)

confusion persists in the tables because Table section A does not have the same columns as Table section B, where in the latter, magnitude and significance are separated. However, we have attempted to apply the Matrix during the case study visits and this is discussed further at section 6.2.

3.8 Photomontage

3.8.1 The illustration of potential landscape or visual impacts using photographs, wireframes and photomontage is now commonplace and expected in EIA, and videomontage may soon become more widespread. The development of these and related visual or virtual reality techniques is now an area of major research and development interest. The issues are inevitably complex. Perkins (1992), for example, asks what influences *"perceived realism"*? Whilst image quality may be important, he points out that realism may be affected by the context or content of the image portrayed. A technically accurate and precise photomontage that placed Edinburgh Castle on Kintyre will not be perceived as realistic for obvious contextual reasons. Although less extreme, a proposed windfarm placed in a remote landscape may be perceived by a viewer as containing an element of incongruity and inappropriateness that will affect their evaluation of the visualisation.

3.8.2 It should also be obvious that the human eye sees differently than a camera lens, both optically and figuratively. The focusing mechanisms of human eyes and camera lenses are different; human eyes move, and the brain integrates a complex mental image; human vision is binocular and dynamic, compared to a camera that tends to flatten an image. These and related issues of perception have already been referred to in section 3.4.

3.8.3 It therefore follows that when the common recommendation is made that a 50mm standard lens (35mm camera) most closely approximates to the human eye, this *"standard"* or *"normality"* is relative and qualified (and this definition of *"normality*" is challenged in some specialised photographic literature). If a wide-angle lens is used, for example for panoramic effect, the size of the subject in the foreground will increase in relation to the background; in the case of windfarms in a landscape scene, the effect will be to under-represent the relative size of the towers and under-estimate their visual magnitude.

3.8.4 Cornwall County Council (1996) (Appendix A: Visual Impact Assessment of Delabole Wind Farm) notes that *"for photographs taken within 500 m of the site, a standard (75 mm) lens was used on a medium format camera. For all the others, a 200 mm lens was used. The combination of the two sizes of lens seemed to provide the most realistic image of the turbines/wind farm in the landscape".* This is an unusual set of conclusions that we have not been able to verify.

3.8.5 Shuttleworth (1980) is a relatively early example of a continuing body of work using photographs as surrogates for real landscapes, although the work is mainly concerned with landscape character and quality assessment, and not visualisation and realism *per se*. He points out the obvious differences and distortions between the two-dimensional image and the three-dimensional perception of a scene or viewpoint by a human observer. He stresses the need to insert aids in photographs to provide constancy scaling and perspective resolution. Perceptual ambiguity can be reduced if the field of view is as large as possible and if depth cues (paragraph 3.4.6) are deliberately included in the photograph. Interestingly, Shuttleworth found that photographic simulation was most reliable in dealing with the overall perception of the landscape, but less reliable when dealing with perception of detailed elements and characteristics in the landscape.

3.8.6 LI-IEA (1995)(and updated in LI-IEMA, 2002) contains general guidelines on photomontage (and CAD, including ZVI) but contains little technical detail for photographs or

ZVI. Sparkes & Kidner (1996) remark that photomontages are not cheap to produce, are fundamentally inflexible and of course cannot depict movement. They also suggest they can give a pessimistic impression of a development because for the turbines to be visible on the photograph, they tend to be painted in white or given a black outline, resulting in them having a high degree of contrast compared to expectations in reality. This was not our experience during the case-study research (paragraphs 6.1.16-6.1.21).

3.9 Significance

3.9.1 Prediction and then evaluation of significance are at the heart of EIA. All developments produce effects, which may be positive or negative. All developments produce effects which vary in size or magnitude and such variation may be spatial or temporal or both. It may or may not be feasible, technically or economically, to reduce or mitigate such effects. After mitigation, an effect may still be significant because of size, location, type, risk or related factors. Such significance may be temporary or permanent, reversible or irreversible. Significance is therefore always relative and context-specific, which may be local, regional, national, supra-national or international.

3.9.2 Ultimately, significant is whatever individuals, people, organisations, institutions, society and/or policy say is significant – it is a human evaluative and subjective judgement on which there may or may not be consensus. It is therefore important that two separate but critical characteristics of all effects – magnitude and significance – are clearly distinguished.

3.9.3 The wide diversity of opinion evident on the merits or otherwise of windfarms, including their visual effects, and the implicit expression of opinion on significance within that diversity of opinion, should not be surprising. It is therefore also important that in any ES, the foundations and assumptions on which significance is based must be clear and explicit.

3.9.4 Remarkably, perhaps, significance is little researched in relation to visual impacts. Exceptions are Bishop (in press), referred to at paragraph 3.2.7, and Stamps (1997), who offers a detailed review of the issue (including the related issues of design guidance and design review) and a theoretical and methodological model for assessment based on a statistical analysis of human preference ratings for before and after scenes. However, his focus, and his case-studies, are based on urban design issues in California.

3.9.5 The legal and regulatory starting points in Scotland are the Environmental Impact Assessment (Scotland) Regulations 1999 (Circular 15/1999) which require that *"the aspects of the environment likely to be significantly affected by the development"* are included in the ES, but offer no specific guidance on definitions of significant. The guidance states that impacts are more likely to be significant in sensitive locations, examples of which are listed. In the case of windfarms, the *"likelihood of significant effects will generally depend upon the scale of the development, and its visual impact … EIA is more likely to be required for commercial developments of five or more turbines, or more than five MW of new generating capacity".* The complementary PAN58 (Environmental Impact Assessment)(Scottish Executive, 1999) does not offer specific guidance on definitions of significance.

3.9.6 Specifically for landscape and visual effects, the LI-IEA Guidelines (LI-IEA, 1995) are widely referred to and appear to have achieved status as a de-facto national standard. However, the Landscape Institute has produced an advice note[6] that emphasises that the Guidelines are general, non-prescriptive, and were not intended to offer a preferred methodology. In particular the note is at pains to point out that the examples given (Figure 3.1 [classification of sensitive landscape/visual receptors and impact magnitude] and 3.2 [the relationship between sensitivity and magnitude in defining significance thresholds]) are illustrative only. *"On no account should they be linked and then applied in the assessment of a proposed development. As paragraph 3.62 states: "… it must be stressed that this is only* *an example. Every project will require its own set of criteria and thresholds, tailored to suit local conditions and circumstances …"".*

3.9.7 In the second edition of this guidance (LI-IEMA, 2002), the advice given is less prescriptive and stress is laid on "*informed and well-reasoned judgement supported by thorough justification*" as well as the need to consider issues, including significance, on a case-by-case basis (Box 7.3, LI-IEMA, 2002). Broad professional landscape consensus does exist, as the similarities in the examples given in Appendix 6 of LI-IEMA (2002) show, but detailed differences of interpretation are inevitable. Despite arguments to the contrary that appear in some of the ESs we have examined, there appears to be no statutory guidance on a definition or definitions of significance. Guidance states that potentially significant effects may occur in some sensitive locations (landscapes), with the implication that an effect of a defined magnitude in one location could be significant but that the same effect in another, less sensitive, location would not.

3.9.8 The value judgement of significance is played out through development control and the public inquiry system, in that decisions of re-design, re-siting of turbines, planning conditions and even refusal of permission can be said to be the result of statutory, public and political debate on which visual effects are and are not judged to be significant. It would be an interesting and informative study to test these ideas through a detailed examination of development control and public inquiry case-law, but this was beyond the scope of the current study.

3.9.9 It therefore follows that the definitions and judgements of significance contained within an ES are ultimately those of the developer and/or the consultant, even allowing for the existence of a degree of consensus among landscape professionals who would be expected to share some common standards and norms. Whilst no criticism of the honesty or professional integrity of the parties is intended concerning the case study examples in this project, it is a truism that a developer must want to minimise the number of significant impacts identified, and that a professional is torn between their role as an expert and their role as an advocate. Whilst there are examples in existence of patently biased and promotional Environmental Statements that developers have treated as little more than public relations documents, even in ostensibly fair, balanced and unbiased statements there can exist more subtle and entirely understandable nuances and judgements that can be challenged. Statutory consultees, other professionals and decision-makers are therefore free to accept or reject many definitions and judgements, unless consensus exists.

3.10 Public Attitudes

3.10.1 There is a little research, some survey and much anecdotal evidence that public attitudes to renewable energy, wind energy and windfarms are complex and dynamic. Krohn & Damborg (1998) review a range of international studies and show that (a) there is broad public support for renewable energy in general, (b) there is high (around 80%) public support for wind power, including similar levels of support in the UK based on thirteen surveys conducted between 1990 and 1996, but that (c) there are important and significant differences in attitudes and opinions in the particulars. In other words, there may be a significant difference between attitudes expressed (positively or negatively) in a general way, and actual behaviour in terms of opposition to new developments.

3.10.2 Whether such differences are labelled NIMBYism or invested with more subtle attempts to explain an apparent contradiction is a matter for research and debate (Wolsink, 1994, 2000). At a simplistic level, windfarms are not different from other developments such as hospitals, roads and waste disposal sites, in that the majority of the public accepts the necessity for these but may be vociferous opponents of local developments. Also, studies for windfarms show that human perceptions of potential noise and potential landscape or visual effects are the key issues. Windfarm interests have been interested to summarise and promote the results of such studies (e.g. BWEA, 1996), although it is worth stressing here that such summaries may show evidence of selectivity in interpretation, and most surveys have been of a type best described as general public attitude and opinion surveys that have not focused on the more detailed questions being examined in the current study.

3.10.3 Duddleston (2000) reports on a post-development survey (by telephone) of public attitudes and opinions concerning the Beinn Ghlas, Novar, Hagshaw Hill and Windy Standard windfarms. Residents within a 20 km radius of each site were sampled (the study used the following zonal definitions: 0-5 km – high proximity zone; 5-10 km – medium proximity zone; 10-20 km – low proximity zone). Perversely at first sight, perhaps, a slightly higher proportion of respondents in the medium and low proximity zones (11% and 12% respectively) said that they disliked the windfarm because it was unsightly or spoiled the view compared to those (8%) in the high proximity zone, but this bald result ignores detailed local visibility issues (for example, the Novar site is essentially invisible in the high proximity zone, except for specific and limited localised viewpoints, but more visible beyond this zone). This point is elaborated by Duddleston (Table 4, page 12), where she shows that a higher proportion of respondents in the medium proximity zone see the windfarm from their home or garden or when travelling on local roads compared to those in other zones, and they also see the windfarm more frequently (every day or most days). The survey then asked people to compare their anticipated and actual problems. For all effects including *"look of the landscape being spoilt",* the results show actual effects to be around 15-20% of anticipated effects.

3.10.4 Whilst windfarm interests are keen to offer these (and other) results from public attitude surveys as evidence that public reaction and opposition to windfarms is exaggerated, it could equally be interpreted as evidence that detailed attention to the planning, impact assessment, siting and design processes is successful in minimising effects or mitigating potentially significant impacts. The Duddleston survey did not address specific visual questions, such as whether the windfarm as built appeared more or less prominent than they (the public) had expected or had judged from inspection of pre-project visualisations (the main sources for pre-project information were local newspapers, other media and word of mouth, with some consultation by developers in the high and medium proximity zones). It therefore offers no results to inform the detailed questions being asked by the current project.

3.10.5 We have not discovered any public attitude or opinion surveys that address the specific issue of the relationships between turbine size, distance, visibility and impacts.

3.11 Cumulative Effects

3.11.1 This general phenomenon is flagged or raised in many discussions and policy documents as an important issue. A relatively recent report is Energy Technology Support Unit (2000). This is generic guidance on principles and processes but contains little specification or technical detail on issues of magnitude, distance and significance.

3.11.2 Piper (2001) has analysed three cases of the cumulative effects of two or more projects, including windfarms in Holderness (Yorkshire) and Kintyre. In Holderness (study for East Riding of Yorkshire Council), the boundary of the study area was seen as the maximum distance (about 20 km) from which the windfarms might be seen (in a coastal region of very flat topography). The basic approach involved defining landscape character and determining the sensitivity of the landscape (based on potential change, intrinsic character and potential visibility). The study defined several visibility thresholds as follows: 0-2 km: turbines a prominent element in the local landscape – high visual impact; 2-5 km: turbines would appear as clearly visible element in landscape – high-medium or medium visual impact. In terms of best practice for cumulative effects assessment, Piper rates the Holderness study as limited and partial; for example, no cumulative zone of visual influence map was produced to show overlapping affected areas within different dominance thresholds. For the Kintyre project (study for Scottish Natural Heritage) the study area was defined as a radius up to 30 km, assuming turbine heights to blade tip of up to 68 m, and based on five projects or potential projects at various stages of resolution. As for Holderness and in terms of best practice for cumulative effects assessment, Piper also rates the Kintyre study as limited and partial; for example, landscape character assessment was not used and no explicit assessment of significance in relation to distance is made.

3.11.3 MosArt Associates (2000) have prepared an analysis of landscape character and sensitivity to windfarm development for Cork County Council, but this was an area based study akin to the similar capacity studies being carried out in Scotland and elsewhere, and contains few detailed technical recommendations on aspects of VIA. With regard to cumulative effects, however, it recommends the use of overlapping ZVI and, pending a further study, that the outer limit of cumulative effect is set at 10 km separation, with any larger separation not considered as having a cumulative effect. For individual applications, it recommends a basic ZVI of 20 x 20 km and, for large turbines (a height of more than 60 m), a ZVI of 30 x 30 km.

3.11.4 Information on a current research study on cumulative impact of wind turbines, commissioned by the Countryside Council for Wales, is at Macaulay Land Use Research Institute (2002). At present the material available here is largely literature review, much of which is general and non-specific for windfarms. For example, it reviews controversies over the differences between professional and lay public preferences for landscape and scenic quality; it reviews several studies (largely drawn from the USA and the Netherlands and much from the late 1980s) on perceptual studies of windfarms (but much of this is focused on attitudes and symbolism, and general design issues) and it reviews a familiar range of tools for VIA, including ZVI and viewpoint analysis.

4 CASE STUDY SITES

4.1 Introduction

4.1.1 The following sections provide a short description of each windfarm, followed by a condensed analysis of each Environmental Statement (Appendix 1), concentrating on key aspects of the VIA [7]. For each viewpoint visited we provide a brief summary of the prediction or judgement made in the ES, and then a brief comment based on our site appraisal. An overview of the site appraisals is then presented, followed by some brief conclusions.

4.2 Beinn An Tuirc

The Windfarm

4.2.1 The windfarm was constructed in 2001. The original proposal was for 50 turbines with a hub height of 40.5 m and a total height of 62.5 m. As built the windfarm consists of 46 turbines with height to hub of 40.5 m and total height of 62.5 m. Viewpoints were selected by negotiation with the local planning authority and SNH. The site moved south during negotiations because of ornithological interests and the layout also changed for this and visual reasons. There are significant locational differences between as assessed and as built.

The Environmental Statement

4.2.2 The ES material available to us was varied and complex and it proved difficult to cross-match, collate and test the documentation. The main statement (no date) is based on layout G (layouts D, E, F and G are referred to). The ZVI radius (study area) is declared as 15km, but is actually 16.6 km to accommodate the spread of the windfarm layout of 3.3 km. Chapter 9 in the ES includes a detailed discussion of the basis for the selection of 15 km. The basic ZVI is a zone of theoretical visibility (bare-ground or worst-case scenario). Computer calculations are also made of the zone of actual visibility taking account of trees rendered in the program as standardised forestry blocks. Relative visibility in the ZVI is based on a hub height of 40.5 m, not the maximum height, but this decision is not explained.

4.2.3 Eighteen viewpoints were selected based on site survey and consultation with SNH, Argyll & Bute Council and North Ayrshire Council (Arran). Site assessments were made based on visualisations (photographs and wireframes), not photomontages. The effects on both stationary viewers and moving viewers are distinguished and analysed and a long list of factors considered in assessment is provided. Orientation of the turbines in relation to the prevailing winds is considered. Separate reports exist containing *"Wireframe Overlay Illustrations"* (May 1998)(viewpoints 1, 2, 5, 11, 12, 13 and 15 only) and *"Photomontages"* (no date)(prepared for viewpoints 2, 5, 11, 12, 13 and 15 only). The recommended viewing distance for visualisations is 24 cm. It is not clear if these separate reports refer to the 18 viewpoints in the main ES.

4.2.4 At the end of each viewpoint assessment (descriptive), a statement is made as to the anticipated effect (e.g. *"moderate adverse effect on visual amenity"*) and the significance (e.g. *"significant"*). The ES makes reference to the Environmental Assessment Regulations and concludes that minor effects are not significant, but moderate and major effects are significant. The basis for the assessment of significance does not appear in the main ES (layout G), but is described and discussed in detail in a supplementary report, *"Assessment of Landscape and Visual Effect Layout F, Draft 2"* (1997), as is the technical detail of the ZVI, DTM etc. We also obtained a packet of visual material (ZVI, site layout, wireframes) dated 1999 that in one case referred to layout H. We assume that layout H is close to the as built windfarm.

4.2.5 Although based ultimately on professional judgements by more than one assessor, this ES is explicit in listing and discussing the factors taken into account in judging very significant, significant and not significant or no effect. The details in the ES are long and relatively complex and are not repeated here for that reason. The supplementary report (1997) is effectively a second version of the ES, based on Layout F, but concerned only with the landscape and visual effects. A full set of ZVI, visualisation, photomontage and related materials is presented.

Site Survey

4.2.6 There are 19 viewpoints in the ES. Seven are on the islands of Gigha or Arran and 2 are in the sea; these were not visited during this study. Of the 10 remaining, 5 were not visited due to their remoteness. To assess them would have involved some hill walking which may have been feasible in better weather but was not practical due to the time constraints of the project and the poor weather conditions. Therefore only five out of 19 viewpoints were assessed.

4.2.7 We made a total of 9 visits to the 5 viewpoints (viewpoint 6 involved walking 2 miles so we visited it only once when the weather was good) but were only able to make 5 useful assessments of 4 viewpoints due to the weather.

Table 5: Viewpoint Analysis for Beinn an Tuirc

VP	Distance (km)	No of Visits	ES Description (main ES)	Site assessment	Photomontage/wireframes (main ES)	Wireframes (supplementary)
1	5.85	2	States 11 turbines visible.	None visible. This may be due to layout changes.	Totally inaccurate, looks like layout change.	
2	4.35	2	States 35 turbines visible over 2 hills. States 'moderate adverse impact'.	23 then 11 visible over 1 hill. Although the number and layout were not accurate, 'moderate adverse impact' is correct.	Inaccurate in number and position. Turbines looked bigger in reality than in photomontage.	Called viewpoint 1. Wireframe shows 23 turbines with extreme tips of three more (which were obscured by vegetation in reality). The individual positions are reasonably accurate. The overall position and size of the farm is accurate.
3	7.8	2	States 30 turbines visible. States 'new visual focus' and 'moderate adverse impact'.	15 visible. "Moderate adverse impact' may be too strong as there are already many manmade elements in this landscape.	Not accurate in position or number. Size looked bigger in reality.	Called viewpoint 2. Two wireframes, one without vegetation and one with blocks of trees. The former shows 15 turbines with the tip of one more. The overall position and size is accurate. The latter wireframe shows only 11 turbines and the tip of one. As we saw more it would appear that the screening effect of the trees has been overestimated.
6	6.6	1	ES states 21 turbines visible and 'low adverse impact'.	7 visible (although light conditions poor). 'Low adverse impact' is correct.	Not accurate in number or position.	Called viewpoint 5. Shows 8 turbines.

4.2.8 There were substantial changes in layout between the ES and construction, accounting for the major discrepancies we found. We do know that the number of turbines was reduced by 4 and the whole position was shifted south because of ornithological interests. Apart from the numbers and positions, we generally agreed with the assessments of impact and significance and there was only one disagreement where we felt that the impact had been slightly overstated, but again layout change may have affected this assessment.

Conclusions

4.2.9 Full technical details of the VIA are provided and justified in the ES and potential errors are acknowledged. Magnitude, sensitivity and significance are separated, justified and discussed in detail and in a balanced way. Major changes between assessment and construction mean that this ES is not strictly accurate. The turbines look bigger in reality than in the photomontages. The newer wireframes to accommodate the layout changes are generally accurate regarding the positioning and overall impact of the windfarm with minor inaccuracies regarding individual positions of turbines and screening effects of trees.

4.3 Beinn Ghlas

The Windfarm:

4.3.1 The windfarm was constructed in 1999. The original proposal was for 16 turbines with a hub height of 40 m and a total height of 61.5 m. A total height of 65m was used in the ES landscape assessment for reasons that are not explained, which might have resulted in over-prediction of the ZVI. As built the windfarm consists of 14 turbines with a height to hub of 35 m and a total height of 57 m. SNH judge that all the main or significant viewpoints were covered, although views from roads to the west (leading to Loch Awe) were ignored or underestimated, and emphasis was perhaps not placed on views by walkers on nearby hills. Although 2 turbines were removed, we understand that the other 14 locations were not changed.

The Environmental Statement

4.3.2 The ZVI is shown for an area of 30 x 30 km, distinguishing the differing numbers of turbines to be seen. However, the resolution is crude and it is not overlain onto an OS map, making locational referencing difficult. This was produced using a DTM (worst-case conditions, ignoring structures, forests etc) of the 1:25,000 OS map, but no details of potential errors are given. The VIA then uses photographs for 17 viewpoints using a wide panoramic format camera and wireline visualisations. Five views are illustrated using photomontage.

4.3.3 Significance (Volume 1) is based on LI-IEA (1995). First, magnitude was defined as:

> *High – Notable change in landscape characteristics over an extensive area ranging to intensive change over a more limited area.*
> *Medium – moderate changes in local area*
> *Low – virtually imperceptible changes in any components*

4.3.4 And then sensitivity was defined as:

> *High – important components or landscape of particular distinctive character susceptible to relatively small changes*
> *Medium – landscape of moderately valued characteristics reasonably tolerant of changes*
> *Low – a relatively unimportant landscape. The nature of which is potentially tolerant of substantial change*

4.3.5 These were then combined into a classification as:

> *Significance Substantial – the product of high sensitivity and high magnitude, or medium sensitivity with high magnitude*
> *Significance Moderate - the product of medium sensitivity and medium magnitude, or low sensitivity with high magnitude*
> *Significance Slight - the product of low sensitivity or low magnitude*

4.3.6 This schema is essentially similar to LI-IEA (1995), but in this case it is logically flawed and incomplete, in that in a 3 x 3 matrix (magnitude versus sensitivity) there must be 9 classes, but only 6 are referred to in the ES (and only 6 examples are illustrated in the detailed technical appendix (Volume 3)). No distinctions are made between magnitude, sensitivity and significance for landscape impacts as opposed to visual impacts. For each viewpoint, a description leads to categorisation of significance, although the authors then introduce terms such as very slight (presumably lower than slight). The significance terminology then changes in a later summary table to minor-moderate-significant. Although not explained, the implication is that only substantial impacts are judged to be significant. Four additional viewpoints (using a Linhof panoramic format camera giving 90^0 field of view) were produced to give further wirelines and photomontages. This supplementary report to the ES does explain sources of discrepancy between the ZVI predictions and on-site evaluation (including data interpolation errors).

Table 6: Viewpoint Analysis for Beinn Ghlas

VP	Distance (km)	No of Visits	ES Description	Site assessment	Photomontage
4	9	2	ES states 13 turbines visible and that "they would not be conspicuous in most lighting conditions".	Only 4 visible but weather conditions poor. We could still distinguish them clearly and they stood out more than was suggested in the ES.	The turbines seemed about twice the size in reality. There were fewer visible but these stood out more on the skyline.
5	13	2	ES states 10 visible and described as minute elements in the landscape and impact 'slight'.	10 visible. Assessment correct.	The turbines look much taller in reality and more spread out than in the photomontage.
6	10	1	ES states that no turbines would be visible from the road.	None visible.	N/A
7	-	1	This was a viewpoint chosen to evaluate the access track and substation.	We could not make out any track or locate the substation.	N/A
10	8	2	States 10 turbines would be visible and would be inconspicuous in most lighting conditions and impact 'slight'.	10 visible on each visit. Description incorrect. Underestimates appearance and impact.	N/A
11	11	2	States that towers of 10 and rotors of a further 4 would be visible. States "barely discernible in most lighting conditions" and "slight impact".	We saw only 3 but the cloud was low. Assessment correct but in better weather conditions this could be an underestimate.	N/A
13	13	2	States all turbines visible and "barely discernible in most lighting conditions" and "slight significance".	All turbines visible. Incorrect that turbines would be "barely discernible in most lighting conditions" as we saw them clearly in poor light. "Slight significance" correct.	N/A
B	14	2	States all (14) turbines visible and "barely discernible in most lighting conditions" and "significance slight".	13 visible but weather poor. Incorrect that "barely discernible in most lighting conditions" as we saw them very clearly in poor light. "Significance slight" correct.	Turbines seem much more noticeable and distinct than on PM. They seem bigger and more spread out.

Site Survey

4.3.7 There are 17 viewpoints in the ES. Three were not visited because they were remote. Out of 26 visits to 14 viewpoints we were only able to make 9 useful assessments of 8 viewpoints due to weather conditions.

4.3.8 Although we generally thought that the number of turbines and the impact/significance ratings were accurate (bar one underestimate), we thought that the descriptions of visibility were on the whole an underestimate. The photomontages also appeared to underestimate size and the positions seemed inaccurate.

Conclusions

4.3.9 The technical details of the VIA in the ES are not provided in full, nor are they justified, and potential errors are not always acknowledged. There is no explanation given on the potential accuracy (or otherwise) of the photomontages. Magnitude, sensitivity and significance are separated, justified (very succinctly) and discussed, but not separately for landscape and visual effects, and there is some inconsistency of terminology.

4.4 Deucheran Hill

The Windfarm:

4.4.1 The windfarm was constructed in 2001. The first proposal that was given the name Deucheran Hill was for 12 turbines with the height to hub not stated but a total height of 76 m. As built the windfarm consists of 9 turbines with height to hub of 46 or 60 m and total height of 62.5 or 76.5 m. Viewpoints were selected after consultation.

The Environmental Statement

4.4.2 There is some complexity and lack of clarity within this ES because a separate ES (not examined in this study) was prepared for an earlier proposal (named Cruach nan Gabhar) with 24 (and then 15) turbines. The proposal was later modified, the turbines reduced to 12 (and then 9) and the name was changed to Deucheran Hill. In the Deucheran Hill ES, visual re-assessments are restricted to those 3 viewpoints (from an original 14) where an increase over the Cruach nan Gabhar proposal(s) is expected. For other viewpoints, the (now pessimistic) assessments based on Cruach nan Gabhar are used in the Deucheran Hill ES. A table (Table 5.1) compares the number of turbines visible for each windfarm, distinguishing between (rotor) tips and hubs. Towers are to be coloured off-white/ pale grey with a semi-matt surface.

4.4.3 The ZVI is a worst-case survey (bare ground), but the screening effect of conifer plantations is noted. The data used and resolution are not stated. The distance used is 15 km (overlain on 1:50,000 OS map (reduced)) but this distance is not justified. A revised ZVI is then produced (supplementary drawings) for 7 x 79 m and 2 x 93 m turbines (as built).

4.4.4 Visualisations use wireframes and it is emphasised that these are not photomontages. The camera was at a height of 1.8 m using a 50 mm focal length lens and a recommended viewing distance of c23 cm. The ES draws attention to the limitations of the visualisations and stresses that the graphics (dark delineation of towers on a white background) can over-represent the true width and impression of the towers. Accordingly, it is stated that whilst the height representations are correct, at distances beyond 4-6 km the width is over-represented.

4.4.5 This ES adopts a common methodology for assessing significance for each impact category (based on LI-IEA (1995) and Department of the Environment (1995)). The landscape and visual assessment methodology is explained in detail in Appendix E and magnitude (for visual receptors) was defined as shown in Table 7.

Table 7: Magnitude of Impact – Visual Receptors (Table F3 from Deucheran Hill ES)

MAGNITUDE OF IMPACT	
HIGH	Major change in view: change very prominent involving total or partial obstruction of existing view or complete change in character and composition of view through loss of key elements or addition of uncharacteristic elements.
MEDIUM	Medium change in view: which may involve partial obstruction of existing view or alteration to character and composition through the introduction of new elements. Change may be prominent but not substantially different in scale and character from the surroundings and the wider setting. Composition of the view will alter. View character may be partially changed through the introduction of features which, though uncharacteristic, may not necessarily be visually discordant.
LOW	Minor change in view: change will be distinguishable from the surroundings whilst composition and character (although altered) will be similar to the pre-change circumstances.
NEGLIGIBLE	Very slight change in view: change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.

4.4.6 Sensitivity was defined as the *"importance of the individual element being assessed e.g. the landscape type or location …",* categorised as Low, Medium or High. The sensitivity of visual receptors is defined and considered in detailed evaluative tables – tourists (high sensitivity), travellers (low), local recreation (high), walkers and climbers (high), estate workers/farmers (medium), residents (high) – with both landscape and visual effects being assessed. These were then combined as shown in Table 8.

Table 8: Impact Matrix (Table 1.2 from Deucheran Hill ES)

MAGNITUDE			
HIGH	Moderate	Moderate/Major	Major
MEDIUM	Low/Moderate	Moderate	Moderate/Major
LOW	Low	Low/Moderate	Moderate
NEGLIGIBLE	Negligible	Negligible/Low	Low
	LOW	MEDIUM	HIGH
		SENSITIVITY	

Note: *"shaded boxes are not considered significant in terms of the Regulations".*

4.4.7 This schema is essentially identical to LI-IEA (1995). Significance is explained and justified. The authors state that only Moderate/Major and Major impacts are judged (by them) to be significant.

4.4.8 There is discussion of cumulative issues in relation to this and other proposals in the area. A cumulative ZVI is included as are 7 wireframes (representing the three windfarms considered) and to justify the conclusion of (cumulative) insignificance.

Site Survey:

4.4.9 There are 14 viewpoints in the ES. Five are on Arran or Gigha and were not visited. Of the 9 on the mainland, 2 were remote. We made a total of 12 visits to 7 viewpoints (2 viewpoints were quite remote so we had time to visit them only once) and were able to make only 6 useful assessments of 5 viewpoints due to weather conditions.

4.4.10 From the few viewpoints we had to go on, we conclude that this ES was quite accurate both in the visualisations and in the descriptions and conclusions. Discrepancies we found were very slight (both in underestimating and overestimating impact) and possibly caused by unavoidable differences in perception between individuals and interpretation of terms such as slight, moderate etc.

Conclusions

4.4.11 The technical details of the VIA in this ES are provided (if not always justified) but potential errors are not acknowledged. Magnitude, sensitivity and significance are separated, justified and discussed. There is much explicit advocacy and argumentation in this ES, in addition to objective impact assessment. Whilst this may appear to run counter to any general best practice guidance that an ES should as far as possible be objective, fair, balanced and not a public relations document, the ES does take space to explain the basis of the arguments. Irrespective of whether one agrees with this argumentation, the separation of objective and subjective assessment, and advocacy, is generally clear.

Table 9: Viewpoint Analysis for Deucheran Hill

VP	Distance (km)	No of Visits	ES description	Site assessment	Photomontage
3	8.9	1	Stated that the tip of 1 turbine would be visible.	Nothing visible but the light was low.	The turbine shown on the visualisation was not visible so cannot comment on the accuracy of positioning
4	16.2	2	States no turbines visible	Accurate, no turbines visible	
5	10.3	2	States no turbines visible	Accurate, no turbines visible	
6	5.4	1	States no turbines visible	Accurate, no turbines visible	
8	13.3	2	ES states 9 hubs visible. States that the scale would remain subordinate to the underlying landform.	1 and 9 were visible on different visits due to varying weather conditions. Correct that the scale would remain subordinate to the underlying landform, but this underestimated the effect of character change in the landscape. Conclusions of impact significance etc correct.	Very accurate in positioning but turbines seem much larger than in the visualisation.

4.5 Dun Law

The Windfarm

4.5.1 The windfarm was constructed in 2000. The original proposal was for 34 turbines with a hub height of 35-46 m (but 45 m is used in the VIA) and a total height of 54.5-68 m (but 66.7 m is used in the VIA). As built the windfarm consists of 26 turbines with height to hub of 40 m and total height of 63.5 m. SNH judge that all potentially significant viewpoints were covered, including some recommended by SNH. There was some adjustment of tower positions between as assessed and as built, partly in response to SNH concerns with the risk of in line views of rows of turbines from key viewpoints, but SNH were not fully involved in these detailed adjustments between an outline permission and construction.

The Environmental Statement

4.5.2 This ES is in parts complex, confused and confusing and it is difficult to tease out the elements of the VIA (for example, pages are not numbered, contradictory but unexplained details appear in different sections, and cross referencing to photomontages is erratic). For the ZVI, radii of 7 and 20 km appear to have been used at one stage (ignoring vegetation, structures etc). One ZVI shows the number of nacelles (hub) visible, but the scale is hard to interpret. Figure 4 in the main report shows a mapped ZVI (called Visual Analysis) of up to 8 km (concentric rings are drawn at 2, 4 and 8 km), overlain on a 1:50,000 map of 14 x 16 km. Figure 5 is a theoretical ZVI of up to 16 km. No technical detail is provided, nor is the varied menu of ZVI explained.

4.5.3 Eight viewpoints are examined, all from publicly accessible locations, chosen after consultation with SNH and Borders Regional Council. There is a wireline for each viewpoint, and a photomontage for seven viewpoints (based on photographs using a 50 mm lens in 35 mm format). In a supplementary report, alternative layout options are examined, and Option E (which appears to be close to the as built windfarm) is analysed using wirelines and additional photomontages for viewpoints 2, 4, 6, and 7.

4.5.4 The evaluation of significance is in part contained within each written viewpoint analysis. The ES states that Energy Technology Support Unit guidelines were used (i.e. Stevenson & Griffiths, 1994) as follows:

Dominant	*< 2 km*
Visually intrusive	*1.0-4.5 km*
Noticeable	*2.0-8.0 km*
Elements in the landscape	*7 km and above*

4.5.5 These guidelines do not actually distinguish magnitude and significance, except implicitly. However, it is hard to determine how these were used, and the ES then proceeds to discuss views and viewpoints in bands of 0-2, 2-4, 4-8, and 8-16 km in order to assess visibility and hint at significance. Words such as dominant, prominent, intrusive, conspicuous are used, but an explicit declaration of significance is not always applied.

Site Survey

4.5.6 There are 12 viewpoints in the ES. One is remote and one is on private land with hostile signage; neither was visited. Of the 10 remaining, we made a total of 19 visits to 10 viewpoints and were able to make 19 useful assessments. This ES makes no explicit prediction of the numbers of turbines visible from each viewpoint and is erratic in offering a judgement of significance.

4.5.7 Assessing the accuracy of the ES is impossible because few exact predictions are made. Allowing for some post-assessment design changes, visualisations were reasonably accurate in positioning but not an accurate representation of the windfarm in reality.

Conclusions

4.5.8 All the key elements of VIA are present in this ES – ZVI, wirelines, photomontage – and some technical detail is provided - but there is a lack of clarity and limited justification for judgements made. Magnitude, sensitivity and significance are not clearly separated, justified and discussed.

Table 10: Viewpoint Analysis for Dun Law

VP	Distance (km)	No of Visits	ES Description	Site assessment	Photomontage
A	0.2 - 0.48	2	States "dominant element in view".	17 turbines visible to W of A68, including overhead power line. Large vertical elements in bare moorland plateau. Constantly changing perspective from fast moving cars. Other turbines largely hidden behind shelter belt to E.	Largely accurate, but wide angle lens used which produces distorting effect.
B	1.2 – 2.4	1	States "dominant and prominent".	26 turbines are visible, context as for viewpoint A.	Same comments as for viewpoint A.
C	1.15	2	States "prominent and intrusive, conspicuous and significant".	26 turbines are visible. At this distance, differences between skylining and backgrounding are irrelevant.	Largely accurate, some small differences probably due to post-ES relocations.
D	1.95	2	States "prominent".	14 turbines are visible. Forestry and other elements in middle and foreground reduce effect of windfarm, and forestry will screen view in time.	PM3 is reasonably accurate, but three turbines at extreme left are missing, whilst PM4 is more accurate.
F	4.2	2	States "prominent on the horizon".	11 turbines are visible but partly screened by foreground hedge.	8 turbines shown on PM but 11 visible on site and PM gives impression much smaller than reality.
H	4.75	2	States visibility "limited to the tips of the blades of 6 turbines". Impact "not significant".	Windfarm is invisible at this point	N/a.
I	9.0	2	States "very small and distant element in view".	13 turbines are visible but are not easy to count with the naked eye and movement not visible. Moving along road ± 0.5 km, turbines much more conspicuous. Effect appears due to complex middle and foreground elements at viewpoint I.	N/a.
J	5.8	2	Impact "slight".	4 turbines just visible above trees, but only with aid of binoculars. Windfarm is effectively invisible. Overhead power line and pylons dominate the view; background tree growth may have screened turbines.	N/a.
K	7.0	1	"Visibility limited to the upper parts of towers and glimpsed views of rotating blades silhouetted above the horizon". Impact "not significant".	23 turbines are visible. Movement clearly visible to naked eye.	Not accurate; the PM mis-labels Dun Law which lies to extreme right of PM.
X	4.3	2	"Prominent on the horizon".	16 turbines visible but movement scarcely visible because of orientation of rotors at 90^0 to viewer.	Largely accurate.

4.6 Hagshaw Hill

The Windfarm

4.6.1 This was Scotland's first windfarm, constructed in 1995. The original proposal was for 30 turbines with a hub height of 35 m and a total height of 55.5 m. As built the windfarm consists of 26 turbines with height to hub of 45 m and total height of 65.5 m. There is therefore a significant difference (in height of the turbines) between as assessed and as built.

The Environmental Statement

4.6.2 The ZVI is a worst case analysis for a radius of 12 km from the centre of the site, shown on a reduced 1:50,000 OS base map, but the choice of distance is not explained. The data used to generate the ZVI are not stated and potential errors are not acknowledged. The ZVI map only shows visibility as present/absent and does not show visibility varying in relation to the numbers of turbines.

4.6.3 There is discussion and argumentation concerning the diversity of opinion concerning the visual and landscape effects of windfarms, drawing from other public opinion surveys. Concerning significance, there is some generalised but inconclusive argumentation to the effect that many factors affect visibility, perception and significance. Within the text, evaluative statements such as marginal significance and relatively insignificant component are used freely. The issue of visibility is introduced by the use of photographs (some panoramic, but by splicing photographs taken with a 50 mm lens) of Delabole and Carland Cross windfarms (of similar height to the Hagshaw Hill proposal), and there is extensive discussion of the relative effects of these at varying distances. Based on this review, the ES states that *"we consider that significant visual impacts, if they exist, will in our opinion only be experienced within a range of up to 1.5 km from the turbines. However, we have allowed a margin of 0.5 km and extended the range to up to 2 km".* The ES then allows that other factors may need to be considered in restricted circumstances, so that *"we do not consider that at a distance greater than 6 km to 6.5 km that the proposal, if seen, would be significantly adverse in views for those who might adopt a negative stance towards them".*

4.6.4 Sixteen visualisations are provided using a mixture of photomontage or photographs with wireline illustrations or wirelines only. Some of these are large panoramas (14 x 96 cm) and all have a recommended viewing distance of 9.5 inches (24 cm). These locations were agreed with SNH, who also represented the interests of Clydesdale District Council. The limitations of these are stressed, including a statement that they (the photomontages) over-represent the appearance of the turbines at distances beyond 4 km to 6 km. Each visualisation is accompanied by discursive text that interprets the view but does not lead to a precise declaration concerning significance. A summary is then provided, leading to a more general appraisal of effects in relation to landscape character (zones).

4.6.5 This detailed Landscape and Visual Assessment (Appendix B, Volume 3) is then translated into the main statement (Volume 1) in a general overview that offers the broad conclusion that *"although the windfarm may be seen over a wide area, there will be few views that will perceptibly change from their present overall character to any significant extent".* It states that the height of the turbines has been reduced from 64 m to 55.5 m (as a result of internal and external consultations). However, the as assessed height (Volume 3) was 55.5 m and the as built height is 65.5 m. We do not understand the reasons for these differences. It might be expected that this discrepancy of 10 m would have introduced error into both the ZVI and the visualisations.

Table 11: Viewpoint Analysis for Hagshaw Hill

VP	Distance (km) - Direction	ES assessment	Site observations	Photomontage
1	3.25	Bare exposed landscape setting above gentler wooded landscape with AGLV to east in view. Conspicuous in certain conditions.	26 turbines visible. Conspicuous in bare landscape. Appears closer because of low light levels and orientation of the development which is in a horizontal plane to the viewer.	Layout of turbines accurate. 30% are lower than on pm.
2	4.5	Waste disposal heaps to W substantially influence view. Substantially screened by topography and development	20 turbines visible. Waste disposal heaps do not substantially influence view as they are below the ridgeline. No topographical screening from the road. Dominant feature as there are minimum number of detractors.	Reasonably accurate. Wider development area than shown.
3	4	Edge of Douglas Conservation Area. Majority of turbines are screened from view. Relatively small and more distant component. Not a significant adverse effect.	11 turbines visible. No towers are visible. Not a dominant feature on the skyline.	Much lower levels of development than shown.
4	4	Influence of the development encroaches into the setting of the AGLV. Will not dominate or significantly affect the quality of the landscape.	22 turbines visible. Does not dominate the scene owing to the landscape character of the valley, but it is a visible feature on the skyline.	Differences in the clustering of the turbines from this viewpoint add to the impact in the centre of the scene. More turbines shown with towers than actually appear on site. Deciduous valley- side trees and conifer blocks limit visibility by acting as detractors.
6	14	Urban environment. Near detractors. Relatively insignificant component with little influence on the urban experience.	24 turbines visible. Strong vertical elements and foreground topography add interest and detract from development. Scale of windfarm small in the scene. Movement only detectable in sunny conditions by glinting off blades.	Individual turbines on pm appear smaller than on site
7	8	Substantially screened by topography. Not a significant change	5 turbines visible. Indistinct over shoulder of hillside. Contrast low.	
8	8	Urban environment seen over conifer plantation and street lights are detractors. Marginal change No real visual significance	24 turbines visible. View of development framed by houses, lines of which lead the eye to Hagshaw Hill, therefore because of this more impact in the view 'No real visual significance' incorrect.	More obvious in view than in wireframe
9	7.75	Fleeting views.	16 turbines visible.	In wireframe the

		Discernible, but not significant adverse effect.	Discernible. Visible but of similar scale to trees and smaller than other more dominant elements closer to the road. Fast speed of travel means windfarm is less obvious. Much more noticeable from junction 12 on M74.	elements appear smaller in scale than in reality
10	8	Turbines are not the highest or most extensive landscape elements in view. Strong horizontal lines.	24 turbines visible. Visual interest in the foreground. Moderately dominant in this sensitive landscape.	Turbines appear taller and more evenly spaced than in pm.
11	2.5	Detractors in view. Will add feature of visual interest	Tip of only 1 turbine blade visible. No significant effect.	N/A
12	12	The nature of the change will not significantly adversely affect either the context of the view or the quality of the wider view.	26 turbines visible. Situated on the highest land in view. Movement attracts attention and increases visibility and intrusion.	
13	12.5	Small and relatively insignificant. Discernible only on clear days. Limited degree of visual influence. No significance. Adverse impact for negative viewers.	26 turbines visible. Clearly visible on skyline to SSW spread across hilltop. Larger in view than any other vertical element in landscape, but not dominant.	Elements appear smaller in wireframe than with naked eye but suspect this is the effect of the moving image.

Site Survey

4.6.6 All viewpoints (listed) were visited twice each except 3, 7 and 12, which were visited once each.

4.6.7 From the site observations the ES is accurate in its predicted assessment in 8 out of 12 of the view points. The photomontages were accurate in 2 out of 11 cases. Of the 9 that were inaccurate, three showed the windfarm larger than it appeared on site and in six of the illustrations the windfarm appears larger as built than in the photomontages. The viewpoint selection provided good coverage of the area with the exception of travel towards the site in a south west direction from Rigside to Douglas on the A70 and particularly around junction 12 on the M74 where the impact was higher and the development has a more significant visual impact than VP 9 (along the northbound carriageway of the M74).

Conclusions

4.6.8 The technical details of the VIA are mostly provided in this ES (if not always justified) but potential errors are not acknowledged. A significant (10 m) discrepancy between the height of the turbines as assessed and as built raises serious doubts about the accuracy of the ZVI and visualisations. The landscape and visual effects are not clearly distinguished, but are interwoven. Magnitude, sensitivity and significance are separated, justified and discussed, but the treatment is extremely discursive so that it is difficult to separate the inherent complexities of the issues. There is also much explicit advocacy and argumentation in this ES, in addition to objective impact assessment.

4.7 Hare Hill

The Windfarm

4.7.1 The windfarm was constructed in 2000. The original proposal was for 20 turbines with a height to hub of 40 m and total height of 60 m. As built the windfarm consists of 20 turbines with height to hub of 62 m and total height of 85.5 m, a dramatic difference that might have resulted in under-prediction in the ZVI. Viewpoints were selected after consultation. This proposal went to a public inquiry through written representation. Although approval was given, the siting of individual towers was a reserved matter that was not followed through fully by further consultation with SNH, and there are significant differences between as assessed and as built.

The Environmental Statement

4.7.2 The ZVI is based on a 20 x 20 km grid centred on the site. The shortest distance from the edge of the site to the limit of the ZVI is 8.5 km and the longest distance is approximately 13 km. The ZVI is the zone of theoretical visibility (worst case scenario). No explicit calculation is made of the zone of actual visibility taking account of ground cover or structures, but it is mapped according to the number of turbines visible (1-7, 8-13 and 14-20). Eight viewpoints were selected based on consultation with Cumnock & Doon Valley DC, SNH and New Cumnock Community Council (shown on Map 14, Main Report), and these are shown as 8 photomontages in the Main Report (prepared using a 50 mm lens and a recommendation that these be viewed from 17 cm).

4.7.3 Impact assessment is based on the number of turbines visible and distance. The ES states that the windfarm would be clearly visible at distances less than 1 km, distinct at 1 – 3 km and less dominant at 3 – 6 km. Beyond 6 km the prediction is that the turbines are increasingly indistinct. The sensitivity of receptors (residents, travellers etc), the degree of screening, visibility effects (eg weather) and field of vision are also considered and discussed. Meteorological data for a distant but comparable weather station is used to estimate and quantify the effects of cloud cover on visibility.

4.7.4 There is a complex but clear and explicit manipulation of several criteria to produce impact rating scales and then an integrated evaluation of both magnitude and significance based on a combination of receptor sensitivity, screening, distance and visibility, with significance classes described as none-minor-moderate-significant. Reference is also made to mitigation by choice of rotor blades (3 not 2) and colour (non-reflective finishes and pale colour).

Site Survey

4.7.5 All viewpoints listed were visited twice.

4.7.6 From the site observations the ES is accurate in its predicted assessment in 5 out of 8 viewpoints. The photomontages showed 50% accuracy in their predicted visual impact (2 out of 4), the inaccuracy representing an under estimate in the visual impact on site. Hare Hill occupies a dominant hill top location visible in particular from directions south clockwise to north east. The siting and topography restricts views from the closest housing at New Cumnock, but views of the windfarm are apparent along the majority of the Glen Afton road, a scenic drive. The ES provides predictions on the anticipated level of impact based on criteria of significance. These criteria were sensitivity of different receptors, extent of screening and or backgrounding of the development by landform or vegetation, distance of the development and the visibility as measured by the field of vision. These were found to be accurate. Visual effects not predicted by the Environmental Statement include: the impact of the views from the A76 travelling south east from Cumnock to New Cumnock which is increased by intervisibility with Windy Standard (the two windfarms occupy the highest ridges in the view), although at this distance the significance of intervisibility is limited. However, the experience for the driver is of windpower as a noticeable feature in the landscape. The implication of this is for the effects of intervisibility on any future windfarm development.

Table 12: Viewpoint Analysis for Hare Hill

VP	Distance (km) - Direction	ES assessment	Site observations	Photomontage
1	4.5	Significant impact.	5 turbines visible. Vertical interference in view from telegraph poles which are more dominant than the turbines	
2	3.5	9-11 turbines visible. Significant impact increased by the heritage associated with the Glen and the sensitivity of the human receptors.	12 turbines visible. Wind farm covers undulating tops of hills and the variety of heights of the turbines and the variation in topography provides some lessening of effect, but it is the only major development in this area of the attractive valley.	Reasonably accurate. (on 13 Feb Light and contrast in the sun make the turbines more obvious and it appears closer in sunlight.)
3	5.5	Significant impact. Comments as viewpoint 2	16 turbines visible. Bulk of hills and rock faces are greater in scale than the turbines and this lessens the visual intrusion. Moderate element in the landscape made more dominant by movement and skylining	Towers appear taller and less clustered than in p.m
5	6.0	Moderate impact Approximately 8 turbines visible	12 turbines visible. Intricacy of the landscape receptors reduces impact	
6	8.0	Moderate impact. Significance reduced by being greater than 5 km.	14 turbines visible on the skyline. Inter-visibility with Windy Standard increases the perception of the scale of the development.	Reasonable accuracy, but towers do not appear tall enough as the blades in the p.m appear to go down to the ground.
7	4.2	9 turbines on average in view. Farmsteads and dwellings highly sensitive to change and have a wide angle of view, but this would be moderated by distance and screening.	14 turbines occupy a wide angle of view on the hillside in a horizontal plane to the viewer. Screening by topography and the horizontal banding in the view provides an acceptance of the development width.	Reasonable accuracy. Turbines are lower to the E and higher to the W than shown.
8	8.5	Minor impacts. Average of 8 turbines visible, but impacts substantially reduced by distance and effects of atmospheric conditions which would reduce visibility throughout much of the year.	9 turbines visible. Foreground urban and rural detractors reduce the apparent impact of the development.	Pm. Does not link to location plan.

4.7.7 The number of view points chosen was limited and a particular omission was from B741 travelling north east just to the west of Knockburine where 16 turbines at a distance of 10km appear suddenly over the ridgeline and the impact increases as the driver travels towards the windfarm before it becomes obscured by vegetation and topography.

Conclusions

4.7.8 The technical details of the VIA are provided in this ES although potential errors are not acknowledged. The recommended viewing distance for photomontages is extremely short. Magnitude, sensitivity and significance are separated, justified and discussed in an explicit and balanced way.

4.8 Novar

The Windfarm

4.8.1 The windfarm was constructed in 1997. The original proposal was for 34 turbines, but height to hub and total height are not stated in the ES (landscape section), which casts doubt on the accuracy of the VIA. As built the windfarm consists of 34 turbines with height to hub of 35 m and total height of 55.5 m. SNH judge that all the main or significant viewpoints were covered, in consultation with Highland Council, including addition of a viewpoint from Ben Wyvis. There was some (but not major) adjustment of tower positions between as assessed and as built, and there were larger changes regarding ancillary works (access tracks etc) during construction, but these were not considered in the present study.

The Environmental Statement

4.8.2 It is stated that the ZVI was supplied to the landscape consultants by National Wind Power Ltd and no technical detail is provided, nor is the ZVI presented in the ES. The radius used was 10 km *("the turbines would be inconspicuous beyond that distance although they may be visible"*), plus two selected viewpoints beyond 10 km. No explicit calculation is made of the zone of actual visibility taking account of landform, ground cover or structures, and no account is taken of the spatial distribution of individual turbines, which covers approximately 3 km.

4.8.3 Thirteen viewpoints were selected based on site survey and consultation with SNH and Highland Regional Council. Each view was used to assess landscape character, then for impact assessment. Photographs were taken with a wide panoramic format camera. Wirelines are referred to but not shown. Photomontages are shown for 5 viewpoints, but no details of their preparation, limitations or recommended viewing distance are provided (except that they are shown as before and after images, based on the original photographs taken with the wide panoramic format camera). These photomontages are never referred to in the detailed VIA.

4.8.4 The ES refers to the amount of change in assessing impact but there is no reference to character or the concept of capacity. The issues of magnitude and significance are merged and drawn from the Department of Transport Design Manual for Roads and Bridges. Volume 11 – Landscape Assessment as follows:

> *Substantial – where the proposals would cause a significant change in the existing view.*
> *Moderate - where the proposals would cause a noticeable change in the existing view.*
> *Slight - where the proposals would cause a barely perceptible change in the existing view.*
> *No change – where no change would be discernible.*

4.8.5 Only substantial impacts are regarded as significant. This scale is applied at each viewpoint, related to human receptors (e.g. travellers, residents, walkers) and summarised in a table. Reference is also made to mitigation by colour of tower *("a light hue of neutral colour*").

Table 13: Viewpoint Analysis for Novar

VP	Distance (km)	ES Description	Site assessment	Photomontage
1	8.5 – 9.75	Predicts 17 turbines visible and quality "pleasant" and impact "slight to moderate".	23 are visible on site. Turbines are inconspicuous unless you actively search for them. However, 10 were backclothed against snow covered hills giving weak contrast (would be stronger against vegetation).	Difficult to check accuracy of PM at this distance (Ben Wyvis in cloud and so not seen in PM). Panoramic lens completely misrepresents scene.
2	6	Predicts 25 turbines visible and quality "very pleasant" and impact "moderate".	22 are visible on site. Turbines clearly visible in good light.	No PM.
3	5-6	Predicts 24 visible in part and quality "pleasant" and impact "moderate".	22 are visible on site but part-screened by row of trees in middle-foreground.	No PM.
4	4 - 6	Predicts 20 visible in part and quality "pleasant" and impact "substantial".	17 are visible on site.	PM is largely accurate representation of turbines in two groups but wholly underestimates visual effect due to use of panoramic lens.
5	2	Predicts 12 visible in part and quality "pleasant" and impact "substantial".	13 are visible on site.	No PM.
8	6.5	Predicts 13 (part) visible and quality "very pleasant", compromised by overhead power lines directly over viewpoint and impact "slight".	12 visible on site. Overhead power line not strictly "in view". Perception of turbines constantly changing as they are lit-unlit by movement of sun in and out of cloud. In photograph, use of panoramic lens "shrinks" centre hills to give very misleading impression.	No PM.
9	10.5	Predicts all 34 visible in part, and that quality is "pleasant" and impact "slight to moderate".	Fewer visible (13) than predicted but visibility poor. House now constructed in immediate foreground.	No PM.
10	15	Predicts 27 visible in part and quality "very pleasant" and impact "slight".	26 turbines visible, but not clear with naked eye and binoculars needed to check. Movement not detectable at this distance. Those backclothed were clearer but those skylined much less distinct.	Visibility on site much clearer than when PM photograph taken. Hills behind windfarm not an indistinct blur in reality.
11	3	Predicts 10/11 visible and quality "high" and impact "substantial".	11 turbines visible on site.	No PM.

Site Survey

4.8.6 There are 13 viewpoints in the ES. Three were not visited because they were too remote and one because it was on private land. Out of 9 visits to 9 viewpoints we were able to make 9 useful assessments.

4.8.7 The predictions of the numbers of turbines visible were generally very accurate or accurate, and differences may be as much to do with re-siting decisions after assessment as with any errors in the VIA. The photomontages were seriously misleading for two reasons; first, their small size and secondly the use of a panoramic lens camera.

Conclusions

4.8.8 The technical details of the VIA are not provided in full in this ES, nor are they justified, and potential errors are not acknowledged. The ZVI is not provided. There is no explanation given on the potential accuracy (or otherwise) of the photomontages and in fact they are never referred to (we did not have access to the main statement, Volume 1, where such reference may appear). Magnitude, sensitivity and significance are identified but not separated with any clarity, nor are landscape and visual effects clearly distinguished.

4.9 Windy Standard

The Windfarm

4.9.1 The windfarm was constructed in 1996. The original proposal was for 40 turbines with a height to hub of 40 m and total height of 60 m. As built the windfarm consists of 36 turbines with height to hub of 35 m and total height of 53.5 m, which might have resulted in over-prediction in the ZVI. Viewpoints were selected after consultation with SNH and local authorities.

The Environmental Statement

4.9.2 The ES states that a *"computer based study was used to delineate areas of potential visual access within a radius of 16 km*" but such a ZVI does not appear in the ES. Figure 8 shows circles at radii of 5 km and 10 km plus selected viewpoints beyond 10 km drawn on a 1:100,000 scale OS map, but there is no indication of relative visibility in relation to topography and this is not a ZVI. There is a note that *"normally the radius of the search area is 10 km, on the basis that the largest features, the turbines, are generally inconspicuous beyond this distance although they may be visible".* Significance is not treated explicitly. It is stated that *"the assessment of impact is the description of the amount of change within the landscape in conjunction with a consideration of the landscape character"* (sic). Passing reference is made to the Department of Transport Design Manual for Roads and Bridges Volume 11: Landscape Assessment. Elsewhere in the ES, summary tables bring all impacts to a common scale of minor, moderate and significant, although these terms are never explained or justified.

4.9.3 Twenty viewpoints were selected, mostly within 15 km of the centre of the site. A table provides, for each viewpoint, a location, short description, distance, note on predicted visibility (number and effects) and a declaration of significance. Although never justified, the significance terms used are slight, moderate and significant, despite the fact that the DoT Design Manual referred to earlier uses the terms no change, slight, moderate and substantial. Wireline diagrams are referred to but not shown. These viewpoint descriptions are repeated in the text. For six viewpoints, selected after discussion with the Regional Council, photomontages are produced, but these are never referred to in the assessment of viewpoints and no technical details on their production or use are provided. The summary section uses the terms moderate and substantial. There is acknowledgement of the existence of a parallel proposal for a windfarm at Harehill and potential issues of intervisibility and cumulative effect are noted but not analysed.

Site Survey

4.9.4 All the listed viewpoints were visited twice

Table 14: Viewpoint Analysis for Windy Standard

VP	Distance (km)	ES assessment	Site observations	Photomontage
1	9.5	Nil	Not visible	
2	13.5	Impact slight	Not visible, obscured by foreground vegetation	
3	13	Turbines skylined in distance. Impact slight.	27 turbines in centre of view. The only obvious development.	Turbines appear smaller and less as individual units in the pm than in reality.
7	13	Nil	Not visible, but Hare Hill is	
8	11.5	Nil	Not visible, but Hare Hill is	
9	11.5	Nil	Not visible, but Hare Hill is	
10	11	Possibly views of parts of the turbines	Not visible	
11	4.5	Nil	Not visible	
12	13.5	Turbine development would be indistinct. Turbines in view would be set against the hillside and within the cover of Carsphain forest. Impact slight	26 turbines visible in the distance. Smaller in scale than Hare Hill, which can be clearly seen nearer to the viewer.	
13	13	Impact slight compared with the already approved Hare Hill wind farm.	Not visible	
15	7	Nil	4 turbines visible along the river valley. The bulk of the hillsides in this location decreases the turbines apparent size.	
16+17	4	6 turbines would be visible on top of very dominant hills. Significant change in view.	4 turbines visible. Steep sided valley with conifer plantations in a range of topography. Turbines are seen as large-scale skyline elements. Drama of the site appears to reduce impact.	Accurate for the 4 largest turbines. Two above nacelle cannot be seen.
18	5.5	?????	Dodd Hill obscures views	
19	10	Nil	Nil	

4.9.5 From the site observations the Environmental Statement is accurate in its predicted assessment of 9 out of 13 cases. Of the photomontages assessed, one was accurate and one showed the windfarm larger than it appeared on site. There were insufficient photomontages within this ES to comprehensively illustrate the visual effects of the windfarm as built. Visual effects not predicted by the Environmental Statement include: the impact of the views from the A76 travelling south east from Cumnock to New Cumnock is increased by intervisibility with Hare Hill (the two windfarms occupy the highest ridges in the view), although at this distance the significance of intervisibility is limited. However, as mentioned previously, the experience for the driver is of windpower as a noticeable feature in the landscape and the implication of this is for the effects of intervisibility on any future windfarm development. Although the statement refers to the approval of permission for the Hare Hill windfarm there is no information on intervisibility. This is a key feature in long distance views from A76 travelling south east from Cumnock and minor roads (VP 12). This is considered as a major shortcoming, but we understand that commercial confidentiality restricted availability of information to carry out a cumulative assessment.

4.9.6 The topography of the site severely restricts the visibility of the windfarm from close range. The choice of viewpoints close to the development gave an assessment of no effect in 7 of the 20 viewpoints. This could have been picked up as a desk study by a theoretical ZVI to which topographical data had been applied.

Conclusions

4.9.7 The technical details of the VIA are not provided in this ES and potential errors are not acknowledged. There is no ZVI and no wireframes. The photomontages are never analysed or discussed. The landscape and visual effects are not clearly distinguished. Magnitude, sensitivity and significance are not distinguished, justified and discussed and there is inconsistency in the terminology used. Although there is reference elsewhere in the ES to effects on landscape, people, recreation etc, the overall structure of the ES makes it difficult to locate and link each of these elements of a comprehensive VIA.

4.10 Other Windfarms and Environmental Statements

4.10.1 Access to some further ESs was possible (Appendix 3), in hard copy or via the www, and key data on ZVI and distances has been extracted from these (and included in Table 16). A more systematic review of a wider selection of ESs was considered in the original plan for the project, but time limitations, compounded by the fact that a comprehensive collection of ESs for Scottish windfarms is not available in either SNH or the Scottish Executive Library, means that such further research has been restricted.

5 OVERALL ANALYSIS

5.1 Introduction

5.1.1 We now analyse a range of generic issues concerning visual impact assessment, based on a consideration of the evidence gathered from all the assessments made at all the viewpoints visited, and considering the literature examined and the environmental statements reviewed. We concentrate on visual effects and leave the key issues surrounding technical visualisation to the final discussion.

5.1.2 Although it is tempting to try to offer specific and conclusive diagnoses or prescriptions, it is clear that the wide variety of factors that influence the core issues under investigation – magnitude, distance and visibility – are such that any generalisation is dangerous. On the other hand, practice cannot proceed effectively if the conclusion is that there are so many variables that nothing useful can be said. An attempt is therefore made to strike a balance between definitive conclusions and an acknowledgement of the context-specific issues that can affect these conclusions. Whenever we make a comparison – for example, that movement increases apparent size or visibility – this is always assuming that other factors are held constant (e.g. light, distance etc).

5.1.3 This analysis applies to windfarms operating in Scotland and in landscape areas of a particular character. The detailed conclusions may or may not be directly applicable to other areas of the UK and to other landscape types.

5.1.4 The size range of the windfarms examined was from 53.5 – 85.5 m overall height but the majority were 53.5 – 65.5 m. However, a new generation of machines is now under development or construction with overall heights approaching 100 m. It is expected that our conclusions on distances or distance ranges would therefore need to be increased for these taller wind turbines.

5.2 Influences on Visibility

General Visibility

5.2.1 In general we found that the turbines are perceptible at a range of from 15 – 20 km from the windfarm and up to 25 km in specific cases and conditions. These distances only apply in clear conditions and if you are specifically looking for the turbines and not just looking at the landscape. It is likely that the turbines would be perceptible to a casual observer at distances of from 10 – 15 km, unless they were highly sensitive or observant or a resident.

5.2.2 The distance over which turbine detail is noticeable is about 5 - 8 km. At a distance of more than about 10 km it is not possible to identify the taper of the turbine tower or identify nacelle detail. At distances up to approximately 12 km turbines are perceived as individual structures that, dependant on layout, may or may not form a group. At a distance of more than about 10 km the turbines begin to be perceived as a group forming a windfarm, rather than as individual turbines.

5.2.3 Higher turbines are visible over a larger distance and this is reflected in our recommendations for ZVI in Table 17. Taking account of the distance ranges over which effects operate at the case-study sites, we judge that an increase in overall height to something approaching 100 m for third generation turbines will result in these distance ranges increasing by around 20% in many cases. When the number of turbines is considered, the influence of a greater number of turbines on the visible distance is less certain, and probably depends on turbine layout, grouping, and the scale of the turbines/windfarm relative to the scale of the landscape. Impact diminishes as distance increases, but is not necessarily directly proportional to turbine number.

Proportional Visibility

5.2.4 Sometimes the whole structures (tower, nacelle and blades) are visible, fully or predominantly, above the horizon. Sometimes the view includes a mixture of elements – the whole structure of some, the upper part of the tower or the extreme tips of rotors of others. In extreme cases, the only elements visible are rotors. The first case is more visually coherent and the eye sees the structures with clarity. The appearance of just the rotors, or the nacelle and rotors, above the horizon produces a disconcerting effect when they are moving that we would describe as less visually coherent, although the observer may mentally fill-in the missing elements. The former appearance can have less impact than the latter at the same distance, because the latter effect is unusual and disturbing even when it is familiar.

5.2.5 The visual layout of turbines in relation to the horizon and skyline profile is therefore an important factor for consideration when assessing the effect at a viewpoint. The extent, pattern and proportions of structures in the view in relation to the scale and form of the landscape and the skyline are all important.

Lighting

5.2.6 We observed that direct sunlight shining on the turbines, either intermittently as the sun moves in and out behind clouds, or for longer periods in bright clear conditions, has the effect of increasing the prominence of the structures and this effect operated over a wide middle distance range. Viewpoints to the south of a windfarm (in the arc from east through south to west) experience this effect whereas back-lit effects occur at viewpoints to the north (in the arc from east through north to west).

5.2.7 Glinting, as the sun is reflected directly into the eye of the observer, can occur over long distances, at least up to 12 km, but is very occasional and is also sensitive to very small changes in angle of view. A flickering effect as the movement of the blades casts a shadow on the tower can occur in bright sunlight and can attract the eye at relatively short distances of from 3 - 5 km; this effect is most marked when the angle of the sun is low in the sky. These potential effects should be considered for viewpoints involving residents or motorists.

5.2.8 The seasonal effects of light (linked with weather and cloud cover) should be considered in relation to human receptors. For residents, year-round conditions are relevant. For tourists and other recreationists, winter conditions will affect fewest people and summer conditions will affect most.

Movement and Orientation

5.2.9 The movement of the blades, in all cases where this is visible, increases the visual effect of the turbines because it tends to draw the eye. We could detect movement with clarity at distances up to 15 km in clear conditions or conditions of strong contrast between the rotors and the sky, but only if you are specifically looking for the windfarm. On occasions, movement was not visible at 6 km in weak contrast. At a distance of more than about 12 km blade movement can become hardly perceptible and we judge that blade movement is perceptible to the casual observer at up to approximately 10 km. Movement was more perceptible when backdropped against dark vegetation compared to grey sky.

5.2.11 Since windfarm rotors are designed to move, the only significant circumstance when a static illusion will result in a generally lesser effect is at viewpoints oriented at 90^0 (± a small deviation of perhaps 10^0) to the prevailing wind direction. Because the prevailing wind in the UK is generally from the south west, viewpoints in the quadrants from south through south west to west, and from north through north east to east, will experience the longest periods of exposure to visible movement. Viewpoints in the opposite quadrants will experience more static effects and we observed this effect at relatively short distances of 2-5 km. We also judged that rotors seen in the plane oriented at 180^0 to the viewpoint appear relatively nearer. It was difficult to assess whether the visibility of movement is affected significantly by the diameter of the rotors or the height of the structures.

Distance, Colour and Contrast

5.2.12 At short distances the colour is clearly seen and colour and light do not have a dramatic modifying effect on visibility, except in extreme overcast conditions or at dawn or dusk. As distance increases, the eye cannot distinguish colour and all structures are seen as grey (this effect would apply whether the turbines were pale grey, yellow or blue). Light coloured (lit) turbines appear closer than grey (unlit) turbines at similar distances. Seen against a blue or pale sky, but not sunlit, grey turbines appear dark. As the sky darkens, because of cloud cover or time of day or season, the contrast between sky and turbines decreases and at long distances (e.g. over approximately 10 km) the turbines may become indistinct because of this. Turbines can appear white against a dark sky if they are lit by sun through patches of cloud. At shorter distances, the contrast between sky and turbines still decreases, but the reduction in visibility is much less because the eye and brain use more linked cues including colour and form and texture as well as contrast.

Contrast, Skylining and Backclothing

5.2.13 The recommendation to use off-white or pale-grey for each element of the structures is because the majority of views by the majority of people are of skylined structures seen against a blue or grey sky. This is because sites for windfarms to date are elevated relative to the majority of receptors. In fact the majority of the viewpoints assessed in the study were middle to long range (5 – 15 km) and skylined. The commonest appearances were dark (grey) turbines seen against a lighter sky and light (grey) turbines seen against a darker sky.

5.2.14 Backclothing is a more frequent phenomenon for viewpoints at elevations higher than the windfarm, although there are a few examples from the case-study sites of backclothing against distant hills and mountains, such as at Novar clearly seen at 15 km against the backcloth of Ben Wyvis, and some against middle-distance hills such as at Dun Law from close-range viewpoints. In winter, backclothing can be against snow-covered hills. Because our surveys did not cover many viewpoints of this type, our site appraisals on this issue are more limited.

5.2.15 As the sky darkens, those turbines seen against the darkening sky become more difficult to perceive, and the ones which are seen against a backcloth of landform and vegetation become relatively more prominent. It is clear from some photomontages and some viewpoints assessed that off-white or pale-grey structures seen against a backcloth of moorland vegetation, including heather, semi-natural grassland and conifer plantations, are much more prominent than when seen against either clear or grey skies. This suggests that the effect of backclothing against vegetation is to extend the visible distance considerably. We observed at a few locations when backclothed turbines were lit by sunlight that they were much more conspicuous than when lit but skylined.

Elevation of Windfarm and Receptor

5.2.16 The area occupied by windfarms is sometimes large and several important effects need to be considered from high-elevation viewpoints. Walkers and others at higher elevations will be within sight of the windfarm for longer periods of time. Visual detractors and man-made elements will be more limited and, apart from the mass of the landform, will be smaller in scale. The turbines will also be backdropped to a greater extent than from lower elevations and the colours of the turbines and vegetation types will have an effect of increasing relative visibility. Air clarity may also be higher at elevation. From higher sites with their long distance views of the landscape beyond the windfarm, there is an effect that can appear to make the turbines look closer than those at the same distance but skylined, and intervisibility as a visual factor can increase in importance.

Colour and Design

5.2.17 All of the case study turbines appeared to be off-white or pale-grey and the current study was not able to explore what additional influences colour might have on VIA, nor have we examined other detailed design factors that may also be relevant to VIA, including tower shape and individual turbine design. As noted earlier, colour effects are mainly important for skylined views at close range but could be more important at longer ranges for backclothed views.

Landscape character and receptors

5.2.18 The character of the landscape and especially elements within it affect perceptions of magnitude. In landscapes that were free of man-made elements the turbines were sometimes much more conspicuous in the middle and long-distance ranges and this affected our judgements of their magnitude. Windfarms or turbines framed by other developments sometimes had a greater apparent impact than those with no framing, because the other elements provided visual cues for judging size, depth and distance.

5.2.19 In the south west region of Scotland the character of the southern uplands is of long ridges, which are a strong horizontal element in the landscape. Other horizontal features, river valleys and their vegetation, hedges and walls, built development and coniferous plantings, often increase this horizontal effect. The windfarms seen during this research can create the impression of another horizontal band at middle range and longer distances, especially where intervisibility between two windfarms occurs.

5.2.20 Consideration needs to be given to the heights, layout and numbers of turbines in a windfarm because the visual impact of a larger number of smaller turbines may be lower (as they are in a scale related to the landscape character) than a windfarm with a smaller number of larger turbines which may in turn be perceived as having a higher visual intrusion level owing to their lack of apparent size-similarity with the horizontal bands in the landscape into which they are to be inserted.

5.2.21 The influence of character will vary for different landscape types, although this is not an issue explored in detail in the current project. However, the technology and economics of turbine design will probably be a more important driver of turbine design and tower height.

5.2.22 Cumulation and intervisibility can be important issues, owing to the breadth of some developments on the skyline, as well as proximity. The orientation of windfarms with respect to others in the visual field needs to be considered to lessen the apparent scale of development. This observation arose especially in the south west region.

5.3 Assessment of Visibility

5.3.1 We discuss this broad issue in greater detail in Section 6. Here, three general points can be made.

5.3.2 We found that there was a general tendency to underestimate the magnitude of visibility in the ES descriptions compared to our judgements on site. This may be related to the frequent under-representation seen in photomontages (paragraphs 6.1.16 – 6.1.17). No doubt consultants use these for evaluation as much as other parties. If this tendency to underestimate magnitude is widespread, for whatever reasons, it does suggest that much of the published guidance and some of the implied judgements on significance in relation to distance will tend to be conservative. Many anecdotal and derivative distance-significance judgements may therefore need to be lengthened to compensate for underestimation caused by reliance on photomontage. In addition, earlier field studies (e.g. Stevenson & Griffiths, 1994) devised distance bands based on first generation turbines, and our conclusion is that these bands need to be increased for second and third generation structures.

5.3.3 We judged that wireframes *tended* to cause less under (or over) estimation of visibility and visual effect, compared to photomontages, perhaps because they do not purport to be other than indicative of potential visibility. Wireframes are used more as a working tool for VIA whereas photomontages are also used to simulate realism. In other words, whilst both wireframes and photomontages are required to be (and generally are) accurate in terms of the positioning, spatial distribution and size (especially height) of the towers, wireframes (unlike photomontages) are not expected to offer a *realistic* visualisation or impression of the on-site view that will exist after construction of the windfarm.

5.3.4 This may also be an appropriate point to raise a subtle presentational point about visibility assessment. Because many factors act to decrease or increase apparent magnitude (and therefore potential significance), there is a tendency in all the ESs examined (and in guidance such as is shown in Table 3) to adopt what might be termed the *"half-empty"* rather than the *"half-full"* approach to assessment. For example, guidance and assessment often emphasises the factors that decrease visibility ("*only prominent in clear visibility*") rather than the factors that increase visibility ("*always prominent in clear visibility*"). Although both statements are in one sense identical, a different adverb produces a different impression.

6 DISCUSSION

6.1 Visual Impact Assessment

Zone of Visual Influence

6.1.1 It proved impossible to carry out comprehensive tests of the accuracy of the ZVI in the case-studies for two main sets of reasons. First, the area covered by a typical ZVI is very large, for example 225 km^2 for a 15 x 15 km ZVI, and a systematic checking of such a large area would have required intensive, time-consuming site visits. Also, almost all ZVI were based on topographic worst case scenarios, making site survey difficult when the bare terrain of the ZVI is in reality populated by vegetation, buildings and other structures and elements (Wood, 1999, 2000). Second, many windfarms were significantly different in the details as built compared to as assessed; such differences included changes in the numbers of turbines, changes in the overall height of turbines, and changes in the site-specific locations of individual turbines. For these reasons, our diagnoses concerning ZVI are largely based on the literature described in the background research.

6.1.2 ZVI are never accurate (Hankinson, 1999). They contain several sources of error and it may not always be feasible to separate these errors or to estimate their size and potential effects. If the errors are known, this should be stated. The existence of error should always be acknowledged. Such errors may matter less if the purpose of the ZVI is to compare the relative effects of two or more sites or to compare alternative layouts, where it is the comparison which is being evaluated, and not the precision of specific locations. They are not necessarily a reliable basis for predicting visibility from exact locations, which must always rely on additional pre- and post-ZVI desk and site assessment. They are a useful basis for selecting potential viewpoints for consideration (but must be subjected to detailed site testing), perhaps using wireframe or photomontage techniques.

6.1.3 Most ZVI examined are worst case, based on a topographic digital terrain model only. Increasing sophistication by the addition of data on forests, woodlands and other elements in the landscape is at the same time both desirable and subject to the introduction of further errors of detail and interpretation.

6.1.4 All ZVI examined are not distance-sensitive, that is they do not attempt to combine the effects of distance and visibility to generate what has been termed a fuzzy viewshed. This is sensible, given the subjectivity and complexity of this factor, which is best considered as a separate and distinct exercise in any assessment.

6.1.5 The presentation of the ZVI in some ESs could be improved. Overlaying the ZVI onto an OS base map (at 1:50,000 or 1:100,000 scales) is essential to help the interpretation of the ZVI and is also necessary in the initial stages of selecting representative or key viewpoints.

6.1.6 Where the degree of visibility is illustrated using a graded tone or a range of colours, careful thought on presentation and explanation is required to minimise the risk of creating a distorted impression. This can arise because the number of turbines visible sometimes increases as the distance increases, due to topography, whilst the relative size or visual effect decreases in parallel. A shaded ZVI that uses denser tones for areas where the number of visible turbines is greater can create an impression that is diametrically opposed to the probable magnitude and significance of the visual effects. One solution might be to adopt the use of the term ZTV (Zone of Theoretical Visibility) for what is now commonly referred to as the ZVI in order to emphasize the theoretical, potential and limited nature of the information shown in such a map. Another solution might be to produce a second map (perhaps called the Zones of Visual Effect: ZVE) where the predicted magnitude of the effects (Table 18 and Section 6.2) is translated onto the ZTV to illustrate the effects that distance (and other factors) are expected to have on the size and intensity of the visual effects. Finally, a composite map (perhaps called the Zones of Visual Significance) could be considered which combines the ZTV and the ZVE with the thresholds and criteria used for assessing significance, to illustrate graphically what is now only explored using a limited number of key viewpoints. We are not aware that such presentation techniques have been attempted experimentally, nor have we explored fully the potential conceptual, technical and interpretational difficulties, but this may be an area for further research and development in the application of CAD and GIS tools.

Table 15: Published Technical Recommendations for Visual Impact Assessment

		ZVI (distance in km)	ZVI	ZVI	Visualisations	Photomontage
Tower height →		*Not specified*	*c60 m*	*c95 m*		
CC (1991)		10-15				
BWEA (1994)		-	-	-	Recommended but non-specific	Recommended but non-specific
Stevenson & Griffiths (1994)		10			Recommended and specified	Recommended and specified
LI-IEA (1995) & LI-IEMA (2002)		-	-	-	Recommended but non-specific	Recommended but non-specific
Thomas (1996)		-	20	-	-	-
TJP (1997)			15			
CuCC (1999)			20		Key viewpoints within 10 km radius	
CPRW (1999)*			20	30		
CCW (1999)		10-20				
SNDC (2000)		20				
MAA (2000)			20	30		
SNH (2001)		25			Key viewpoints up to 10 km radius	
SE PAN45 (2002)		-	-	-	Recommended but non-specific	Recommended but non-specific

* Sinclair-Thomas recommendations (Table 4).

6.1.7 On the question of a recommended radius for a ZVI in relation to the proposed overall height of towers, we have reviewed the recommendations that appear in published guidelines (Table 15) and the practices in the case-study and other ESs (Table 16). In no case-study has a developer used the recommended radius contained in Sinclair-Thomas (Table 4), and whilst there is a suggestion in Table 16 of a trend for the radius to increase in size as the height of towers increases, this is by no means clear.

Table 16: ZVI in Environmental Statements in Relation to Number and Size of Towers.

	Windfarm	Date of ES	Height of Tower (maximum including rotor)(m)*	Number of Towers*	ZVI (km) **	Viewpoints (number)
1	Delabole	1991?	40.4	10	7.5	Not known
2	Burnt Hill	1993	60	19	17	27
3	Hare Hill	1994	60 (85.5)	20	10 (8.5-13)	8
4	Hagshaw Hill	1994	55.5 (65.5)	30 (26)	12	16
5	Novar	1995	? (55.5)	34	10	13
6	Windy Standard	1995	60.0 (53.5)	40 (36)	16 (10?)	20
7	Dun Law	1996	66.7 (63.5)	34 (26)	8 (16)	8
8	Beinn Ghlas	1997	65 (57)	16 (14)	10	13
9	Beinn An Tuirc	1997?	62.5	50 (46)	15	18
10	Gartnagrenach	1998	63	24	15	9
11	Deucheran Hill	1999	76 (76.5 & 62.5)	12 (9)	15	14
12	Meikle Carewe	1999?	78	14	25	22
13	Kielder	2000	82	107	20	Not known
14	Black Law, Carluke	2001?	90?	70	23	Not known

* First quoted figure is as in ES. As-built height and number may differ and figures in parentheses are as-built if known to differ from as-assessed in ES.
** Two figures are quoted where there is a lack of clarity or contradiction in the ES.

6.1.8 Based on our diagnoses concerning the effects of distance, our arguments that relatively small effects could be significant for highly sensitive receptors, the precautionary principle which is now widely established as best practice in environmental policy, and taking account of the increasing sizes proposed for new developments, we recommend the general guidelines shown in Table 17.

Table 17: Recommendations for ZVI in Relation to Overall Height.

Height of turbines (total including rotors)(m)	Recommended ZVI distance (km)
50	15
70	20
85	25
100	30

6.1.9 The figures in Table 17 are approximate and should be adjusted either upwards or downwards to suit local circumstances and in the context of local or regional landscape character and landscape or visual sensitivity. Despite the trend towards larger and taller structures, it is unclear what ultimate limits might exist, because optimum tower height depends on an integration of economic, meteorological, technological and environmental factors. The recommendations in Table 17 would need to increase for heights greater than 100m, although at distances much greater than 30 km the limit of visibility to the human eye is being approached.

6.1.10 The cost of digital data is very low but computation times will increase for ZVI for larger radii. The calculation of line-of-sight from a digital terrain model (DTM) in GIS is therefore still computationally intensive (Kidner et al, 1997) and such costs may be one reason for developer or consultant reluctance to extend the radii of ZVI. However, we judge that this cost is still a relatively small element of an overall EIA. A further reason for resistance to larger radii might be tactical and psychological, in that increasing even a ZTV increases the likelihood that designated or valued landscapes will appear on the zonal map at the margins, so perhaps fuelling fears among developers that an increase in potential significance will be perceived if the radius is increased. We have commented on this and related issues, and possible ways to address it, at paragraph 6.1.6.

Viewpoints

6.1.11 The general result from our brief interviews with SNH project officers was that they felt that developers had listened and accepted SNH recommendations concerning the selection of viewpoints. Whilst hindsight might occasionally suggest a key viewpoint that was omitted, we judge that any significant underestimation of visibility is often due to post-ES siting and design changes rather than to any key omissions at the scoping stage. For some case study sites, additional post-ES visualisations had been prepared. However, there are occasional instances of omission, an issue that arises particularly in the south west region where intervisibility and cumulative effects were sometimes acknowledged but not analysed and assessed.

6.1.12 From our analysis of the case study sites, we can detect no clear rationale for the number of viewpoints selected that might lead to recommendations. For example, Table 16 shows a wide variation in the number of viewpoints selected, unrelated to the size or number of turbines or the size of the ZVI. The number selected is a result of negotiation between the developer or the consultants and statutory consultees, especially the local planning authority and SNH. Whilst there may be some developer-resistance to producing very large numbers of visualisations on the grounds of time or cost, additional influences must also be the landscape character within the ZVI and the probability or potential significance of visual effects based on the density of human habitation, transport or recreational routes, strategic recreational sites or scenic viewpoints and so on. Local Plans and related Supplementary Planning Guidance may also influence the selection of viewpoints, although we have not examined this issue. A case-by-case approach to viewpoint selection through negotiation is therefore the only feasible option.

6.1.13 We did note that in some ESs, viewpoints are described as being selected to show a *"representative"* range of visual effects. We also noted a frequent tendency for several *"not visible"* viewpoints to be selected for assessment. By way of contrast, the Harehill windfarm is visible at seven of the eight viewpoints assessed (and probably visible at the eighth), but the Windy Standard windfarm is invisible at nine of the 15 viewpoints assessed. Whilst acknowledging that the ZVI, used for identifying potential viewpoints, will contain errors, this phenomenon appears at first sight to be odd. The ES is required by law and regulation to assess potential significance, and if the ZVI predicts invisibility, then detailed assessment seems unnecessary. Although we have not explored the possible reasons behind this, it may be that consultees wish to see further proof of invisibility beyond the ZVI, and that there is deep distrust of the accuracy of ZVI.

6.1.14 The choice of precise viewpoints in the case-study ESs sometimes seemed less than ideal. There were occasions when we assessed a viewpoint and noticed that a very short distance nearer to or even further away from the windfarm the turbines were more prominent. We found this at Dun Law and Deucheran Hill and Beinn an Tuirc. There were some viewpoints for Deucheran Hill from which the windfarm was not visible, but from the same location Beinn an Tuirc was very visible or even dominant. Perversely, this viewpoint was not used in the Beinn an Tuirc ES, but a viewpoint nearby selected for Beinn an Tuirc demonstrated a much reduced or zero impact.

6.1.15 If visualisations are therefore being used for what are effectively three separate purposes, (a) to test the ZVI, (b) to provide a representative selection of visual effects (essentially this is visual survey and not assessment), and (c) to assess the potential significance of effects at key viewpoints, then these three purposes should be distinguished. Although mixing these purposes might appear harmless, it can result in an ES that contains potentially and superficially very misleading information. For example, statements to the effect that *"the windfarm would only be visible from three of the fifteen viewpoints assessed"* can be inserted freely and truthfully, without acknowledging that twelve of these may have been selected specifically to show just such a non-visible and therefore non-significant effect.

Wireframe and Photomontage

6.1.16 Photographs (and therefore photomontage) are subject to a range of limitations. They may not reproduce small objects or texture, rendering of colour is variable, light levels are not reproduced accurately, the small scale can tend to distort, and contrast is generally lower than in reality. However, and accepting these limitations, they are useful and essential tools in VIA. Our own view is that wireframes can be as useful as photomontage in many circumstances, because they are cheaper to produce, so more can be requested, and because they do not purport to be other than indicative of potential visibility.

6.1.17 The accuracy of photomontage has at least two dimensions. First, a photomontage can and should be accurate in the sense that the positioning, spatial distribution and size (especially height) of the towers is accurate in relation to the landscape and other elements or structures in the picture. This is achieved by meticulous attention to a number of detailed requirements that are familiar in photomontage (and wireframe) technology. Second, the accuracy of a photomontage can be judged on the degree to which it creates a realistic visualisation or impression of the on-site view that will exist after construction of the windfarm. This consideration is more subjective and impressionistic, but realism can be enhanced by avoiding obvious distortions caused by some lenses, and by considering size and viewing distance, discussed below.

6.1.18 A photomontage can imply a degree of realism that may not be robust, and can seduce even a critical viewer into investing more faith in that realism than may be warranted. Certainly our case-study analyses confirm a widespread belief that photomontages almost always underestimate the true appearance of a windfarm from most viewpoints. This is in contrast to statements in some ESs that overestimation occurs because of the technique used to produce the photomontage.

6.1.19 There can be several causes of this underestimation. The most obvious is the use of panoramic or wide angle lenses that produce subtle and sometimes not so subtle distortion. Wide angle lenses in particular have the effect of enlarging the foreground and reducing or receding the background in a manner that directly under-represents the apparent magnitude of windfarms in landscape scenes. We therefore endorse the general use of the 50 mm lens on a 35 mm format camera. For photomontage, the focal length of the lens used and other relevant technical detail should always be quoted.

6.1.20 A second reason is the common submission of visualisations that are relatively small, often accompanied by a recommendation to view them from an unnaturally short distance. For example, some case-study ESs suggested viewing distances of 17, 23 or 24 cm. Our judgement is that this configuration is a strain on the eyes, is difficult or impossible to use and fails to capture any semblance of realism. Because most viewers will in practice observe these images from longer distances, a subtle but powerful under-representation of the visual effect is introduced.

6.1.21 A typical, comfortable viewing distance for reading A4 pages is 30-40 cm, and a typical, comfortable viewing distance for larger images at either A4 or A3 held at arm's length is 50-60 cm. We therefore recommend that what is comfortable and natural for the viewer should dictate the technical detail and not *vice versa*. This means that visualisations should be designed for typical viewing distances of 30 – 50 cm and that most visualisations should be correspondingly larger (a recommendation also made in Stevenson & Griffiths, 1994). A full image size of A4 or even A3 for a single frame picture, giving an image height of approximately 20 cm is therefore to be preferred, rather than the common use of images with a height of approximately 10 cm.

6.2 Effects of Distance

The Sinclair-Thomas Matrices

6.2.1 We tested the Sinclair-Thomas Matrices (Table 4) during our site visits and found them difficult to use because of the imprecision of the terminology used, and because the separation between magnitude and significance was not always clear or was mixed. In addition they take no account of the influences of different landscape character or visual context. Whilst there is probably not much controversy over a judgement that the visual effect is dominant close to a windfarm and indistinct or negligible at long distances, the matrices lack clear differentiation in the middle-distance zones. It is here, of course, that most debates and controversies over magnitude and significance exist. In general our on-site assessments were in agreement with Sinclair-Thomas at viewpoints near to a windfarm and at long distances, but we consistently rated the visual effect as either much less or lower in the middle-distance zones, or we were unable to reach a robust judgement because of a lack of differentiation in definition between distance classes. For example, we were never able to distinguish the difference between Band C *("Clearly visible with moderate impact: potentially intrusive")* from Band D *("Clearly visible with moderate impact: becoming less distinct* ") on visual grounds.

An Alternative Schema

6.2.2 We have therefore devised the following schema as an alternative to the Sinclair-Thomas or other distance-magnitude guidelines, based on the results from the current research project. This schema is offered as a suggestion for testing and further evaluation, and our earlier comments on issues of magnitude and significance should underline the inherent difficulties in devising any schema that is likely to enjoy universal consensus, even among trained professionals. We suggest that the following approach might at least help clarify the issues sometimes hidden within the generalised statements that appear in some literature.

6.2.3 First, we suggest use of the conceptual model shown in Figure 2. The issues are complex and this cannot be wished away. The first factor to be considered is physical form of the development, which varies with the windfarm structures, their number and layout. The second factor to be considered is visibility in a physical sense, including distance to the viewpoint, weather effects and the seasons – what we have termed the ambient conditions in Figure 2. The third consideration in terms of magnitude (left side of Figure 2) is a large number of factors that modify the visual effect, some related to human perception and some related to physical elements and design of the environment. We believe that this is a structured and enlightened approach to the assessment of magnitude.

6.2.4 Second, we suggest that magnitude be described as shown in Table 18. The terms large, small etc are used because magnitude means size. For each size class, we offer a single keyword descriptor, which is then qualified with other words to try to paint a verbal picture of the size effect. Each class is a range, and the boundaries are explicitly not fixed or defined. It is important to emphasise that no judgement of significance is implied in this table and the words have been chosen to describe size only, in so far as this is possible.

6.2.5 Our judgement is that in the very large, large and negligible distance zones, there are very few factors that modify the physical visual effects to any great extent, although all will have some slight modifying effect. However, a host of modifying factors needs to be considered in the broad middle distance zones. These are listed in Figure 2, divided into those that tend to increase the perception of magnitude and those that tend to reduce it. In judging the appropriate size class for any predicted visual effect at a particular viewpoint, these factors need to be considered explicitly.

6.2.6 It is important to stress that the critical classification is the visual size class and not the distance. Three examples emphasise this point. It is the size class descriptor *prominent* that is important visually, not whether the viewpoint happens to be at 1 km or 2 km from the turbines. If the prevailing wind is such that the turning rotors will appear directly facing the viewer for most of the time, the turbines will appear more visible than if the prevailing view is to blades at right angles to the viewer; in this case, it is perfectly feasible for the perceived magnitude to be judged as *conspicuous* rather than *apparent*. If meteorological data shows that aerial visibility will be low for a high proportion of the year, the average magnitude of the visual effect will be correspondingly lower; in this case, it is perfectly feasible for the perceived magnitude to be *apparent* rather than *conspicuous*.

6.2.7 Magnitude must then be linked with sensitivity to seek evaluation of significance, discussed in the next sections.

6.3 Receptor Sensitivity

6.3.1 For sensitivity (right side of Figure 2), we recommend use of the words high and low, rather than large and small, because the words high and low imply a level of intensity rather than a size associated with magnitude. Both the sensitivity of the human receptor and the interaction with their location or the type of viewpoint may need to be evaluated.

6.3.2 Whilst there appears to be a general consensus, expressed in much guidance (e.g. LI-IEA, 1995; LI-IEMA, 2002)) and in ESs and elsewhere, that assessing sensitivity is subjective and depends in the end on experience and balanced professional judgement, we suggest that this consensus should apply mainly to landscape assessment. For the related but distinct area of visual assessment, it seems to us that this is as much a matter for people as for professionals. When a landscape or other professional writing in an ES identifies a range of human receptors – residents, walkers, tourists etc – and then categorises their visual sensitivity as high or medium or low - it needs to be acknowledged that this is the professional acting as a representative or surrogate; they are not applying professional experience and judgement, *per se*.

6.3.3 Although this type of human sensitivity categorisation seems intuitively reasonable, we know of no detailed evidence to support it. Also, of course, people's perceptions, attitudes, preferences and sensitivities are known to be highly diverse and variable. Further, people are not either residents or walkers; most people may be both of these things, and other things, at different times of the day, or seasons, or through their behaviour, lifestyles or lifetimes.

6.3.4 We therefore recommend that in any ES there is an explicit description of who the human receptors are, and a description of their suggested sensitivity, with further detailed justification if possible, including their number, mobility, exposure time etc. If and when detailed research is carried out to test the range and diversity of such sensitivities, then this information can be used directly in EIA.

Figure 2: Conceptual Model for Visual Impact Assessment

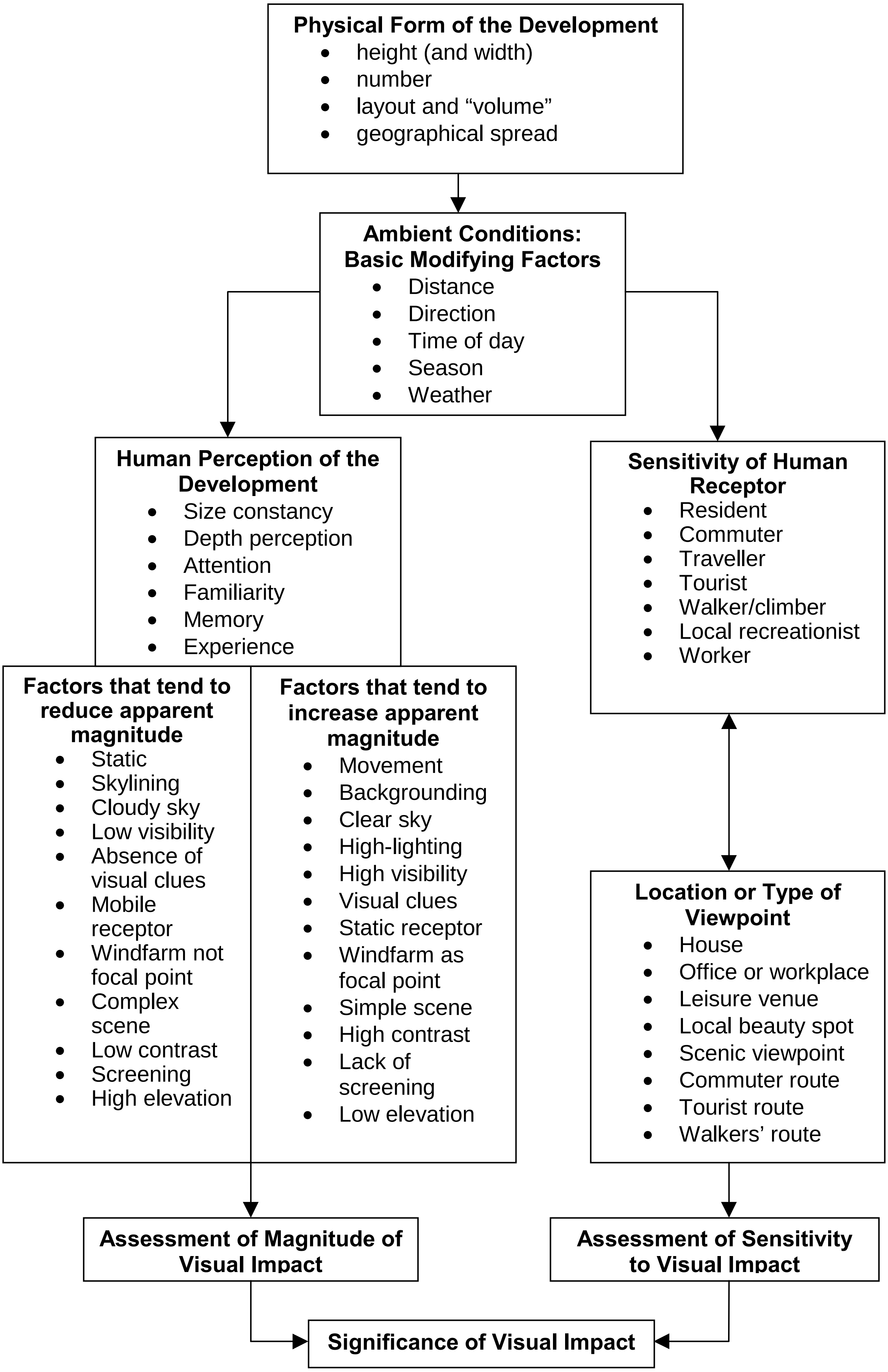

Table 18: Size Classes, Names and Descriptors for Visual Effect (Magnitude)

Size Class	Name	Descriptors – appearance in central vision field	Modifying Factors (Figure 2)
Very Large	Dominant	Commanding, controlling the view	Few
Large	Prominent	Standing out, striking, sharp, unmistakeable, easily seen	Few
Medium	Conspicuous	Noticeable, distinct, catching the eye or attention, clearly visible, well defined	Many
Small	Apparent	Visible, evident, obvious	Many Limit of Potential Visual Significance ↓
Very Small	Inconspicuous	Lacking sharpness of definition, not obvious, indistinct, not clear, obscure, blurred, indefinite	Many Limit of ZVI ↓
Negligible	Faint	Weak, not legible, near limit of acuity of human eye	Few

6.4 Significance

6.4.1 Of all the issues surrounding VIA, significance is the most subjective and intractable. We therefore recommend that the link between magnitude and sensitivity is made explicit to arrive at judgements of significance. The use of simple matrices is, we believe, a helpful tool for mapping and explaining the basis for the judgements made. However, as LI-IEA (1995) has stressed, the matrices in those guidelines are indicative suggestions only, and a case-by-case approach is required in assessing significance for individual windfarm proposals. The LI-IEA (1995) model matrix of three classes on each axis producing 9 cells, only 3 of which are typically judged as significant, is in our view simplistic and unrefined and quite unsuitable as a tool for widespread use. In particular it implies a degree of certainty about a very restricted definition of significance that we do not believe is justified. Expanding a 3 x 3 (9 cells) matrix to 4 x 4 (16 cells) or even 5 x 5 (25 cells) is much more representative of the diversity of size and sensitivity found in visual impact assessment. These matrices do not appear in LI-IEMA (2002), perhaps because of the risk that they will be applied indiscriminately. Instead, LI-IEMA (2002) emphasises that *"Significance is not absolute and can only be defined in relation to each development and its location. It is for each assessment to determine the assessment criteria and the significance thresholds, using informed and well-reasoned judgement supported by thorough justification for their selection …."* and goes on to give several examples (Appendix 6) of criteria, definitions of magnitude and interpretations of significance used by different landscape practices for different project types and landscape settings. There is a lack of statutory guidance on the definition and evaluation of significance and this may be one reason for some simplistic approaches to a complex and difficult issue.

6.4.2 We are not persuaded by the common declaration or assumption found in some of the ESs examined that a medium effect imposed on a medium sensitivity receptor is necessarily insignificant, nor that a small effect on a high sensitivity receptor is also insignificant. For example, LI-IEMA (2002) states that *"in wilderness landscapes the sensitivity of the people who use these areas may be very high and this will be reflected in the significance of the change*". It therefore appears to us feasible that a small change for a highly sensitive receptor could be judged to be significant. An example of the problem of interpretation of significance appears in the ESs for the Beinn an Tuirc and Deucheran Hill windfarms. Both declare they are based on the EIA Regulations, but the former concludes that moderate and major effects are significant, whilst the latter concludes that only major and moderate-major effects are significant. However, ultimately this is just playing with words, and as we have already pointed out, the law, regulations and statutory materials offer no unequivocal guidance. Until such time as robust consensus on significance, based on detailed research, can be claimed with confidence, best practice requires that the bases for all judgements made are clear and explicit on a case-by-case basis.

6.5 Conclusions

6.5.1 VIA is complex. All the issues surrounding magnitude and visualisation (e.g. factors affecting visibility, human perception, ZVI, camera specifications for photomontages), and all the issues surrounding significance (e.g. the sensitivity of human receptors, and the meanings of words such as material change and fundamental change), are subject to complexity, controversy and uncertainty. This research and report has reviewed, examined and explored these issues in detail. It has tried to explain the influence of different issues and effects and to offer guidance on their interpretation and application to VIA.

6.5.2 VIA requires an explicit recognition of this complexity, controversy and uncertainty. The provision of detailed technical information is essential in any VIA to ensure that the issues can be understood and sound judgements made. The overriding consideration is that the quality of the VIA needs to be high if the evaluation of impacts is to be sound.

6.5.3 Given the wealth of research, guidance and experience revealed by this study (even if some of it is contradictory), we were surprised at the general lack of reference to and use of this material in the ESs examined. This apparent failure of research and even practice-based research to penetrate quickly into EIA and VIA practice is an issue that may need to be examined and addressed.

7 RECOMMENDATIONS FOR BEST PRACTICE FOR VISUAL IMPACT ASSESSMENT

In this section our detailed recommendations are presented and summarised as concise bullet points. Their justification is contained within the preceding review, analysis and discussion. Although some may seem obvious or even trivial, there is such variation in the content of the VIA in the Environmental Statements examined that even these simple points need emphasis in the interests of best practice.

7.1 General

- Generic Best Practice Guidance on EIA should also be followed for VIA, including the requirements for assessment to be rigorously documented and explained, integrated, consistent, balanced and objective and for presentation to be logical, clear and well-structured
- Cumulative effects and the cumulation of windfarm projects should be considered and assessed whenever relevant
- Comprehensive scoping based on consultation should be carried out
- Clear distinctions should be made between magnitude, sensitivity and significance
- The inherent complexity, controversy and uncertainty in VIA should be acknowledged and addressed
- High quality VIA depends on a detailed and explicit declaration of the basis upon which all aspects of the VIA have been made, especially magnitude, sensitivity and significance
- Significant post-assessment changes should be re-assessed, re-visualised and re-evaluated
- Wider use should be made of the existing wealth of research, guidance and practice experience

7.2 Landscape and Visual Assessment

- Visual Impact Assessment is an integral but distinct part of Landscape and Visual Assessment and should be distinguished from Landscape Assessment, including Landscape Character Assessment, Landscape Sensitivity and Landscape Significance
- The *"Guidelines on the Environmental Impacts of Windfarms and Small Hydroelectric Schemes"* (Scottish Natural Heritage, 2001) and *"Guidelines for Landscape and Visual Impact Assessment"* (LI-IEMA, 2002) should be used.

7.3 Zone of Visual Influence

- A ZVI should appear in any Environmental Statement, superimposed on an OS base map at 1:50,000 or 1:100,000 scales
- The data used to calculate the ZVI should always be described. The use of OS Panorama Data and a 50 m cell size is recommended
- The existence of error should always be acknowledged and if possible the errors should be assessed and discussed
- A theoretical (computer generated) ZVI should always be tested and verified by desk and field study and the results of those tests should be described
- Distance for ZVI should be based on the recommendations in Table 17 and should be justified, including any alternative distance used
- Distance for ZVI where cumulative effects is an issue should be adjusted, extended and justified

- ZVI should assess the degree of visibility based on the numbers of turbines visible, at least to the maximum height and if possible based on nacelle/hub height and on total height
- Any extensions to a worst-case (bare ground) ZVI to include computer modelling of built and landscape elements should be subject to these same recommendations

7.4 Viewpoints

- Viewpoints should be selected by negotiation with statutory consultees, including the Local Planning Authority and Scottish Natural Heritage, and public consultation and participation should be considered
- The number should be selected to achieve an effective assessment of key viewpoints and an effective assessment of representative viewpoints, as two distinct considerations
- Viewpoints should be selected in order to identify both potentially sensitive receptors and potentially significant views or locations or landscapes
- Precise selection on site should be made to avoid detailed positioning which underestimates the visual effect by the judicious positioning of screening objects
- If used to verify the accuracy of any ZVI, such verification should be distinguished from its use to assess potential sensitivity and significance
- If viewpoints are also used as part of any landscape assessment, this should be clearly distinguished from the visual assessment
- The precise location (including OS grid reference point), orientation to the proposed development, date, time of day and weather conditions should be stated for each viewpoint

7.5 Visualisations

General

- The focal length of the lens and camera format used for photographs (and derived visualisations) should always be stated
- Use of a 50 mm lens in a 35 mm format is recommended, or equivalent combinations in other formats
- Panoramas should be produced by splicing standard photographs and not by the use of specialist cameras, in order to minimise distortion

Wireframes

- Wireframes should be used in an appropriate combination with photographs and photomontage, as both working and presentation tools
- Wireframes may occasionally be preferred to photomontage because they reduce the risk of implying a false realism

Photomontages

- The limitations of photomontage should be recognised and acknowledged, especially a tendency for photomontage to consistently underestimate the actual appearance of a windfarm in the landscape
- A natural viewing distance of 30-50 cm should dictate the technical detail of their production
- A full image size of A4 or even A3 for a single frame picture, giving an image height of approximately 20 cm, is required to give a realistic impression of reality

7.6 Magnitude

- Magnitude (size) of visual effects should be described and the categorisation justified
- Terminology such as large – small should be used
- The use of the size classes and descriptors in Table 18 is recommended
- Distance should not be used mechanistically to predict magnitude at a particular viewpoint because of the potential effects of other modifying factors

7.7 Environmental Conditions and Human Perception

- The specific environmental conditions at or affecting each viewpoint should be stated and analysed, including factors such as season and weather, air clarity, movement, orientation to prevailing winds, visual cues, screening and elevation of the wind farm in relation to the viewer (Figure 2), as well as the detailed design and layout of the windfarm
- Available data should be used wherever possible (e.g. meteorological data)
- Specific aspects of human perception at or affecting each viewpoint should be stated and assessed, including factors such as size constancy, depth perception, attention, familiarity and experience (Figure 2)

7.8 Receptor Sensitivity

- Different human receptors should be distinguished and described (Figure 2)
- Terminology such as high – low should be used
- Their characteristics and behaviour, including factors such as mobility, should be distinguished
- Their number, degree and time of exposure and other relevant factors should be analysed, using available data wherever possible
- Their assumed sensitivity should be described and justified
- Distinctions should be made between assumed human receptor sensitivity and that based on landscape professional experience and judgement

7.9 Significance

- The basis upon which significance and non-significance has been assessed should be described and justified
- Significance (and sensitivity) is highly context and project specific and this needs to be recognised and addressed
- Every project requires its own set of criteria and thresholds, tailored to suit local conditions and circumstances

7.10 Conclusion

- The increasing development pressures for windfarms require that VIA is approached in a comprehensive, explicit and systematic way and that the inherent complexity, controversy and uncertainty are addressed.

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10 APPENDICES

Appendix 1: List of Environmental Statements and Related Documents Used for Case Study Sites

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Appendix 2: Additional Data Sources for As-built Case Study Sites

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Deucheran Hill: http://www.pgen.com/news/default.asp?display=detail&News_ID=294&Category=16 (accessed 15 February 2002)

Dun Law: http://www.geo.ed.ac.uk/scotgaz/features/featurefirst7717.html (accessed 15 February 2002)

Hagshaw Hill: http://www.ecogen.co.uk/hagshaw.htm (accessed 15 February 2002)

Hare Hill: http://www.scottishpower.com/newsdesk/pr113010_23_10_2001.htm (accessed 15 February 2002)

Novar: http://www.natwindpower.co.uk/novar/index.htm (accessed 15 February 2002)

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Appendix 3: List of Other Environmental Statements and Related Documents

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Appendix 4: Project Brief

Visual Assessment of Windfarms - Best Practice

Background

In reviewing Environmental Impact Assessments (EIAs) for windfarms it is apparent that there is a great deal of variation in the way that assessment of both visual impact and the significance of visual impact are dealt with in these documents. There is also a degree of contention amongst landscape professionals about the appropriate distance for Zones of Visual Influence (ZVI) surveys and a corresponding need for some independent opinion on all the above aspects.

Aims of study

- to identify any relevant work on visibility, visual impact and significance
- investigate visibility of existing windfarms
- to compare as-built visibility with estimates of visibility in EIAs
- draw conclusions about appropriate distances for ZVI in different circumstances

Method

It is anticipated that the study will begin with a brief literature review to identify any relevant work previously carried out on visibility, visual impact, zones of visual influence (ZVI) and criteria for assessing significance of visual impact. This review may include published EIAs. Some consideration of other types of development (such as transmission towers) may be required, where the methods used are relevant to the current study.

A selection of 10 existing windfarms would be visited. Several visits will be necessary to embrace a variety of lighting and weather conditions. These conditions should be documented as part of the assessment.

The selection would be agreed at the inception meeting, but would be drawn from developments located in N England and mainland Scotland. A list of existing windfarms in Scotland is included at Appendix 1 (not attached).

Using the EIAs for each of these developments, consultants would check the visibility from each of the viewpoints identified, comparing actual visibility with that anticipated by the EIA. Consultants would need to liase with the relevant SNH contact and the competent authority concerned to obtain the most recent EIA, establish the degree to which this reflects the as-built development, verify whether the selection of viewpoints took into account SNH comments, and any other relevant background information. Note that consultants must contact the appropriate SNH Area office in order to obtain permission before entering private land. Contact details will be provided at the inception meeting.

Consultants may need to identify and assess further viewpoints, where for example, SNH had requested other viewpoints but the request was ignored, or where an overly restrictive ZVI may have excluded others.

In reviewing EIAs for existing developments, consultants should also review the reliability of wireframe and photomontage representations of proposals and draw conclusions about their accuracy. It is not envisaged that photography will be required as part of this study.

Using all the information gained above, consultants should draw conclusions about:

- whether there is any published best practice guidance available on the topic
- the visibility of existing windfarms in different conditions
- whether this was anticipated by the EIA and accurately portrayed in wireframes and photomontages
- whether the ZVI was broad enough to include all viewpoints with significant visibility

Best practice recommendations should then be made on the basis of these conclusions.

Project outputs

Written report, maps, tables, including extracts from EIAs.

Programme

Project initiation	w/c 17 December 2001
Draft report	15 February 2002
Final report	8 March 2002

References

- Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydro-electric Schemes
- Guidelines for Landscape and Visual Impact Assessment

Appendix 5: Summary of Findings from a Study of Hagshaw Hill Windfarm (Turnbull Jeffrey Partnership, 1997).

"As light conditions change, particularly the colour and nature of the sky backcloth, the perceptibility of the turbines changes. When turbines are perceived against a white or light sky backcloth, they appear dark. As the sky backcloth darkens, those turbines seen against the darkening sky backcloth become more difficult to perceive, and the ones which are seen against a backcloth of landform become more prominent. Also, when sunlight shines on the turbines, they become more prominent.

The turbines are perceptible at a range of more than 20 km from the windfarm (two researchers identified them in excellent visibility conditions at about 29 km). This range only applies if you are specifically looking for the turbines, not just looking at the landscape. It is likely that the turbines would be perceptible to a "casual" observer at a distance of up to approximately 17-20 km.

Blade movement is an important consideration, as it tends to draw the eye towards the turbines. Blade movement is perceptible at a range of about 15-17 km, but only if you are specifically looking for the windfarm. At a distance of more than about 15-17 km, blade movement is not perceptible. Blade movement is perceptible to the casual observer at 10-15km.

At a distance of more than about 12 km, the turbines are perceived as a group forming a windfarm, rather than as individual turbines. At a distance of less than 12 km, turbines are perceived as individual structures which, dependant on layout, may or may not form a group. The distance at which turbine detail becomes noticeable is about 8 km. At a distance of more than about 8 km, it is not possible to see the taper of the turbine or identify nacelle detail.

Turbines generally appear more visually satisfying when they appear fully or predominately above the skyline, rather than partially above the skyline. Where only the turbine blades are visible above the skyline, this looks very unusual.

Visual layout of turbines in relation to the skyline profile in an important factor to consider when assessing the impact on a viewpoint. The issue of the extent and pattern of turbine layout in relation to the scale and form of the skyline is important.

Where the windfarm and viewpoint occur in the same area of landscape character, the potential for a higher impact on the viewpoint is increased. Where they do not occur in the same area, the potential is reduced.

Analysis of the research findings leads to the conclusion that there are a large number of inter-related factors which need to be considered when selecting an appropriate cut-off radius, and that no exact figure can be arrived at with any degree of certainty. Relevant considerations are the size, colour, layout and number of turbines, weather conditions, the type of landscape in which the windfarm and viewpoint are located and whether blade movement is perceptible. Professional experience of siting similar objects in the landscape leads to the belief that use of higher turbines certainly results in a greater cut-off radius. However, when the number of turbines is considered, the influence of a greater number of turbines on the radius is less certain, and probably depends on turbine layout, grouping, and the scale of the turbines/windfarm relative to the scale of the landscape. Certainly, impact diminishes as distance increases, but is not necessarily directly proportional to turbine number.

In considering the above points in relation to the proposed Beinn an Tuirc windfarm, professional judgement has concluded that 15 km is a reasonable ZVI cut-off radius to use for practical assessment purposes as the distance beyond which there is unlikely to be a significant adverse landscape and visual effect because: movement of the blades would generally not be perceptible; the proposed windfarm would appear as a small-scale element in the landscape beyond such a distance ; it is unlikely that the windfarm site would occur in the same area of landscape character as viewpoints which are more than 15 km away from the windfarm; beyond this distance, the turbines would be perceived as a group forming a windfarm, rather than individual turbines. This 15 km radius accords with Argyll & Bute Council's opinion of long and short-range visibility expressed in their Windfarm Policy document: "The choice of representative viewpoints should reflect long and short-range visibility (15 -0.5km)……" [Reference 3, Appendix D].

It is acknowledged that there remains a degree of uncertainty in adopting this distance. It is also acknowledged that, depending on weather and lighting conditions, the windfarm would be visible from greater distances. However, given the range of variable factors which require consideration to determine such a radius, it is considered that a 15 km cut-off radius is a reasonable distance to adopt in this situation in relation to the likelihood of a significant adverse landscape and visual effect occurring."

11 NOTES

[1] "Grey literature" is a term used to describe documents, reports, policy guidance and so on that are not officially published in the sense of having an ISBN or ISSN number and which are therefore not certain to be accessible through official library cataloguing sources.

[2] Environmental Statements are an important resource and data-base for policy development, research and case work (for all project types). We noted that there is no central system within SNH for cataloguing and storing ESs, and apparently no systematic policy of retention in area offices. Considerable effort was needed to obtain the requisite ESs for this project, mainly by the landscape team in headquarters. We strongly recommend that SNH consider establishing a recording and retention system for such documents. In fact there is no centralised and reliable system for ES storage in the UK generally or in Scotland. The Scottish Executive Library in Edinburgh is apparently charged with their retention, at least for a period (lists appear in PAN58: EIA), but enquiries reveal that their collection is partial.

[3] Therivel (2001) and others sometimes refer to the Zone of Visual Intrusion and LI-IEMA (2002) refers to the Visual Envelope Map (VEM).

[4] Other terms used include viewshed, visual envelope and intervisibility maps.

[5] The literature also refers to "fuzzy viewsheds" to describe the degree to which the target might be distinguished given such phenomena as atmospheric conditions, the eyesight of the observer and the object-background contrast etc.

[6] Landscape Institute Advice Note 01/99: Guidelines for Landscape and Visual Impact Assessment. London.

[7] It should be noted that this analysis of the ESs was confined to the VIA elements only and any positive or negative comments do not imply any judgement on the overall quality of the ES or the overall quality of any combined Landscape and Visual Assessment. Research (e.g.Glasson et al, 1997) shows the overall quality of ESs in the UK to be highly variable, based on a wide range of criteria including both technical content and presentation.

Visual Representation of Windfarms

Good Practice Guidance

29 March 2006

Prepared for Scottish Natural Heritage, The Scottish Renewables Forum and the Scottish Society of Directors of Planning

by

horner + maclennan &
1 Dochfour Business Centre
Dochgarroch
Inverness
IV3 8GY

T: 01463 861460
F: 01463 861452
E: inv@hornermaclennan.co.uk

Envision
21 Lansdowne Crescent
Edinburgh
EH12 5EH

T: 0131 535 1144
F: 0131 535 1145
E: info@envision3d.co.uk

SNH COMMISSIONED REPORT

Summary

VISUAL REPRESENTATION OF WINDFARMS GOOD PRACTICE GUIDANCE

Report No: FO3 AA 308/2
Contractor: horner + maclennan and Envision

BACKGROUND

This guidance is derived from research reported within the publication Visual Assessment of Windfarms: Best Practice, by the University of Newcastle (2002). The sections of this original work concerning visibility maps, viewpoints and visualisations have been updated and refined through a review of current VIA practice, current illustrative methods, consultation with stakeholders and reference to other guidance documents.

The production and use of visual representations forms just one part of the Visual Impact Assessment (VIA) of proposed windfarm developments and, in turn, this forms just one part of the wider Landscape and Visual Impact Assessment within an Environmental Impact Assessment. Yet within the visual analysis process itself, there is a wide range of different tools and techniques that can be used. This Good Practice Guidance advises on the different purposes, uses and limitations of these and sets down some minimum technical requirements.

MAIN FINDINGS

- Visibility maps and visualisations are tools for VIA. They help the landscape architect or experienced specialist assessor to identify and assess potential significant visual impacts, and help the wider audience of an Environmental Statement to understand the nature of these visual impacts through illustration.

- Various software is available to produce visibility maps and visualisations of windfarms. These possess different strengths and weaknesses. In this respect, minimum standards can be defined; however there is no 'one size fits all' solution.

- The choice of visibility mapping and visualisations forming part of a VIA should be based on why they are being produced, how they are to be used, and what information they can provide. This decision should occur in an informed and methodical manner, in consultation with the determining authority and consultees. This process, including the technical specification of visualisations, should also be clearly documented within the ES.

- Different people read visibility maps and visualisations in different ways. This is partly based on their experience and understanding of landscapes and the typical visual impacts of windfarms, and partly from their experience and understanding of how visualisations compare to how a development actually looks once built.

- New method of visibility mapping and visualisations will continue to develop, as will other approaches not included within the scope of this study, such as the use of computer animation and the representation of cumulative impacts. Consequently, it is envisaged that the content of this Good Practice Guidance will require future updating.

For further information on this project contact:
Frances Thin, SNH Inverness. frances.thin@snh.gov.uk

For further information on the SNH Research & Technical Support Programme contact:
snh.org.uk/research

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Rob Forrest	Scottish Renewables Forum
Jason Ormiston	Scottish Renewables Forum
Ted Leeming	Natural Power Consultants
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Frazer McNaughton	Scottish Natural Heritage
Jenny Simmonds	Scottish Natural Heritage
Nigel Buchan	Scottish Natural Heritage
Kay Hawkins	E4environment Ltd
Phil Marsh	spatial data analyst
John Rennilson	Scottish Society of Directors of Planning

In addition, many planners, landscape consultants and windfarm developers participated in the development of this project through contribution to a series of workshops held in September 2004.

Natural Power and Green Power are acknowledged for giving permission to use some of their photography and ES material, and to base hypothetical visualisations on some of their windfarm site data.

This publication builds upon the original findings of the SNH research report - 'Visual Assessment of Windfarms: Best Practice', produced by the University of Newcastle in 2002. It was initially led and developed by John Benson of the University of Newcastle, until John's sudden and extremely sad death in March 2004.

John Benson was a well-respected researcher and consultant at the forefront of this work. He had the ability to see all sides of an issue with great clarity, fair-mindedness and understanding and was a great mentor to all that worked with him. It is hoped that the fruition of this work does his reputation justice. The draft report was developed by John and his colleagues at the University of Newcastle, Karen Scott and Maggie Roe; and then, from December 2004, this work was completed by horner + maclennan and Envision.

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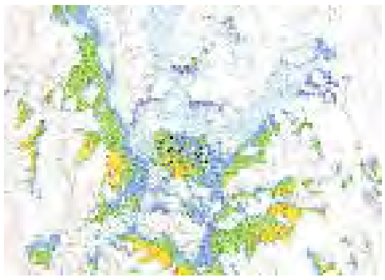
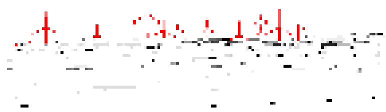
1 Introduction

1 'Pictures speak louder than words'. Images are an incredibly powerful medium in conveying information – both positive and negative, and in capturing our imagination. The visual assessment of windfarms, however, involves much, much more than just looking at pictures. It requires detailed site assessment of a visual resource while also considering data on the potential effects of a development.

2 While images are very powerful and useful in communicating information, they can never tell the whole story. They can never replicate the experience of seeing a windfarm in the landscape, whether they are photographs, maps, sketches or computer generated visualisations, and prepared to the highest specification and skill possible. Similarly, however, assessment in the field will be considerably limited without the benefits of technical data such as visibility maps and visualisations that demonstrate the technical aspects of a proposed development.



3 Visual analysis forms just one part of a Visual Impact Assessment (VIA), the process by which the potential significant effects of a proposed development on the visual resource are methodically assessed. In turn, VIA forms just one part of a Landscape and Visual Impact Assessment (LVIA) and the wider process of Environmental Impact Assessment (EIA). All of these processes are directed by specific guidelines and/or legislation, some of which are listed in figure 3 and Appendix i.



4 Detailed information on the process of LVIA, together with a recommended methodology, are provided within the 'Guidelines for Landscape and Visual Impact Assessment' (GLVIA), produced by The Landscape Institute and Institute of Environmental Management and Assessment (2002).

5 The purpose of an EIA is to identify and assess the potential significant effects of a proposed development. Its findings are presented within an Environmental Statement (ES). An applicant will usually appoint specialists to conduct the different studies that make up this report; for VIA, it is usual to appoint landscape architects.

6 A combination of illustrative techniques are used during the VIA process. The most commonly used include computer generated visibility mapping, wirelines and photomontages, together with hand drawn diagrams and sketches. These can show where a proposed development may be seen from and how it may appear in terms of its basic characteristics such as size, pattern and shape.

7 It is important to stress that visualisations, whether they are hand drawn sketches, photographs or photomontages, will never appear 'true to life'. Rather, they are merely tools to inform an assessment of impacts; and, like any tool, their application requires careful use. Interpretation of visualisations always needs to take account of information specific to the proposal and site, such as variable lighting, movement of components, seasonal differences and movement of the viewer through the landscape. Thus visualisations in themselves can never provide the answers – they can only inform the assessment process by which judgements will be made.

How this Good Practice Guidance has been developed

8 This guidance has been prepared by independent consultants acting on the behalf of Scottish Natural Heritage (SNH), the Scottish Society of Directors of Planning (SSDP) and the Scottish Renewables Forum (SRF). It is derived mainly from research reported within the publication 'Visual Assessment of Windfarms: Best Practice' by the University of

Newcastle (2002). This original work has been updated and refined through reference to a range of material and sources, including:

- a review of current VIA practice represented by a range of windfarm ESs;
- a review of current illustrative methods representing a range of interests, experience and expertise;
- advice from participants at three workshops involving the key stakeholders of windfarm developers, consultants and planning officers (the latter also describing key concerns raised by the public); and
- existing guidance (see 'Other sources of information' section).

9 This work was begun by the University of Newcastle in 2003, led by John Benson, and later completed by horner + maclennan and Envision.

Aims and Objectives of the Good Practice Guidance

10 This Good Practice Guidance focuses upon only the Visual Impact Assessment (VIA) element of Landscape and Visual Impact Assessment (LVIA). This process usually requires visibility maps and visualisations that are then used differently by different people for different purposes. Some visualisations will directly inform judgements made within the VIA (and thus guide the scale, location and design of the windfarm), while others will be used for general illustrative purposes. Their common aim, however, is to help inform judgements on the potentially significant effects of a proposed windfarm on the landscape and visual resource.

11 The accuracy of these illustrations is often questioned. Sometimes this is due to unfamiliarity and thus a misunderstanding regarding their specific purpose, and the limitations of visibility maps and visualisations to depict what can actually be seen by the naked eye.

The University of Newcastle (2002) highlighted that photomontages "..can imply a degree of realism that may not be robust, and can seduce even a critical viewer into investing more faith in that realism that may be warranted". Sometimes, their accuracy is questioned simply because there remains considerable variation between how illustrations are presented within ESs, and these different methods have various strengths and weaknesses.

12 The methods used to produce visibility maps and visualisations have developed significantly since the first windfarms were planned in the UK at the beginning of the 1990s. This has been aided by continued effort on the behalf of many consultants, developers, researchers and consultees to try to find more effective ways of representing the effects of windfarms in the landscape. There has also been a progressive change in the availability, cost and capability of computers, software and digital data used to produce computer-generated images. This situation continues to change as new techniques develop.

13 For these reasons, Scottish Natural Heritage in conjunction with Planning Authorities (represented by the Scottish Society of Directors of Planning) and the Scottish Renewables Forum has produced this Good Practice Guidance.

Figure 1: The aims of the Good Practice Guidance

- To advise on the purposes and uses of different visibility maps and visualisations of windfarms, ensuring that their relevant strengths and limitations are better recognised and understood;
- To advise on the various methods of producing visibility maps and visualisations;
- To promote and encourage good practice in the production of computer generated visibility maps and visualisations;
- To ensure that the approaches, methods and techniques used in the production of visualisation tools and illustrations are technically sound and robust and hence carry credibility; and
- To enable the Good Practice Guidance to be easily updated as new methods and techniques become established.

What the Good Practice Guidance is not

14 The Good Practice Guidance is designed to summarise and explain what is feasible, available and reasonable in terms of current good practice in the production of illustrations. However:

- It is not an exhaustive guide to all possible techniques, nor does it prescribe a single method or brand of software;
- It is not intended to be highly prescriptive, nor suggest that there is a 'one size fits all' solution;
- It does not remove the need for consultation, good judgement and the adaptation of tools and techniques for different developments and different locations; and, most importantly,
- It is not intended to inhibit or stifle innovation in the development and use of new approaches, tools and techniques.

15 This guidance specifically applies to onshore windfarms within Scotland; however some of the principles established through this guidance may be relevant to other development types or within other locations. Additional guidance may be developed in the future that builds upon this work, exploring and/or incorporating additional aspects of windfarms, such as cumulative assessment or offshore developments.

16 The production and use of visibility maps and visualisations are but one aspect of a complex interplay of factors considered within the VIA process (and thereby also the EIA process). Hence, it is neither feasible nor appropriate to define a single approach, as agreement requires consultation and site-specific judgements. Rather, this guidance seeks to identify the key factors that need to be considered when making decisions about what is the most appropriate approach for a particular project (as later summarised within figure 35).

17 In addition to computer generated (or computer assisted) visualisations, landscape and architectural design has for centuries been aided by the illustration of proposed change by hand drawn sketches and diagrams. Given that the creation and use of these images is long established, this Good Practice Guidance will not consider these methods in any detail, although they are mentioned in paragraphs 223-228.

18 Methods of visualisation using computer animation and video montage were not included within the scope of this study. This was because:

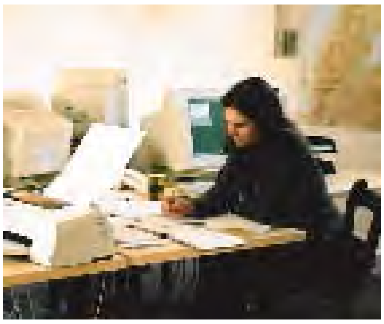
- These were not assessed within the original study by the University of Newcastle (2002);
- They rarely form an essential part of the ES, but tend to be a supplementary tool; and
- There has so far been insufficient methodical assessment of how these compare against individual built schemes within Scotland.

19 Finally, it should be stressed that **the quality of a LVIA depends on much more than just good practice visibility maps and visualisations**. These are just tools to inform the assessment process and, even if of a high quality, will not diminish the requirement for a thorough and professional LVIA. **Equally, however, it is important to stress that it is extremely difficult to carry out a high quality LVIA without visibility maps and visualisations that meet good practice standards.**

Who should use the Good Practice Guidance?

20 This Good Practice Guidance is intended for all those with an interest in the VIA of windfarms.

- For **developers**, the guidance offers an overview of what is technically available, feasible and reasonable in terms of producing visibility maps and visualisations so that they can be better informed when instructing their consultants and commissioning ESs, as well as discussing proposals with determining authorities and consultees.



- For landscape architects and other specialist consultants, the guidance advises on the technical specifications for a range of visibility maps and visualisations commonly used in VIA practice and advises on their strengths and weaknesses.
- For consultees, the guidance presents recommended standards in terms of the quality and type of visibility maps and visualisations that can be used to inform EIA, and advises on how these should be interpreted and used.

- For officers from planning authorities/ determining authorities, the guidance also presents recommended standards as described above for consultees. It will also inform scoping opinions and assist planning officers and decision-makers in their interpretation and use of visibility maps and visualisations as presented within Environmental Statements.

- This document is not targeted at the general public, given its specialist nature and technical content. However, for those members of the public particularly interested in this subject, the guidance should aid their understanding of what visibility maps and visualisations can and cannot do, and how this information should be interpreted when included within a VIA or ES.

How to use the Good Practice Guidance

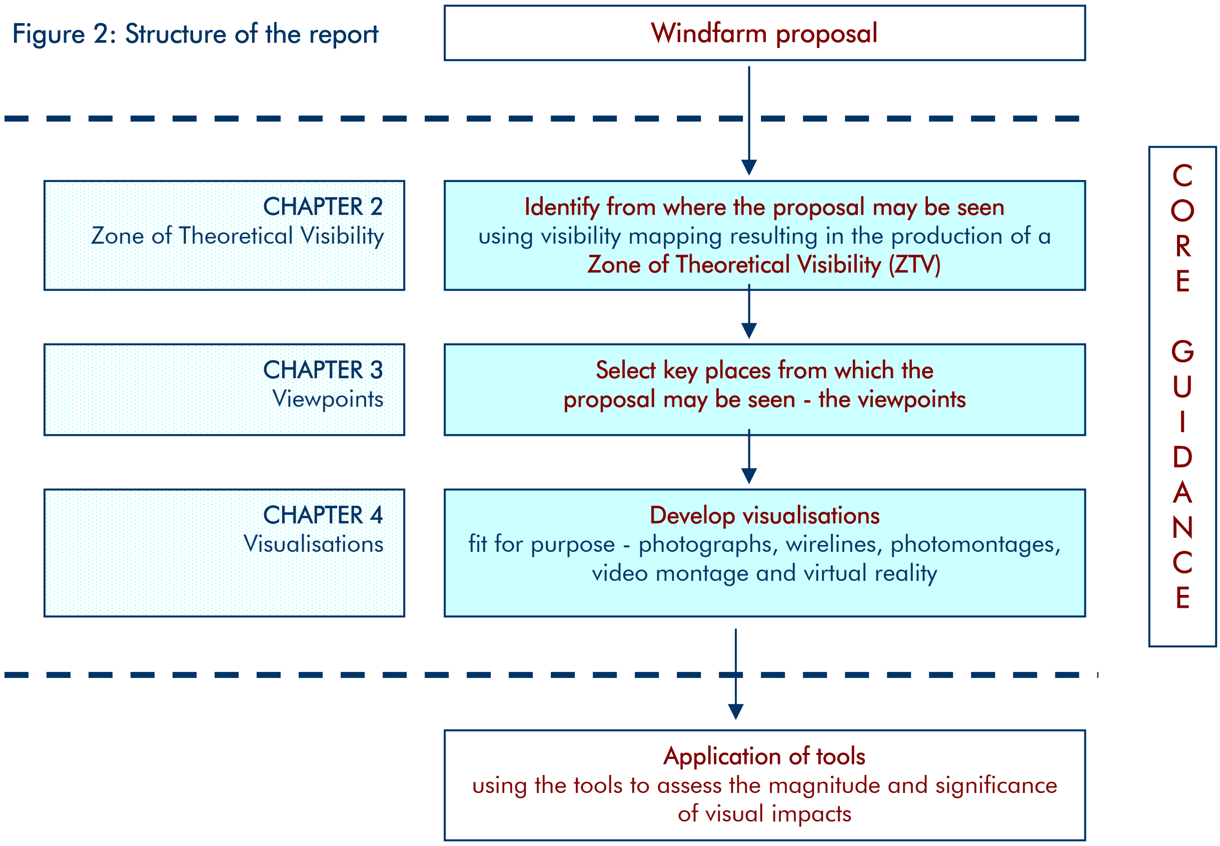
21 The guidance is presented in different sections so that it can be used as a reference tool. Not all of the information contained within the guidelines will be relevant in all circumstances.

22 The main body of this guidance is divided into a series of sections which broadly relate to the stages of a VIA process as shown in the diagram below. It is intended that the loose-leaf format will allow flexibility of use

and future updating of the guidance as new techniques are developed and experience grows.

23 The core of the Good Practice Guidance lies in chapters 2, 3 and 4 where the technical recommendations for different tools and techniques are explained as well as their uses and limitations. Where recommendations are based on complex and/ or detailed technical factors, these are further explained in the technical appendices.

Figure 2: Structure of the report



Glossary of key terms

24 A glossary is included within Appendix ii. However there are a number of key terms used throughout this document that need to be explained at an early stage as follows:

Digital Terrain Model (DTM). This term refers to the way in which a computer represents a piece of topography in 3-dimensions as a digital model. The terms Digital Elevation Model, Digital Ground Model and Digital Height Model are also used and are synonymous.

Landscape and Visual Impact Assessment (LVIA). This is the professional and methodical process by which assessment of the impacts of a proposed development on the landscape and visual resource is undertaken. It comprises two separate and distinct parts - Landscape Impact Assessment and Visual Impact Assessment.

Landscape Impact Assessment. This is the process by which assessment is undertaken of the impacts of a proposed development on the landscape, its character and quality. GLVIA (2002) states that "*Landscape effects derive from changes in the physical landscape, which may give rise to changes in its character and how it is experienced*".

Panorama. An image covering a horizontal field of view wider than a single frame. Panoramic photographs may be produced using a special panoramic camera or put together from several photographic frames. Wirelines and photomontages may also be produced as panoramas. See Appendix B.

Photomontage. A visualisation which superimposes an image of a proposed development upon a photograph or series of photographs. For windfarms, photomontages are conventionally used to illustrate proposed wind turbines within their setting. However tracks and other ancillary structures may also be shown. Photomontages are now mainly generated using computer software.

Significant. This term is used to describe the nature of a change. VIA, LVIA and EIA aim to identify and assess significant effects. For each project, levels of significance will be categorised and defined in relation to the particular nature of the resource and the proposed development.

'Telephoto Photomontage'. A type of photomontage (see above) based on a photograph taken using a telephoto lens (over 50mm when using a 35mm camera).

Visual Impact Assessment. This is the professional and methodical process which is used to assess the impacts of a proposed development on the visual appearance of a landscape and its visual amenity. GLVIA (2002) states that "*visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity*".

Visualisation. Computer simulation, photomontage or other technique to illustrate the appearance of a development. This term is used within this Good Practice Guidance to include photographs, but not Zone of Theoretical Visibility (ZTV) maps.

Wirelines. These are also known as wireframes and computer generated line drawings. These are line diagrams that are based on DTM data and illustrate the three-dimensional shape of the landscape in combination with additional elements. For windfarm projects, wirelines usually show just wind turbines. However, some software also allows the representation of additional elements such as access tracks and masts.

Zone of Theoretical Visibility (ZTV). Also known as a Zone of Visual Influence (ZVI), Visual Envelope Map (VEM) and Viewshed. This represents the area over which a development can theoretically be seen, based on a DTM. The ZTV usually presents a 'bare ground' scenario - that is, a landscape without screening structures or vegetation. This information is usually presented upon a map base.

Visual Impact Assessment (VIA)

25 Visibility maps and visualisations are only tools. Within VIA, they are produced to aid the identification and assessment of significant visual effects.

26 General guidance on assessing significance of effects is contained within the Guidelines for Landscape and Visual Impact Assessment (Landscape Institute & Institute of Environmental Management & Assessment, 2002). Consequently, this document does not include guidance on this topic. Rather, this report focuses on the choice, production and use of visibility maps and visualisations.

Cumulative Landscape and Visual Impact Assessment (CLVIA)

27 As the number of proposed windfarms increases in Scotland, the issue of potential cumulative impacts becomes ever more important. This Good Practice Guidance will not, however, provide specific guidance on cumulative visibility maps and visualisations. This is for two main reasons:

- It is believed that Good Practice Guidance on the visual representation of individual windfarms should be established and adopted before venturing into the more complex arena of cumulative issues; and
- when this study was first commissioned, there was little existing research on the effectiveness of CLVIAs and the respective cumulative impacts of windfarms.

It is hoped, however, that guidance on the cumulative visual representation of windfarms will be produced in the near future. In the meantime, it is recommended that reference be made to the relevant documents listed within the following section and Appendix i.

Other sources of information

28 This Good Practice Guidance should be read in combination with existing guidance for LVIA, VIA, EIA and CLVIA. Existing guidance particularly relevant to the LVIA of windfarms in Scotland is included within the following figure 3:

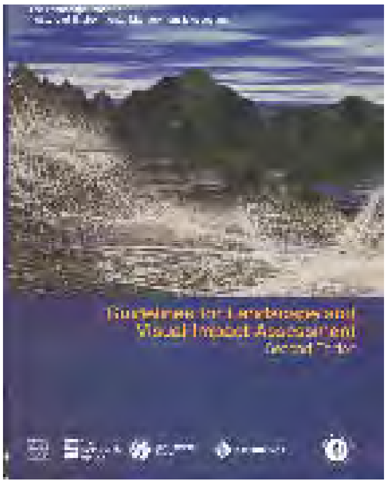


Figure 3: Existing guidance relevant to the LVIA of windfarms

- Landscape Institute & Institute of Environmental Management & Assessment (LI-IEMA). 2002. Guidelines for Landscape and Visual Impact Assessment. 2^{nd} Edition. Spon Press, London.
- Scottish Executive. 1999. Planning Advice Note 58. Environmental Impact Assessment.
- Scottish Executive. 2002. Planning Advice Note 45. Renewable Energy Technologies.
- Scottish Executive. 2000. National Planning Policy Guidance 6. Renewable Energy Technologies.
- Scottish Natural Heritage. 2001. Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydroelectric schemes. SNH:Redgorton, Perth.
- Scottish Natural Heritage. 2003. Policy on Wildness in Scotland's Countryside (Policy Statement No 02/03). Available at www.snh.gov.uk.
- Scottish Natural Heritage. 2005. Cumulative Effect of Windfarms. Version 2 revised 13.04.05. Guidance. Available at www.snh.gov.uk.
- Scottish Natural Heritage. 2005. Environmental Assessment Handbook, 4^{th} edition. Available at www.snh.gov.uk.
- University of Newcastle. 2002. Visual Assessment of Windfarms: Best Practice. SNH: Redgorton, Perth.

29 In addition, a number of landscape capacity studies for windfarms have been produced covering different parts of Scotland. For details, refer to www.snh.gov.uk.

30 The Landscape Institute produced Advice Note 01/04 in June 2004 on the 'Use of Photography and Photomontage in Landscape and Visual Assessment'. Further details on the issues raised by this note are included in the Technical Appendices A-E.

2 Zone of Theoretical Visibility

31 The term 'Zone of Theoretical Visibility' (ZTV) is used to describe the area over which a development can theoretically be seen, and is based on a Digital Terrain Model (DTM) and overlaid on a map base. This is also known as a Zone of Visual Influence (ZVI), Visual Envelope Map (VEM) and Viewshed. However the term ZTV is preferred for its emphasis of two key factors that are often misunderstood:

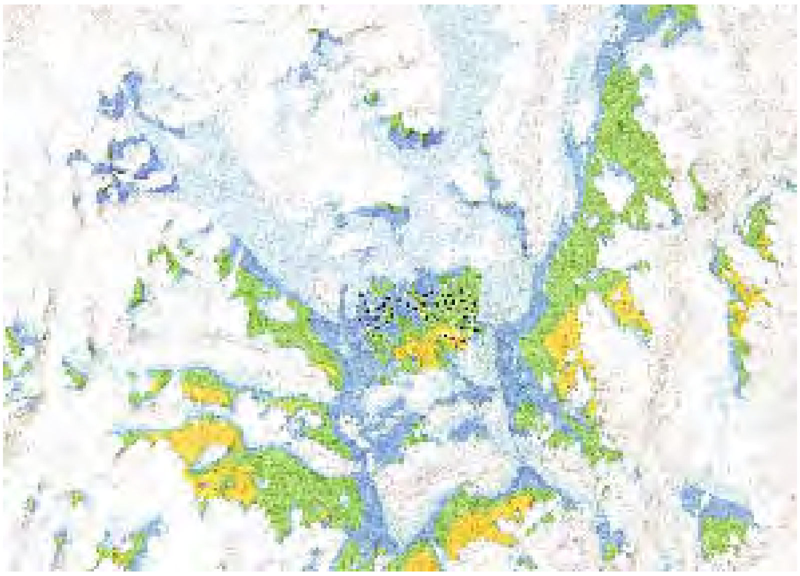
- visibility maps represent where a development may be seen theoretically – that is, it may not actually be visible in reality, for example due to localised screening which is not represented by the DTM; and
- the maps indicate potential visibility only - that is, the areas within which there may be a line of sight. They do not convey the nature or magnitude of visual impacts, for example whether visibility will result in positive or negative effects and whether these will be significant or not.

32 This section of the report highlights the following key issues with regard to ZTVs:

ZTV preparation	• ZTV data • ZTV calculation • Viewer height • Extent of ZTV

Presentation of ZTV information	• Base map • Colour overlays • Visibility bands • Recording ZTV information • ZTV development for a project • ZTV production

Good Practice Guidance Summary



33 ZTVs are calculated by computer, using any one of a number of available software packages and based upon a DTM that represents topography. The resulting ZTV is usually produced as an overlay upon a base map, representing theoretical visibility within a defined study area.

34 Production of ZTVs is usually one of the first steps of VIA, helping to inform the selection of the study area in which impacts will be considered in more detail. ZTVs provide the following information:

- where visibility of a windfarm is most likely to occur;
- how much of the windfarm is likely to be visible (within bands of various numbers of turbines);
- how much of the wind turbines is likely to be visible if separate ZTVs are produced showing visibility up to blade tip height, and visibility up to the hub or nacelle; and
- the extent and pattern of visibility.

In combination with a site visit, possibly with initial wireline diagrams, this information enables the landscape architect or experienced specialist assessor to identify a provisional list of viewpoints, and allows the determining authority and consultees to judge how representative these are and whether they include particularly sensitive vantage points.

35 Importantly, ZTVs indicate areas from where a windfarm may be seen within the study area, but they cannot show how it will look, nor indicate the nature or magnitude of visual impacts.

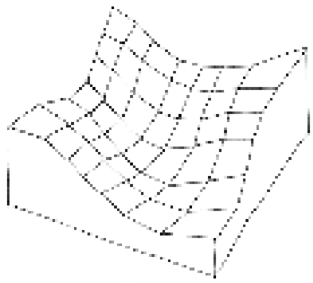
Table 1: Uses and limitations of ZTVs
(numbers in brackets refer to paragraph numbers in text)

USES OF ZTVs	LIMITATIONS
• A ZTV gives a good indication of the **broad areas** from where a windfarm might be seen (31, 34). • A ZTV predicts **theoretical visibility** (31). • A ZTV is a useful **tool** as long as its limitations are acknowledged. • The ZTV can be used to **identify viewpoints** from where there may be significant visual impacts, enabling an assessment to consider these with the aid of visualisations (34). • A ZTV is a useful tool for comparing the relative visibility patterns of different windfarms or different wind turbine layouts (84-85).	• A ZTV is only as accurate as the data on which it is based (49-51). • A ZTV **cannot indicate the potential visual impacts** of a development, **nor show the likely significance of impacts**. It shows potential theoretical visibility only (31, 33). • It is not easy to test the accuracy of a ZTV in the field, although some verification will occur during the assessment of viewpoints. • A ZTV, if prepared to good practice guidelines, will be adequate as a tool for VIA; however is will never be entirely 'perfect' for a number of technical reasons. Most importantly, in order to handle large areas of terrain the DTM data is based on information which does not allow detail to be distinguished below a certain level. There are also differences in the way that the software package 'interpolates' between heights in the calculations made (44-45).

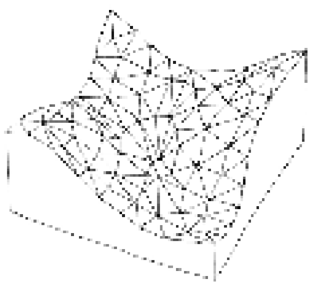
ZTV preparation

ZTV data

36 A ZTV is produced using a computer-based software package. Several of these are commercially available, for example, most windfarm design packages and many Geographical Information System (GIS) packages have this facility. However, operation of even the most user-friendly package requires a high level of expertise and understanding of all the specific features and assumptions applied by the software.



Square grid DTM



TIN

37 ZTV production begins with a Digital Terrain Model (DTM) that represents the ground surface as a mesh of points. This may form a regular grid of squares when seen on plan, known as a Square Grid DTM, or an irregular network of triangles, known as a TIN (Triangulated Irregular Network).

38 A Square Grid DTM is fundamentally incapable of representing terrain features smaller than the cell size, such as a small knoll or outcrop. Such features are either lost between grid points or represented by one point only. A TIN can, in principle, represent finer detail than a Square Grid DTM as it can represent all the detail shown by contours. However, in practice, a Square Grid DTM with a suitably chosen cell size will represent almost as much detail and may interpolate better between contours on less steeply sloped land.

39 Both formats are acceptable. The choice between them is most likely to depend on the software being used and from where the data is sourced. It is common practice for a Square Grid DTM to be chosen if OS data is to be used, while a TIN is used when based on independent and/or detailed survey data, enabling high and low points to be better represented.

40 The Ordnance Survey (OS) supply data in two formats - gridded, which has already been interpolated into a

Figure 4: Comparison digital terrain models

Wireline drawing of OS Panorama DTM at the supplied 50m grid size

Wireline drawing of OS Profile DTM of the same area at the supplied 10m grid size. As would be expected, far more terrain detail is apparent in this DTM. Also, because the source is 1:10,000 contours rather than 1:50,000, the shapes of quite large landscape features are better represented.

Square Grid DTM, and as contours, which is the usual starting point for constructing a TIN.

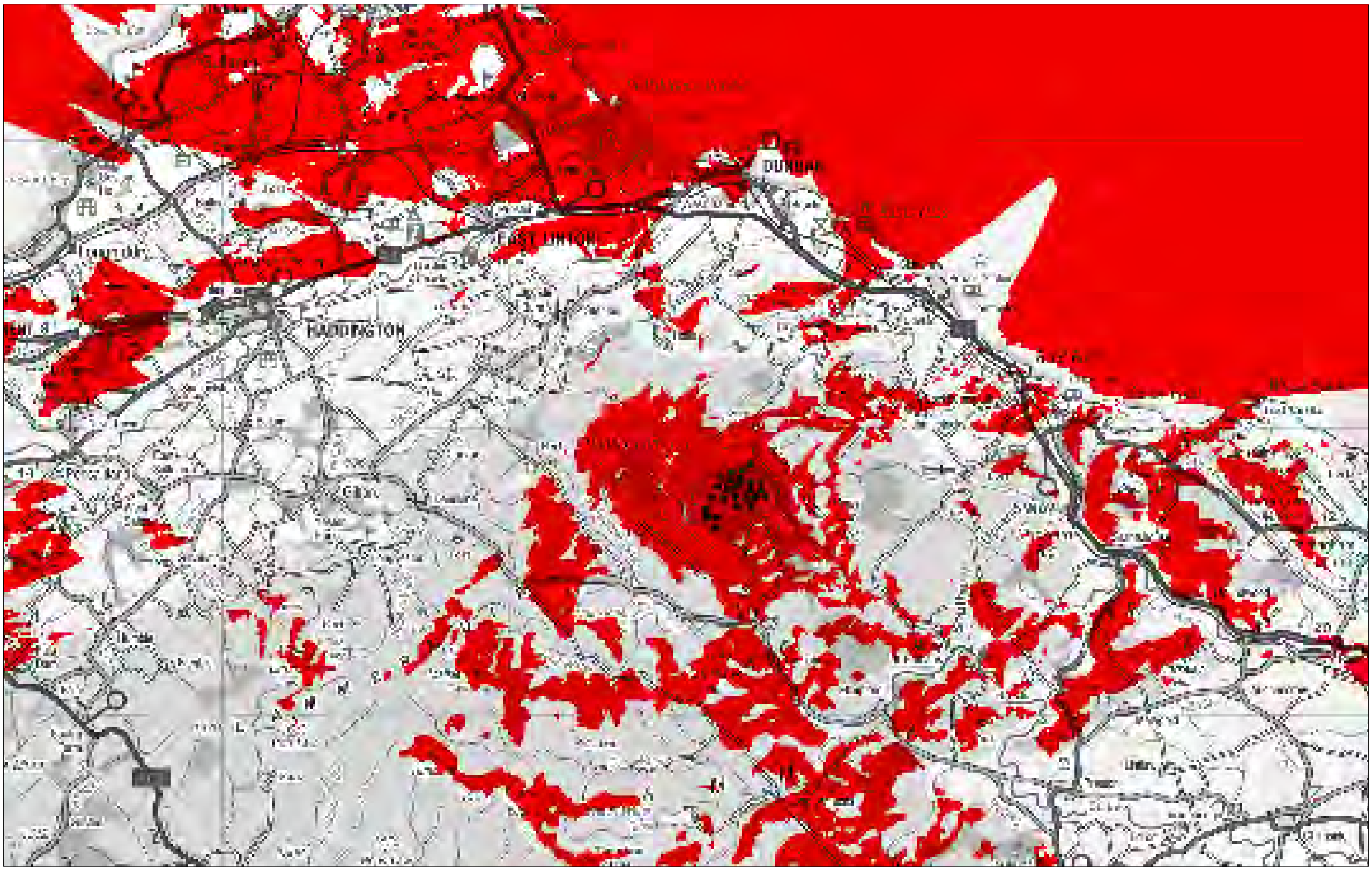
41 The OS Square Grid DTM product, 'Landform Profile', uses a 10m cell size and is interpolated from the contours shown on OS 1:10,000 and 1:25,000 scale mapping. An earlier product, 'Landform Panorama', once temporarily withdrawn, but now re-launched, uses a 50m cell size and is derived from 1:50,000 scale mapping.

42 The 10m Landform Profile DTM provides a more precise representation of topography than the 50m Landform Panorama DTM, as illustrated within figure 4, although, not surprisingly, it is more expensive. Landform Panorama DTM is less precise not only because of the larger cell size, but also because the shape and detail of the 1:50,000 scale contours used as the source data are themselves more simplified than the 1:10,000 scale contours. If Landform Panorama DTM is used, it is important that the resolution at which it is provided is used and the grid is not down-sampled, as shown in figure 5.

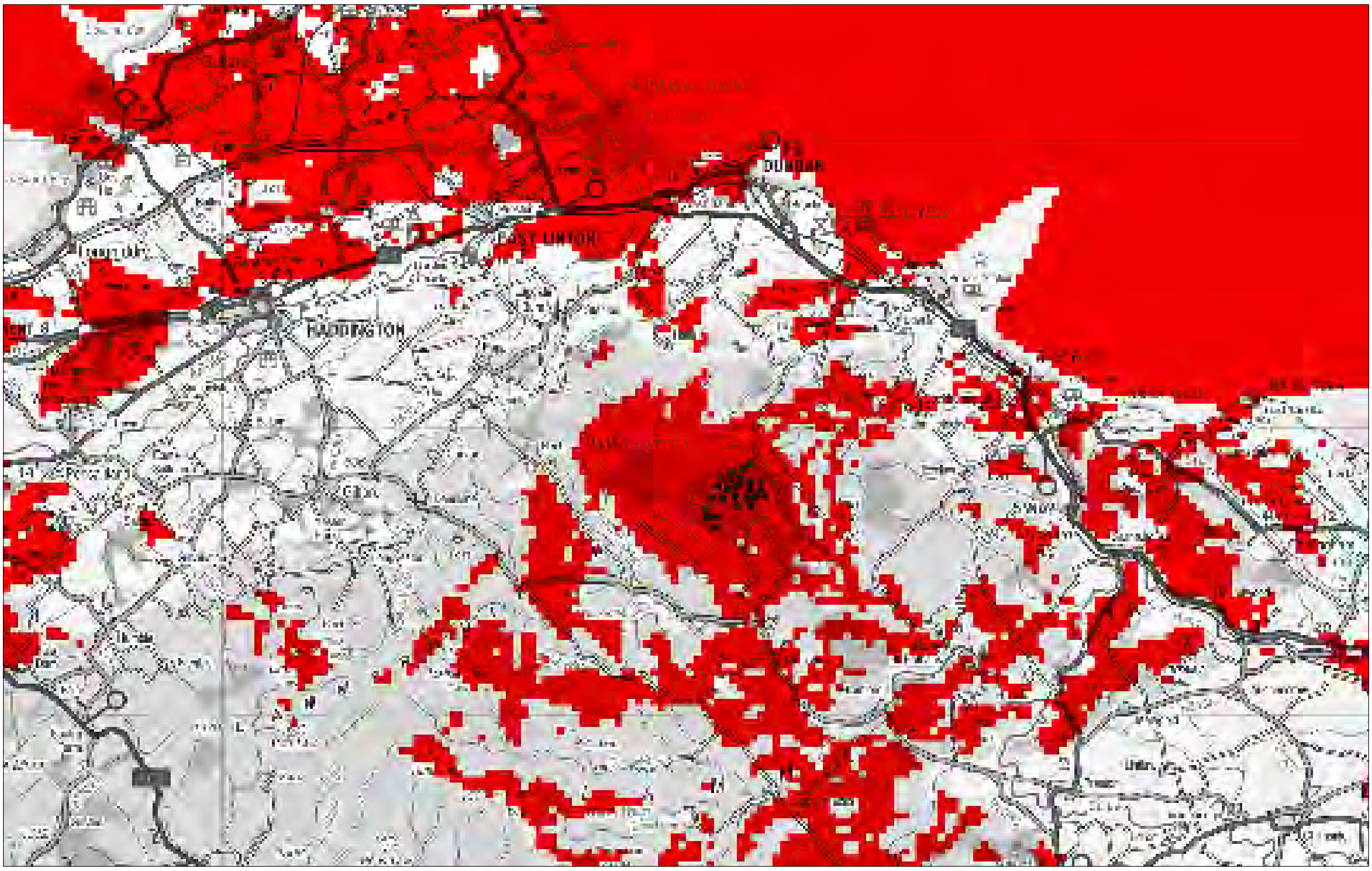
43 OS Landform Panorama DTM is considered an acceptable product, especially if the landform is simple. However the recommended preference is for OS Landform Profile, especially if the terrain is very rugged.

44 Although considered adequate for the purposes of VIA (given that ZTVs are just a tool for assessment), the accuracy of most DTMs is limited and they do not include accurate representation of minor topographic features or areas of recent topography change, such as open cast coalfields, spoil heaps and mineral workings. Known significant discrepancies between the DTM and the actual landform should be noted in the ES text. If survey information on recent topographic change is available, together with the necessary software to amend the DTM, it may be

Figure 5: Comparison of ZTV grid size



ZTV of windfarm based on OS Landform Panorama data at the supplied 50m grid size



ZTV of windfarm based on OS Landform Panorama data with the grid size downsampled to 250m. Some small areas of theoretical visibility are not shown at all, while others are over-represented. (Scale 1:250,000) useful to include it. However, any changes to the DTM should also be noted in the text.

45 The OS provides accuracy figures for each of its data products (expressed statistically as root-mean-square error in metres). Where the DTM is obtained from another source, the expected accuracy can also usually be obtained from the data supplier. These accuracy figures should be stated within the ES. However, non-experts may find it difficult to extrapolate from this a judgement of precision. Therefore it is preferable if these figures are accompanied within the ES by a general statement from the landscape architect or experienced specialist assessor that confirms that the levels of accuracy fall within acceptable limits.

46 An alternative to the OS DTM products is NextMap which offers a grid with a cell size of 5m. This is a Digital Surface Model (DSM) derived from airborne radar data. As its name implies, the grid is a model of the upper surface of the land, including vegetation, buildings and other ground cover. As such, it can provide a good basis for calculating visibility including the effects of such features. A parallel product is also available from the same source which is a DTM with a cell size of 5m or 10m. However, as this is derived from the DSM with ground heights estimated from the height to the top of ground cover, its accuracy is not entirely reliable, except in very open areas.

47 ZTV production also requires data on the locations and heights of the proposed wind turbines. For the purposes of ZTV calculation, it is sufficient to represent each proposed turbine as a single point in space, located directly above the centre of the proposed base of the turbine. The height specified is usually that at either hub/nacelle height or at a blade tip pointing straight up, but can be at any other point on the turbine depending on the ZTV analysis required.

48 It is recommended that separate ZTV calculations are run for the overall height (to blade tip) and for the

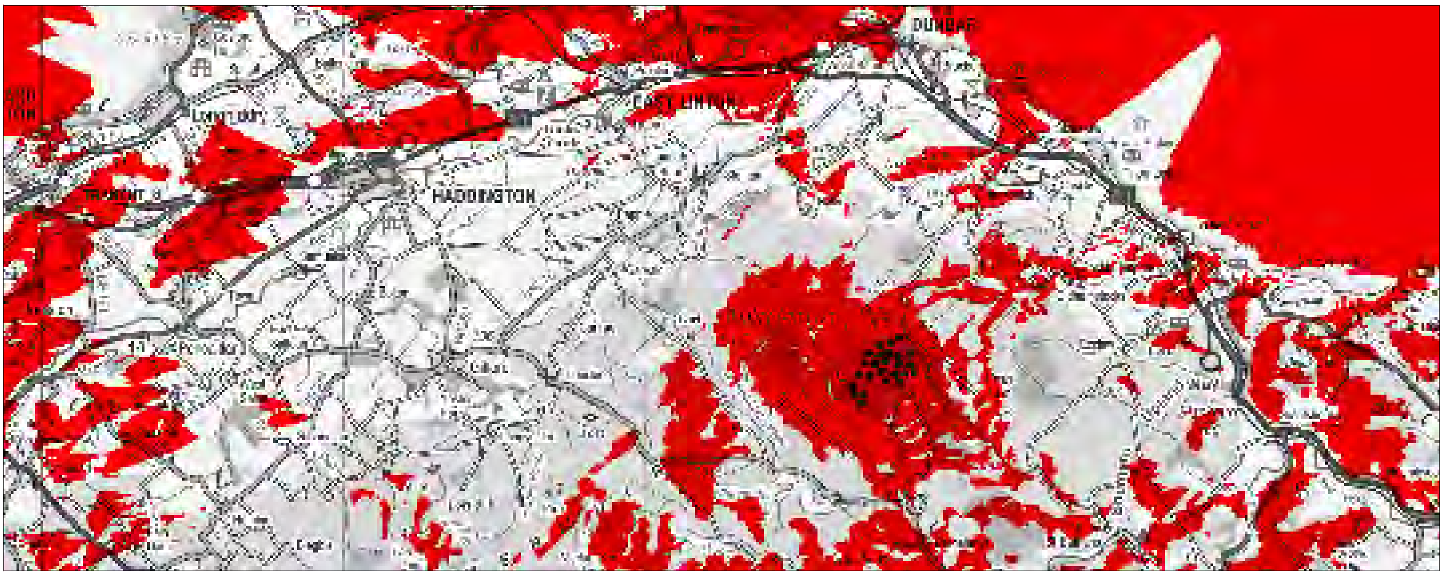
height of the turbine to its hub (representing the nacelle that houses the generator on top of the tower). This is a useful comparison that helps to identify areas where turbine blades may be visible, but not the tower or nacelle. For a single proposed turbine, it can also be useful to run ZTVs with other targets, such as 1m above the ground and at the base of the rotor sweep which, in combination, provide an indication of where almost all the turbine or just the rotor sweep may be visible.

ZTV calculation

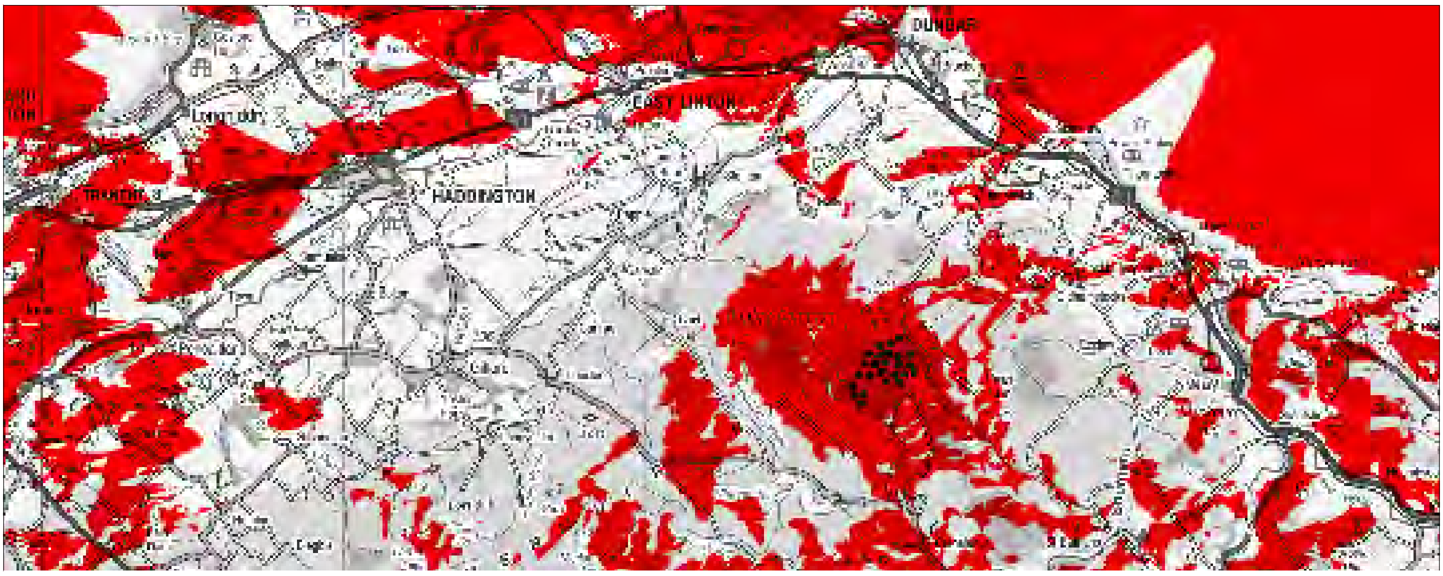
49 In principle, all ZTV software packages are similar, but variations in the detailed routines (algorithms) used for each mean that slight variation in results may be produced by different packages using the same data. Most differences stem from different choices in the shape of the ground surface that the software assumes to exist between the grid points in the DTM and tend to result in insignificant discrepancies. Some software packages offer both a standard and 'fast' option for ZTV calculation. 'Fast' implies the use of mathematically approximate methods in order to speed up the computation, which tends to result in greater errors. It is recommended that this is only used to obtain a quick, provisional result which will be later superseded by a more comprehensive calculation. It is also important, that users of ZTV software ensure that they are clear about the technical limitations inherent in their chosen package.

50 Visibility is affected by earth curvature and the refraction (bending) of light through the atmosphere, particularly at greater distances, as shown on figure 6. Therefore this effect should be included in the ZTV calculation as its absence will tend to overestimate visibility. Appendix F treats this issue in more detail and includes a table of the vertical difference introduced by earth curvature and refraction with distance. At 10km, the vertical difference is enough to

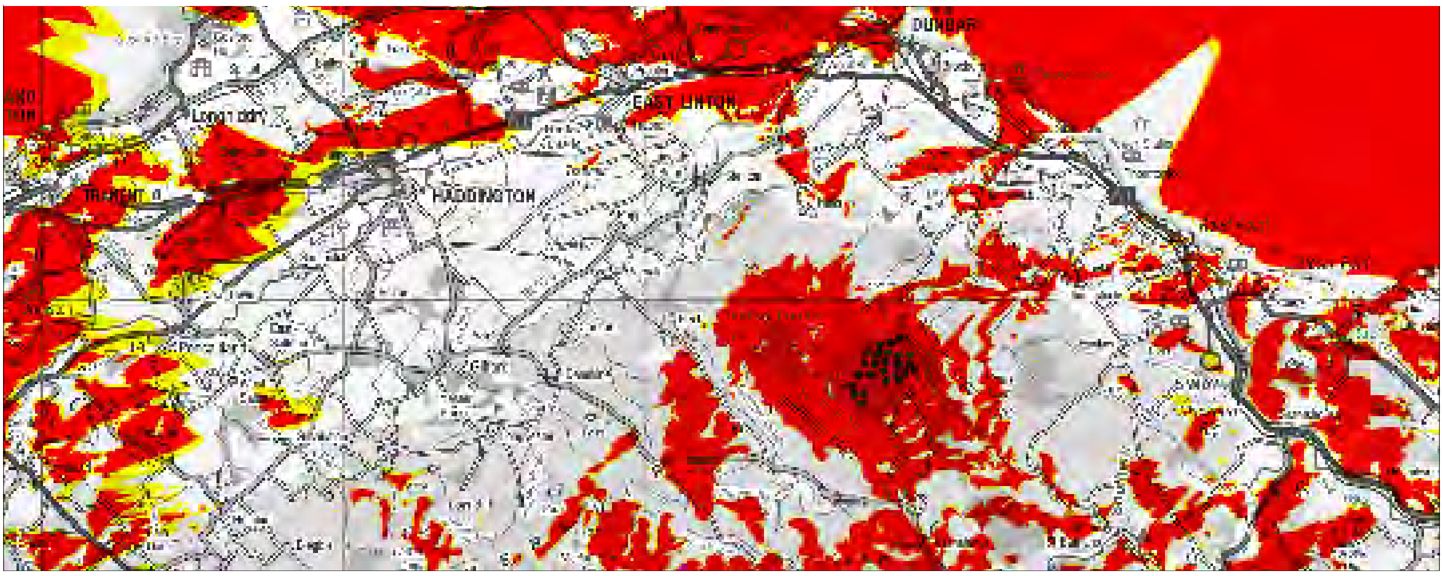
Figure 6: The effects of earth curvature upon a ZTV



a: ZTV of windfarm including effects of earth curvature and atmospheric refraction



b: ZTV of windfarm without earth curvature or refraction



c: Above images superimposed. The yellow areas indicate areas from which the windfarm would not be theoretically visible but which are shown as visible on the ZTV map without earth curvature or refraction. The areas principally affected are naturally those with more distant views. Depending on the shape of intervening topography, these areas can be quite large. (Scale 1:250,000) hide a single storey house and it increases more rapidly thereafter.

51 These limitations, inherent in the data and in the method of calculation should always be acknowledged and, if possible, quantified. Note that these limitations may either over or under-represent visibility. As a general rule, ZTVs should be generated to err on the side of caution, over-representing visibility. There are no defined thresholds for this allowance; rather, judgements will need to be made based on professional expertise in this field.

52 A ZTV usually represents visibility as if the ground surface was bare; that is, it takes no account of the screening effects of intervening elements such as trees, hedgerows or buildings, or small scale landform or ground surface features. The ZTV also does not take into account the effects of weather and atmospheric conditions in reducing visual range. In this way, the ZTV can be said to represent a 'worst case scenario'; that is, where the windfarm could potentially be seen given no intervening obstructions and favourable weather conditions (while accepting that the DTM data can sometimes understate visibility at the very local level). To understand how this might be affected by typical visibility conditions within a particular area, Met Office data on visibility conditions can be obtained.

53 Some software does allow the use of more sophisticated datasets, enabling some screening effects to be taken into account. Examples are the application of data which applies different 'thickness' to various land uses such as forestry and urban areas, and the use of digital surface data obtained from laser-based aerial surveys which represent the tops of vegetation and buildings. At present, for most projects, this data does not make a considerable difference to the pattern of visibility, while tending to be very expensive; therefore, its use should be limited to specific projects where the benefits will be notable.

Care needs to be taken when assessing this kind of information, as its accuracy is limited by data availability and the constant change in landscape conditions. The results will also be closely tied to the specifications used, for example the height of trees; as a consequence, these should be noted within the ES.

54 In some situations, it might be useful to map other characteristics such as the number of wind turbines seen against the skyline or what proportion of the horizontal field of view is likely to be occupied by the visible part of a windfarm, known as the 'horizontal array angle'. This information is particularly useful for considering the impact of a very large windfarm or several windfarms where they would be seen together within panoramic views. However, for most windfarms, the width of view can usually be more simply judged by considering the distance to the development in combination with wireline diagrams from specific viewpoints.

55 Any analyses that calculate characteristics other than simple visibility over base ground should be produced in addition to bare ground visibility, not as an alternative to it. Although these currently have various limitations as described above, improvement and development of this kind of data is likely to occur in the future.

Viewer height

56 As the ZTV calculates the number of wind turbines visible at each of a number of points just above the ground, a measure of viewing height is required. Often this is set at 1.5–2 metres. The rationale for this height is usually given as relating to viewer height and/or camera height to maximise correlation between the ZTV and visualisations. However, although viewer height is an important element of the ZTV calculation, the error inherent in the DTM is of about the same magnitude (1.5 metre RMS error for Landform Profile, 2.5 metre RMS error for Landform

Panorama). Consequently, it is recommended that the viewer height adopted should try to both avoid errors arising from DTM and inaccuracy close to a viewpoint, for example due to local undulations, as well as taking into account the typical height of a viewer. To satisfy these criteria, it is recommended that a standard viewing height of 2 metres is used.

Extent of ZTV

57 As previously discussed, a ZTV map illustrates locations within a study area from where a development is potentially visible. However, just because a development can be seen, it does not automatically follow that this will result in significant visual impacts. This creates a circular process of decision-making. That is: the distance of a ZTV should extend far enough to include all those areas within which significant visual impacts of a windfarm are likely to occur; yet the significance of these visual impacts will not actually be established until the VIA has been completed; and the VIA process needs to be informed by the ZTV. As part of this cycle of assessment, the recommendations given within Table 2 below act as a starting point. However, the actual extent required may need to be adjusted inwards or outwards according to the specific characteristics of a landscape and/or proposed development. It is advised that determination of the extent of the ZTV should be discussed and agreed with the determining authority and consultees.

Figure 7: Process of determining ZTV extent

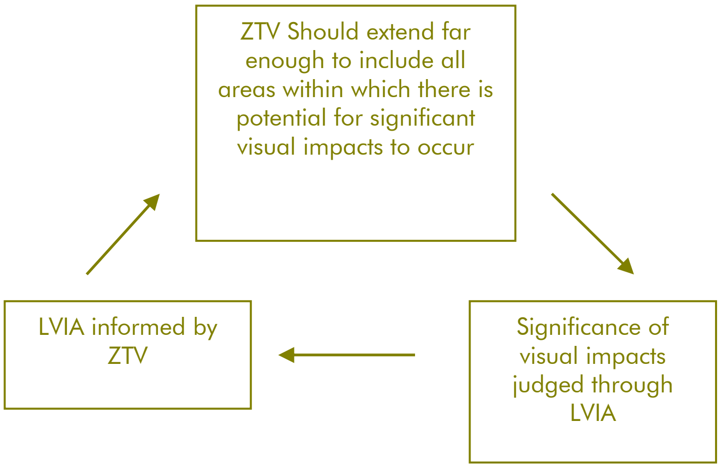


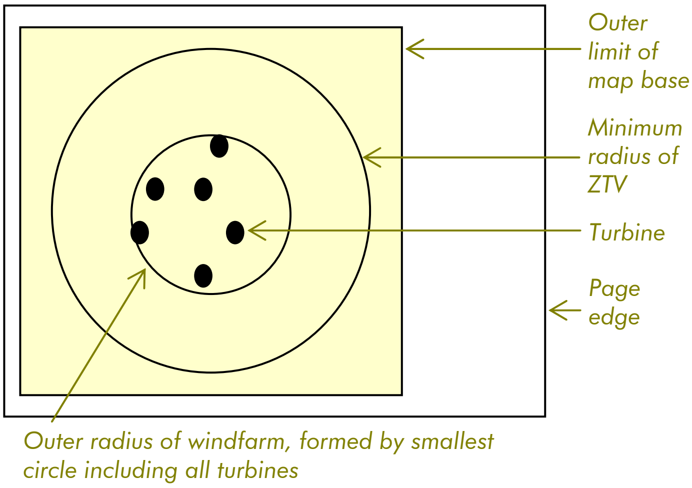
Table 2: recommended distance of ZTV

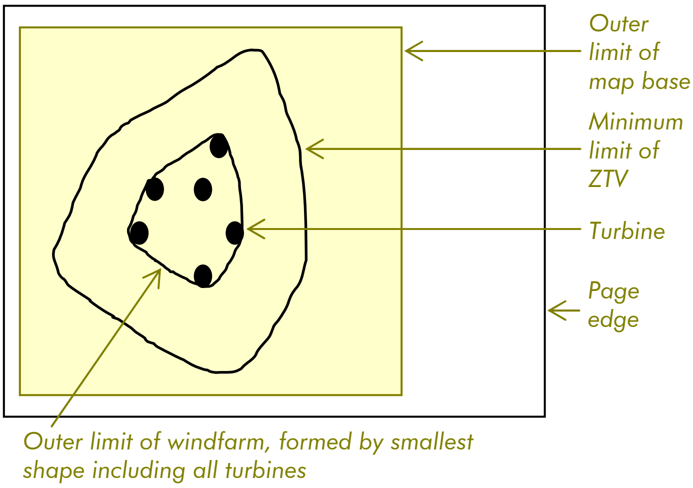
Height of turbines including rotors (m)	Recommended ZTV distance from nearest turbine or outer circle of windfarm (km)
up to 50	15
51-70	20
71-85	25
86-100	30
101-130*	35*

*These figures are based on recommendations within 'Visual Assessment of Windfarms: Best Practice' (University of Newcastle, 2002). * This category was recommended by the late John Benson, based on experience and extrapolation of evidence presented within the publication cited above.*

58 The extent of a ZTV is typically defined as a distance from the outer turbines of a windfarm. This can be to the nearest turbine or as incorporated within a specific shape, as shown below. The most suitable option will usually depend on the layout of the windfarm.

Figure 8a and 8b
Measuring the extent of a ZTV

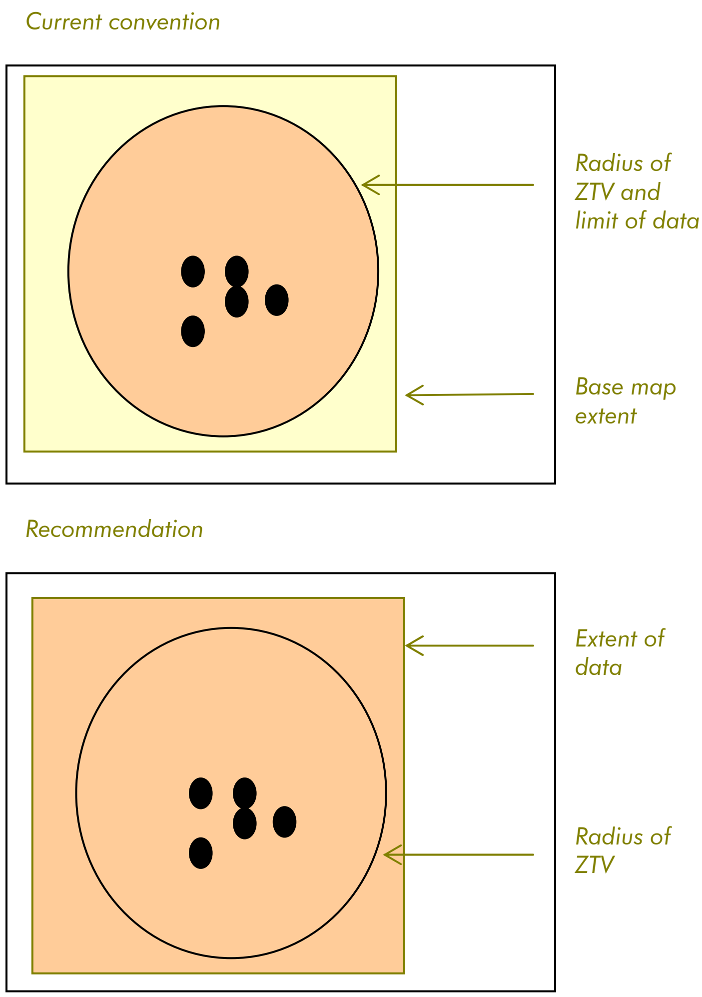




59 If a windfarm is very small and concentrated in layout, typically 5 wind turbines or less, it may be reasonable to measure the extent of the ZTV from the centre of the site. However this should always be agreed with the determining authority and consultees.

60 ZTV information is often shown as stopping at the outer radius of the ZTV and not the edge of the map base, unlike other information usually presented within a LVIA such as landscape character and landscape designations. This cut-off can appear slightly irrational upon a rectangular base map, seeming to imply that visibility ceases at a defined distance (although it is acknowledged that, when considering cumulative visibility from multiple developments, limiting data to this boundary may improve clarity of the separate ZTVs). Consequently, it is recommended that a ZTV overlay for an individual windfarm should extend to the border of the map that includes the recommended ZTV distance.

Figure 9a and 9b
Presentation of ZTV information



61 Table 2 provides recommended distances for ZTV data. These are based on turbine height. However this is just one factor which affects potential visibility and, as discussed previously, the ZTV distance may need to be adjusted up or down depending on the specific environmental conditions and landscape context in addition to the nature and scale of the proposed development.

62 The recommendations within Table 2 are based upon the total height of a turbine to blade tip. However it is important to understand that visibility of turbine blades and turbine towers differs. At close distances, turbine blades often seem more noticeable than the towers due to their movement; while at far distances, the turbine towers are usually more prominent because of their greater mass, and may actually be the only element visible at very great distances. This creates a slightly odd situation; that is, the categorisation of visibility to blade tip at far distances, while turbine blades might not actually be visible at these distances. However, the reality is that the categories of turbine height used in Table 2 act only as a 'yard stick', and similarly defined categories based on tower or hub height would likely provide the same recommendations. The only notable discrepancy might be if a wind turbine was unusual in its proportions, for example having a high hub with a smaller than usual rotor diameter. However the difference of visibility that would occur in these circumstances at far distances is unlikely to be significant; and, even if it were predicted as being significant, the difference could be accommodated by adjusting the ZTV as discussed in paragraph 61above, as part of the usual process of confirming ZTV extent for a specific scheme.

63 For turbines between 53 and 85 metres total height, the University of Newcastle (2002) reported that it was not possible to identify the taper of a turbine tower or identify nacelle detail at distances over 10km. They

also reported that blade movement could be detected up to15km in clear conditions, or where there was a strong contrast between the rotors and the sky, but that a casual observer may find blade movement unnoticeable beyond 10km. These observations highlight that visibility of the different aspects of wind turbines will vary. However most new wind turbines are of heights much greater than those on which these observations are based and, unfortunately, it was not within the scope of this study to carry out site assessment of more recently built, taller wind turbines on which additional guidance could be based.

64 Some practitioners have suggested that, as it usually becomes difficult to see turbines clearly when over 30km away, extending a study area further than this is unlikely to ever be necessary. Although there is obviously some validity to this argument, it is nevertheless the case that some exceptional visibility conditions occur at times in Scotland. Combined with the fact that some key vantage points in Scotland, such as the tops of mountains or hills, are of very high sensitivity in terms of scenic value, some windfarms could clearly be seen at certain times from very sensitive locations at great distances away. This means it is feasible that, in exceptional circumstances, visibility of a windfarm or windfarms could result in significant effects beyond 30km. This highlights the importance of determining ZTV extent in agreement with the determining authority and consultees for a specific project.

65 It has been suggested that the ZTV radius should also depend on the number of wind turbines in a development. In purely technical terms, visibility extent is not actually dependent on the number of turbines, as a single 100m turbine would technically be as visible as 100 x 100m turbines from a set distance. However a larger windfarm would obviously be more noticeable, particularly as the eye tends to be attracted to groups or patterns when it might otherwise miss a

single element. So although the guidance included in Table 2 above would be applicable for most windfarms and should be used as the 'starting point' for ZTV production, it may be acceptable to adopt a reduced study area for a smaller development and it may be advisable to explore a wider area for a larger windfarm.   This should be agreed in consultation with the determining authority and consultees.

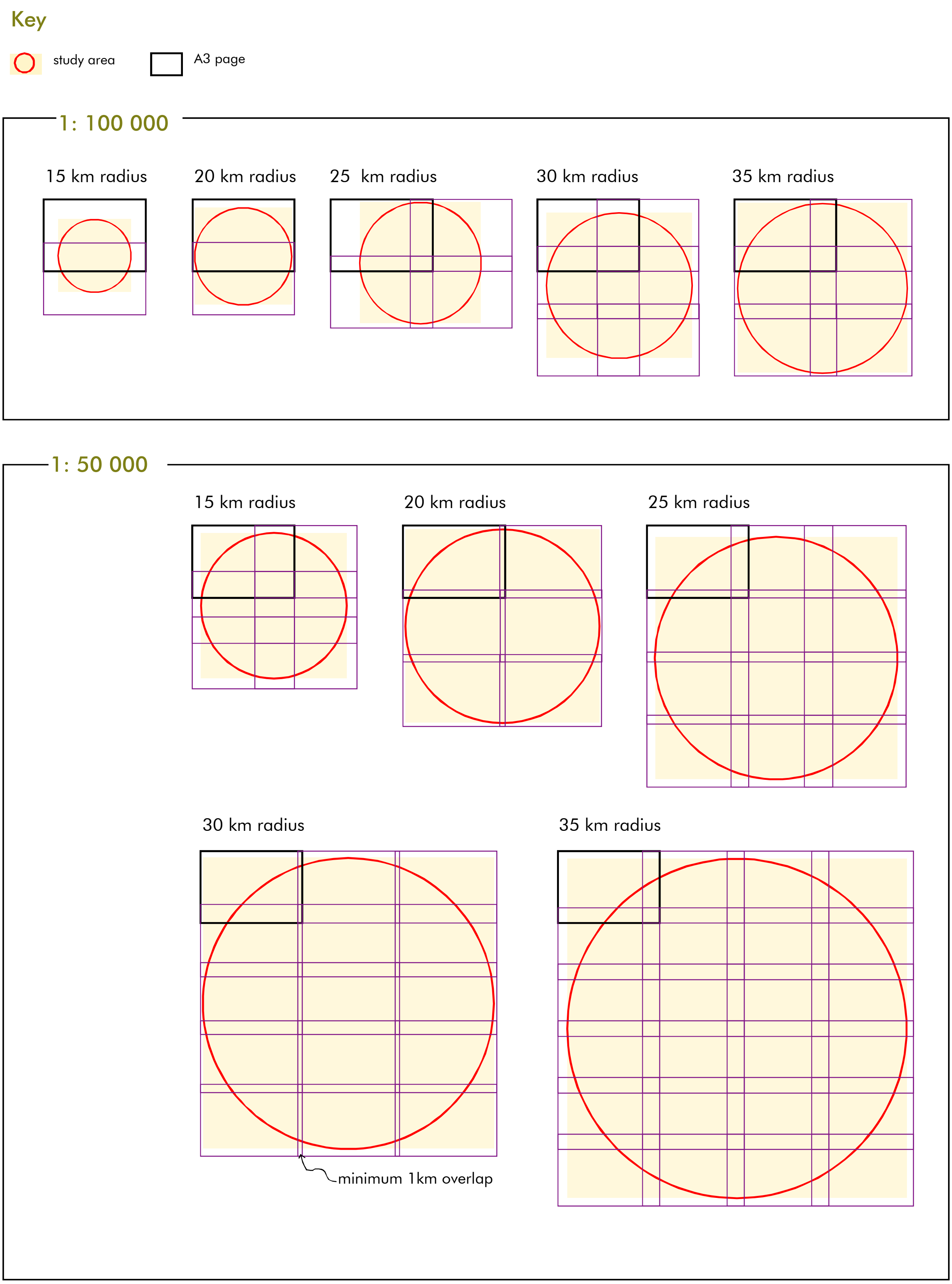
Presentation of ZTV information

Base map

66 A ZTV should be superimposed on a clearly legible base map at a recognised standard scale, such as the Ordnance Survey (OS) 1:50,000. For an ES in A3 format (420 x 297mm), showing a ZTV extending from a site up to a 30km radius, a scale of 1:250,000 will be required to fit a single page. At this scale, the ZTV can only provide an overview and thus another more detailed ZTV is required for use as a working tool for VIA, consultation and design. This should be provided on a 1:50,000 OS base (copied at either 1:50,000 or 1:100,000) to be able to illustrate sufficient detail, as shown in figure 10a and b. However a ZTV at this scale obviously results in a much larger map as detailed within Table 3. Conventionally, this is presented as either a single fold-out plan or as separate A3 sections (with minimum 1km overlaps).

67 Single maps are usually clearer as they show the whole study area on one sheet, but they may be more difficult to handle and require folding and insertion within a wallet in the ES. Separate A3 maps will divide the study area, and possibly the site, into sections, so a supplementary and overlapping site-centred map may also be required. Although, a high number of sheets may be required to cover an entire study area in this way, as shown in figure 11, not all of the study area may require detailed coverage if the ZTV overview identifies that large areas within the study area would

Figure 11: Overlap of A3 sheets to illustrate ZTV coverage



have no visibility of the proposed development at all. Conversely, for particularly sensitive areas, it may be useful to produce large-scale enlargements (representing the information used by the assessor when zooming in on the ZTV on a computer screen) in order to examine small areas of theoretical visibility.

Table 3: Size of ZTV at various scales and to fit standard paper sizes

ZTV extent (from single point)	Size of single map				Number of A3 separate sheets*	
	1:100,000		1:50,000		1:100,000	1:50,000
	Image size	Paper size	Image size	Paper size		
15km	300x300	A2	600x600	A0	2	6
20km	400x400	A2	800x800	A0	2	6
25km	500x500	A2	1000x1000	-	4	12
30km	600x600	A0	1200x1200	-	6	15
35km	700x700	A0	1400x1400	-	6	24

68 For a ZTV to be clear and legible when overlain with colour shading, the base map needs to be in greyscale. This is to prevent confusion of overlays, for example a yellow overlay upon blue coloured lochs will appear as green, and this could be confused with woodland (figure 12). To maximise legibility, it is also important that the base map is of a high quality resolution and not too light or dark.

69 Each individual wind turbine should be clearly marked upon the ZTV, usually shown as a small circle or 'dot', depending on the base map against which it has to be distinguished. Although it is recommended that the ES includes a map that shows individual turbine numbers and their grid coordinates, and that the ZTV should include reference to this map, it is best not to include this information on the ZTV itself in order to keep this map as clear as possible.

70 It is recommended that viewpoint locations (numbered) also be shown on the ZTV, although it is important to

label these carefully to avoid obscuring vital ZTV information. This requirement is discussed further in paragraph 114.

71 For ease of legibility it is recommended that the ZTV show concentric rings to indicate different distances from the proposed development, for example 10, 20 and 30 km. However, the areas encircled by these rings should not be shaded or coloured as this may imply a direct relationship between distance and relative visibility or visual impact that would be misleading. To maintain legibility, the number of rings should also be limited.

72 Where ZTVs need to show potential visibility of different components of the wind turbines, this should be clearly explained as follows:

- a ZTV 'to blade tip' shows potential visibility of any part of a wind turbine up to its highest point (but not all of the wind turbine would necessarily be seen);
- a ZTV 'to hub' or 'to nacelle' shows potential visibility of any part of a wind turbine up to the height of its hub or nacelle (but not all of the wind turbine tower would necessarily be seen); and
- Comparison between ZTVs to blade tip and nacelle/hub allows identification of those areas from which the turbine towers might not be visible, but the blades (or part of these) would.

Colour Overlays.

73 Areas of potential visibility should be illustrated by a colour overlay. This should be slightly transparent so that the detail of the underlying map can be seen. Transparency within most software is expressed as a percentage – the amount of colour dots to clear space per unit area. The level of overlay transparency chosen should ensure that the detail upon the base map remains clearly discernible and no single colour appears more prominent than another.

74 If a range of colours is to be used, the shades and tones should be chosen carefully. Darker colours tend to read as portraying greater visibility than lighter colours whilst several colours of similar tone tend to convey information of equal importance. Using different shades of only one colour should generally be avoided as the distinctions between bandings usually appear merged and this can also imply a gradation of impacts represented by the decreasing shades that is misleading (figure 13a).

75 Legibility of a ZTV map tends to decrease with greater numbers of colours. For this reason, 7 colours should typically be the maximum used on any one map. It is recommended that these are bright and strongly contrasting as is illustrated within the scheme shown in figure 13b.

76 When selecting the colour palette to be used on a ZTV, it is important to consider how the colours would be seen by different viewers. One of the most important considerations is how the same colour will be represented differently according to the specification of different computer screens and/or printers. It is recommended that practitioners always print out draft copies to check that any discrepancy between these still produces a clearly legible map, and then print out the final copies on the same printer.

77 When choosing a colour palette, it is also important to consider colour blindness. It is estimated that around 7-8% of males and 0.4-1% of females in Britain have some form of colour blindness. To them, legibility of maps depends on the type of colour blindness they have, the shade and brightness of the colour, and on the contrast and combinations of colours used. This requires careful consideration and is not just a simple issue of avoiding the juxtaposition of red and green.

78 While it would be useful to specify a standard range of colours consistently legible to colour blind people, it is impossible to develop this without also standardising

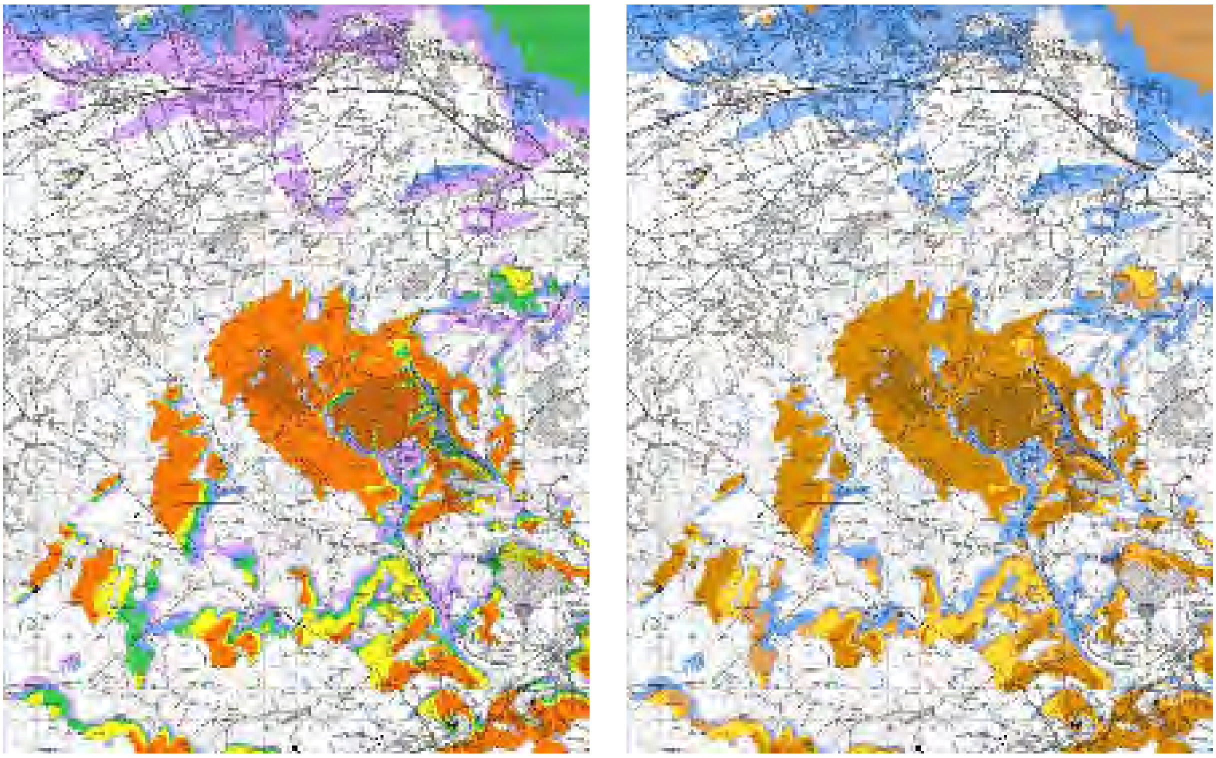
Figure 14: Colour blindness

There are various web-based tools which help map makers to devise a palette of colours which are readable for the majority of the population and have colour charts which compare normal vision with various types of colour blindness.

ZTV maps should be checked for colour blindness legibility for instance by running them through a web based tool like Vischeck (www.vischeck.com) This allows any image to be shown as it would appear for people with the three main types of colour blindness. It can be downloaded or used online.

computer screens and colour printer reproduction. Thus, as an alternative, it is recommended that individual maps shown within each ES are checked for colour blind legibility using a quick clarification tool, for example as described within figure 14.

Figure 15: The effect of colour choice on ZTV clarity for colour blind people



The map on the left shows a possible colouring of a ZTV in five bands. The version on the right has been processed to simulate the effect of red/green colour blindness on these colours. (Carried out using the Photoshop filter distributed by Vischeck.com.) The blue and violet bands are difficult to distinguish, as are the orange and green bands. This map would not be easily readable by a person with red/green colour blindness.

Visibility bands

79 The theoretical visibility of different numbers of wind turbines (within a single development, or different windfarms within a cumulative ZTV) is usually distinguished upon a ZTV as different coloured bands. It is important to highlight that these bands differentiate between the visibility of different numbers of wind turbines as a tool for assessment. They are in no way intended to imply that greater numbers of turbines will necessarily result in higher levels of visual impact. These bands are particularly useful for

identifying potential viewpoints where the visibility of the windfarm varies considerably within an area.

80 The number of visibility bands should be high enough for each band to represent just a small range of turbine numbers, whilst low enough to avoid the need for too many colours which can appear confusing. For example, with 30 turbines, it is better to have 6 bands each covering 5 turbines (1-5, 6-10, etc) rather than 3 bands of 10 turbines which would provide limited resolution, or 10 bands of 3 turbines which would appear confusing. As mentioned in paragraph 75, it is recommended that no more than 7 colour bands should be used upon a ZTV.

81 Where equal banding is impossible (for example 11 turbines), then the widest band size chosen should apply to the lower end of the scale – for example 1-3, 4-5, 6-7, 8-9, 10-11, as greatest resolution is then retained where visibility is furthest.

82 For a small windfarm, an alternative to different coloured bands representing the visibility of turbine numbers, is to produce numerous ZTVs that each represent visibility of an individual turbine or individual group of wind turbines. This is a very useful tool for designing turbine position where a variable landform strongly affects visibility. The downside is the need to overlay or compare numerous ZTV maps. For anyone with access to a software package such as Photoshop, a high number of ZTVs can be better managed as transparent layers upon the same base. The various layers, representing visibility of different wind turbines or groups, can then be turned on and off to illustrate various visibility scenarios. However, production of maps in this format will inevitably need to occur only as a supplement to paper copies within an ES to ensure accessibility of this information for all.

Recording ZTV information

83 It is vital within an ES to include information on all the key assumptions made in ZTV production, and to summarise these within the VIA. This should include the following information:

	Table 4: Information on ZTV production to be provided
1	The DTM data from which the ZTV has been calculated, including original cell size and whether this has been sampled down.
2	Confirmation that it is based on a bare ground survey, or provision of information on the specifications of additional land use data if this has been incorporated.
3	The viewer height used for the ZTV.
4	Confirmation that earth curvature and light refraction has been included.
5	The extent of the ZTV overlay as a minimum distance from the development, in addition to the frequency of any distance rings shown.
6	The numbers of wind turbines represented for each colour band.
7	The 'target height' used for the turbine and whether this is to hub or blade tip.
8	Confirmation that the ZTV software does not use mathematically approximate methods (see para 49).

ZTV development for a project

84 ZTV maps are very useful as a tool for comparing alternative turbine layouts, turbine numbers and turbine heights as a scheme develops. This also means that it is important to consider how they will be used throughout the entire VIA and EIA process, as well as how they are presented in the ES. This is because, as the design of a windfarm develops, the ZTV specification may need to change. For example, it may seem sensible to have 6 separate bands of 11 turbines for a 66 turbine windfarm and 6 separate bands of 9 turbines for a 54 turbine windfarm. But if a particular windfarm is reduced in size from 66 to 54 wind turbines it is important to keep the original bands

(that is 1-11, 12-22, 23-33, 34-44, 45-55, 56-66) even though there would not be any visibility shown for the highest band. Otherwise, it is impossible to directly compare the relative visibility of the original proposal and the revised windfarm. Sometimes there may be reasons why this practice is difficult, for example if amendment to a scheme would result in either too few or too many bands. In these situations, a judgement needs to be made regarding the most appropriate banding. If this involves amendment of the original range, it is useful to include an additional ZTV showing this range within the ES appendices.

85 Similarly, if an extension to an existing windfarm is proposed, it is recommended that the original range of bands is retained and supplemented by additional bands of the same interval to represent the additional turbines. For example, if the original ZTV bands were for 1-5, 6-10, 11-15 and 16-20 turbines, the proposed extension should have a ZTV that shows additional bands 21-25 and 26-30 turbines etc.

ZTV production

86 Where a ZTV map forms part of an ES, it should be accessible by all members of the public and thus should be produced on paper. However, as discussed in paragraph 82, in some cases it will be useful for the developer to provide the determining authority and consultees with a digital version in addition to the paper map. This also allows them to enlarge the ZTV on screen or focus in on particular areas of concern, making for a more flexible product. Production of this additional information will require agreement by the developer.

87 It has been suggested that ZTV information could also be made publicly accessible on developers' websites. However there are issues of map licensing and file sizes that are difficult to overcome, in addition to the difficulty in ensuring high quality resolution on a website, and the alternatives such as multiscale

mapping (for example streetmap.co.uk and getamap.co.uk) require very specialised (and expensive) hosting arrangements. A potential disadvantage of this to the developer is also that they have reduced control over the use and quality of any printed outputs.

Table 5: GOOD PRACTICE GUIDANCE SUMMARY

ZONE OF THEORETICAL VISIBILITY			
	Paragraphs in report	Minimum requirements	Preferred requirements
ZTV data	41-45	OS 50m Panorama data if simple landform, OS 10m Profile data if rugged terrain.	OS 10m Profile data.
	44-45	Describe inherent limitations of data and methods of calculation.	
	52-53	Use bare ground data.	In specific circumstances, datasets may be useful where there are likely to be significant screening effects, for example by vegetation or buildings, produced in addition to the bare ground ZTV; Obtain data on visibility conditions in the area to help interpretation of visibility data.
	48 54-55 72	ZTVs should be produced for both total height of turbines to blade tip and hub/nacelle height.	In specific sensitive situations, ZTV should also show proportion of turbines visible and/or numbers upon the skyline.
	50	Earth curvature should be included in ZTV calculation.	
	50	The refraction of light should be included in ZTV calculation.	
	56	ZTV based on viewer height of 1.5 – 2.0m.	Viewer height of 2.0m
	57 61-65 71	ZTV extent to comply with Table 2 subject to consultation and agreement with determining authority and consultees.	Aid legibility by showing concentric circles upon ZTV map at defined distances such as 10, 20 and 30km, whilst avoiding confusion of lines.
	58	Distances on which the ZTV is based should be measured from the nearest turbine or the smallest circle containing all the turbines of the site unless otherwise agreed with the determining authority and consultees.	
	59	For developments of 5 turbines or less, the ZTV can be calculated from the centre of the site.	
	60	ZTV overlay should extend to the edge of the map base containing the study area.	

Presentation of ZTV	82,86	Present ZTV maps in paper form.	Production of ZTV maps in paper and digital form, with varying visibility bands distinguished as separate layers upon a base map that can be interrogated using imaging editing software or GIS.
	66	Overview ZTV map at 1:250,000 based on 1:250,000 OS map	
	66-67	Detailed ZTV map(s) at 1:100,000, based on a 1:50,000 OS map. Where these are provided as separate sheets there should be an overlap of at least 1km between neighbouring maps (numbered and keyed). There may also need to be an overlapping site-centred map.	Detailed ZTV map(s) at 1:50,000, based on a 1:50,000 OS map. Detailed ZTV mapping covering specific areas at a more detailed scale where there are particularly sensitive visibility issues.
	68	The base map should be very clear and printed in 'greyscale'.	
	69	Each individual turbine should be clearly marked upon the ZTV. Reference should be made to a plan contained within the ES which shows the individual turbine numbers and grid coordinates.	
	73	Colour overlays upon the ZTV map representing visibility should be partially transparent and allow clear visibility to the underlying base map.	
	75	For legibility, a maximum of 7 colours/ shades should be shown overlaid upon a ZTV map.	
	74-76	Colours for overlays should be bright and strongly contrasting. Their choice should take into account typical variation in computer screen and printer reproduction, and consider legibility for colour blind persons.	
	75 79-82	If visibility bands are used, there should be a maximum of 7 bands and, if equal banding is not possible, the widest range should apply to the lower end of the scale.	If varying visibility is distinguished, it is useful to also produce this information digitally, arranged as separate layers upon a base map in imaging editing software or GIS.
	83	Information on the data and assumptions that have been used during the ZTV production as in Table 4. This information should be included within the VIA (or referenced appendices).	
	84-85	Maintain the format of the ZTV map throughout the VIA process if possible, so that comparisons can be made as the scheme develops.	Include ZTVs representing design development within appendices of VIA.
	69	The location of viewpoints (numbered) should be shown on the ZTV.	

3 Viewpoints

88 The term viewpoint is used within Visual Impact Assessment (VIA) to define a place from where a view is gained and represents specific conditions or viewers (visual receptors). During the VIA process for a proposed windfarm, a number of viewpoints are chosen in order to assess:

- the existing visual resource;
- the sensitivity of this resource to windfarm development;
- the proposed design (incorporating mitigation measures to minimise any adverse impacts); and
- the predicted appearance of the final proposed development.

This section of the Good Practice Guidance will address the selection of viewpoints and the information that should be provided for them.

89 It is important to stress that viewpoint assessment forms just one part of VIA. Because of the 'powerful' nature of viewpoint images and the widespread recognition of some of the locations from where these are taken, there is often over-emphasis of their role. But VIA also includes assessment of the following:

- the extent and pattern of visibility throughout the study area (thus considering those areas from where a windfarm will not be seen, as well as those areas from where it may);
- views of the proposed windfarm from areas of potential visibility other than the selected viewpoints; and
- sequential views.

90 The viewpoints used for VIA must be carefully selected to be representative of the range of views and viewer types that will experience the proposed development. They should also form part of the "description of aspects of the environment likely to be significantly

affected by the development" (PAN58 , paragraph 65).

91 In addition to representative viewpoints, specific viewpoints may also be chosen for their importance as key viewpoints within the landscape. Examples are local visitor attractions, settlements, routes valued for their scenic amenity, or places with cultural landscape associations. These will be supplementary to the range of representative viewpoints and will usually be identified through consultation with the planning authority and SNH, although they may be confirmed also by local people and special interest groups at public meetings and/or exhibitions.

92 The following issues regarding viewpoints are considered within this section of the Good Practice Guidance:

Selection of viewpoints	• Number of viewpoints • Viewpoint siting

Use of viewpoints

Recording viewpoint information

Good Practice Guidance summary

Table 6: Uses and limitations of viewpoints
(numbers in brackets refer to paragraphs in text)

USES OF VIEWPOINTS	LIMITATIONS
• Carefully chosen viewpoints enable representation of a diverse number of views within a study area. • Carefully chosen viewpoints enable representation of a diverse number of viewers who experience the landscape in different ways (90,98, Table 7). • Viewpoints enable consultees to assess specific views from important viewpoints for example tourist attractions, mountain tops and settlements (91, 101). • By considering a range of views at different viewpoints, the designer can consider how the windfarm image varies in appearance, informing design development (100). • Views from numerous viewpoints can be assessed to determine sequential effects that occur as one moves through the landscape. • By assessing viewpoints in combination with ZTV maps, it is possible to consider the potential pattern of visibility for a windfarm in 3 dimensions.	• Whilst the choice of viewpoints is very important, it must be remembered that VIA should also be based on other aspects. An over-heavy emphasis on viewpoint selection and assessment may create the erroneous assumption that this is the only aspect of VIA (89). • There may be a tendency to focus on the particular characteristics of specific viewpoints, rather than considering these as being just broadly representative of a wider area. Consequently, it is usually inappropriate to make design modifications to change the visual effects of the proposed windfarm from a single viewpoint. This is because this may have negative 'knock-on' effects a small distance away or from other viewpoints. Rather, a more holistic approach should be adopted that considers the overall windfarm image from separate viewpoints in relation to the design objectives. • A point, and thus viewpoint, is by its very nature static whilst views tend to be experienced on the move as well as when stationary. • Some viewpoints may be difficult to access and require lengthy walks to reach them. As a result, some people might not be able to assess the viewpoint on site. They will therefore need to rely on the landscape architect or experienced specialist assessor's assessment and visualisations to indicate predicted visual effects. • On account of the limitations of DTM data, several provisionally identified viewpoints may need to be visited before finding a location that is suitable to be a VIA viewpoint. • Information on the exact location and conditions of individual viewpoints is required to be able to create accurate visualisations (111-112). • Some requested viewpoints might be judged inappropriate due to unacceptable health and safety risks (99).

Selection of viewpoints

93 Viewpoints are initially selected as being those places from where a proposed development is likely to be visible and would result in significant effects on the view and the people who see it (receptors). This is informed by the ZTV and other maps, fieldwork observations, and information on other relevant issues such as access, landscape character and popular vantage points. This data enables a provisional list of viewpoints to be developed that can be later refined through further assessment, consideration of provisional wireline diagrams and discussions with the determining authority and consultees such as SNH. Interested members of the public may also advise on sensitive local vantage points at public meetings and/ or exhibitions held by the applicant.

94 It is important to stress that, even though a ZTV is very useful in focusing upon those areas with potential visibility of a proposed development, the ZTV is only one source of information used to inform the selection of viewpoints. Over-reliance on a ZTV to highlight viewpoints can result in over-concentration on open locations with the greatest visibility of a site, often far from the proposed development. This may be at the expense of potential viewpoints where visibility is less extensive, but from where views of the site are more typical.

95 Nevertheless, during early consultations regarding the provisional list of viewpoints, it is useful if the determining authority and consultees are provided with a copy of the ZTV. In certain circumstances, a selection of provisional wireline diagrams may also be helpful to give an impression of possible impacts from viewpoints. It is important to highlight, however, that the LVIA information that will accompany the visualisations within the final ES, and thus inform their interpretation, will not usually be available at this early

stage. Consequently, a degree of caution should be exercised when circulating wirelines during this period.

96 During the initial stages of VIA, viewpoint wirelines are used to inform the design development of the proposed windfarm. Some of these viewpoints will be described and assessed within the main ES report; however others may ultimately be omitted, for example because they show very similar results to another viewpoint. Nevertheless, details regarding these original viewpoints should be included within the ES appendices if they have informed the design process. Likewise, during the VIA process, it may be found that some of the originally identified viewpoints will not actually have a view of the windfarm due to local screening or changes to the windfarm design. These should also be documented within the ES.

97 The issues discussed above regarding the selection of viewpoints highlight that a flexible approach needs to be adopted. This also reflects the iterative nature of VIA and the way in which parties will gradually become more familiar with a site and proposed development. Consequently, the developer must be aware that additional or alternative viewpoints may need to be considered throughout the VIA process if more information is required by either the landscape architect or experienced specialist assessor, or the determining authority and consultees.

98 The range of issues that influence the selection of viewpoints is listed in Table 7 below. The aim is to choose a representative range of viewpoints from where there is likely to be significant effects.

Table 7: Views and viewers to be represented through choice of viewpoints	
View type	• **Various landscape character types** (separate and combinations of type) • **Areas of high landscape or scenic value** - both designated and non designated, for example National Scenic Areas, Areas of Great Landscape Value, Gardens and Designed Landscapes, Search Areas for Wild Land, tourist routes, local amenity spaces • **Visual composition**, for example focused or panoramic views, simple or complex landscape pattern • **Various distances** from the proposed development • **Various aspects** (views to the north will result in a very different effect to those facing south) • **Various elevations** • **Various extent of windfarm visible**, including places where all the wind turbines will be visible as well as places where partial views of turbines occur • **Sequential** along specific routes
Viewer type	• **Various activities,** for example those at home, work, travelling in various modes or carrying out recreation • **Various mode of movement,** for example those moving through the landscape or stationary

99 The assessment of viewpoints should not involve unacceptable risks to health and safety – either to the LVIA assessor or to others who may wish to later analyse the viewpoint assessment on site, such as staff from the determining authority and consultees, or the general public. Examples of these situations could include viewpoints from motorways, railway lines, scree slopes or cliffs.

100 Viewpoints within the local area immediately surrounding the windfarm are particularly useful to understand and develop the windfarm layout and design.

101 In addition to representative viewpoints, specific viewpoints may also be important as key viewpoints

within the landscape, for example local visitor attractions, scenic routes, or places with cultural landscape value.

102 In identifying viewpoints, it is important to consider whether a cumulative Landscape and Visual Impact Assessment (CLVIA) is also required as part of the ES. If it is, the choice of all viewpoints should be informed by the cumulative ZTV as well as the individual ZTV. Although it is possible to add supplementary viewpoints as part of a cumulative VIA, it is preferable to use the same viewpoints for both the individual and cumulative VIA to enable direct comparisons to be made. Likewise, it is also useful to choose viewpoints already used for other windfarm LVIAs in the surrounding area. The use of these may allow direct comparisons and also assist the determining authority, consultees and the general public who are already familiar with these viewpoints. It is hoped that further guidance on CLVIA may be provided in the future.

103 As the VIA progresses, it is useful to consider how the appearance of the windfarm from the separate viewpoints would be best illustrated within the ES. Further information on the choice of visualisations is included within the section of chapter 4 on 'Presentation of Visualisations', paragraphs 242 to 265.

104 The reasons for selection or omission of viewpoints recommended by consultees, should be clearly justified and documented within the ES.

Number of viewpoints

105 The number of viewpoints for separate projects will vary greatly depending on how many are required to represent likely significant effects from the range of views and viewers of a development as listed in Table 7. As mentioned previously, the initial list of provisional viewpoints, will be high. This is necessary to enable identification of the required viewpoints

during the early stages of the VIA, and to ensure no key viewpoints have been omitted. This process will involve the production of numerous wirelines too, as one will need to be produced for each viewpoint and for every layout and design option.

106 After reducing the number of viewpoints down to only those that are required to represent potential significant effects on views and viewers, it is common for there to be around 10- 25 viewpoints within a VIA in Scotland. However, this number will vary depending on the specific circumstances of a proposal. It is important to highlight that over-provision of viewpoints can be as unhelpful as under-provision. This is because an excessive number of viewpoints, for example including those that do not have significant impacts, may distract attention from the smaller number of viewpoints where impacts are significant. Additionally, a high number of viewpoints will also require more time to be assessed by the determining authority and consultees and result in a more expensive ES (in time, computing effort and graphic production) – both for the developer and people that wish to purchase the report. As a consequence, an appropriate balance must be struck through the VIA consultation process in terms of providing sufficient, but not excessive, numbers of viewpoints.

Viewpoint siting

107 Following agreement on the general location of viewpoints through consultation, the selection of the precise viewpoint site should be considered carefully. If, on visiting a potential viewpoint, it is apparent that there will be no view of the proposed development, for example due to localised screening, this location should be amended or withdrawn.

Figure 16: Deliberate positioning of distracting or screening features within a photograph

a: b: c: d: e: f:

These photographs were all taken within 50m of each other and all show essentially the same distant view of an existing windfarm, with only the foreground detail differing. **a** shows the view seen adjacent to a house. **b** is from the public road immediately outside the house. **c**, **d**, **e** are successively more open views from the same road. **f** is from the road verge adjacent to the tree visible in the middle of **a**.

If the purpose of the viewpoint is to illustrate the view from one specified important view, one window in a house perhaps, then it should include whatever foreground obstruction happens to be in the view, as in **a** above. Otherwise, if a viewpoint is to represent potential views from a locality, then it should be as unobstructed as possible, as in **f** above.

108 The siting of viewpoints needs to balance two key factors:

- the likely significance of impacts; and
- how typical or representative the view is.

For example, in choosing a viewpoint along a stretch of main road, the magnitude of impacts may be greater along one section, but the likelihood of focusing on the view, that is its sensitivity, greater in another, for example at a lay-by. In all cases, judgement needs to balance these factors and this decision-making process must be documented. Most importantly, the location chosen must avoid the view of the windfarm being misrepresented by the inclusion of atypical local features, such as a single tree in the foreground, as illustrated in figure 16. Where this has mistakenly occurred, the viewpoint location should be revised and the photographs retaken. Conversely, it is also unacceptable to wander too far from the most prominent viewpoint in order to avoid typical foreground objects, for example moving into a neighbouring field when the view is intended to be from a road, in order to avoid the inclusion of the roadside fence or hedgerow.

Use of viewpoints

109 Viewpoints are used within VIA as sample locations from where to assess the existing visual resource, the design and siting of the proposed development, and potential visual impacts. Further information on their use is included within the Guidelines for Landscape and Visual Impact Assessment produced by the Landscape Institute and Institute of Environmental Management and Assessment (2002).

110 Viewpoints are primarily used for carrying out VIA. However, it is usually considered expedient to record elements of the landscape assessment at the same time, especially in relation to the landscape experience, as there is often significant overlap

between landscape and visual impacts. Where this takes place, however, it is very important to distinguish clearly between the information used for the VIA and that recorded for the Landscape Impact Assessment (LIA) to avoid confusion between the two.

Recording viewpoint information

111 It is important to record the field conditions in which a viewpoint is assessed, including information as listed in Table 8 below.

Table 8: Viewpoint information to be recorded

no	Viewpoint	Specification required
1	Precise location	12 figure OS grid reference, measured in the field, ideally using GPS or a large-scale map.
2	Viewpoint altitude and Viewing height	Viewpoint altitude in metres above Ordnance Datum (m AOD) (May be better interpolated from map or DTM than relying on GPS height). Viewing height in metres.
3	Nature of view	Horizontal field of view (in degrees).
	Conditions of assessment	
4	Date of assessment	
5	Time of assessment	
6	Weather conditions and visual range	

112 This information is essential to allow others to visit precisely the same viewpoint and make on-site checks or assessment. It also helps others to understand the conditions under which professional judgements have been made.

113 As part of VIA, viewpoint assessment will involve recording baseline conditions 360°around the viewpoint. However, most attention will be paid to the main focus of the view and its setting, the direction of the proposed windfarm, and any other existing and proposed developments.

114 All viewpoints should be numbered and their location shown upon separate maps as follows:

i The ZTV overview map(s) based upon a greyscale 1:50,000 OS base. The viewpoints should be marked using discrete symbols and numbering to avoid obscuring or confusing the ZTV information.

ii The detailed ZTV map(s) based upon a greyscale 1:50,000 OS base. The viewpoints should be marked using discrete symbols and numbering to avoid obscuring or confusing the ZTV information.

iii A detailed map extract on each viewpoint visualisation sheet which indicates the location and direction of the view on a 1:50,000 or 1:25,000 OS base map (although not necessarily the proposed windfarm), potentially reduced to another 'standard' scale, to enable those assessing the view on site to locate themselves in relation to local landscape features.

115 Viewpoint numbering needs to be clear. It is recommended that the original viewpoint numbers are retained right up until the point at which all the viewpoints are finalised and agreed and the VIA has been completed, to keep track of which viewpoints have been added or withdrawn during the VIA process. At this point they can be re-numbered in a continuous and more logical manner. Where material developed during the early stages of the VIA process information is included within the ES and its appendices, to show the development of the VIA, this should show both the original and new numbering so these can be easily cross-referenced.

116 To ease legibility, viewpoint numbering should follow a clear system. Some people number viewpoints in order of distance from a development, which is useful

when considering the effect of distance on impacts, while others number a windfarm in relation to how it tends to be experienced, such as from key routes, leading to isolated vantage points, which is useful when considering sequential impacts. Alternatively, numbering in a set direction, such as clockwise, may be the most appropriate method in terms of being clearly objective and transparent. Of these options, all are acceptable as long as the system chosen is clear and described within the VIA.

Table 9: GOOD PRACTICE GUIDANCE SUMMARY

VIEWPOINTS			
	Paragraph in report	Minimum requirements	Preferred requirements
Selection of viewpoints	90 93	Choice of preliminary viewpoints to be based on likely significant effects and the ZTV, landscape character and landscape experience. The justification for these viewpoints (in terms of what they represent or illustrate) should be stated.	
	93	Assess each preliminary viewpoint against ZTV and wirelines.	
	93, 95 97, 103	Consult on viewpoint choice with determining authority and consultees. Requests for comments should be accompanied by a list of the proposed viewpoints, justification for their inclusion/removal and a ZTV (also cumulative ZTV if relevant).	Wireline diagrams may also be provided for each preliminary viewpoint to inform the consultation process.
	96, 103	Include information on all preliminary viewpoints, whether they are subsequently abandoned or not. Information on those that have been dropped should be included within an appendix to the final LVIA/ ES report.	
	97	Adopt an iterative approach to viewpoint selection. Further/ alternative viewpoints may need to be assessed later in the VIA process if particular sensitivities become apparent.	
	98 101	Select viewpoints to represent different view types and viewer types as listed in Table 7. Specific viewpoints that are important viewpoints of the landscape, for example designated sites and visitor attractions, and from which impacts are likely to be significant, should also be included.	
	102	Consider whether a Cumulative LVIA will be necessary. If so, viewpoint selection should also be informed by the Cumulative ZTV. Cumulative assessment should occur at every viewpoint that cumulative visibility occurs.	If other LVIAs have been carried out in the study area, it may be useful to use some of the same viewpoint locations.

Selection of viewpoints (continued)	105 106	The number of viewpoints should be based on the number needed to represent likely significant visual effects within the range of views and viewer types listed in Table 7.	
	107 108	Determine viewpoint siting and orientation to represent typical views that are likely to result in significant visual effect within an area and reflect the key existing foci. Very localised screening/ distracting elements should be avoided if these are atypical of the area.	
Use of viewpoints	109	Consult GLVIA for use of viewpoints	
	110	Distinguish between aspects of VIA and LIA at viewpoints	
Recording viewpoint information	111-114	Number all viewpoints. Record information on each viewpoint and the conditions of assessment as listed in Table 8.	
	114	Viewpoint locations should be shown on the ZTV maps.	
	114	For each viewpoint, a plan showing its detailed location and direction upon the visualisation figures. This should be at 1:50,000 or 1:25,000, based on OS base maps of these scales	
	115-116	Viewpoints should be numbered in a logical order	

4 Visualisations

117 Visualisations are illustrations that aim to represent an observer's view of a proposed development (figure 17). At the moment, visualisations of windfarms most commonly comprise photographs, computer generated wireline diagrams and photomontages. However the range and use of different visualisations will change over time.

118 Visualisations are very powerful in communicating information – 'Pictures speak louder than words'. This means that people often jump to the visualisations within an ES to gain an impression of a scheme, in a way that they rarely adopt for other specialist information. However, it is important to stress that visualisations in fact represent just one source of data that informs a VIA.

119 A considerable amount of debate on visualisations in the past has revolved around making them 'true to life'. However, it must be stressed that this is impossible. Visualisations, whether they are hand drawn sketches, photographs or photomontages can never exactly match what is experienced in the field. Thus, in contrast, this guidance concentrates on how visualisations should be produced to be most effective as a tool to inform the assessment of impacts. Ideally this assessment would always occur on site, where the visualisations can be compared to the 'real life' view. However, it is acknowledged this is not always possible. It is important to stress that, whatever the circumstances, interpretation of visualisations will always need to take account of information specific to the proposal and site, but which cannot be shown on a single 2-dimensional image, such as variable lighting, movement of turbine blades, seasonal differences and movement of the viewer through a landscape. Therefore visualisations in themselves can never provide the answers, only inform the assessment process by which judgements are made.

120 The production of computer generated wireline diagrams to inform viewpoint assessment by landscape architects and experienced specialist assessors on site has generally involved little dispute, and independent assessors have found in the past that the judgement of impacts based upon these has been largely accurate (University of Newcastle, 2002). However the presentation of photomontages to illustrate visual impacts to a wider audience within ESs has often been a contentious issue. Partly, this has been because the method, format and quality of these visualisations has varied considerably between ESs as different methodologies have been explored and adopted, but also because the decision-making process behind their choice has not always been clear.

121 It is important to highlight that this Good Practice Guidance tackles this issue from first principles – that of what, why, how and for whom visualisations are produced. Thus, while it builds upon the findings of the report 'Visual Assessment of Windfarms: Best Practice', by the University of Newcastle (2002) (see Introduction and paragraphs 8-9), this guidance is not based on adopting certain methods simply out of convention.

122 This section of the Good Practice Guidance considers the selection, creation, use and presentation of visualisations and will highlight the following key issues:

Key issues affecting visualisations	
Photography	• Objectives • Field of view • Choice of camera • Choice of film • Choice of lens • Time of day, direction of sun and weather • Information to record at each photo location
Photographic post-processing	• Scanning • Panorama construction • Turbine Image • Image enhancement
Wirelines	• Use of wirelines • Data • Geometrical properties • Drawing style
Photomontage	• The use of photomontages • Rendering of photomontages • Accuracy of match to photography • Accuracy of lighting • Associated infrastructure and land use change
Other visualisation techniques	• Wirelines superimposed on photographs • Coloured 3D rendering • Hand drawn illustrations • Animation
Choice of visualisation	
Presentation of visualisations	• Presentation for different audiences and uses • Combinations of visualisations • Viewing distance • Information to provide • Paper and printing • Exhibition display
Good Practice Guidance summary	

Key issues affecting visualisations

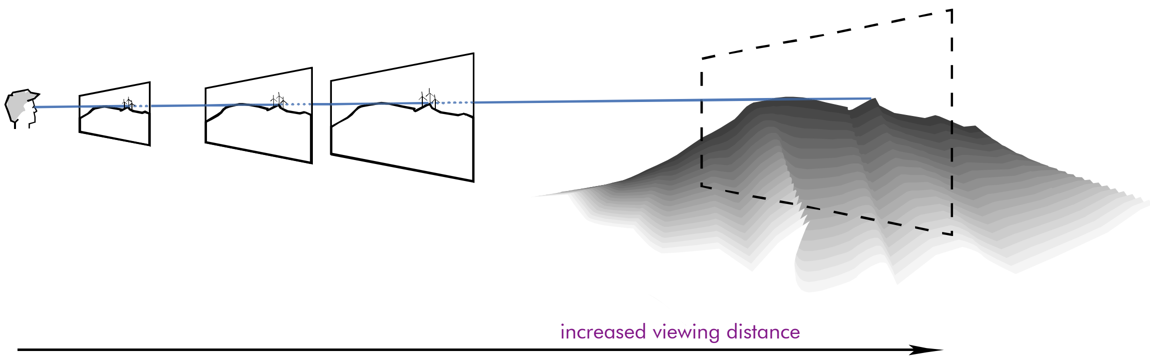
123 Photographs are important visualisations, not only in their own right, but also as a component of other visualisations such as photomontages. Photography is discussed in some detail in this section and also within the Technical Appendices. To understand how photographs represent what we see, it is important to first highlight that the eye is not directly sensitive to the outlines of objects or details in a scene. Instead it relies upon a degree of contrast to make those edges, and therefore the objects they define, visible. Thus there is always a trade-off between detail and contrast. This effect is replicated in photography, where visual representation on screen or the printed page is affected by the resolution of the image (to ensure that sufficient detail is captured) and contrast in the image (to ensure that the detail is visible). A key limitation of photographs in replicating the visual experience is that it is generally impossible to reproduce the full contrast range visible in a scene to the human eye. This means that while, on a bright day outdoors, we may experience a brightness ratio of 1000:1 between the brightest and darkest shades, a good quality computer monitor is only likely to achieve a ratio of about 100:1 and a printed image is only likely to manage 10:1.

124 Having chosen a specific camera, the key factors that determine the size of a visualisation are the selected field of view and viewing distance. These factors should be determined on the basis of being able to clearly represent the key characteristics of a view while the visualisation can be viewed comfortably. The resulting image also requires to be large enough to show sufficient detail.

125 It is important that visualisations are viewed at the correct 'viewing distance' – that is the distance between the eye and the image that directly relates to the visualisation calculations and image size, as shown in figure 18. In the field, the correct viewing distance

is easy to establish, as a viewer can adjust the position of a hand-held visualisation until it appears to correspond with the scene beyond. Very simply, if the photograph is held too close to the eye, the elements in the scene will appear too big; if it is held too far away, the elements will appear too small; and there is only one distance at which the photograph will match the real scene (the correct viewing distance). Unfortunately however, this direct correlation between the printed visualisation and real view is not possible if the viewer is not in the field at the viewpoint location; it is in these circumstances that use of the correct viewing distance is crucial if the visualisation is to be viewed and assessed correctly. The geometrical principle of correct viewing distance is explained in more detail within Appendix A.

Figure 18: The relationship between image size, viewing distance and the 'real-life' view



Using a standard paper size, a projected wind farm image will be smaller at a shorter viewing distance, and larger at a further viewing distance. However if held at the correct viewing distance they will be seen as being the same size. This represents a direct mathematical relationship between the eye and the image of the subject (the landscape).

A key issue is whether this viewing distance is comfortable for the viewer and if this is likely to be used correctly.

126 Not only must the viewing distance be correct, but it must also be set at a comfortable distance. For material printed in an ES and intended to be hand held, this should be between 300mm and 500mm, although a distance between 400mm and 500mm is recommended as a "comfortable viewing distance for

larger images at either A4 or A3 [and presumably larger] held at arm's length " (University of Newcastle, 2002). It also allows easier comparison with the real-life view on site as shown in figure 35.

127 Field of view is discussed in further detail within the section of this chapter on photography, paragraphs 135-144, and within appendices A and D. Although it would be convenient to be able to recommend a standard field of view to be used for all visualisations, analysis on site and of existing ESs suggests that no such standard can be established. Rather, the recommended horizontal and vertical field of view will vary, depending on what is required to illustrate the key characteristics of the visual resource and the key components of the proposed development. In some cases, the recommended horizontal field of view may conveniently fit the dimensions of a single photographic frame. More commonly, however, this requires a panorama photograph (discussed further in paragraphs 172-175 and Appendix B). In most cases, the recommended vertical field of view will conveniently fit within a single frame height (horizontal or vertical orientation); however, in exceptional circumstances, multiple vertical images could also be required in this dimension.

128 In the past, people sometimes doubted the technical accuracy of photos and photomontages as they didn't seem to compare well to the scale of landscape features when directly compared on site. As discussed within the sections on image size (paragraphs 129 and 248) and viewing distance (paragraphs 125-126 and 255-256), while the visualisations were mathematically correct, they were often produced in a format that could not be used comfortably, and thus tended to be used incorrectly. People sometimes assumed that this deficiency would be corrected by taking photographs with a telephoto lens or equivalent. However, as discussed within the section on choice of lens (paragraphs 150-158) and

illustrated in figure 21, it is important to realise that a longer lens length does not necessarily result in a larger or clearer image; rather, the key factors directly influencing this are image size in direct relation to viewing distance and field of view (assuming good quality resolution and contrast).

129 The image height and width will relate to the viewing distance and vertical and horizontal field of view chosen. However, if a short viewing distance and a small vertical field of view is selected, the resulting image may not be large enough to show sufficient detail. To avoid this situation, the University of Newcastle (2002) stated that "an image height of approximately 20 cm is therefore to be preferred". However, following the University of Newcastle's own recommendations in terms of a minimum viewing distance of 300mm and the use of a 50mm equivalent camera lens, the maximum vertical height of an image generated from a horizontal format photograph (landscape format) would be 140 mm. Once cylindrical projection (discussed in Appendix B) is applied this is further reduced to 135mm at the edges and may be further reduced if the image was cropped in scanning. Thus, while an image height of approximately 200mm is recommended, an image height over 130mm is considered acceptable.

130 Visualisations are complementary to ZTVs and vice versa and neither can be interpreted satisfactorily without the other. While a ZTV shows where a proposed windfarm will or will not theoretically be seen (subject to surface screening) and the number of wind turbines (or parts of turbines) likely to be seen from any location, it cannot indicate what the windfarm will look like. A visualisation, on the other hand, simulates the appearance of the windfarm from a particular location, but gives no indication of whether this is characteristic of views over a wider area or peculiar to a specific site. Used carefully together,

a ZTV and a set of visualisations can provide information on all of these aspects.

131 The choice of visualisations for a specific viewpoint will depend on a number of factors described within the sections on choice and presentation of visualisations, paragraphs 232 to 265.

Table 10: Uses and limitations of visualisations
(numbers in brackets refer to paragraphs within main text)

USES OF VISUALISATIONS	LIMITATIONS
• Visualisations give an impression of the appearance of a proposed windfarm (117). • Applied carefully in the field, a visualisation can be used as a tool to help assess the likely visual impact at that point. • Visualisations can aid development of the windfarm layout and design (188). • Presented carefully, visualisations can help illustrate to a 'lay' audience the location and nature of a proposed windfarm (and may be the basis on which this audience will assess a project). • Wirelines provide objective data, while photomontages present an illustration of visual impacts that incorporates artistic interpretation. (186, 236-237).	• Visualisations provide a tool for assessment, an image that can be compared with an actual view in the field; they should never be considered as a substitute to visiting a viewpoint in the field (204). • Neither photographs nor visualisations can convey a view as seen in reality by the human eye. It is very difficult to represent contrast upon the printed page. (119, 134, Appendix C). • Visualisations are only as accurate as the data used to construct them (189-191). • Visualisations can only represent the view from a single location and the ZTV and site visits must be used to determine whether or not it is typical of a wider area. • Visualisations are inherently limited in the field of view and detail they can represent. • Visualisations with very wide panoramic fields of view can be difficult for some people to use and interpret, while visualisations with narrow fields of view may appear to present insufficient context (Table 15 and 135-144). • Visualisations should be used in combination with other VIA tools, including a ZTV (130). • Visualisations presented upon paper cannot convey the effect of turbine blade movement (119).

Photography

Objectives

132 Photography has two main roles in EIA. One is as a simple record and aide-mémoire of site visits and on-site assessment work. The other, on which this guidance focuses, is in producing visual material for inclusion in an ES.

133 Photography for presentation in conjunction with wirelines or other visualisations, or as the basis for photomontage, requires high quality specification. This is because the perspective geometry of the resulting photographic image is necessary in order to use a computer program to generate an image with exactly matching perspective. This in turn implies considerable care in the selection and use of appropriate photographic equipment and supplies.

134 Representing landscape conditions through photography (and thus photomontages) has its limitations and, while some of these effects can be ameliorated and/or compensated for by using presentation techniques discussed in the following section, other effects are less easy to counteract. One of the most significant difficulties of photographing windfarms, in contrast to other types of development, is that they often appear on the skyline where there is little contrast between the light-coloured turbines and a light-coloured sky. In these circumstances, while the human eye can distinguish, in bright outdoor light, a contrast range of around1000:1 or more (the brightness ratio of the lightest to darkest elements in the scene), a picture of the same view taken with a camera and shown on a computer screen will have a ratio of only about 100:1. This range of contrast is reduced to as low as 10:1 when printed on paper.

Field of view

135 The term 'field of view' is used to describe the height and width of a view as represented by an image. These constitute the horizontal field of view and vertical field of view and are expressed as angles in degrees. (The terms 'angle of view', 'included angle' and 'view cone angle' are equivalent but can be ambiguous in some contexts.)

136 There have been suggestions that the horizontal field of view shown in visualisations could be linked to the physical limits naturally seen by a human eye. However it is difficult to derive definite parameters in this way, as a human has an extreme horizontal field of view of about 200°, yet only the 6-10° that falls on the central part of the retinas of the eyes will be in focus at any one time. Thus a viewer moves their eyes and head around to see a view over a wide area. Further information on this subject is included in Appendix C.

137 As viewers typically direct their attention over different widths of view, the size of photograph required to represent a view will vary for different projects and viewpoints, depending on the key characteristics of a view that need to be included within the image (defined by the landscape architect or experienced specialist assessor on site), and the extent of the proposed windfarm which needs to be included.

138 Occasionally this information can all be incorporated within a small field of view, as discussed below, that may conveniently fit within one single photographic frame (representing 39 degrees using a 50 mm lens on a 35mm camera). More commonly for open landscapes in the UK, however, a series of frames will be required that are joined together to form a panorama image. Panorama construction is discussed in further detail in paragraphs 172-175 and Appendix B.

139 Although a viewer will move their eyes and head around a field of view, a central point can be identified, based on the key focus or foci of the view (existing and proposed) and where the eye typically 'rests'. This should also be determined by the landscape architect or experienced specialist assessor on site while carrying out the VIA so that the visualisations can be centred on this.

140 To ensure that the photographs taken for each viewpoint (which may be taken by someone other than the landscape architect or experienced specialist assessor) are able to accommodate the required horizontal field of view, it is recommended that a panorama is taken from each viewpoint that includes the entire width of open view. This may be 360° for some viewpoints. For certain viewpoints, especially where there is a high vertical dimension to the view, as in mountain areas or close to vertical features (including proposed or existing turbines), it will also be advisable to prepare a panorama comprising of vertical 'portrait' frames.

141 For the narrow horizontal field of view contained within a single frame, the differences in geometry between single frame and panorama are not marked (see Appendix B for more details). Nevertheless, photographs should be clearly identified as either single frame or panorama if a mix of the two types is used. Figure 19 shows the comparison between a panorama and a single frame view of the same scene. The panorama includes context missing from the single frame view. The single frame is slightly wider than the equivalent central portion of the panorama. This is because the image scale increases with horizontal distance from the centre of the image in the case of a single frame, whereas it is constant in the case of a panorama.

142 In the section on visualisations (7.5) within 'The Visual Assessment of Windfarms: Best Practice' (2002), the

University of Newcastle recommends that "a full image size of A4 or even A3 for a single frame picture, giving an image height of approximately 20cm, is required to give a realistic impression of reality". During the early stages of developing this Good Practice Guidance document, John Benson of the University of Newcastle explained that this recommendation derived from the need to promote larger sized visualisations to enable sufficient detail, clarity and longer viewing distances than conventionally used at that time, rather than promoting a particular field of view that would limit visualisations to single photographic frame dimensions or paper sizes. He acknowledged that this push to produce taller images and longer viewing distances, and the assumption that these would be limited to A3 page sizes, meant that the implications of accommodating the required horizontal field of view was not sufficiently considered at the time. Indeed, in 2002, few developers had submitted panorama images at the recommended viewing distances and image height, although a few had produced what they termed as 'enlarged photomontages' that happened to include just a single photographic frame and fitted an A3 page.

143 It has been suggested by some that familiarity with the traditional proportions of a single frame photograph (3:2) or television screen (4:3) means that these proportions of image might be preferred by the general public instead of a panoramic image. However, there is ever-increasing use of 'unconventional' formats in communication, eg 'wide-screen' computers and televisions, and common use of image software such as photo stitching to produce panorama photographs at home. So familiarity presents fairly weak grounds on which to base field of view criteria. By contrast, defining the field of view in terms of the specific characteristics of the visual resource and development proposal provides criteria that can be continuously applied in a transparent and methodical manner.

144 The field of view is one of two factors that determine how large a visualisation image will be when presented on paper (Table 14 and 15); the other being the viewing distance. It is likely that there will always be pressure to keep viewing distances low to limit paper size on wide panoramas, and to use longer viewing distances for larger images in order to take advantage of the greater levels of detail possible. These issues are discussed further in the section on Presentation of Visualisations, paragraphs 242 – 265.

Choice of camera

146 To take photographs for visualisations, the choice of camera and lens represents the first of a series of judgements that must be made in terms of choosing the most appropriate photographic equipment and processes. All these will determine the quality of the final images in the printed ES. This is discussed further in Appendix B. The geometry of the image must be known and be able to be matched on a computer and the detail captured must be sufficient to produce a reasonable image quality as finally printed.

147 In general, a high quality camera is required to produce satisfactory results for ES purposes because the lenses need to be of high quality both in terms of resolving power (the ability to capture detail) and in freedom from distortion. For film cameras, the minimum standard should be a good-quality 35 mm SLR, with manually adjusted focus and exposure settings, and with a range of good-quality fixed focal length lenses. For digital cameras, the ideal is again a SLR with a range of good-quality fixed focal length lenses. The use of compact zoom digital cameras is not recommended due to the distortion these create.

147 The construction of panoramic photos requires accurately levelled photographs. To achieve these, a tripod is absolutely essential, as is a spirit level, to set the camera accurately so that it is not tipped up or down, or to either side. Special tripod heads for

panoramic work are available. These have a built-in spirit level, levelling screws and an indexing mechanism to allow the direction of view to be set in fixed increments. These are quite expensive but can speed up photographic work and simplify subsequent panorama construction.

148 Panoramic cameras are available, which can shoot a panorama onto a long length of 35mm film or a whole roll of 120mm roll film. While appealing at first sight, these are generally less practical than the use of a sequence of frames taken on an ordinary film or digital camera and subsequently spliced together. Panoramic cameras are discussed further in Appendix B.

Choice of film

149 Choice of camera film is important for non-digital work. The grain and resolving power of the film will affect the quality of the finished images and the detail represented in them. Very fast film (ISO 400 and above) should be avoided, except when it is vital that photography has to be done in very poor lighting conditions, as these films tend to have a coarser grain structure than slower films and poorer resolution in low-contrast parts of the image. Rather, a good quality ISO100 film (or ISO 200 on days with poorer light) from a reputable manufacturer is recommended. Good quality amateur film is generally satisfactory and does not have the requirement for refrigerated storage that many professional films have. Very slow film (below ISO 100) can prove difficult to use on-site and, although its very fine grain structure can produce superb results, exposure times need to be quite long on all but the brightest of days, which sometimes results in blurring of grass and leaves in the wind. Colour print film is a better choice than slide film as a source for scanning, because it retains more detail in shadows than is often the case with transparencies.

Choice of lens

150 The camera lens forms an image of the scene in front of the camera on film or on a digital sensor. The longer the focal length of the lens, the larger will be the scale of the image. For good quality lenses, substantially free of distortion, the perspective is exactly the same. This issue is discussed further in Appendix D.

151 As a longer focal length lens projects a larger scale image of the scene on to the film or sensor, any element in the scene will, therefore, cover more film grains or pixels and will be captured in more detail than would be the case with a shorter focal length lens. However, because the scale of the image is larger, but the film frame size or sensor size remains the same, it is also true that a smaller field of view (and thus context of a view) is captured. There is therefore inevitably a trade-off between the field of view and the resolution of detail as shown in figure 21. The use of a longer lens does not mean that an image, or elements within the image, will necessarily appear larger. Rather, this is a function of the field of view and viewing distance applied as discussed in paragraphs 124 and 125.

Figure 20

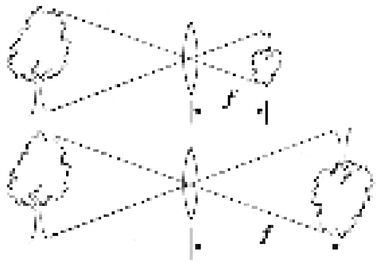


Image size is directly proportional to focal length.

152 With 35mm film, a 50mm focal length lens has been found to be a good compromise (Landscape Institute & Institute of Environmental Management & Assessment, 2002). It does not present the very finest detail visible to the human eye, but nevertheless captures much of it and is sufficient for most purposes (see Appendix C). A longer focal length lens will capture more detail, but only at the expense of reducing the vertical field of view and therefore loss of foreground and sky. A shorter length lens would result in the converse – a larger field of view, but with reduced detail.

153 To increase the amount of foreground and sky visible, photographs may be taken in 'portrait' format. This is

particularly useful where there is a strong vertical component to a view, for example where there are steep mountains, or where wind turbines would appear very close to the viewer.

154 Appendix D includes a table that lists the various field of view dimensions that result from taking photographs with lens of varying focal length.

155 There are very specific circumstances where a telephoto lens may be useful to illustrate a windfarm; for example where this would appear in the far distance and against the sky. In these situations, it is difficult for a photograph to adequately show the presence of turbines against the sky, due to the difficulties of the photo picking up the contrasts of shade between the sky and the turbines as discussed previously in paragraph 134. In these circumstances, some compensation for the restricted range of shades may be possible with the provision of additional detail as provided by a photograph taken with a telephoto lens. However it is important to realise that the viewing distance for this telephoto view when printed will be much further than for the more conventional photographs based on the use of a 50mm lens (or equivalent) and thus may be difficult to view easily. In addition, a telephoto view will usually omit contextual information and thus should only be provided in addition to a 50mm lens (or equivalent) view for the same viewpoint.

156 The following photographs (figures 22a-22c) of the existing Dun Law windfarm show a comparison of effect using alternative lens lengths for an image of the same size but requiring varying viewing distance.

157 1If using a telephoto lens to take pictures, it is important that this is of a fixed length. For, while zoom lenses are convenient for general photographic use in allowing the view to be framed up in the camera, rather than by subsequent cropping, they are always an optical compromise. Their resolving power

is never as good as their equivalent fixed focal length lens and some geometrical distortion is almost always introduced into the image. The latter usually varies with focal length setting (see Appendix D). Also, other than setting a zoom lens at its upper or lower focal length limit, it is impossible to set it precisely to a given focal length, resulting in variations in focal length between viewpoints and difficulties in matching computer generated images.

158 Most digital cameras have a sensor area smaller than a 35mm film frame (although this is likely to change in time). So, although the image size will be the same for any given focal length, the digital camera has a smaller field of view. The only sensible solution to this problem is to use a shorter focal length lens, often a 28 mm lens, in order to achieve the required coverage. Even with a very good lens, this will introduce a small amount of barrel distortion (see Appendix B), which may be acceptable or can be corrected with appropriate image processing software. The use of a compact zoom digital camera is not recommended.

Time of day, direction of sun and weather

159 Key environmental factors affecting the quality of a photograph are the angle of the sun, the direction of the sun and the level of humidity (creating haze, cloud or rain). If a photograph is taken in fine conditions, the most important issue tends to be the direction of the sun, although low light can emphasise the vertical element of the landscape. Conventional wisdom states that the sun should be behind the photographer for the best lighting in a scene. In practice however, having the sun directly behind the camera can make some landform shapes less apparent and side lighting often gives the best impression of the topography. Looking directly into the sun, especially in the winter when it is low in the sky, is to be avoided, unless sunset views need to be illustrated.

160 Whilst it is appropriate to consider a range of weather conditions in the VIA, the viewpoint photographs should be taken in weather, visibility and lighting conditions that would allow operational wind turbines to be captured on a photograph (which requires greater light intensity, clarity and contrast than when viewed with the naked eye). This is more likely to be achieved by maximising the contrast between the turbines and their background. This requires taking account the effect of lighting, background and turbine colour as shown in Table 11 below. Table 11 indicates how the optimal lighting will also vary with turbine distance. The actual distance will depend on the brightness of the light, the focal length of the lens used and the resolution of the film and printing technology.

161 It is rarely possible to achieve the desired photographic contrast in grey and overcast conditions, unless the turbines would be back-lit or in shadow. Land with heavy snow cover gives a background similar to brightly lit clouds and can present similar problems in achieving the required contrast.

Table 11 - Best weather and lighting for photographing turbines

Turbines	Background	Weather	Ideal lighting
Near/ middle distance	land	Bright sunshine	Front or side lit
	sky	Blue sky, bright sunshine	Front or side lit
		Cloudy, bright	Back lit or in shadow
		Dark storm clouds, bright sun	Front or side lit
Distant	land	Bright sunshine	Front lit
	sky	Blue sky, with clouds	Back lit or in shadow
		Cloudy, bright	Back lit or in shadow
		Dark storm clouds, bright sun	Front lit

Source: Kay Hawkins, E4environment Ltd and Phil Marsh

162 Realistically, it is not always possible to arrange for the photography from each viewpoint to be taken under ideal conditions when there is a tight project timescale. However, photographic expeditions should be planned (by reference to weather forecasts, web cams and local information) as far as is practical to coincide with good conditions, with visits to viewpoints to the east of the site in the morning, and to the west in the afternoon.

163 With wide panoramas, a variation of light across the image is inevitable. The critical issue is to ensure good lighting of both the proposed development site, and the key characteristics and features within the surrounding landscape that are most likely to be affected by the proposed windfarm. Where a panorama is to be produced from a series of frames spliced together, it is important to choose an exposure setting (shutter speed and aperture) that is appropriate for the most important part of the scene and to apply that exposure setting to all frames within the panorama.

164 Whatever the weather and light conditions, the minimum requirement is for photographs to clearly show the proposed windfarm site and its context and, if they are to be used as the basis for photomontage, they should be able to have wind turbines clearly illustrated upon them.

Information to record at each photo location

165 To assist with the construction of visualisations back in the office or studio, the photographer should keep a record of important information about the viewpoint location, equipment used etc, as listed in Table 12. This information is best recorded in a photo log for each photo point. The records of information within this log may be made by separate assessors and photographers on different days and, as a consequence, should be sufficiently comprehensive for both parties to understand the conditions under which

all visits occurred. Some of this information needs to be included on the final visualisation (see Table 16). Some photographers find it helpful to record the shutter speed and aperture settings used and, in the case of a digital camera, the ISO setting used (although this is usually all recorded in the EXIF data associated with each frame).

166 It can also be useful to take a photograph recording the position of the tripod location in relation to local features such as a cairn or signpost. This can be helpful both during the production of the visualisations and in the event that the location has to be re-visited.

Table 12 - Information to be recorded at each photograph location (in addition to viewpoint information listed in table 8)

- Camera type (SLR, digital)
- Lens focal length (for example 50mm)
- Film speed (for example 100 ASA)
- Frame numbers as read off the camera (although these may need to be calibrated with the negative numbers which may be different)
- Spacing between the frames (for example 30 degrees for 50mm shots)
- Compass bearings to distinctive elements in the view that will assist with the scaling and placement of the turbines (plus sketch of the view with these elements marked if appropriate).

Source: Kay Hawkins, E4environment Ltd

167 For compass bearings, it is more accurate to use a sighting compass, as bearings to within 0.5 degrees can be measured. However, sighting compasses do not have the variation adjustment (to compensate for the difference between grid and magnetic north). There is less risk of mistakes if the bearings are recorded in the photo log and recalculated back in the office to allow for the appropriate number of degrees deviation. Significant deviations in the compass bearings will be caused by nearby metal objects

(including passing vehicles) and, if this is a possibility, it should be noted.

Scanning

168 Assuming that all photographic preparation work will be carried out digitally for ES work, the next step in the process is to import the images into a computer system. With a digital camera, this is very straightforward and is done directly, with no risk of image degradation. However, with a film camera, a scanning stage is required. Scanning should be carried out using negatives rather than prints, as they retain a greater range of contrast than can be represented on photographic paper.

169 It is possible for an experienced professional to adequately scan from negatives on a relatively inexpensive flatbed scanner. Some of these will come with a range of settings for different film stocks while others will require some experimentation to obtain the best results. A true optical scan resolution of 2400 ppi (points per inch) is adequate for most purposes, giving a 3400 x 2267 pixel image from each 35 mm frame.

170 It is, however, difficult to keep the film as scrupulously dust-free as is desirable when scanning, and it is extremely laborious work. Both of these factors make it an attractive proposition to have the film scanned professionally. Many photographic processors offer this service and will provide a CD-ROM and a set of prints as a packaged service, which should ensure a good standard of cleanliness. However the quality of the scanning varies considerably. In particular, detail is often lacking in very light or dark areas of the image, so that features obvious on prints are hard to pick out on the scans. It is worth having test scans done before committing valuable photography to any of these services. Also, some cropping can occur and it can be difficult to ascertain precisely how much, which makes the calculation of, and scaling to, a chosen viewing distance difficult to achieve.

171 Although digital photography and scanning from 35mm negatives both produce digital photographic images, they are different. In the case of a digital camera, the sensor is accurately centred on the axis of the camera lens, so that the optical centre of the photographic image falls exactly in the centre of the digital image area. With scans from film, no matter how accurately it is done, there is always some residual misalignment, which is compensated for by slightly cropping the image. Because of this, the optical centre of the photographic image is not certain to accurately fall in the middle of the digital image, which means that some image processing operations cannot be reliably applied to them.

Panorama construction

172 Photographic frames are projected onto a plane surface to correspond to the plane of the film or sensor on which the image was first captured. A panorama involves the projection of frames onto part of a cylinder (see Appendix B for a discussion of these issues). It is possible to take a series of frames and to find the overlap point between each adjacent pair and then to splice them together. In this case, however, the frames correspond to a series of facets rather than a smooth cylinder. In consequence, straight lines, such as kerbs or rooflines, which run from frame to frame, appear to kink sharply at the panel joins. It is possible to improve this by using many very narrow panels, but cumbersome to do so.

173 A number of software packages are available to take a series of separate frames and combine them into a single panorama (software to do this often comes on the CD accompanying a new digital camera). Most of these programs attempt to do the whole operation automatically by trying to find matching elements in adjacent frames where they overlap. They also remap the image mathematically so that it forms a smooth cylindrical panorama and blend out any mismatches

in colour between frames. Unfortunately, even with the best software, the ability to carry out the image matching operation is not entirely reliable. Some programs allow the user to manually over-ride the splicing; others do not and will produce images unacceptable for professional use in an ES. There is always some residual mismatch at the joins between adjacent frames and the usual solution is for the overlap area to be blurred, to hide the artefacts created by the slight mismatch. Naturally, this also destroys valuable detail. As a consequence, the finished panoramas are never as geometrically accurate as ones which are created carefully using manual tools and therefore should not be used as the base image for photomontages.

174 Tools are available as plug-ins to image processing software which facilitate the creation of panoramas manually. Each frame should ideally first be corrected for any barrel distortion in the image (this step can only be done satisfactorily with an image from a digital camera as it must be applied symmetrically with respect to the optical centre of the photographic image). A remapping operation is then required to convert the planar geometry of the photographic frame to a cylindrical image. Once overlapped and spliced, the geometry will match consistently across adjacent frames without the kinks apparent without correction. Finally, the colours of each frame can be adjusted to achieve a uniform colour balance across the entire panorama.

175 In theory, as long as the component images used to construct a panorama cover the scene with no gaps, it would be possible to splice them together. In practice, some overlap is required. There are two main reasons for this:

- Some minimum overlap is necessary to see the same detail on two adjacent frames in order to align them accurately; and

- it is often useful to have some scope to choose which of a pair of adjacent frames is used as the source for a particular part of the image, for example to compensate for the effects of changing lighting or moving cloud shadows, to remove the effects of vegetation moving in wind or to remove moving vehicles.

Too much overlap, on the other hand, will increase the work involved in splicing panoramas. In general the overlap should be somewhere between one quarter and one half of the width of an individual frame.

Turbine image

176 The turbines shown on a visualisation should represent reasonably faithfully the shape of the intended turbines for a project. Ideally, they should be based upon detailed line drawings of the actual turbines proposed; but they should at least have the correct hub height and rotor diameter. This will allow the proportions of the turbines to be understood from the visualisation as well as confirm actual visibility. Some practitioners prefer to depict all turbines with the rotors set to have one blade pointing straight up, whereas others prefer these set at random angles, helping to simulate more realistically the fact that the turbine blades will be moving. The disadvantage of setting blades at random angles is the risk of ‘losing’ turbines behind the landform because the blade angle happens not to put a tip high enough in its arc to be seen. On the other hand, having all the blades at the same angle can produce a very ‘regimented’ effect that appears less realistic. Consequently it is recommended that, for all ‘working’ copies of wireline diagrams, turbines are always shown with one blade positioned straight upwards, while photomontages, as illustrations, can show turbines at random positions. However, even accepting the more illustrative quality of photomontages, it should be ensured that all the wind turbines that could potentially be seen from a

viewpoint are shown within the image, even if their highest blades are on the diagonal.

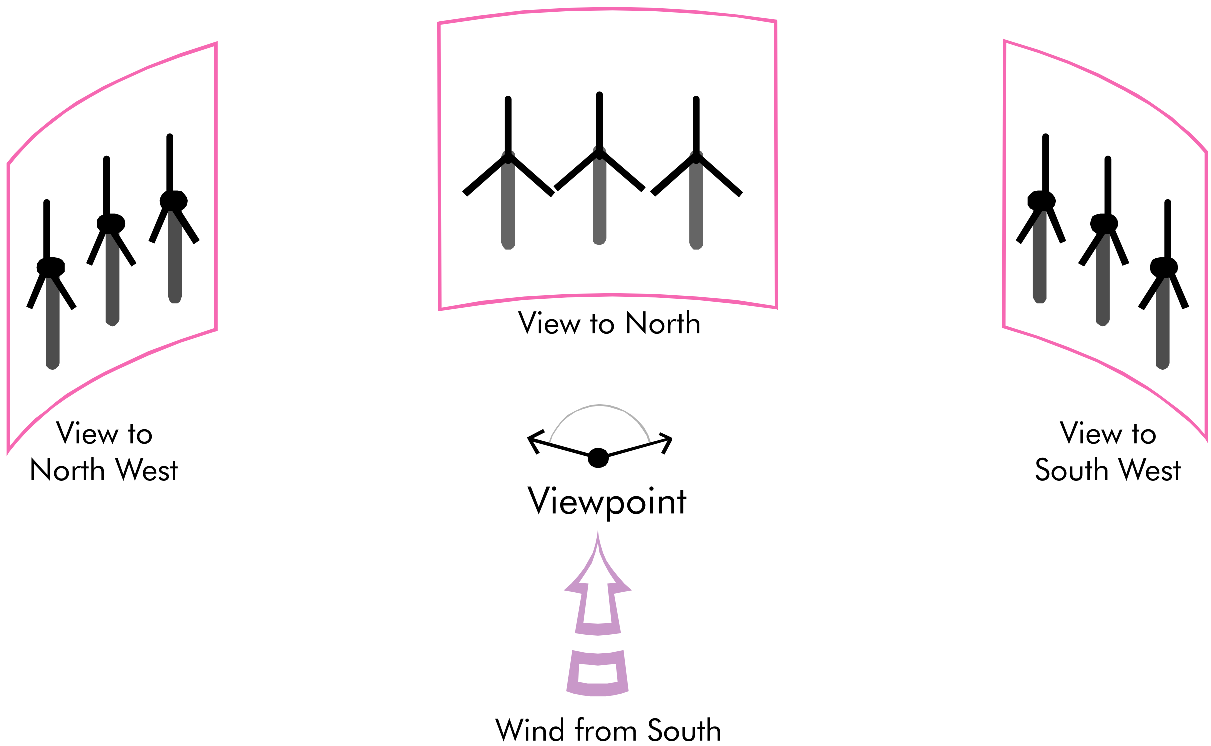
177 Turbines can be shown in three different ways:

- Every turbine individually facing the viewpoint;
- Every turbine facing the same direction, but this varying between viewpoints so that the ones in the centre always face forwards towards the viewpoint; and
- Every turbine facing the direction of the prevailing wind at each viewpoint.

178 Some software can only show the turbines facing the viewpoint as it uses a 2-dimensional representation of the turbine, but most offer a choice. It is often stated that a wind turbine is most visible when seen 'face on', and therefore this should be represented as the 'worst case scenario'. However, when 'face on', the wind turbine image can actually appear more simple and comprehensible than when it is seen at an oblique

Figure 23: Variable direction of wind turbines

Turbines all facing into the wind, as would be seen from the viewpoint



angle, so the latter can actually result in similar levels of impact. The key issue to highlight here, once again, is that visualisations are tools, and that they can only represent the likely effect of a development at a particular time. Thus, the most important objective should be to present an honest representation that informs the viewer's prediction of how the turbine rotors would appear in different conditions.

179 To meet this objective, the first option for turbine direction listed in paragraph 177 above is not recommended; this is because this image would in reality rarely occur over a wide horizontal field of view and would thus appear improbable. Both the second and third options are acceptable. The presentation of turbines facing the prevailing wind will tend to create the most realistic image throughout an ES. If all the wind turbines face the same way, but in an alternative direction, this is equally accurate. However the choice of direction may be questioned where there are numerous windfarm developments visible over a wide field of view and the choice of direction seems to favour illustration of one windfarm more than another.

Image enhancement

180 Enhancement of images is an inherent part of photographic production. Photo processing involves judgements - there is no process by which a 'pure' photo can be produced without the application of human decision-making, from exposure timing to the specification of the camera, and whether this is applied manually or automatically.

181 Although enhancement, for example to maximise clarity, has traditionally occurred within the photographic darkroom, this practice has often raised concern with regards to producing digital photographs and photomontages. This may be because it is difficult to quantify the level of enhancement in a way that is easy to understand, raising the suspicion that an image has been 'doctored', and is consequently

Figure 24: Various levels of image sharpening

Digital photograph contrast enhanced and colour balanced

Sharpened for printing

Grossly over-sharpened

Figure 25: The effect of colour balancing an image

Digital photograph as taken

Blue cast removed by colour balancing

Contrast and brightness enhanced

misleading. In reality there is no way to avoid a photograph being 'doctored' as this is an integral part of photograph and photomontage production. The only way to ensure that this is to acceptable standards, is to require the use of extreme care by a suitably experienced professional. The extent of enhancement must also be limited to that which would conventionally occur in a darkroom to improve the clarity of an image, not change its essential character. For example, it is important that any enhancement, such as sharpening elements within a view, is carefully balanced throughout an image, not just the wind turbines; otherwise other features may seem less prominent in comparison.

182 Sharpening an image slightly can also help fine detail visible in the field, be visible on printing. This operation works by identifying areas of high contrast in the image, which correspond to the detail we see, and locally further increasing the contrast so that the detail becomes more apparent. However this operation must be applied carefully as over-sharpened images can result in a hard dark line that appears at the skyline and a corresponding light edge to the sky above it, while miniscule details can appear unrealistically prominent and fussy (see figure 24).

183 It is also helpful to sometimes adjust the brightness and contrast of an image so that, for example, no detail is unnecessarily lost in deep shadow, while also ensuring that the sky does not bleach out to white or pale grey as the shadows are lightened. Colour balance across the whole image sometimes needs adjustment, even if the photography was taken in good conditions, to remove unwanted colour casts (see figure 25). These operations are available in photographic image processing software and are techniques similar to those used within a conventional darkroom. They do not change the content of the image.

184 Conversely, if changes are made to sky colour alone, which is sometimes done to ensure that turbines are visible, the content of the image is effectively changed. This approach should therefore only be employed if there is no other practical alternative and targeted enhancement is clearly noted adjacent to the affected images. In these circumstances, it may be advisable to ensure that the original photographs are available, if required, to demonstrate the degree and nature of the enhancement that has taken place. However, as discussed in paragraphs 180-181above, it must be understood that even the original photographs will have been enhanced to some extent through standard photo processing.

Wirelines

Use of wirelines

185 Wirelines are computer generated line drawings, based on a digital terrain model (DTM), that indicate the three-dimensional shape of the landscape in combination with additional elements. They are a valuable tool in the windfarm VIA process as they allow the assessor to compare the position and scale of the turbines within the wireline to the existing view of a landscape.

186 Wirelines are particularly useful to the landscape architect or experienced specialist assessor as they strictly portray objective data. This means that, by comparing wirelines with a view on site, the assessor can make clear and transparent judgements on the likely visual impacts in a variety of environmental conditions, safe in the knowledge that the wirelines have not been subject to manipulation that cannot be quantified. They can also reveal what would be visible if an existing screening element, for example vegetation or a building, is removed.

187 It is important to highlight that wirelines are not intended to portray a 'true to life' visualisation of a

proposed windfarm. Rather, their use in VIA relies on interpretation that is based on experience of the visual impacts of windfarms and how these typically compare to the representation of a windfarm within wireline diagrams.

188 Wireline diagrams are extremely valuable in the windfarm design process, as they are relatively quick and easy to produce, so that many sets will usually be generated as a windfarm layout evolves. The benefit of these wirelines is that, not only do they clearly convey the overall windfarm image that results from the layout and siting, but they also show how this is affected by the position of individual wind turbines, that can be easily identified and re-positioned in an attempt to improve the effect. The assessor will usually identify individual turbines using computer software. However, for the benefit of the ES reader, it is essential to include some wirelines within the appendices that have individual wind turbines numbered. This aids understanding of the design process, as documented with reference to individual turbine numbers, and also enables further mitigation measures in relation to individual turbines to be discussed more easily. A limitation, however, is that individual numbers for wind turbines may change during the design process, as wind turbines are added and removed. Consequently, when comparing recent wirelines to those produced in the early days of a project, some number correlation may be required.

Data

189 The accuracy of a wireline depends on the accuracy of the data used to create it. In general, this data will be the same as that used for calculation of the ZTVs, commonly the OS Landform Panorama or Landform Profile DTM products. See paragraphs 41-44 for a fuller discussion of these issues.

190 It is important that, for each project, sufficient DTM data is used to enable the full landform background to

the turbines to be seen and thus easily matched to a view on site or photographs of the existing landscape. For some views, DTM data may need to extend further than the LVIA study area because the distant horizon extends beyond this limit.

191 The quality of Landform Panorama varies widely across the country, largely reflecting the variable quality of the contours on the OS 1:50,000 scale First Series mapping which was used as a source in the late 1980s. Some narrow ridges and peaks are in particular not well represented and can produce wireline diagrams that do not closely resemble the scenes they are supposed to depict. In these cases, it is worth using the Landform Profile DTM, which is usually a better representation of the landform even if downsampled to 50 m simply for use as a 'patch' to repair the Landform Panorama DTM. In a few situations, the Landform Profile DTM may be found to give a poor representation of small but important local landform features. Some of the data, such as NextMap, now available using radar or laser based aerial survey techniques may be appropriate in this situation for critical viewpoints.

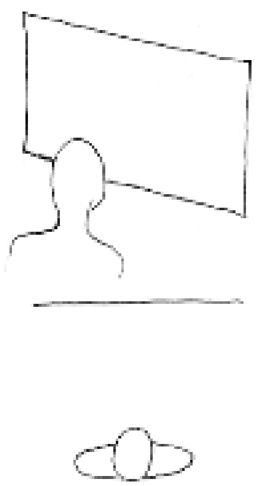


Figure 26a: Planar perspective

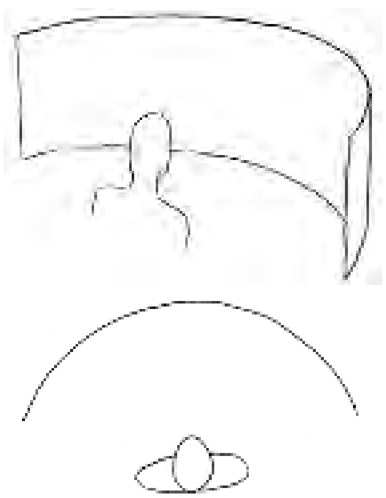


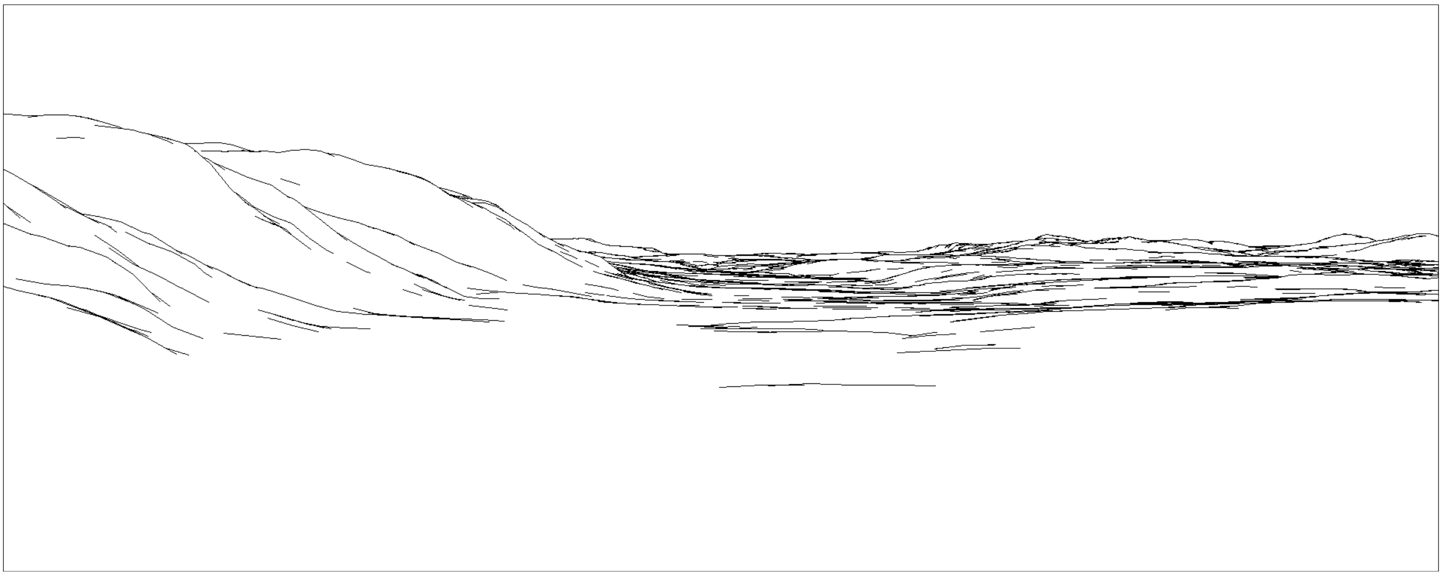
Figure 26b: Panoramic perspective

Geometrical properties

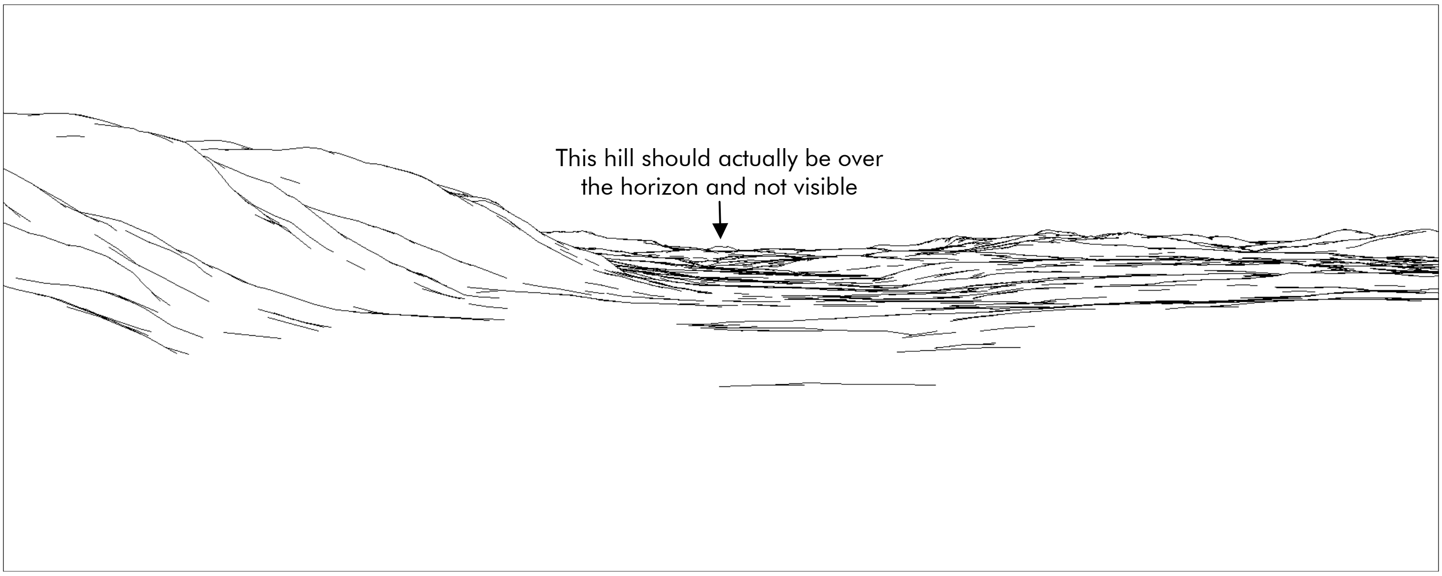
192 As is the case with photographs and photomontages, most wirelines used in windfarm ES work are panoramas. Some software packages can produce true cylindrical panoramas directly; others will produce panoramas, but approximate them as a series of planar panels, generally with an option to specify how many panels are used. Provided that the individual panel width is kept to 20° or less, an acceptable match to a photographic panorama is usually achievable.

193 Some software cannot produce panoramas at all, only simple planar perspectives. The horizontal field of view can generally be specified (sometimes indirectly as an equivalent notional focal length) and will often allow very wide angles to be used. It is however very

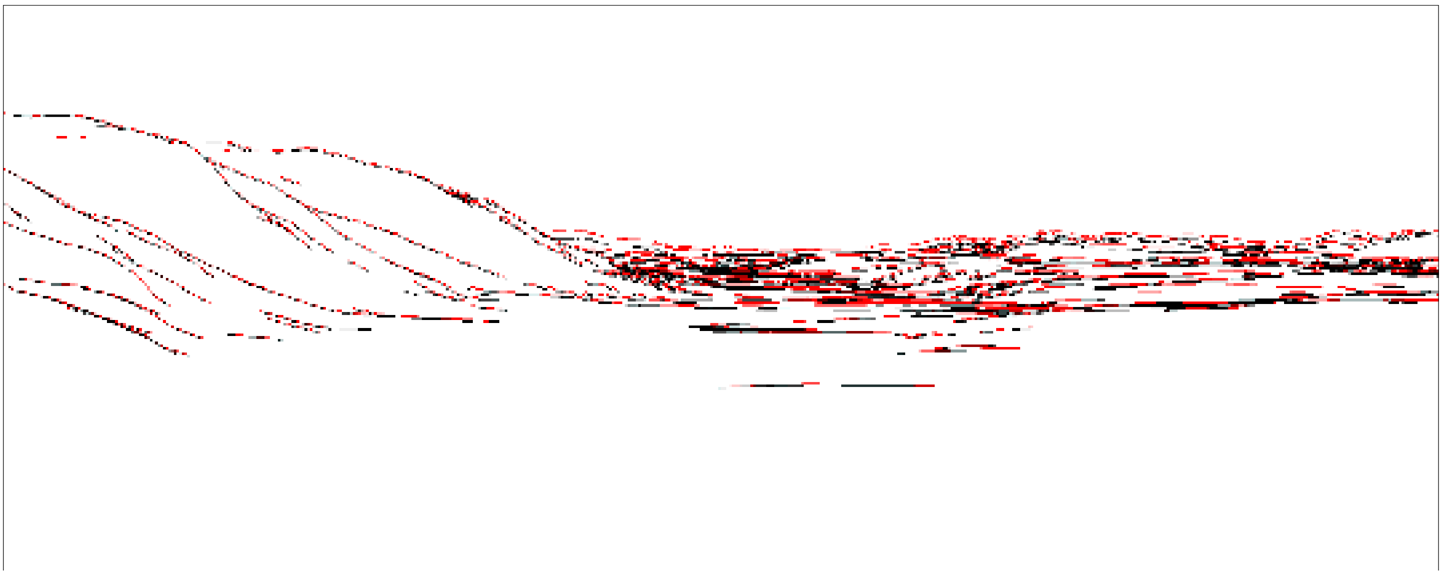
Figure 27: The effect of earth curvature on wireline composition



Wireline image of DTM including effects of earth curvature and atmospheric refraction



Wireline without earth curvature or refraction



Above images superimposed. The version with no curvature is shown in red. Note that distant hills are wrongly placed on the image and also some geographical features are shown which in reality are over the horizon. The image without earth curvature would be impossible to superimpose satisfactorily on a photograph.

important to bear in mind that a planar perspective is not the same as a panorama (there is more detail on this topic in Appendix B). Panoramas can always be approximated with software like this by generating a series of panels that approximate to the required perspective, and then splicing them together in the way that would be done with photographs.

194 Software packages designed for depicting areas of terrain usually include the effect of earth curvature, whereas general-purpose CAD packages most often do not. As pointed out in paragraph 50, the effect of earth curvature increases rapidly with distance from the viewpoint and has a profound effect on the resulting view (figure 27). Wirelines constructed without earth curvature will at best be a poor match to photographs, and at worst will be seriously misleading, as they show features in the distance which in reality would be hidden below the horizon (see Appendix F).

Drawing style

195 Wirelines consist of little more than simple line-drawings of the DTM and the windfarm. However, there are a range of graphic styles used to depict these which can affect the clarity and legibility of the finished image. A number of options are acceptable; however it is important that the same format is used within a single ES.

196 The DTM is most commonly drawn as a mesh seen in perspective. While this is a faithful depiction of the landform as represented by the DTM, it can often result in the more distant parts of the scene becoming unreadable as the grid lines get closer together, eventually merging into solid colour. An alternative, offered by some packages, is to draw only the outline of the topographic features in the scene, approximating to the lines one might draw as a sketch of the scene (figures 28a and 28b). While this approach results in a less cluttered image and one

similar to that which might be hand drawn by a landscape architect or experienced specialist assessor, it can sometimes make the shape of some features harder to understand in three dimensions. A few packages offer a further option of drawing the outlines and also putting in the mesh in a different colour or lighter shade. While the options available within separate software packages may limit choice, it is worthwhile trying alternatives to see which works best for a particular project.

197 Colour is useful to highlight the wind turbines in contrast to the landform lines or mesh, especially in distant views where the effect of merging lines noted above often occurs and where some turbines may only just be visible against the landform. It is sometimes argued that this unnecessarily draws attention to the windfarm but, as the purpose of the diagram is to depict the geometrical relationship between the windfarm and landform, this is not a compelling argument. There are a number of options, such as those listed below and shown in figures 28a and28b.

- Green turbines on a black DTM;
- Red turbines on a black DTM;
- Black turbines on a grey DTM;
- Blue turbines on a grey DTM; and
- Grey turbines on a green DTM.

198 Using the same colour and/or shade for the turbines and DTM grid is not recommended due to the lack of distinction between them, as already discussed. However, all the other options listed above, and potentially others too, are acceptable with the caveat that care must be taken to ensure that the type of colouring does not produce an illusion that the turbines are closer than the landform on which they are sited.

199 Varying colours of turbines can be used to distinguish separate windfarms within a view or existing turbines from proposed wind turbines planned as an extension.

200 Turbines can also be numbered, as mentioned in paragraph 188, so that the individual turbines visible can be directly referred to a layout plan also showing turbines numbered. Unless the windfarm is a very small development, however, this information will usually take up a large amount of space upon the wireline image and, similar to any other labelling, may reduce clarity and distract from the wireline image itself. Consequently, it is generally preferable to label duplicate wirelines within an appendix (just a selection of key viewpoints may suffice). This labelling may need to be done manually, depending on the software used.

201 Features other than wind turbines, can also be modelled into the wireline, depending on the software being used. In this way, existing landscape features can be shown, such as pylons or distinctive buildings, which will help direct comparison with the photograph of the existing view (as long as these do not obscure the wind turbines). In addition, other elements of the windfarm development can be shown, such as the route of access tracks. Inclusion of reference objects, such as field boundaries can help the process of matching the perspective and the photograph during photomontage preparation (although these will usually not be desired in the final wireline used in the ES).

Photomontage

The use of photomontages

202 The basic concept of photomontage is simple; it combines a photograph of an existing view with a computer-rendered image of a proposed development. In this way, photomontages are used to illustrate the likely view of a proposed development as would be seen within a photograph (not as it would appear to the human eye in the field). However, it is important to stress that, although the scale, siting and geometry of photomontages are based on technical data, the other qualities of the image are open to judgements, albeit professionally informed, similar to a hand-drawn illustration. In addition, as already discussed in the section on photography in paragraph 134, photomontages are subject to the same limitations as photographs for representing existing windfarms; that is, that it is difficult to replicate their visibility to the human eye in the field because a printed image cannot replicate the same range of contrast. This is of particular importance when trying to see light-coloured structures at a distance against a background of similar colour and brightness.

203 Photomontages are not generally required by the landscape architect or experienced specialist assessor to carry out VIA. Instead, they will normally use wirelines while carrying out site assessment, to ensure their judgements are based on objective data, as described in paragraph 186 (although, in addition, they will usually consider all information available). However photomontages can help illustrate the visual impacts that have been assessed within the VIA to an audience that is less familiar with windfarm developments, the particular landscape in question and/or how windfarms typically appear in a landscape in comparison to their representation by wireline diagrams.

204 Although photomontages are based on a photo of the existing landscape, it is important to stress that they should never be considered as a substitute to visiting a viewpoint in the field. This is because they are only a tool for assessment. They provide a 2-dimensional image that can be compared with an actual view of the landscape to provide information, such as the scale of a proposed development, but they cannot convey other qualities of the landscape experience that can only be appreciated in the field.

205 Given the limitations of depicting turbines in photos or photomontages of the landscape (as discussed in paragraph 134), their production will usually be of most value for views within 15km of a windfarm site for turbines up to 130 metres high to blade tip. However this will depend on the specific windfarm design and environmental conditions and, consequently, this parameter should usually be discussed and agreed with the determining authority and consultees.

Rendering of photomontages

206 In order to address the difficulty of representing windfarms clearly within photos, it is common practice to exaggerate the prominence of the turbines to ensure that they stand out in the finished photomontage, as discussed previously in the section on photography image enhancement (paragraphs 180-184). When done poorly, this results in a level of visibility unwarranted by the conditions seen in the photograph. However, where done sensitively, this can improve the clarity of an image, comparable to the conventional processing of photographs within a darkroom. Consequently, as for the section of this guidance on photography, is recommended that the rendering of photomontages is acceptable if carried out extremely carefully by a suitably experienced professional. As a guide, the degree of enhancement should be limited to that which would conventionally occur in a

darkroom to improve the clarity of an image, without changing the essential character of the image. The nature of the enhancement should also be noted within the ES.

207 Where a project involves an extension to an existing windfarm, it has sometimes been the case that existing turbines have been 'painted out' in the photo of existing conditions and re-montaged back so that the images of both existing and proposed turbines match. This effectively changes the record of baseline conditions. Consequently, once again, this practice is not recommended if it can be avoided; however it is acceptable under exceptional circumstances, where carried out with extreme care by an experienced professional and noted within the ES.

208 Most importantly, enhancement and rendering cannot compensate for photographs that have been taken in poor light or weather conditions, for example the blue colouring of white skies because of cloud conditions at the time of the assessment. In these circumstances, the photos should ideally be retaken. Neither should enhancement be used as a way of making turbines appear visible within a photomontage for a viewpoint that is actually so far from the proposed development that existing turbines would not be visible within a photograph. In these circumstances, it would be better to represent the likely visibility of the development using wirelines.

Accuracy of match to photography

209 In order to create a photomontage, the geometry of the overlain rendered image of the windfarm must exactly match that of the base photography. That is, the viewpoint location, height and direction of the view must be identical, as must the horizontal field of view, and both the panoramic photograph and the rendered image must be true cylindrical panoramas.

210 The most reliable method of obtaining this accurate match is to generate a wireline image that matches the photograph. If the wireline can be accurately overlaid onto the photograph, then the fit is good. However, where there are few landform features, this process may require the matching of specific structures identified and mapped on site.

211 A GPS position, taken when the photography was carried out, is almost always sufficient for windfarm applications (viewpoint location errors usually manifest as a mismatch in the horizontal position of elements in the photograph and wireline and are always more apparent in closer objects or landscape elements). If it is impossible to obtain a simultaneous match on both near and distant landform features, then the viewpoint position is incorrect and will need to be either re-measured on site or worked out through iteration, depending on the magnitude of the discrepancy and the presence of identifiable objects in the scene.

212 Matching of photographs and wirelines can usually be satisfactorily achieved through knowing the exact location of the viewpoint and windfarm and then adjusting the direction of view to align distinctive features shown within these images. In certain landscapes, where there are few distinctive topographic features, it is necessary to use man-made features such as masts, pylons or buildings in addition. Even when features of these types are clearly visible in photographs, it is often difficult to identify them on the map. If it is anticipated that use will have to be made of built features, then it is worth noting these while taking the photographs and taking compass bearings towards them with a good quality sighting compass. Once identified, these features can be added to the computer model used to create the wirelines and then be treated as alignment aids like topographic features.

213 Note that it is not sufficient to take a compass bearing of the camera's direction of view and then to assume

that this will be sufficient to set the correct direction for a matching wireline.

214 Adjustments should be made until a satisfactory match between topographic features in the wireline and the photograph are achieved across the whole width of the panorama to ensure that there are no errors of scale. If this cannot be achieved, then the fields of view do not exactly match and the parameters must be adjusted further. It is often the case that a small rotation needs to be applied to the panorama to compensate for residual errors in levelling the camera.

215 Once a satisfactory match has been achieved, it is then possible to use the parameters for the wireline as perspective parameters for rendering the turbines for photomontage. Many packages combine wireline and rendering and some also include the facility to overlay the wireline on the photograph while adjusting parameters. However, the best quality is usually obtained using a separate computer program designed for high-quality rendering. Note that most rendering programs do not include the effect of earth curvature, so it may well be necessary to make vertical adjustments to the turbine positions accordingly before rendering.

216 The rendered windfarm should be overlaid on the photograph using a matched wireline for reference, to ensure that the position is correct.

Accuracy of lighting

217 The lighting model used to render windfarm images for photomontages should be a reasonably faithful match to the lighting visible in the base photograph. Consequently it is recommended that the date and time that the photographs were taken should be recorded by the photographer/assessor to enable an exact sun direction to be calculated although, in practice, so long as the direction of light is correct to

within about 10 degrees, a convincing match can be obtained.

218 The effect of light and shade on wind turbines is an important aspect of their visual character and should be represented well. There may be a conflict between achieving realistic lighting and ensuring that the windfarm is clearly visible on the completed photomontage, and thus it will usually be a matter of professional judgement to achieve a satisfactory compromise based on an understanding of lighting conditions and experience of windfarm visibility.

Associated infrastructure and land use change

219 Windfarm proposals include elements other than wind turbines, typically including tracks, borrow pits, cabling and a substation. Additionally, a windfarm development may be both directly and indirectly responsible for vegetation and land use change. If these elements are likely to result in significant impacts, either individually and/ or collectively, they should be included in photomontages if possible, as shown in figure 29.

220 Some of these elements may be difficult to model well, particularly changes in vegetation. In these circumstances, it may be necessary to render them directly onto the photomontage, guided by a wireline or other computer generated image to ensure that the positioning, perspective and scale of these elements is correctly represented.

Figure 29: Representation of land use change (in addition to wind turbines) using photomontage

a: Photograph of existing conditions

b: Photomontage showing proposed land use change in association with windfarm

Other visualisation techniques

Wirelines superimposed on photographs

221 One difficulty of comparing separate wirelines and photographs, is that it is often difficult to interpret the exact spatial relationship between elements in the two images. One alternative is to present the wireline superimposed upon the photograph as shown in figure 30. This is almost a hybrid between a wireline and a photomontage. It has the advantage that the time consuming rendering stage of photomontage construction is avoided; however, in order to achieve a satisfactory superimposition of wireline on photograph, it is still necessary to achieve a quality of perspective match equal to that required for photomontage.

Coloured 3D rendering

222 Wireline diagrams are not suitable for depicting all the works that may be associated with a windfarm, both individually and collectively, for example forestry works, access tracks and borrow pits. One solution, short of a full photomontage, is to use a coloured computer rendering of the scene. This can represent the additional features required, whilst retaining much of the abstract simplicity of a wireline diagram. These techniques are not widely used and different rendering packages offer different facilities, so it is difficult to make firm recommendations on this practice at this stage.

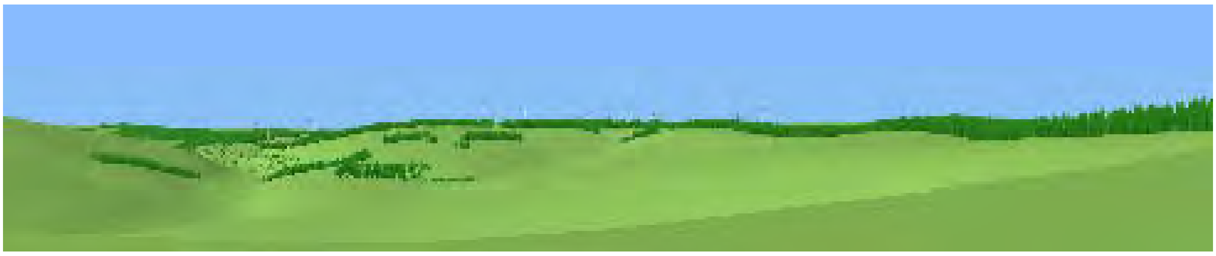


Figure31: Coloured rendering showing proposed forestry works associated with a windfarm

Hand drawn illustrations

223 Drawings and paintings have been used for centuries to illustrate proposed landscape or architectural change. However, it is the production of these using computers that has resulted in radical changes to the way images are conventionally presented, with an associated demand for these to be based on technical data for which accuracy can be measured.

224 There are instances, however, when hand drawn illustrations remain an invaluable tool to the process of visual analysis and the illustration of impacts within an ES. This is mainly because they can offer the following:

- a clarity of image, by omitting some of the distracting details that might be prominent within a photograph but which are actually overlooked on site;
- they can incorporate an element of interpretation by highlighting prominent focal features; and, finally,
- their limitations are obvious – they are clearly not trying to replicate an exact view as it would be seen by the human eye.

225 However, for these same reasons, hand drawn illustrations also have disadvantages, chiefly that their quality is closely linked to the nature and abilities of the illustrator and they may be distrusted for incorporating 'artistic licence'. Hand drawn sketches are commonly included within ESs in two different formats as discussed below.

Diagrammatic sketches and annotated visualisations

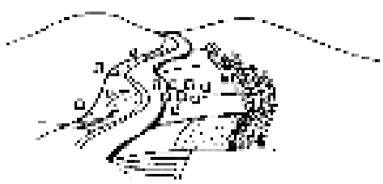


Figure32: Diagrammatic sketch of a landscape

226 Diagrammatic sketches allow the key visual elements of the visual composition to be drawn out and highlighted. This may be in relation to the landscape or the windfarm development, highlighting the main visual characteristics and principles of design. The

advantage of using this medium is that important points can be stressed without these being clouded by insignificant details. In addition, these diagrams are clearly not attempting to replicate an actual view.

227 It is useful to include within an ES visualisations that are annotated to show the position of key elements of the windfarm proposal, such as access tracks and borrow pits, in addition to the turbines. It is also useful to include turbine numbering on some of the visualisations so that individual machines can be easily identified and cross referenced.

Free-hand sketches

Figure33: Free-hand sketch of a landscape

228 Free-hand sketches may be based on just observation, or made in combination with a computer generated image. They can highlight the key visual elements or components of a view, similar to other hand drawn illustrations but, even better, they can also convey some of the elements of landscape experience, such as exposure, landform shape and colour. These can be used in combination with photographs within an ES, but should not be used as a substitute for these.

Animation

229 Wind turbines are intrinsically dynamic objects, with large moving parts and variable orientation, so static images are in many ways an unsatisfying medium of illustration. Computer animation, videomontage and virtual reality techniques are being used to some extent to address this issue.

230 To date, most animation and videomontage has been used principally as a means of conveying a general impression of a development to the determining authority and the public, rather than as a tool for carrying out VIA or as part of an ES. However considerable scope exists for their use in the future as various techniques are developed and presented, and then tested against windfarms once these have been

built (similar to the scrutiny applied in the past to wirelines and photomontages). At present, the application of these techniques require specialist contractors.

231 Guidance on the various methods of animation is not within the scope of this study. However, it is hoped that supplementary information on this subject may be provided at a later date as the practice develops further.

Choice of visualisation

232 This section considers which, how, why and by whom photographs, wirelines and photomontages should be used.

233 To record the baseline conditions of a view, a photograph is required to be presented within the ES. In addition, a wireline diagram is required to indicate the position, scale and shape of proposed wind turbines. Photomontages can also be useful, to provide an impression of visual impacts and help people to interpret the judgements of the landscape architect or experienced specialist assessor, especially if they have less familiarity and/or experience of the particular landscape in question and how windfarms appear in different conditions. However photomontages can only illustrate how a windfarm would appear in a photograph of a development, not how it would appear in reality as discussed in paragraph 119.

234 The choice of viewpoints to be illustrated using photomontages in addition to wireline diagrams may be impossible to determine until after the initial stages of VIA, although many practitioners observe that it is predictably difficult to produce clear photographs, and thus photomontages, of windfarms from distances over 15km. It is recommended that the local planning authority and SNH are consulted regarding the final choice of visualisations for each viewpoint wherever possible.

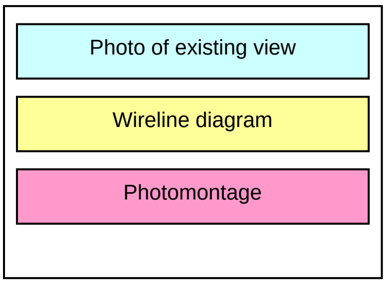


Figure34: The triple arrangement of visualisations

235 In the past, there was often some dissatisfaction with the convention of presenting visualisations from separate viewpoints as a triple arrangement comprising a photograph of the existing view and corresponding wireline diagram and photomontage as shown in figure 34 opposite. This was no fault of the visualisation arrangement *per se*, but because it is not possible to present the triple visualisation at A3 paper

size while satisfying recommended image height and viewing distance criteria (paragraphs 126 and 129). This resulted in three key problems:

- the image was not clear because it was too small to represent the required amount of detail (discussed further in Appendix D);
- the image was held at the correct viewing distance, but this was too close to be viewed comfortably; or
- more commonly, the image was naturally held by the viewer at a comfortable distance, but this was not at the defined viewing distance so that the geometry of the image was incorrect and thus the image scale (and the elements seen within it) was viewed incorrectly.

Nevertheless, the triple format is a useful arrangement and should still be considered as one method for visualisation presentation when using sheets over A3 size, as described within Table 15 and shown in figures 38 and 40.

236 It is important to highlight that the production of different visualisations involves varying levels of data interpretation. Wirelines are based purely on objective data and thus, if only these are used to carry out visual analysis on site, there is a very clear, simple and direct relationship between the data and judgements made. In contrast, the production of photomontages incorporates a much more complex process of judgements in order to construct and render these, similar to any artistic illustration. In this way, although the scale siting and geometry of photomontages can be technically measured, the other qualities of the image will vary in relation to the skill and experience of the illustrator.

237 The difference between photomontages and wirelines in terms of the nature of information they convey and how this informs judgements, was considered by the University of Newcastle (2002). They state "wireframes [wirelines] tended to cause less under (or

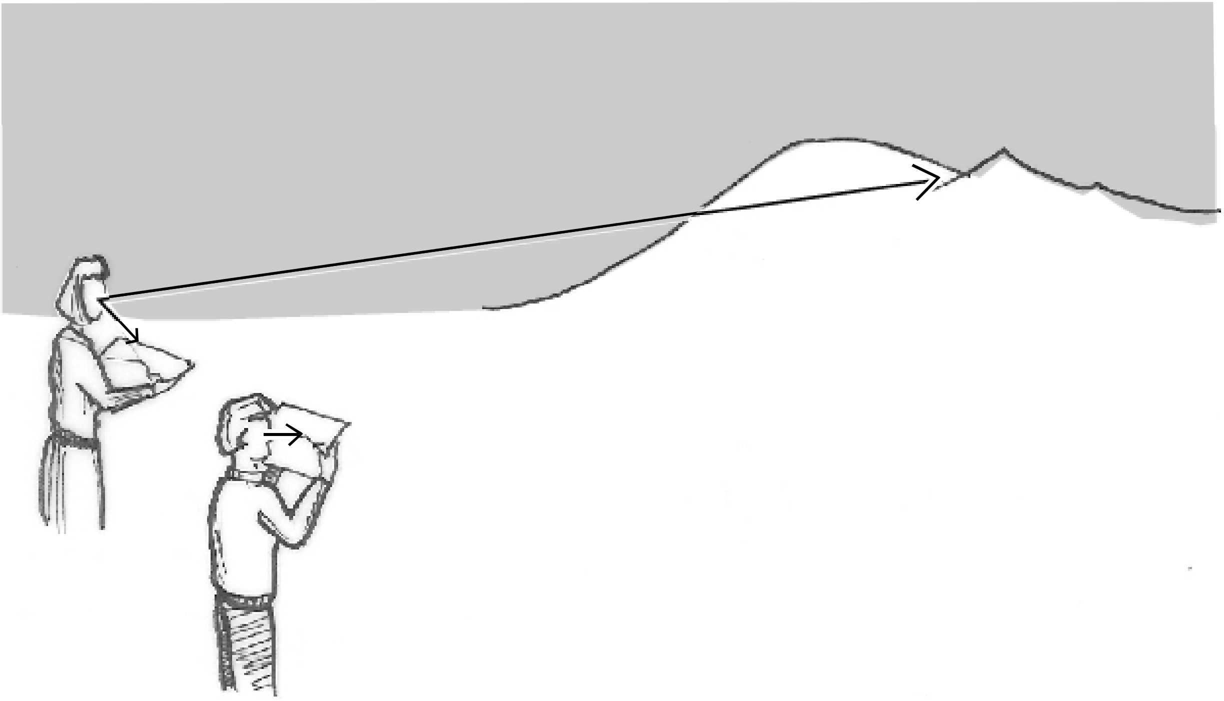
over) estimation of visibility and visual effect, compared to photomontages….".

238 Photomontages are discussed in more detail within the separate section on these within paragraphs 202-220. The proportion of viewpoints illustrated using photomontages within an ES will vary, depending on the specific characteristics of the proposed development and the landscape and visual resource; however ESs within Scotland commonly include photomontages for around one third of the viewpoints illustrated.

239 In certain circumstances, 'regular' photomontages (which are based upon a 50mm lens or equivalent) may be supplemented by a telephoto photomontage. This is where the photograph of the existing view is taken using a telephoto lens (as described in paragraph 155). Normally this would provide no benefit over a photo taken with a standard 50mm lens (or digital equivalent) and enlarged to a sufficient image size and comfortable viewing size, as shown by figure 21. However, in specific circumstances, the additional detail shown in a telephoto photograph can help compensate for the lack of shade differentiation able to be illustrated upon the printed page (refer to paragraph 134). These circumstances tend to occur where a windfarm would be seen in the very far distance against the sky. In these instances, the benefits may compensate for the disadvantage that this creates in terms of having to view an image at a very long viewing distance (figure 22c) and that this distance will vary from other visualisations produced for the same viewpoint.

240 It is important to stress that visualisations should never be used as a substitute to visiting a viewpoint. They remain only a tool for assessment - that is as an image that can be compared with an actual view of the landscape while other elements of the landscape experience can also be appreciated that are unable to

Figure 35: Use of a comfortable viewing distance



At a comfortable viewing distance (400 - 500mm) the viewer can alternate their view between the existing landscape and the visualisation, easing direct comparison and thus judgements on the proposed effect.

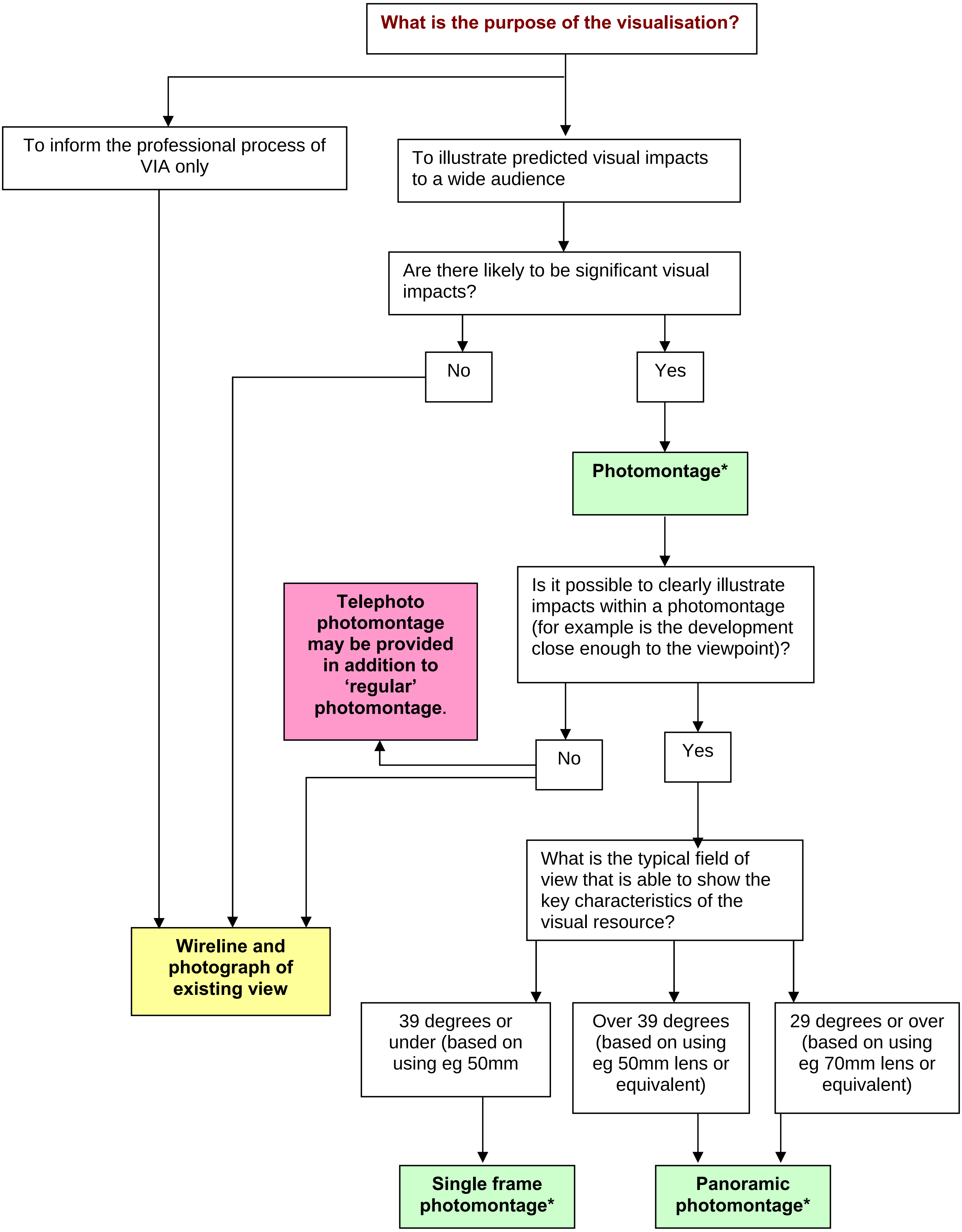
At a short viewing distance (300mm or less) the viewer can only either see the visualisation in front of them, or the existing view - not both. Thus direct comparison is less easy.

be incorporated within a two dimensional picture. To allow this use, it is recommended that visualisations should either be available to be taken out on site by the individual or, alternatively, are mounted upon boards out on site, as illustrated in figure 36. Because of a risk of vandalism or theft, the latter arrangement may be possible during organised visits only.

Figure 36: Visualisation mounted on a board on site in order to provide a direct comparison with present conditions.
(Image courtesy Stuart Young Consulting)

241 Table 13 sets out the various applications of visualisations by different users, while figure 37 indicates the process by which different visualisations may be chosen.

Figure 37: Process of choosing visualisations for each individual viewpoint
(subject also to consultation and agreement with the Planning Authority and SNH).



*plus photograph of existing view and wireline

Table 13: Use of visualisations within VIA

User	*Process*	*Visualisation**	*Use*	*Basis of judgement*	*Judgement*
Landscape Architect or Experienced Specialist Assessor	LVIA as part of EIA	Wireline	On site comparison with visual resource	Professional knowledge and experience of Visual Impact Assessment (VIA), windfarms, and how wireline visualisations compare with built windfarms	Judgements of visual impact magnitude and significance of effect to be reported in ES
		Photomontage	On site comparison with visual resource	Professional knowledge and experience of VIA, windfarms, and how photomontage visualisations compare with built windfarms	For general information only, not usually basis of professional judgement
Officer from Planning Authority or Consultee	Assessment of ES	Wireline	On site comparison with visual resource	Knowledge and experience of the landscape, windfarms, and how wireline visualisations compare with built windfarms	Confirmation of judgements made in LVIA part of ES
		Photomontage	On site comparison with visual resource	Knowledge and experience of the landscape, windfarms, and how photomontage visualisations compare with built windfarms	Supplementary information to help illustrate the likely visual impacts of the windfarm in its landscape setting in addition to associated developments and/ or land use change
Determining authority	Assessment of ES	Wireline	On site comparison with visual resource or, of lesser value, in comparison with photo of existing visual resource	Advice from planning officers. Variable experience of the landscape and windfarms.	Assess planning officers' report regarding confirmation of judgements made in LVIA part of ES
		Photomontage	On site comparison with visual resource or, of lesser value, in comparison with photo of existing visual resource	Advice from planning officers. Variable knowledge and experience of the landscape and windfarms.	Supplementary general information to help illustrate the likely visual impacts of the windfarm in its landscape setting in addition to associated developments and/ or land use change

Member of the public	Understanding of ES and general visual effect of proposed development	Wireline	Access to ES only likely to occur in public building, thus comparison with photo of existing visual resource	Variable background knowledge on the landscape and visual impacts of windfarms.	General indication of the likely visibility, scale and form of the wind turbines.
		Photomontage	Access to ES only likely in public building, thus in comparison with photo of existing visual resource.	Variable background knowledge on the landscape and visual impacts of windfarms.	Supplementary information to help illustrate the likely appearance of the windfarm.

** Telephoto photomontages may also be produced and used in specific circumstances as supplementary information as described in paragraph 239.*

Presentation of visualisations

Presentation for different audiences and uses

242 There are numerous different ways to present visualisations within windfarm ESs. The most appropriate format will depend on a number of factors as follows:

- How and by whom the information will be used;
- Where the information will be used;
- What is required to be illustrated by the visualisation; and
- How the information will be distributed.

243 The landscape architect or experienced specialist assessor will use visualisations as a tool for VIA, both interpreting the images and basing their assessment on a high level of experience and knowledge of VIA and windfarms, as well as a clear understanding of how visualisations differ from views seen with the naked eye. Planners will use visualisations similarly, although they tend to use photomontages (rather than wirelines) more than the assessor. They may also study the visualisations to verify the landscape architect or experienced specialist assessors' findings. The general public will more commonly use photomontages as an illustration of the predicted image of a windfarm and expect minimal interpretation to be required.

244 If the visualisations are to be used in the field, there is generally less need to explain and stress the differences between these images and real life views, although the importance of minimising page size and page 'fold-outs' will be greater. If the visualisations are to be viewed only in an office, home or other building, it will be more important to emphasise how the visualisations should be used and their limitations in relation to real life views, whilst the size of images may be more flexible. For public meetings or displays, visualisations will usually need to be larger; but the

limitations of viewing remote from the real view also apply.

245 The specification of the visualisation will affect how it can be presented, particularly what size of paper is required to illustrate the required horizontal field of view, viewing distance and desired image height. Figures on the size of paper required to accommodate these variables are included in Table 14. There is no perfect solution, as the choice of paper size inevitably involves trade-offs between clarity, ease and cost of reproduction, and practicality of use. All formats have advantages and disadvantages, some of which are described in Table 15.

246 The developer is required to send paper copies of the ES to the determining authority and consultees. However they may charge for some or all parts of the ES if requested by other parties or individuals. As a consequence, for the sake of maximising accessibility, it is in everyone's interests to minimise the potential costs of reproduction. To enable greater numbers of people to study visualisations on site, it may be possible to produce a select number of these within the ES Non Technical Summary (NTS) or as a separate appendix (either free or for a small cost). The disadvantage of producing an extract of this sort, however, is that the visualisations may be misused or misunderstood due to the lack of accompanying information that is found within the main ES.

247 Options may exist for purchasing an ES digitally on CD or for the report to be available via the developer's website, which would incur minimal financial cost. However some domestic or office PCs may struggle to handle the volume of data involved in the photographic images used. In addition, as many of the visualisations represent a wide field of view that would ordinarily be printed at a size larger than most computer screens, the viewer will either need to view these images at a shorter distance than specified or,

alternatively, zoom in on only one part of the image at a time – both of which are unsatisfactory practices.

248 The size of paper required to illustrate visualisations will depend on 4 key factors: the field of view represented by the photograph (paragraph 127); the viewing distance of the paper (see paragraphs 125-126 and 255-256 and Appendix A); the required image size to be clear (showing sufficient detail) (paragraph 129); and how many images are required to fit on each sheet. As mentioned in paragraph 129, an image height over 130mm is acceptable, while an image height of approximately 200mm high is recommended. The following table shows some examples of how these factors influence paper size.

Table 14: Size of paper required to accommodate specific field of view, image size and viewing distance (using 50mm camera lens).

Viewing distance of 500mm, with image height of 200mm			Viewing distance of 400mm, with image height of 200mm		
Field of view (deg)	Width of paper required (mm)	Standard paper size	Field of view (deg)	Width of paper required (mm)	Standard paper size
30	262	A4	30	209	A4
40	349	A3	40	279	A3
50	436	A2	50	349	A3
60	524	A2	60	419	A2
70	611	A1	70	489	A2
80	698	A1	80	559	A2
90	785	A1	90	628	A1
100	873	A0	100	698	A1
110	960	A0	110	768	A1
120	1047	A0	120	838	A0
130	1134	A0	130	908	A0
140	1222	> A0	140	977	A0
150	1309	> A0	150	1047	A0
160	1396	> A0	160	1117	A0
170	1484	> A0	170	1187	> A0
180	1571	> A0	180	1257	> A0

Combinations of visualisations

249 When presenting visualisations in an ES or at an exhibition, it is usual to present combinations of visualisations together, most commonly photograph and wireline, or photograph, wireline and photomontage. This allows the user of the ES to refer to a photograph of the existing conditions and then make a direct comparison between this and the wireline and photomontage.

250 In the past, it has been common practice to present all three of these images together, one above the other on a single A3 sheet. However, as discussed previously in paragraph 235, this layout is only possible if the fields of view shown, the viewing distances, or both, are severely limited beyond recommended standards.

251 A number of alternative options exist for producing combinations of visualisations within an ES. Some of these are described below, illustrated diagrammatically within figure 38, and shown as examples of presentations in figures 39-44. However it is important to stress that these options represent just a few of the many possible scenarios available and each of these has advantages and disadvantages. There is no perfect solution, as implied within Table 15. Rather, the relative pros and cons of all options need to be weighed up for each VIA while considering the following guidance.

- For every viewpoint
  A photo of the existing view and corresponding wireline diagram is required. The viewing distance should be over 300mm, with a recommendation of between 400-500mm. The field of view of the photograph should be determined by the landscape architect or experienced specialist assessor based on the key characteristics of the visual resource and the extent of view required to illustrate this in relation to the windfarm (see paragraphs 135-138).

If the recommended image height of 200mm is used (University of Newcastle, 2002) for the photograph of the existing view (taken with a 50mm focal length lens or equivalent and printed with the minimum acceptable viewing distance of 300mm), this combination can only be accommodated upon an A3 height sheet if the wireline is severely cropped both top and bottom (figure 39). This may be acceptable, where there is only little variation of landform represented within the lower and upper parts of the image, and thus little wireline information is required to be able to directly compare this to the photograph. However, for viewpoints where this is not the case, either the height of the image size needs to be less, the page larger, or the photograph and wireline need to be shown on separate pages. Neither of these options is ideal, as detailed in table 15. Consequently, a decision needs to be made that is based on balancing the relative advantages and disadvantages for each viewpoint.

- For viewpoints where there is likely to be significant visual impacts and where illustration is possible using photomontage
  A photomontage, if required, may either be presented together with the photograph and wireline, as a triple arrangement, as discussed in paragraph 235 and shown in figure 40, or upon a separate page from the photograph and/or wireline. The advantages of the former is that direct comparison between all the visualisations are possible; the advantages of the latter is that presentation on a separate page emphasises the different quality of information that the photomontage presents while maximising its legibility. Whichever format used, the image height, horizontal field of view and viewing distance should match the photograph of the existing view and meet the minimum standards stated.

- For viewpoints where there is likely to be significant visual impacts, but where it is not possible to adequately illustrate the windfarm due to its far distance and because it is seen against the sky.
  In these circumstances, the viewpoint should usually be illustrated using a photograph of the baseline conditions in addition to a wireline diagram. However, in exceptional circumstances, as discussed in paragraph 239, for example a designated site of international importance, a photomontage based on a photograph taken with a telephoto lens may be useful. However it is important to highlight that this photomontage should only be produced in addition to the 'regular' photomontage (based on a 50mm lens) and upon a separate sheet. It should never be produced in isolation as it will not show the full context of the view in relation to the windfarm and key characteristics of the visual resource. Additionally, the use of these photomontages should only be provided with caution, as they will usually require a very long viewing distance that means that the montage needs to be wall mounted or held by another person, and this viewing distance will obviously differ from the other photomontages within the ES, which is not recommended.

- For viewpoints where there are very wide or panoramic views
  As previously discussed, the width of view of the photograph, and thus the standard photomontage, should be based on a judgement of what is necessary to illustrate the key characteristics of the visual resource comprising the 'essential' setting to the proposed development (paragraph 127). However, in certain circumstances, for example where a viewpoint enjoys a panoramic view up to 360°, such as from a mountain top, it may be useful to also include an additional 'context' photograph of the wider panorama. Not because this is required to illustrate the essential setting of

the proposed windfarm, but just for background information. This context photograph should be presented together with the standard photograph, with an outline showing which part of it corresponds to the extent of the standard photograph. Given that the context photograph is for background information only, it does not need to meet recommendations for image size or viewing distance (this should be noted on the visualisation).

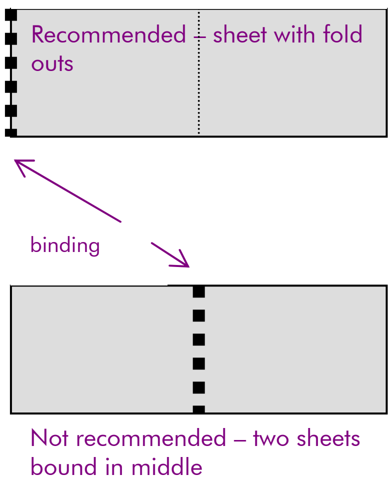
Table 15: Comparison of advantages and disadvantages for different visualisation combinations						
Option no fig no	Paper size	horizontal field of view based on 50mm lens/ viewing distance	Approximate height of image (mm)	No of sheets required to show photograph, wireline and photomontage	Advantages	Disadvantages
1	A1	117° VD = 400mm	Photo = 200 Wireline = 140 Photomontage = 200	1	Triple arrangement allows direct comparison between existing photograph, wireline and photomontage. Clarity of recommended image size and viewing distance. Large paper size may be simpler to present at exhibition.	Large paper size is unwieldy. Requires vertical and horizontal fold-out within A4/ A3 ES document.
1a 40	A2	82° VD = 400mm	Photo = 140 Wireline = 100 Photomontage = 140	1	Triple arrangement allows direct comparison between existing photograph, wireline and photomontage. Large paper size may be simpler to present at exhibition.	Large paper size is unwieldy. Requires vertical and horizontal fold-out within A4/ A3 ES document. Image height shorter than recommended size for best representation.
2 42a, b, c	A3	57° VD =400mm	Photo = 200 Wireline = 200	3	Clarity of recommended image size and viewing distance.	Can only accommodate narrow horizontal field of view that will only be acceptable from a limited number of viewpoints. Comparison of existing photograph and wireline more difficult on separate sheets
3 41a, b	A3	76° VD =300mm	Photo=150 Wireline =100	2	Size of sheet easy to accommodate within ES report.	Image height shorter than recommended size for best representation. Viewing distance shorter than recommended. Need to crop wireline.

Option no fig no	Paper size	horizontal field of view based on 50mm lens/ viewing distance	Approximate height of image (mm)	No of sheets required to show photograph, wireline and photomontage	Advantages	Disadvantages
4 43a, b	A3 height A2 width	110° VD =300mm	Photo = 150 Wireline = 100	2	Allows wider horizontal field of view than on A3.	Image height acceptable, but shorter than recommended size for best representation. Viewing distance shorter than recommended. Fold-outs are more difficult to manage within ES document.
5 44a, b	A3 height A2 width	94° VD =500mm	Photo = 200 Wireline = 200	3/4	Image height meets recommendations and allows wider horizontal field of view. If supplementary telephoto photomontage shown, may improve visibility of very distant windfarm seen against the sky	Comparison of existing photograph and wireline more difficult on separate sheets. Fold-outs are more difficult to manage within ES document. If supplementary telephoto photomontage included, this will need to be viewed at viewing distance that varies from other visualisations and is usually longer than can be hand held.
6	A3 height A3 and A2 width	57° VD =400mm	Photo = 200 Wireline = 200 Context photo = 70mm	3	Image height meets recommendations. Limited horizontal field of view. Supplementary panorama photograph can show wider context of site.	Supplementary 'context' panorama photograph will be limited in height if included upon same page as standard photomontage. If A3 width, narrow horizontal field of view.

Option no fig no	Paper size	horizontal field of view based on 50mm lens/ viewing distance	Approximate height of image (mm)	No of sheets required to show photograph, wireline and photomontage	Advantages	Disadvantages
7	A2 portrait	57° VD =400mm	Photo = 200 Wireline = 200	2	Photo and wireline can be shown on a single page and thus directly compared easily.	A2 size page difficult to include within ES and use on site. Either as loose map within bound wallet, or bound sheet that has to be folded up and out. Photomontage sheet either on different sized paper or inefficiently occupying small proportion of A2 sheet.

252 To allow easy comparison between visualisations on separate pages, it is recommended that these are included within a loose leaf format so they can be taken out and observed side-by-side as necessary. This arrangement also facilitates the temporary removal of certain graphics for use in the field. However, with this flexibility comes the risk that parts of the ES, and particularly the visualisations, may be extracted, and either not returned or, alternatively, inserted back incorrectly. This is a difficult issue to resolve although, as discussed in paragraph 246, it may be ameliorated if some key visualisations for each scheme are available (either free or at a small cost) within a separate document or within the ES Non Technical Summary.

Figure 45 – Binding of oversize sheets within report’



253 Where visualisations are not required to represent a very narrow horizontal field of view, a sheet wider than A3 will be required. These can either be bound within the document with fold-outs to the side, or alternatively, included as loose folded sheets within a bound wallet. Double-sized A3 sheets or an extended A3 sheet (A3 height +A2 or A1 width) are sometimes bound into a document so that the image extends over both facing pages; however these face the problem of the binder obstructing or distracting attention to/from part of the image, even if using a minimal sized velo binder, and are thus not recommended. Nevertheless, if binding is carried out in this way, it is advised that the visualisation is positioned so that the proposed development does not lie within the spine area.

254 Usually, it will be appropriate to present the photograph, wireline and photomontage such that the proposed wind turbines are centralised in the horizontal field of view. However, at certain viewpoints, it may be appropriate to centre the view on an alternative feature, or part way between two or more foci. These additional foci may or may not be windfarms. In these circumstances, it is important that the proposed windfarm does not appear at the far

edge of the image. This is because sufficient context/ horizontal field of view needs to be provided for each of the foci.

255 As previously highlighted, it is important that visualisations are viewed at the correct 'viewing distance' – that is the distance between the eye and the image that directly relates to the visualisation calculations and image size. This is discussed further within paragraphs 125-126 and 255-256 and Appendices A and C. This distance should always be stated next to a visualisation. In addition, the visualisation should be large enough to show sufficient field of view and detail as described further in paragraphs 129 and 248.

256 To accommodate the horizontal and vertical field of view required at the recommended viewing distance, there will usually be a requirement to use pages larger than A3, either as pull-outs or folded within a wallet. It is important that the viewing distance should be the same for all visualisations in an ES (unless there is a very good reason for doing otherwise, which should be stated and clearly justified). This avoids the need to search out the specification for viewing distance on every image and to repeatedly adjust the position of the document. Experience has shown that, where different viewing distances are used, rather than the viewer altering the distance at which they view each visualisation, there is a tendency to either just adopt the first viewing distance marked and assume this to be standard or, alternatively, adopt a single 'average' viewing distance for convenience. Either action is unsatisfactory as it results in some of the visualisations being viewed incorrectly.

Information to provide

257 Information provided on the specification of a visualisation should be sufficient for the reader of either an ES or a display board to understand the basis of the visualisation, but not so much as to be

overwhelming. Some of this information should be shown upon the visualisation sheet itself, while the remainder can be put within the VIA or appendices. The information provided should include that within the following Table 16.

Table 16: Information to accompany visualisations	
1	Overall 'health warning' summarising how the photomontage should be used and its limitations, and referring to further detail on this issue elsewhere in the ES
2	Information on viewpoint location, altitude and horizontal field of view, as listed within Table 8.
3	Direction of centre of photograph as a bearing
4	Correct viewing distance
5	Whether the image is panoramic or planar perspective and/ or cylindrically projected.
6	Distance to nearest visible turbine in kilometres
7	Cross reference to assessment of viewpoint within VIA and relevant technical appendices. Cross reference to information on photography, listed within Table 12, within VIA and/ or relevant technical appendices.
8	Position of view horizon where there has been unequal cropping between the top and bottom of the image (for example because the key view from a mountain top is downwards)

258 Additional information on the production of the visualisations is important (for example the camera specification and date and time of photograph). However this is not required to interpret the visualisation, and thus can be provided elsewhere within the VIA text or in a clearly referenced appendix.

Paper and printing

259 There is an extremely wide variety of different printers and paper types available with which to print visualisations. To obtain the best results in relation to the size and type of visualisation, it is recommended that advice is sought from specialist providers.

However a number of very general guidelines can be provided within this Good Practice Guidance.

260 If using an inkjet printer, in order to produce a higher contrast finish (where ink sits on the surface rather than soaking in), a high gloss paper is recommended as shown within figure 46a. Very glossy paper, similar in appearance to photographic paper will tend to provide the best image resolution. However this is very expensive and tends to be heavy and thick; so, while it is useful for exhibitions, it can add undesirable weight and bulk to an ES document. As a compromise, coated paper is an acceptable alternative (figure 46b), having lower absorption rates than standard copy paper (figure 46c), while possessing some of the shine and impenetrable surface of high gloss paper, and while being less expensive and heavy.

261 If using a colour laser printer, a smooth white copier paper is usually recommended. This should be of at least 90gm weight.

262 The quality of a printed visualisation will depend significantly on the printing process and set-up. Colour inkjet printers tend to show more detail than other machines because of their higher colour range and resolution. However, it is generally difficult to produce large numbers of pages in this way; so, for mass printing, either colour laser printing or professional printing may be advisable.

263 Printing multiple copies of sheets larger than A3 can be expensive and, if folding is required, may result in a bulky ES report. However, these difficulties must usually be accepted if recommendations for viewing distance, field of view and presentation are to be met; indeed, they are already commonplace for most windfarm ES submissions in Scotland.

Exhibition display

264 Exhibitions provide an opportunity to present larger visualisations. There is a definite advantage in printing at large sizes to include as much detail as possible, particularly photographs and photomontages. The viewing distances should always be stated, as for ES visualisations and as noted within Table 16. These may be larger than the 500mm maximum appropriate for hand-held material. The use of a footplate or cordon in front of exhibition boards can direct viewers to the correct viewing distance.

265 Cylindrical panoramas should either be presented on a curved surface, or presented in a way that allows sideways movement from one side of the image to the other at a constant viewing distance (see Appendix B).

Table 17: GOOD PRACTICE GUIDANCE SUMMARY

VISUALISATION			
	Paragraph in report	Minimum requirements_	Preferred requirements
General	119 134	The limitations of visualisations should be understood before making any assessment based upon them. Assessment of visualisations off site should include consideration of the description of viewpoint characteristics within the ES that cannot be represented by a 2-dimensional image.	Assessment of visualisations should be carried out on site where direct comparison can be made to the real life view.
Key issues affecting visualisations	124	The size of visualisation should be determined by the most appropriate vertical and horizontal field of view and the recommended viewing distance (while being large enough to show sufficient detail).	
	126	A viewing distance of 300mm – 500mm.	A viewing distance of 400 – 500mm.
	127 143	The horizontal and vertical field of view for each visualisation should be determined by the landscape architect or experienced specialist assessor.	
	129 142	An image height of over 130mm for hand-held material.	An image height of approximately 200mm for hand-held material.
	130	Viewpoint visualisations should be assessed together with other aspects of VIA, including visibility as shown by ZTVs.	
Photography	146	SLR camera for 35mm film or digital SLR	
	135-138	Field of view, vertically and horizontally, should be determined by the landscape architect or experienced specialist assessor, in addition to the central point of the photo.	A panorama should be taken to extend the entire width of open view (excluding towards the sun if this is at a low angle)
	147	Levelled photographs, using tripod and spirit level	Panoramic tripod head
	149	Fine-grained 35mm film (ISO 200 or less)	Film ISO 100 or less

	Paragraph in report	Minimum requirements_	Preferred requirements
Photography (continued)	152-153 157-158	50mm fixed focal length lens for 35mm film. Lens giving similar field of view for digital. Do not use zoom lens. Take vertical (portrait) format panorama where a tall vertical field of view is to be represented.	Telephoto lens in very specific circumstances in addition to 50mm.
	159-161 Table 11 164	Ensure good contrast within photograph. Direction and intensity of light should be sufficient to capture existing/ proposed wind turbines on photographs. Not directly into sun. Reveal site and surrounding key characteristics of landscape and visual resource.	Take photographs in strong side light conditions to emphasise topography.
	165-167	Record information on specification and conditions of photographs as listed in Table 12.	
	163	For panorama, manually set exposure setting to ensure good lighting over the entire panorama, but particularly the site and key characteristics of the area.	
Post photographic processing	168-169	Scan negatives to a minimum of 2400ppi, taking care to achieve clean image	Use a bureau service offering Photo CD scans
	174-175	Splice frames manually to build up panorama for photomontages	Use software to re-map frames to cylindrical perspective and correct for lens defects
	173	Use automatic splicing software only for photos to be used as background information and never for photomontages	
	175	Provide overlap of frames by between ¼ and ½ frame width.	
	176	Illustration of turbines should be based upon correct hub height, rotor diameter and general shape	It is recommended that Illustration of turbines should be based on detailed 'engineering' drawing.
	177-179	Wind turbines should be shown all facing a specific compass bearing, not all towards the viewpoint.	Wind turbines shown facing the direction of the prevailing wind

	Paragraph in report	Minimum requirements_	Preferred requirements
Post photographic processing (continued)	180-184	Image enhancement, such as sharpening and colour balance should be avoided if possible. However, if required to improve clarity, this should only be carried by experienced practitioner and with care. Only methods that could be done in a conventional darkroom should be adopted. These should be applied over the whole image, rather than selectively to emphasise only some features that will change the image content.	
Wirelines	189-191	Use OS Panorama DTM as basis for wirelines	Use OS Profile DTM as basis for wirelines
	190	Ensure sufficient data is included to extend to the distant horizon (which may be outwith the study area)	
	194	Include earth curvature correction in wirelines	
	192-193	True panoramas or planar perspectives with a panel width of less than 20°	Ensure that wirelines are true panoramas
	176 197-200	Ensure that all proposed turbines are revealed in wirelines	Include associated elements such as proposed tracks, buildings and overhead electricity lines.
	197 196	Use contrasting colour and/or shade for turbines and DTM mesh	Use DTM landform lines, possibly with lighter coloured broad DTM mesh too, to avoid colour/shading mass seen at far distances.
	188 200	Wirelines with labelled turbine numbers should be included within the ES.	
Photomontage	205	Produce photomontages where significant impacts can clearly be illustrated	
	206	Do not excessively exaggerate the visibility of the windfarm, limiting rendering to that which looks realistic and could be done in a conventional darkroom.	

	Paragraph in report	Minimum requirements_	Preferred requirements
Photomontage (continued)	210	Use a wireline to ensure accurate perspective match with photographs	
	212	Provide 12 figure grid reference to ensure good match of photo and photomontage.	Provide compass bearings to prominent features in the view.
	217	Ensure that lighting of montage matches lighting of photograph. This should be based upon date and time photo was taken.	
	176 219	Illustrate all wind turbines within photomontage.	Show variable rotor position within photomontage. Include additional elements in photomontage, such as forestry works, roads and borrow pits
Other visualisation techniques	221-231	Consider use of techniques other than simple photos, wirelines and photomontages where appropriate.	
Choice of visualisation type	233	Wirelines are required for each viewpoint in addition to a matching photograph of the existing view.	Provide photomontages where impacts are likely to be significant and a windfarm could be clearly seen within a photograph
	236-237	Wirelines should be used where visualisations require to be based on objective data only	
Presentation	246-247	Provide paper copies of all visualisations within the ES	Provide digital copies of visibility maps and visualisations in addition to paper copies, or provide extracts that can be obtained/ purchased separately (free of charge or at minimal cost).
	129	Images should be at least 130mm high.	Images approx 200mm high are recommended.
		If more than one image is shown upon a page, this should be separated by an area or strip of blank space to maximise legibility.	
	249 250 251	A photograph of the existing view should be followed directly by the wireline. The wireline should then be followed by the corresponding photomontage(s) if being produced.	Wirelines should ideally be presented next to the corresponding photograph upon a single page whilst also meeting the recommended image height and viewing distance.

	Paragraph in report	Minimum requirements_	Preferred requirements
Presentation (continued)	249 250 251	A photograph of the existing view should be followed directly by the wireline. The wireline should then be followed by the corresponding photomontage(s) if being produced.	Wirelines should ideally be presented next to the corresponding photograph upon a single page whilst also meeting the recommended image height and viewing distance.
	124 255 256	The page size should be determined by the most appropriate field of view together with the required viewing distance.	
	252	Allow visualisations to be obtained separate from the main ES for direct comparison side-by-side and to be viewed in the field.	Include visualisations within ES in loose leaf format so that visualisations can be extracted and compared side-by-side.
	125-126, 255-256	Always note correct viewing distance on a visualisation. Use a viewing distance of 300-500mm for material intended to be hand held.	A viewing distance of 400-500mm is strongly recommended. The viewing distance should be the same for each visualisation within an ES.
	257	Include all information in Table 16, including location, direction of view, viewing distance and distance to nearest visible turbine on page	
	241 251 Table 13	Consider carefully the different options for presenting visualisations for different viewpoints.	Consult with the Planning Authority and SNH regarding options
	260	Use coated paper for printing.	Use high gloss paper for specific presentations where weight and mass are not a limiting factor.
	240 264-265	Use large display boards for exhibitions. The correct viewing distance should be very obviously marked upon the ground.	Consider use of curved display boards for visualisations at exhibitions. Consider mounting some visualisations on display boards on site at the viewpoint locations for direct comparison with the 'real life' view.

5 Conclusions

266 Visual analysis of windfarms is just one part of the wider study of Visual Impact Assessment. In turn, VIA forms just one part of the wider Landscape and Visual Impact Assessment within an Environmental Impact Assessment. Yet within the visual analysis process itself, there is a wide range of different tools and techniques that can be used.

267 While this Good Practice Guidance can advise on the different purposes, uses and limitations of these processes and set down some minimum technical requirements, it cannot prescribe a single recommended method as there is no 'one size fits all' solution.

268 When selecting the most appropriate type of ZTV mapping and visualisations, it is important to remember why they are being produced, how they can be used and what they can offer. Essentially ZTVs and visualisations are only tools. Behind all their planning, specification and production is the desire for them to aid the assessment of significant visual effects; however they can never reflect the whole story nor, indeed, provide the whole answer.

269 ZTVs and visualisations will be read in different ways by different people, based on their experience and understanding of visual impacts, windfarms, and how these are typically represented by visualisations. As a consequence, there is no single format nor method of production that will satisfy every person's requirements. The Environmental Statement should instead focus on including information used by the landscape architect or experienced specialist assessor in carrying out the VIA, and providing sufficient information to aid other people's understanding of the likely impacts of a windfarm in the landscape and how the judgements within the VIA were made.

270 It is imperative that the selection and use of ZTVs and visualisations as part of a VIA process is carried out in an informed, methodical manner and for this process and its findings to be documented in a transparent way. The integrity and credibility of VIA and EIA depends on a detailed and explicit declaration of the basis upon which all aspects of the assessment have been made. For VIA, this includes the technical specification of visibility maps and visualisations.

271 General guidance on assessing significance of impacts is contained within the Guidelines for Landscape and Visual Impact Assessment (Landscape Institute & Institute of Environmental Management & Assessment, 2002).

272 This Good Practice Guidance provides a starting point for understanding the various methods of visual representation of windfarms, while appreciating that these methods will continue to change and evolve, as people find new and better methods and tools. Thus this report reflects a current understanding of some of the key issues relevant to the visual representation of windfarms, but it is envisaged that this will require future updating.

273 A particular issue that calls for further guidance in terms of visual analysis is the cumulative landscape and visual impacts of windfarms. Whilst the basic principles of VIA for multiple developments are similar to those for individual developments, accumulation makes prediction and assessment during VIA even more complex, and presents new challenges in terms of illustration and presentation. Additional information usually required for cumulative VIA (CVIA) includes cumulative ZTVs and cumulative visualisations.

274 Offshore wind energy development also requires separate guidance in relation to visual representations. While the basic principles of VIA, and the tools used to carry out this process, are the same as for onshore

developments, there are some distinct differences, particularly in relation to visibility over the sea, the horizontal emphasis of views, turbine lighting, and the provision of distinct visual references.

275 Animation and video montage are other methods of visualisation, outwith the scope of this study, for which guidance would be beneficial.

Appendix i

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List of Environmental Statements assessed

These ESs were chosen by the Steering Group to represent a wide range of visualisation methodologies and quality and should not be taken as representing either best or worst practice.

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Appendix ii

Glossary

Definitions are provided below for terms as used in this document (these may differ within other publications).

Reference should be made to the glossary contained within the Guidelines for Landscape and Visual Impact Assessment (2002). Some of the terms are repeated here however (marked by an asterisk), due to their particular relevance to the visual representation of windfarms.

Assessment (landscape). An umbrella term for description, classification and analysis of landscape.*

Cumulative effects. The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.*

Element. A component part of the landscape or visual composition.

Environmental Impact Assessment. The evaluation of significant effects on the environment of particular development proposals.

Horizontal array angle. This term is used to describe the horizontal field of view occupied by the visible part of a windfarm.

Landscape. Human perception of the land conditioned by knowledge and identity with a place.*

Landscape character. The distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived by people. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape.*

Landscape effect. This derives from changes in the physical landscape, which may give rise to changes in its character and how this is experienced. *

Landscape feature. A prominent eye-catching element, for example, wooded hilltop or church spire.*

Landscape resource. The combination of elements that contribute to landscape context, character and value.*

Magnitude. A combination of the scale, extent and duration of any impact.*

Mitigation. Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual impacts of a development project.*

Panorama. An image, covering a horizontal field of view wider than a single frame. Panoramic photographs may be produced using a special panoramic camera or put together from several photographic frames. Wirelines and photomontages may also be panoramas. See Appendix B.

Photomontage. A visualisation based on the superimposition of an image onto a photograph for the purpose of creating a realistic representation of proposed or potential changes to a view. These are now mainly generated using computer software.

Receptor. This term is used in landscape and visual impact assessments to mean an element or assemblage of elements that will be directly or indirectly affected by the proposed development*.

Sensitivity (landscape or visual). The extent to which a landscape or visual composition can accommodate of a particular type and scale without adverse effects on its character or value.

Scoping. The process of identifying the likely significant effects of a development on the environment which are then to be the subject of assessment.

Telephoto Photomontage. A type of photomontage (see above) based on a photograph taken using a telephoto lens (over 50mm).

35mm camera. This is a Single Lens Reflex (SLR) camera that uses a 35mm film gauge with a negative size of 36 x 24mm.

Visual Amenity. The value of a particular area or view in terms of what is seen.*

Visual effect. This results from changes in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity. *

Visualisation. Computer simulation, photomontage or other technique to illustrate the appearance of a development. *

Windfarm. Also known as a 'wind farm'. A development of wind turbines for the purposes of generating energy.

Wirelines. Also know as 'wireframes' or 'computer generated line drawings'. These are computer generated line drawings, based on digital terrain models (DTM), that illustrate the three-dimensional shape of the landscape in combination with additional elements.

Zone of Theoretical Visibility (ZTV). Also known as a Zone of Visual Influence (ZVI), Visual Envelope Map (VEM) and Viewshed. This represents the area over which a development can theoretically be seen, based on digital terrain data. This information is usually presented on a map base.

** As defined by the Landscape Institute and Institute of Environmental Management and Assessment (2002)*

Zone of Visual Influence (ZVI). See Zone of Theoretical Visibility (ZTV) above.

Appendix iii

Acronyms and abbreviations

APS	Advanced Photographic System
CAD	Computer Aided Design
CD	Compact disc
CIA	Cumulative Impact Assessment
CLVIA	Cumulative Landscape and Visual Impact Assessment
cm	Centimetre
DSM	Digital Surface Model
DTM	Digital Terrain Model
DPI	Dots per inch
EIA	Environmental Impact Assessment
ES	Environmental Statement
EXIF	Exchangeable image file
GIS	Geographical Information System
GPS	Global Positioning System
GLVIA	Guidelines for Landscape and Visual Impact Assessment
ISO	International Standards Organisation (set film speed ratings)
LIA	Landscape Impact Assessment
LVIA	Landscape and Visual Impact Assessment
m	Metre
mm	Millimetre
NGR	National Grid Reference
NTS	Non Technical Summary
OS	Ordnance Survey
PC	Personal Computer
PPI	Pixels per inch

RMS	Root mean square
SLR	Single lens reflex
SNH	Scottish Natural Heritage
SRF	Scottish Renewables Forum
SSDP	Scottish Society of Directors of Planning
TIN	Triangulated Irregular Network
VEM	Visual Envelope Map
VIA	Visual Impact Assessment
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence
2D	Two dimensional
3D	Three dimensional

Technical Appendices

A Camera Perspective

Linear Perspective
The pinhole camera
Practical cameras
Wide angle geometry
Image distortion
Correct viewing distance

B Panoramic Photography

Types of panoramic camera
Pseudo-panoramic systems
Fixed lens panoramic cameras
Rotating lens panoramic cameras
Spliced panoramas
Geometrical implications

C Human Vision

Acuity
Detail and contrast
Field of view
Comfortable viewing distance

D Choice of Focal Length

Size of image
Resolution
Field of view and detail

E Taking Good Photographs

Camera
Film
Tripod
Levelling
Focus
Aperture and exposure
Recording photographic details

F Earth Curvature and Refraction of Light

Technical Appendix A

Camera Perspective

Linear Perspective

A1 Leonardo da Vinci wrote, "Perspective is nothing else than seeing a place or objects behind a pane of glass, quite transparent, on which on which the objects which lie behind the glass are to be drawn. These can be traced in pyramids to the point in the eye, and these pyramids are intersected by the glass plane" (Richter and Richter 1939). This description is known as 'Leonardo's window' and is illustrated neatly (if quaintly) by a plate from *New Principles of Linear Perspective* by the English mathematician Brook Taylor (Taylor 1719).

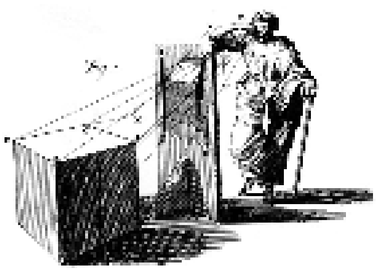


Figure A1: Leonardo's window as illustrated in Taylor's 'New Principles of Linear Perspective'.

A2 In Taylor's diagram, the top corners of a cube, ABCD, are shown projected onto the picture plane as points abcd. Each point on the object is projected onto a corresponding point on the image by a straight line passing through the observer's eye (we have to assume that the other eye is closed for this purpose).

A3 Straight lines in the object are necessarily represented by straight lines in the image. Consider, for example, the line AB. It forms a plane triangle with the observer's eye point O. The intersection of a plane triangle with a plane (in this case the picture plane FGHI) can only be a straight line, so it follows that the projected line ab must also be straight. This property is a characteristic of perspective with a single eye point and a planar picture surface.

A4 The geometry described by Taylor is that found in any textbook on 'measured perspective', the construction of accurate perspective views using drawing instruments (Walters and Bromham 1970). It is also the geometry found in the perspective projections provided by computer graphics software.

The Pinhole Camera

A5 The principle of the pinhole camera was known to Leonardo (in the form of the 'camera obscura') and described by him (Richter and Richter 1939). Instead of the rays of light passing through a transparent picture plane to a single eye point, they pass through a single point, the pinhole, to project an image onto the picture plane. As in the case of Leonardo's window, the straight lines followed by the rays of light ensure that straight lines in the object project as straight lines in the image.

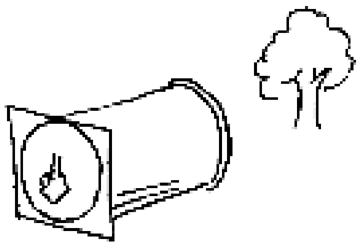


Figure A2: A simple pinhole camera made from an old tin can.

A6 A pinhole camera may be constructed quite simply from an empty tin can with a small hole punched in one end and a piece of tracing paper used as a screen. This is in essence the camera obscura used by some artists in the 17th and 18th centuries as a means of quickly establishing the perspective of a scene, drawing directly onto paper stretched over the back of the device. The longer the distance between the pinhole and the screen, the larger will be the projected image.

Figure A3: A pinhole camera improvised by replacing the lens of a digital SLR with a modified body cap.

A7 A working photographic pinhole camera may be constructed by replacing the lens of a single-lens reflex camera with a pinhole in the form of a small hole drilled in thin sheet metal and supported on an adapted camera body cap. The disadvantage of a pinhole over a lens becomes immediately obvious

Figure A4: Photograph taken with the pinhole 'lens' on a digital SLR as shown in Figure A3.

Figure A5: Photograph taken with 50mm lens on the same digital SLR.

when it is put to use; the pinhole admits very little light, resulting in very long exposure times (up to a 10 seconds) to form an image. The pinhole size determines the sharpness of the image: too large and the image is blurred because each point on the image is illuminated by light from more than a single point in the scene; too small and the diffraction of the light as it passes through the pinhole blurs the image. Even the optimum pinhole diameter of about 0.2mm produces results far inferior to a lens.

Practical Cameras

A8 As mentioned above, the camera obscura was used as a perspective aid by some artists. With just a pinhole, the image would be too faint to use comfortably, particularly if working out of doors, so a lens was used. A good lens behaves in the same way as the pinhole in that the light appears to travel in a straight line from object to image, passing through a point at the centre of the lens. In reality, the light passes through all parts of the lens but is bent by the glass in such a way that light from any given point on the object viewed arrives at a corresponding single point on the image, no matter which part of the lens it passes through on the way. As the light can pass through the whole area of the lens, the resulting image is much brighter than with a pinhole.

Figure A6: Digital SLR fitted with 50mm focal length lens.

A9 The earliest photographic cameras constructed by William Fox Talbot in the 1830s were direct adaptations of the camera obscura with chemically sensitised paper in place of the screen for drawing (Arnold 1977).

A10 All modern cameras follow Fox Talbot's basic model of a lightproof box with light passing through a lens and being focussed onto a sensitised surface, either film or an electronic sensor in modern cameras. The quality of the resulting image is largely dependent on the quality and precision of the lens used.

Wide angle geometry

A11 Although Leonardo's window must necessarily produce a true perspective as the image exactly overlaps the object, very wide fields of view can nevertheless produce results which are surprising at first glance.

Figure A7: Photograph taken with equivalent of a 20mm lens on a 35mm camera, showing perspective and scale effects of extreme wide angle

A12 This example was taken with a very wide-angle lens, giving a horizontal field of view of 84° Elements in the scene towards the corners of the frame seem to be elongated and stretched away from the centre of the photograph. However, referring to Brook Taylor's illustration of Leonardo's window, these elements would be seen by the statuesque viewer at a very oblique angle and the foreshortening introduced by this oblique angle exactly compensates for the elongation in the image. (See the section below on viewing distance.)

A13 This elongation of elements in very wide angle images is often referred to as 'distortion'. However it is incorrect to do so as it is simply a consequence of the geometry of linear perspective.

Image Distortion

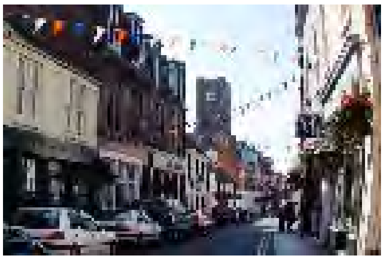


Figure A8: Barrel distortion

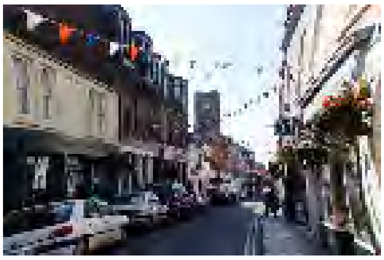


Figure A9: Pincushion distortion

A14 'Distortion' has a very specific meaning with reference to the properties of camera lenses. There are five classes of monochromatic lens defects (that is, ones that do not affect the colour in an image). Of those, the only one that affects the geometry of the resulting image is 'distortion'. (The others, spherical aberration, astigmatism, coma and field curvature only affect image sharpness.) Distortion is the phenomenon of straight lines on the objects in a scene being represented by curved lines in the image. If these curves bend outwards from the centre of the image, the lens (and the image) is said to exhibit 'barrel distortion'. If the curves bend inwards, the condition is termed 'pincushion distortion'.

A15 The best quality fixed focal length lenses are substantially free of distortion. However, wide angle lenses are difficult to make distortion-free and even very good quality examples sometimes have a small amount of barrel distortion.

A16 Zoom lenses are well known to suffer from quite substantial distortion. This is a consequence of the compromises involved in designing a lens which will offer a range of focal lengths and still have a reasonably wide maximum aperture. Typically, a zoom lens will exhibit barrel distortion at the shortest focal length it provides and pincushion distortion at the longest focal length. There may be a point in between where there is effectively no distortion or there may be a combination of pincushion (in the centre of the image field) and barrel (at the edges). Generally, the distortion effects are more pronounced the greater the range of focal lengths provided and are more pronounced on lenses with greater maximum apertures.

A17 With a fixed focal length lens on a digital camera it is possible to calibrate any distortion and remove it by using suitable software.

Correct Viewing Distance

A18 Given a photograph printed on a transparent plastic sheet, it would be possible to go to the location where the camera was set up, to hold the photograph up and to look through it at the actual scene. Clearly, if the photograph is held too close to the eye, the elements in the image will appear too big. If it is held too far away, the elements will appear too small. There will be only one distance at which the photograph will exactly match the real scene. This is usually termed the 'correct viewing distance'. Books on geometrical perspective casting tend to use the term 'perspective distance' for the same physical dimension. Brook Taylor used the term 'principal distance' (Taylor 1719) and that term is still used in camera optics.

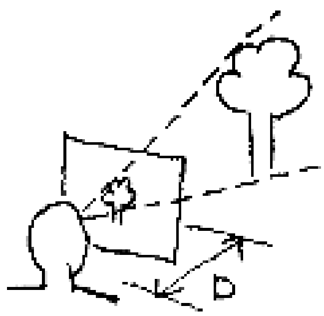


Figure A10: Image and scene coincide only when viewed from the correct viewing distance.

A19 In a pinhole camera, all the light passing through the pinhole really does pass through a single point (or very nearly so, given that the pinhole has a finite size). In a simple (single thickness of glass) thin lens (like a magnifying glass) this is also true. Although the light passes through the whole of the lens, the image formation may be understood as if it converged from the object to the centre of the lens, termed the 'nodal point', and radiated from that point to form an image.

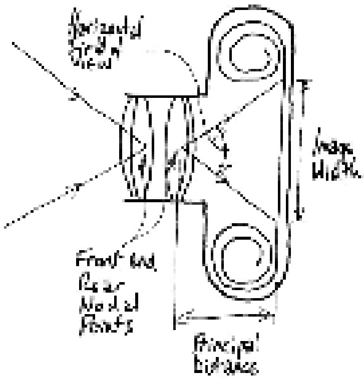


Figure A11: Optical properties of a camera and lens.

A20 In a camera lens, there are generally four or more separate lens elements, typically bonded together in two groups, with the iris of the lens between them. Generally the point at which light from the image appears to converge, the 'front nodal point', is distinct from the point from which it appears to diverge, the 'rear nodal point'. These points are usually almost coincident in a 50mm focal length standard lens for a 35mm camera.

A21 The principal distance is defined as the distance from the film plane to the rear nodal point of the lens. Also by definition, when the lens is focussed on infinity, this is also the focal length of the lens. A pinhole camera does not have a focal length as it has no lens, but it does have a principal distance.

A22 Because most landscape photography is done with the lens focussed on infinity, the distinction between focal length and principal distance is sometimes not expressed precisely.

A23 Although a camera projects its image rather than looking through it as Leonardo's window illustration does, the geometry is exactly the same, except that the image is inverted by the light rays crossing over in the lens's nodal points. Leonardo conceptualised the object as being contained by a pyramid with its apex at the observer's eye. Similarly the whole field of view of the camera will be described by a pyramid whose apex is the lens's rear nodal point and whose base is the area of exposed film.

A24 As the principal distance is the focal length of the lens (assuming it is focussed at infinity), this is therefore also the correct viewing distance for the image if no enlargement is applied to it. Given a 50mm focal length lens and 35mm film, this would give a 36 x 24mm image to be viewed only 50mm from the eye. Some enlargement is therefore necessary. A simple scaling of all the dimensions involved will preserve all the angles of the pyramid which contains the field of view, so for example, the whole image area scaled up to 350 x 240mm would have a correct viewing distance of 500mm.

A25 In other words, if a photograph is taken with a 50mm lens on a 35mm camera and the whole image is printed on a transparent medium to a size of 360 x 240mm, then standing at the point from which the photograph was taken, it will be possible to hold that print at a distance of 500mm from the eye and see the photographic image exactly line up with the real scene, Similarly, a 180 x 120mm print will line up with the scene at 250mm, but will be too close to focus comfortably for most people, and a 720 x 480mm print will line up at 1000mm, but will be further away than the length of one's arms.

Horizontal Field of View

A26 The horizontal field of view for any camera lens is defined by the focal length of the lens and the width of the image formed (the width of the negative for film cameras or the width of the sensor for digital cameras).

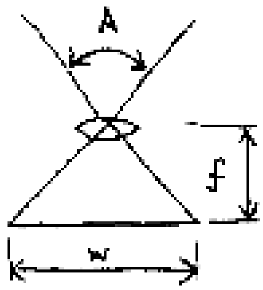


Figure A12: Calculating the horizontal field of view.

A27 The formula for horizontal field of view is as follows:

$$A = 2\arctan\left(\frac{w}{2f}\right)$$

where

A is the horizontal field of view in degrees

W is the width of the image in millimetres (36mm for 35mm film)

f is the lens focal length in millimetres

$\arctan$ is a standard mathematical function (the inverse of the tangent function) and must return degrees in this case.

A28 Examples of horizontal fields of view for a variety of focal lengths in conjunction with 35mm film (with a negative size of 36 x 24mm) are shown in Table 14. Both 'round number' focal lengths and commonly-available focal lengths are shown in Table 18. (Diagonal fields of view are included for completeness as some lens manufacturers quote this as the field of view of their lenses, but the figure is of little practical use.)

Table A1: Focal lengths and fields of view			
Focal length (mm)	Horizontal field of view (degrees)	Vertical field of view (degrees)	Diagonal field of view (degrees)
20	84.0	61.9	94.5
30	61.9	43.6	71.6
40	48.5	33.4	56.8
50	39.6	27.0	46.8
60	33.4	22.6	39.7
70	28.8	19.5	34.3
80	25.4	17.1	30.3
90	22.6	15.2	27.0
100	20.4	13.7	24.4
150	13.7	9.1	16.4
200	10.3	6.9	12.3
250	8.2	5.5	9.9
300	6.9	4.6	8.2
14	104.3	81.2	114.2
18	90.0	67.4	100.5
20	84.0	61.9	94.5
24	73.7	53.1	84.1
28	65.5	46.4	75.4
35	54.4	37.8	63.4
50	39.6	27.0	46.8
85	23.9	16.1	28.6
100	20.4	13.7	24.4
135	15.2	10.2	18.2

Technical Appendix B

Panoramic Photography

Types of Panoramic Camera

B1 A panoramic camera is one designed to take photographs with a very wide horizontal field of view and an image very wide in relation to its height in comparison with conventional photography. There are two main types of panoramic camera: fixed lens and rotating lens. In addition there are several other photographic systems which are styled in one way or another as 'panoramic' but which can be at best only described as 'pseudo-panoramic'.

Pseudo-Panoramic Systems:

B2 APS (Advanced Photographic System) cameras mostly offer 'panoramic' as one of three settings. All this does is to tag the image to be cropped to a 'letterbox' format. The horizontal field of view is not increased; rather the vertical field of view is restricted. There is no good reason ever to use this setting.

B3 Anamorphic adapters are available to fit to the front of ordinary lenses for 35mm single lens reflex cameras. These work in the same way as the lenses used in some types of widescreen cinematography, squeezing a wide letterbox format into an ordinary 35mm frame. Most squeeze the image by a factor of 1.5 or 2, converting the 3:2 aspect ratio of 35mm to 4.5:2 or 6:2 with a correspondingly increased horizontal field of view (Ray 2002). There is inevitably some image degradation and distortion with these adapters and better results are probably achieved with a very high quality extreme wide-angle lens or by splicing several frames together.

Fixed Lens Panoramic Cameras

B4 There are several makes of fixed-lens panoramic camera. Most are medium format (120 or 220 roll

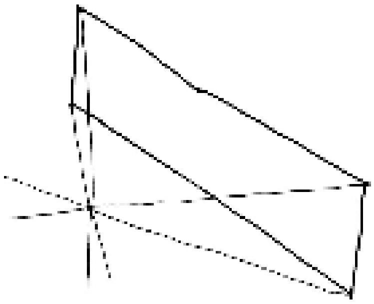


Figure B1: Geometry of fixed lens panoramic camera. This is no different from the geometry of a conventional camera, except for extreme field of view and aspect ratio.

Figure B2: Fuji fixed lens panoramic camera.

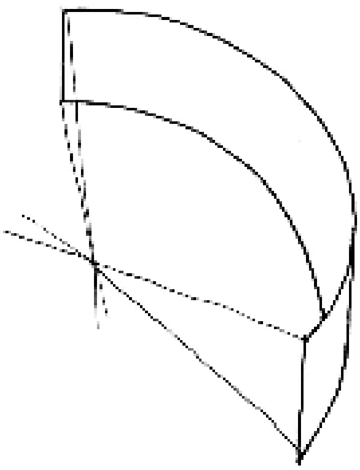


Figure B3: Geometry of rotating lens panoramic camera showing effective cylindrical image surface.

film) but a few are 35mm format. These cameras are really just ordinary cameras with very wide-angle lenses and letterbox aspect ratios. The maximum horizontal field of view offered is about 80° and the perspective is the conventional linear perspective discussed in Appendix A. Consequently, the scale of the image is not constant, with the extreme sides of the image being significantly enlarged compared to the centre and with a noticeable stretching of shapes towards the edges. (There is a corresponding increase in scale towards the top and bottom of the image but this is far less noticeable as the vertical field of view is so much less than the horizontal.) Unless the image content is explained carefully, photography made using this type of camera can be misleading.

B5 As was explained in the case of wide-angle single-frame images, as described in Appendix A, if a panorama of this type is viewed from the correct distance, the oblique line of sight to the edges of the image exactly counterbalance the stretching towards the edges of the image so that the image looks correct. However, viewed at other distances, the scale variation is very much apparent.

Rotating Lens Panoramic Cameras

B6 Rotating (or swing) lens panoramic cameras are also available. As the name suggests, during exposure, the lens rotates horizontally to pan across the width of the image, which can be up to 150 degrees in some makes. While this is happening, the film is wound past a narrow slit which acts as the shutter. (These cameras are commonly encountered when they are used to take school photographs.)

B7 The result is a very wide photograph with a cylindrical rather than planar projection. That is, the perspective will only be theoretically correct if the photograph is displayed on the inside of a cylinder and viewed from its centre. The correct viewing distance will be the radius of the cylinder and will also be the principal distance (or focal length) multiplied by the enlargement ratio of print size to negative size.

B8 The medium format versions of these cameras can produce excellent results. However, owing to the non-standard aspect ratio, it can be difficult to get the resulting negatives printed or scanned.

Figure B4: Widelux medium format rotating lens panoramic camera.

B9 35mm format rotating lens panoramic cameras are lighter and more portable than their medium format counterparts but can produce disappointing results. The focal length of lens is generally quite short (26mm is common) so the size of image detail is slightly smaller than that captured by a 28mm wide-angle lens on a conventional camera. Also, the finite width of the shutter slit results in a slightly less sharp image than would be obtained with the same focal length lens on a conventional camera. The non-standard aspect ratio makes scanning and printing difficult, as in the case of the medium format cameras. Rotating lens panoramic cameras do not in general offer the option to use lenses of different focal lengths as the speed of rotation and speed of film transport are intimately related to focal length.

Figure B5: Noblex 35mm rotating lens panoramic camera.

Spliced Panoramas

B10 Given that panoramic cameras are expensive and cumbersome as well as introducing the technical difficulties in handling the finished photographs which were described above, most practitioners choose to use conventional photography and to assemble panoramas by splicing together sequences of individual frames.

B11 Before the advent of inexpensive scanners and PCs capable of handling large images efficiently, the usual way to assemble a panorama was manually, by physically joining together prints of the individual frames. Anyone undertaking this would rapidly become familiar with the fact that image scale increases towards the edges of the print. There was a considerable knack to finding the point in two adjacent frames where the scale matched and then to make a neat, clean (and irreversible) cut in the print. While it was possible to match the geometry of the images quite accurately this way, differences in brightness and contrast would often show up and repairs to moving clouds or changing lighting conditions were out of the question.

B12 A panorama spliced together out of conventional planar photographs is not strictly a true panorama as it does not form a smooth cylinder. Instead, if each frame were to be set up at the correct viewing distance and orientation to the observer, it would form a polygon on plan. With sufficient frames, this is not a

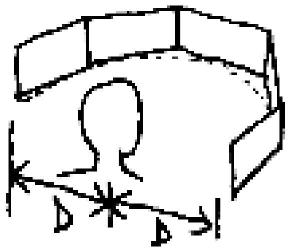


Figure B6: Panorama spliced together out of separate frames without transformation to cylindrical projection

Figure B7: Two adjacent frames overlapped in image editing software ready to splice them together

Figure B8: The splice point has been found and the frames joined together problem in practice and differs only slightly from a true panorama.

B13 With suitable computer image editing software, it is possible to assemble panoramas out of individual frames (either scanned or from a digital camera). The greatest control is obtained by applying a method analogous to the manual method, that is to find corresponding points on adjacent frames where the scale matches and then to crop them at that point. Contrast, brightness and colour balance can be matched quite accurately by eye.

B14 Unless a geometrical transformation is applied to each frame, a panorama assembled digitally will still be a succession of planar panels. Linear elements running across the image, such as overhead wires or kerb lines will kink slightly across each panel boundary. Straight lines in the scene will, however, still project as straight lines.

B15 It is possible to use specialised computer software to transform the geometry of each frame so that it acquires a cylindrical rather than planar perspective. The lens properties need to be known accurately in order to do this. Once transformed, the need to find a point on adjacent frames where the scale matches is obviated; the scale will match correctly everywhere in the region of overlap.

Figure B9: Photograph taken with 50mm lens

Figure B10: Photograph transformed to cylindrical projection using software

Figure B11: Two adjacent frames transformed and overlapped in image editing software ready to splice them

Figure B12: The splice point can be anywhere in the overlap as the horizontal image scale is constant across both images

B16 A wide variety of low-cost panorama-splicing software is available, often bundled free with digital cameras. Most produce superficially convincing panoramas with minimal effort. Left to themselves, they apply a planar-to-cylindrical transformation to each frame, find matching image detail in adjacent frames, colour balance them and then splice them together. The results are not always perfect or even usable. Automatic detection of matching detail is technically difficult to achieve in landscape photographs, where all detail is small and often confusingly similar. If software allows the user to override its choice of splice points, then reasonable control may be applied to the creation of the panorama, if not, then the results will probably not be usable. Most automated panorama software cannot achieve a perfect match across the whole of the area of overlap between frames and disguises this by applying a blurry transition between them. In many cases, this can be obtrusive and visually distracting and may well obscure important areas of detail. The results of an automated splice should be checked carefully and critically. While judicious use of this type of software can produce visually acceptable results, it generally cannot produce the degree of geometrical accuracy needed for the base image for a photomontage.

Geometrical Implications

B17 Planar photographs (conventional single-frame photographs) have a correct viewing distance defined in terms of 'Leonardo's Window' as described in Appendix A. A panorama, on the other hand, is a cylindrical projection rather than a planar one. The equivalent of Leonardo's Window would be a glass cylinder with the eye-point in the centre. A panorama could be constructed in the manner that Leonardo imagined by drawing directly on the cylinder so that the lines exactly coincided with the lines scene in the outside scene. Similarly a panoramic photograph can be superimposed upon the scene by wrapping it around this cylinder. The superimposition will clearly only work correctly if the cylinder is of the correct diameter. The geometry is similar to planar perspectives in that the correct viewing distance is the principal distance of the lens (often the same as focal length) multiplied by the enlargement factor applied to the print. The correct viewing distance is always the same as the radius of the cylinder.

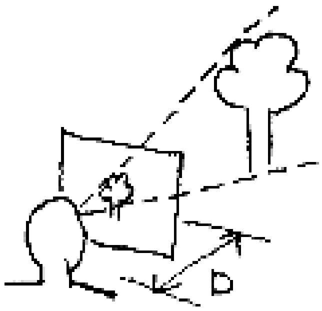


Figure B13: A planar image can be superimposed on the scene it represents when viewed from the correct viewing distance.

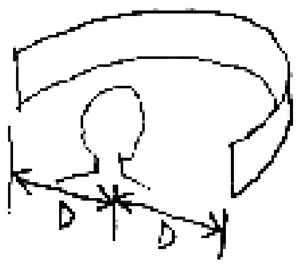


Figure B14: A cylindrical panorama can be superimposed on the scene when viewed from the centre of curvature of a curved surface whose radius is the correct viewing distance.

B18 As in the case of a planar perspective, any straight line segment in the scene will form a plane triangle with the viewer's eye position forming the third vertex. The projection of that line segment on the perspective surface will be defined by the intersection of the triangle with the cylinder described above. With the exception of perfectly vertical or horizontal triangles, the resulting intersection line will always be a curve. A vertical triangle corresponds to a vertical line in the scene and a horizontal triangle to a horizontal line at the same level as the viewer's eye.

Viewing a Panorama

B19 The ideal method of viewing a panorama would be with the image presented as part of a cylinder of the correct radius and then viewed from the centre of that cylinder. Also, ideally, the image should be large enough that viewing comfortably with both eyes is a possibility. This is practical in an exhibition situation, where it would be possible to erect a curved display board several metres wide and to mark a point on the floor for a viewer to stand. Straight lines in the scene, which become curves if the image is laid out flat, look correctly straight when viewed in this way.

B20 Clearly there are many situations where it will be impractical to present a panorama on a curved surface, particularly when a number of panoramas are bound into a document. With care, it is possible to obtain a near-correct view of a cylindrical panorama laid out flat. In the case of a panorama laid flat, the eye point (which would be a single point if the panorama was presented as part of a cylinder), becomes spread out along an imaginary line parallel to the surface of the image and separated from it by the correct viewing distance for the panorama. So long as the gaze is kept perpendicular to the surface of the image, a view from any point along that line will be a good approximation to a correct view. Moving from one end of this line to the other is geometrically equivalent to standing at the middle of the cylinder and turning one's head to left or right. The reason that this approach works is that the eye is capable of seeing only a small part of a scene in detail (generally taken to be about 6-10° - see Appendix C) and there

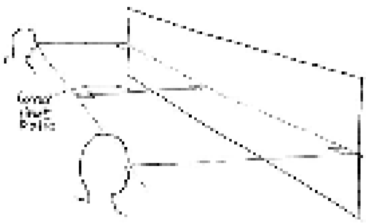


Figure B15: A panorama can be viewed from the correct viewing distance even if displayed flat. The view must always be perpendicular to the plane of th image and never oblique.

is not a great deal of difference between a flat and a curved image over that angle.

B21 With a flat panorama, there is always the temptation to stand back so that the whole width of the image may be seen easily. This misrepresents the image in two distinct ways: firstly, viewing from a distance greater than the correct viewing distance will make the image appear too small; secondly, the view obtained will compress the panorama into a narrower field of view than that obtained in reality at the viewpoint location, thus presenting a view that cannot in reality be experienced.

Figure B16: Planar panorama with a horizontal field of view of 106°. This is the type of image produced by a fixed-lens panoramic camera and is equivalent to an extreme wide-angle single frame. The increase in image scale towards the sides of the image are very apparent.

Figure B17: Cylindrical panorama with a horizontal field of view of 106°. This is the type of image produced by a rotating lens panoramic camera or by splicing together single frames from a conventional panorama. The horizontal scale is the same across the whole width of the image. The viewing distances for both panoramas are the same, so the scales are equal in the centre of the planar panorama.

Calculating the correct viewing distance

B22 The correct viewing distance is the distance at which the perspective in a photograph (or photomontage) correctly reconstructs the perspective seen from the location from which the photograph was taken. It also follows that, as seen from the correct viewing distance, the photographic image will occupy the same horizontal angle as the horizontal field of view it represents. This is true of both single-frame and panoramic photographs.

B23 The single-frame case is simpler geometrically. Seen from above, the photograph is merely a straight line of length *w*. We can construct an isosceles triangle with the apex representing the viewpoint and the height of the triangle, *d*, representing the viewing distance. At the correct viewing distance the apex angle, *A*, of the triangle must correspond to the horizontal field of view of the photograph. The correct viewing distance is then given by:

$$d = \frac{w}{2\tan\left(\frac{A}{2}\right)}$$

(single frame only)

where:

d is the correct viewing distance in mm
w is the image width in mm
A is the horizontal field of view in degrees
tan is the trigonometric tangent function

B24` If the horizontal field of view and the required viewing distance is known, then the formula rearranges thus to give the image width:

$$w = 2d\tan\left(\frac{A}{2}\right)$$

(single frame only)

B25 Finally, if the image width and viewing distance are known, the formula can also be arranged to give the horizontal field of view. (This version of the formula is useful to determine the horizontal field of view that can be accommodated on a fixed page size.):

$$A = 2\arctan\left(\frac{w}{2d}\right)$$ (single frame only)

B26 In the case of a panorama, the image is assumed to be wrapped around the inside surface of a cylinder whose radius is the correct viewing distance. The horizontal field of view must by definition therefore correspond to the arc of the cylinder subtended by the image.

B27 Given the width of the image and the horizontal field of view, the correct viewing distance is given by:

$$d = \frac{180w}{\pi A}$$ (panorama only)

where:

d is the correct viewing distance in mm
w is the image width in mm
A is the horizontal field of view in degrees
π has its usual geometrical meaning

B28 Given the viewing distance and the horizontal field of view, the image width is given by:

$$w = \frac{\pi A d}{180}$$ (panorama only)

B29 Lastly, if the image width and viewing distance are known, this formula can also be arranged to give the horizontal field of view:

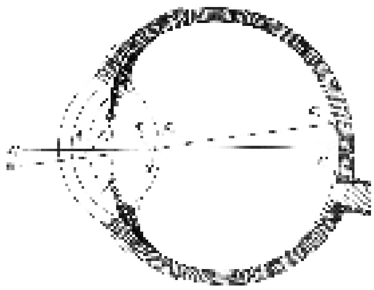
$$A = \frac{180w}{\pi d}$$ (panorama only)

Technical Appendix C

Human Vision

Acuity

C1 Acuity is the ability of the eye to resolve detail. Acuity varies greatly with the brightness of a scene (which corresponds with our everyday experience that fine print is hard to read in dim light). Under bright conditions, the human eye is just able to resolve a pattern of black and white stripes with each stripe covering an angle of 1 minute of arc (1/60 of a degree) (Gregory 1990). The primary reason for this is the spacing of the light sensors at the centre of the eye's retina rather than limitations of the lens system or diffraction at the pupil, both of which would in principle allow finer detail to be resolved. (Pirenne 1967).



Structure of the human eye showing the form of the lens system and the position of its nodal points (from Helmholtz *Handbuch der Physiologishen Optik 1896).*

C2 This figure for acuity does not mean that it is impossible to see objects which are narrower than 1 minute. On the contrary, narrow objects such as overhead wires seen against the sky often subtend narrower angles. The issue is that it is impossible to resolve detail finer than that. Consider, for example, a black-and-white photograph rendered as a halftone for reproduction in a book. The different shades of grey are represented by a pattern of different sizes of black dots on white. At normal viewing distances, the individual dots are not individually resolvable. However, they are not invisible. Each receptor in the eye will receive an image made up of a mixture of several dots and the intervening white paper. The resulting sensation will be indistinguishable from the equivalent shade of grey obtained by mixing the black and white together. The result is that the eye sees shades of grey.

Detail and Contrast

C3 Although we speak of seeing an object, our eyes do not see objects directly. Instead, we detect variations in colour and brightness in a scene and from those infer the boundaries of objects which we then recognise as such. In order for this to take place, there must be sufficient contrast to make those edges, and therefore the objects they define, visible. Contrast may be in colour or in brightness, with contrast in brightness being the more important of the two for vision.

C4 There is a trade-off between detail and contrast. Low contrast limits our ability to resolve detail (Pirenne 1967).

Field of View

C5 The human field of view is hard to define meaningfully. The extremes to left and right are controlled by the optical properties of the lens system of the eyes, which together give a horizontal field of view of about 100° either side of centre. The limits upwards and downwards are defined by an individual's skull configuration, but 60° upwards (limited by eyebrows) and 75° downwards (limited by cheeks) are a good average (Pirenne 1967).

C6 Within that very large overall visual field, only a very small central area will be seen in detail. This is the part of the image which falls on the fovea of the eye and is about 6-10° across (Pirenne 1967).

C7 These figures are based on the naïve assumption that a viewer keeps the head motionless and the eyes fixed on a point. In practice, the eyes automatically turn to place the image of any object we look at on the fovea (the 'fixation reflex') (Pirenne 1970). The horizontal field of view naturally turns as the eyes turn. Turning the eyes far from their central position is uncomfortable, so we tend to turn our heads and if necessary our whole bodies to take in a wide view.

C8 Various figures in to 45-60° range are often quoted as being representative of the human field of view with regard to illustration or photography. It is certainly true that the majority of photographs, paintings and drawing fall into this range, but there is no physiological justification for that figure.

C9 While it is true that we can only see part of the full 360° around us at any one time and only a small fraction of that clearly at any one time, we move our eyes, heads and bodies as necessary and the overall field of view of which we are aware largely depends on what there is to see.

Comfortable Viewing Distance

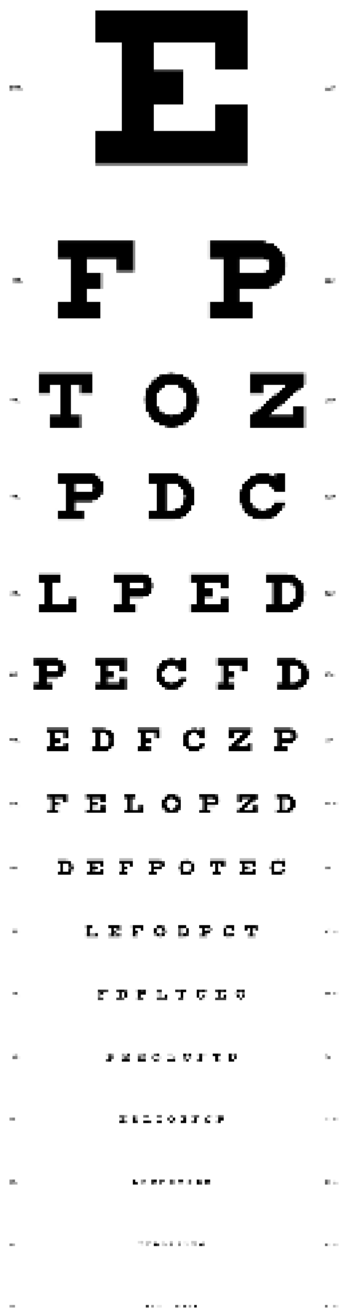
C10 The distance at which we can comfortably focus our eyes is largely determined by age. The ability to change focus is known as 'accommodation' and diminishes with time as the lens in the eye stiffens with age. Very young children can focus as close as 70mm, by age 25 the median is about 100mm and over age 50 it is about 500mm (Gregory 1990). Although the loss of accommodation is a lifelong phenomenon, most people have no need to think about using reading spectacles to compensate until middle age.

C11 John Benson's recommendation of a viewing distance of 300-500mm (Benson 2002) therefore represents a compromise. Some older people will probably need to wear reading spectacles to achieve this.

Reproducing the Visual Experience

C12 There are two issues to be considered in reproducing the visual experience either on a screen or on a printed page. One is the resolution of the image to ensure that sufficient detail is captured. The other is the contrast in the image as presented, to ensure that the detail is visible.

C13 Given the known resolution of the average human eye (1 minute of arc) it is in principle possible to specify a



A Snellen chart for assessing visual acuity (one of several test objects designed by Hermann Snellen). Printed at the correct size and viewed from a distance of 6m, the bars and gaps in the letters in the line DEFPOTEC all subtend 1 min of arc. Being able to read that line at that distance is the definition of 20/20 vision (6/6 in metres) and is regarded as average. Many people can read the next line but few the one below that.

specification for image capture and reproduction which would match that.

C14 The calculations are fairly complicated and involve knowing the resolving power of the lens used, the resolving power of the film, resolution (and other parameters) of the scanner and finally the resolution of the printer used (more complicated than a simple dots-per-inch value).

C15 With a film camera, it is theoretically just possible to capture sufficient detail on 35mm film, provided that the lens and film used are of very good quality, the film processing is to the best professional standards and the scanning is carefully carried out at high resolution. However, even the best film can capture only a limited range of contrast, so that the contrast seen in even a good photograph is necessarily very compressed. This naturally limits the detail that can actually be seen in the image.

C16 The resolving power of a digital camera's sensor is determined by the size of the sensor and the number of pixels it contains. Most digital SLRs have a sensor resolving power which exceeds the resolving power of the camera lens, so provided that a high enough resolution is selected, it should be possible to capture sufficient image data. Just as with film, digital camera sensors are limited in the range of contrast they can capture, therefore similarly imposing limits on the detail that can be seen.

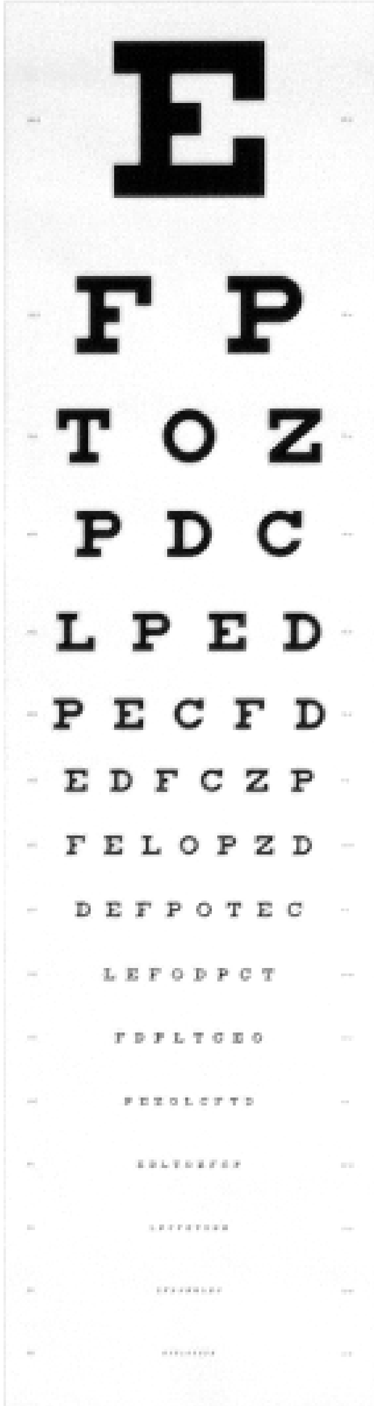
C17 (Note that the subsequent operations applied to an image, including transforming to a cylindrical projection and colour correction or balancing will all have a small detrimental effect on the detail in the image.)

C18 The required resolution in a finished print is easily obtained by current photo quality inkjet printers.

C19 Reproducing the full contrast range visible in a scene is, in general, impossible. On a bright day outdoors, we may experience a brightness ratio of 1,000:1 between the brightest highlights and the darkest shadows. A very good quality computer monitor has a far more limited range available. The lightest colour displayable is the monitor's maximum white and the darkest is the colour seen when the monitor is switched off, usually a dark grey. The brightness ratio is about 100:1 at best. On a printed image, the range is far less, rarely better than 10:1. Acceptable images can only be produced in these media by making compromises: in order to achieve a good tonal range in the middle of the scale, detail in shadows is lost to black and detail in bright areas may bleach out to white. In practice the eye is extraordinarily tolerant of the degree of contrast compression it will accept as 'realistic' in images of outdoor scenes.

C20 It is possible to trade detail and resolution off against one another, so that if the print resolution is higher than strictly necessary then the contrast between adjacent pixels is likely also to be slightly higher and this will allow the eye to pick out more detail. (Consider the image of a wind turbine at a long distance from the viewpoint. A lower resolution image will have pixels which contain parts of both turbine and background and which are therefore of an intermediate colour and possibly hard to pick out. A higher resolution will allow more pixels to be all turbine or all background and therefore easier to distinguish. Even though the eye may well average very fine detail together, the fact that the detail is there makes a difference to the legibility of the image.) Figures 18a, 18b and 18c illustrate this point.

C21 It is just possible to capture the spatial resolution seen by the eye using 35mm photography (or equivalent digital photography) provided great care is taken with the choice of equipment and the procedures used. However, the detail we see in a scene is a function not



Snellen chart photographed from 6m with a 50mm lens on a Fuji Finepix S2 digital SLR. The camera has resolved more detail than the photographer could see (he could read LEFODPCT). The camera would still not capture the fine detail visible in a typical outdoor scene, owing to inability to reproduce the required contrast range. (This is a huge enlargement of a small part of an image, but this does add detail not captured by the camera.)

only of the resolution of our eyes but also the very high contrast present in an outdoor scene. No printing or display technology can come close to these levels of contrast, therefore, it is not generally possible to reproduce the levels of detail that would be easily perceptible in a scene.

Technical Appendix D

Choice of Focal Length

Size of Image

D1 The main difference that different focal lengths of lens make is to change the size of the image on the film (or sensor). Changing from a 50mm focal length lens to a 100mm lens will exactly double the linear scale of the image. (Other changes in focal length will change the scale proportional to the ratio of focal lengths.) Good lenses should be substantially free of distortions and other defects, so there will not be any other differences in the images: the image taken with the 100mm lens will be the same as the centre portion of that taken with the 50mm lens but enlarged to fill the whole frame. Perspective is uniquely determined by the viewpoint position, and direction of view, so is not influenced by focal length (Ray 2002).

D2 Note that the printed size of an image is independent of the focal length. If an image is defined in terms of its horizontal field of view and its correct viewing distance, then those parameters uniquely define the printed size. The only difference between using the 50mm lens and the 100mm lens from the previous paragraph is that the base image taken with the 50mm lens will have to be enlarged more than would be the case with the 100mm lens.

Resolution

D3 The resolving power of most good-quality fixed focal length lenses is about the same (about 80-100 lines/mm at optimum aperture. The resolving power of the film or sensor is naturally unchanged irrespective of the lens used (Ray 2002).

D4 However, as the image on the film is larger with a longer focal length, it follows that the level of detail captured is also greater. (Same lines/mm, but each

Figure D1: Focal length does not alter perspective

Photograph taken with 28mm lens on digital SLR

Photograph taken with 50mm lens on digital SLR

Photograph taken with 135mm lens on digital SLR

All three images can be superimposed accurately and differ only in scale, not in perspective.

millimetre represents a smaller part of the scene in more detail.) Particularly if very large prints are required, a longer focal length lens might be advantageous in order to improve the level of detail.

Field of View and Detail

D5 The larger image scale of a longer focal length lens is accompanied by a correspondingly smaller field of view. For the overall horizontal field of view in a panorama, this is not a problem; it simply means that for a given field of view there will be more individual frames to be processed and spliced together.

D6 For vertical field of view, it is more problematic as that dimension is inherited from the vertical field of view of a single frame. The consequence can be an undesirable loss of foreground and tops of tall objects in the scene. By setting the camera up in portrait orientation, the vertical field of view can be increased somewhat, at the expense of a slightly more fiddly procedure to do so.

D7 In many cases, however, there will be a choice between detail in the photographs and the field of view obtained and both may be undesirable compromises.

Technical Appendix E

Taking Good Photographs

E1 This appendix is not intended to be a general manual of photography; there are plenty of good books available on that subject. Rather, it sets out briefly the main issues relating to photography aimed at constructing panoramas suitable for photomontages and ES work.

Camera

E2 A good quality camera is essential. For photography onto film, a 35mm (or medium format) SLR should be used. For digital photography, a digital SLR should be used, ideally one that is based on a 35mm SLR design.

Figure E1: Good quality digital SLR camera

E3 Lenses should be good quality as well; cheap lenses are likely to produce less sharp images. Very fast lenses (f/1.4 or faster) are useful for taking photographs in poor light, but often have poorer optical characteristics than slower lenses (f/2 or slower). In particular they sometimes have noticeable barrel distortion.

Film

E4 Very fast film should be avoided as it generally has a coarser grain structure and lower resolving power than slower films. ISO100 colour print film is generally the best choice. Kodak, Fuji and Agfa all produce reliable film at this speed. Avoid budget film or 'own-brand' film, which is generally less satisfactory in image quality and less consistent in performance.

E5 Digital cameras will produce a lot of data when operating at the required resolution, so memory cards of at least 512MB and probably 1GB are likely to be required.

Figure E2: Setting up the tripod. The photographer's height tends to dictate the camra's height above ground level under most circumstances.

Figure E3:Camera on a panoramic tripod head. This particular design of head can accept the camera in either landscape or portrait mode. The camera is positioned so that the front nodal point of the lens (the camera's 'eye position') is directly above the axis of rotation of the panoramic head.

Figure E4: Placing a spirit level against the filter-ring of the camera lens allows the camera to be levelled accurately. This works both for landscape and portrait orientations of the camera.

Tripod

E6 A stable tripod is essential. As a minimum, a head with independent tilt adjustments for both pitch and roll should be used. (Ball-head tripods cannot be levelled satisfactorily.) Ideally a panoramic head should be used, allowing a single adjustment to be made for an entire panorama.

Levelling

E7 In order to obtain photographs which will splice together satisfactorily to make a panorama, it is essential that they be levelled accurately. A simple, cheap spirit level will do this quite satisfactorily and, with care, can produce images levelled to an accuracy of about 0.2°. A tripod head with a built-in sprit level and adjusting screws is better. Panorama heads always have spirit levels built in.

Focus

E8 The camera lens should always be focussed on infinity both for consistency and to ensure that the focal length and principal distance are equal.

E9 On auto-focus lenses, the focussing should be set to manual or locked on infinity.

Aperture and Exposure

E10 If at all possible, exposure should be metered once for a complete panorama and then used for all frames either by using a manual setting or by locking the exposure.

E11 For greatest depth of field in the images, aperture should be set to the minimum available on the lens (typically f/16 or f/22). If it is necessary to obtain slightly more resolution, it may help to use a slightly wider aperture: f/5.6 or f/8 are often the optimum settings.

E12 Shutter speed should be selected to obtain the correct exposure consistent with the aperture selected. If there are existing wind turbines in the view, the shutter speed will affect the degree of blurring seen in the photograph due to the movement of the blades.

Recording Photographic Details

E13 As a minimum, the following details should be recorded at each viewpoint used as a photo location:

- Position as an OS National Grid Reference. A hand-held GPS receiver is generally sufficient for this purpose. However, take note of the EPE (Estimated Position Error) figure, which is a measure of accuracy, when taking the reading. An EPE of 8m or more may indicate that there was a poor configuration of satellites, possibly because part of the sky is hidden by buildings or landform. If this happens, the EPE may improve by waiting a few minutes or alternatively it may be necessary to change the location. EGNOS and other supplementary technologies may usefully improve the accuracy of GPS.

- Camera lens focal length. This is obvious but important if more than one lens is being used. (On a digital camera, the EXIF data may record this for you.)

- Frame numbers. With film cameras, frame numbers are useful to identify which frames belong to which locations when the film comes back from processing and scanning.

- Camera altitude above OS datum. The GPS altitude should be noted as a check, but in general a more accurate altitude will be obtained by reference to the OS 1:10,000 or 1:25,000 map and estimating from the contours with reference to the features actually visible on site. This will also generally be more accurate than relying on a height interpolated from the DTM. The height of the camera above ground level should also be recorded, but will often be a constant determined by the photographer's height and the need to be able to see through the camera viewfinder.

- Approximate direction of the centre of the panorama as a bearing in degrees. Also, in some situations, particularly on flat or otherwise featureless terrain, it is useful to take accurate bearings to identifiable objects in the scene using a suitable sighting compass. It is sometimes worthwhile also noting the approximate angular separation of frames in a panorama, although it is often convenient to do this by eye, judging the overlap through the viewfinder, or to rely on the indexing on a panoramic tripod.

- Date and time of photography. In conjunction with the position, this will allow the direction of the light to be calculated for photomontage. Also, on a digital camera, there are no frame numbers to note down, so the date and time may well be invaluable in identifying which photographs belong to which locations by referring to the creation time of each image file. (Of course, this will only work if you have set the date and time correctly on the camera.)

- Wind direction is sometimes also useful if there are existing wind turbines in the photograph and it is desired to match their orientation in a photomontage.

E14 Note that other details to do with observation conditions should also be noted, as listed in Tables 8 and 12.

Technical Appendix F

Earth Curvature and Refraction of Light

F1 OS co-ordinates are not fully 3-dimensional. The northing and easting define a point on a plane corresponding to the OS transverse Mercator map projection and the altitude above OS datum is measured above an equipotential surface passing through the OS datum point at Newlyn. In reality, the earth is of course round, so a correction has to be made in order to position geographical features correctly in three dimensions for ZTV calculation and for visualisation.

F2 If it wasn't for the presence of the Earth's atmosphere, a simple allowance for curvature would be sufficient. The formula for this can be worked out quite easily from Pythagoras' theorem.

F3 Consider an observer at a point ***A*** looking towards point ***B*** at a distance ***c***. The difference ***h*** between the vertical position of ***B*** measured along a true horizontal and along the surface of the earth is the height correction required. Points ***A*** and ***B*** and the centre of the earth (or radius ***r***) form a right-angled triangle. Applying Pythagoras:

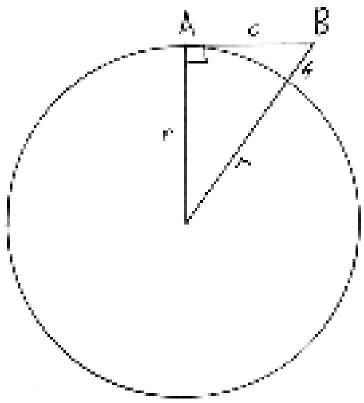


Figure F1: Calculating the height correction due to earth curvature

$$
\begin{aligned}
c^2 + r^2 &= (r+h)^2 \\
c^2 + r^2 &= r^2 + 2rh + h^2 \\
c^2 &= 2rh + h^2 \\
&= 2(r+h)h \\
c &= \sqrt{2(r+h)h}
\end{aligned}
$$

h is very small in comparison with ***r***, so the formula can be approximated with:

$$c = \sqrt{2rh}$$

Rearranging for *h*, we get:

$$\sqrt{2rh} = c$$
$$2rh = c^2$$
$$h = \frac{c^2}{2r}$$

r, c and *h* must all be in the same units, either metres or kilometres.

F4 Note that although the local vertical at ***B*** is very different from the local vertical at ***A*** in the diagram, in reality these points are very close together compared to the size of the earth and assuming that the height ***h*** correction is vertical does not introduce significant errors. (The horizontal correction increases with the square of distance, as in the same way that the vertical correction does, but at 45km from the viewpoint, it is still only about 1m.).

F5 In practice, rays of light representing sightlines over long distances are also curved downwards as a result of refraction of light through the atmosphere, allowing one to see slightly beyond the expected horizon. (The atmosphere reduces the vertical correction due to curvature alone by about 15%.) The standard formula used in surveying work is modified from the one derived above as follows:

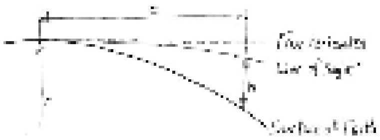


Figure F2: Calculating the height correction due to earth curvature and refraction through the atmosphere

$$h = \frac{c^2(1-2k)}{2r}$$

Where:

h is the height correction in metres
c is the distance to the object in metres
k is the refraction coefficient
r is the radius of the Earth in metres

F6 The parameter ***k*** is not constant but varies with temperature and barometric pressure (and therefore also with altitude). For precise geodetic surveying work both these quantities would have to be measured at both ends of a line of sight. Visualisation and visibility analysis do not require such precision, therefore a representative value may be used. 0.075 is a reasonable average for inland upland observations, but very slightly different values may be found quoted in surveying or navigation textbooks. (***k*** is a <u>numerical</u> coefficient and therefore has no units.)

F7 Taking $\boldsymbol{k}$ = 0.075 and $\boldsymbol{r}$ = 6,367,000m, the following example values are obtained:

Table 19: Height corrections for earth curvature and refraction

Distance c	Vertical correction for Earth curvature and atmospheric refraction h
5 km	1.7m
10 km	6.7m
15 km	15.0m
20 km	26.7m
25 km	41.7m
30 km	60.1m
35 km	81.8 m
40 km	106.8 m
45 km	135.2 m
50 km	166.9 m
55 km	201.9 m
60 km	240.3 m

SCOTTISH NATURAL HERITAGE

Policy Statement

STRATEGIC LOCATIONAL GUIDANCE FOR ONSHORE WIND FARMS IN RESPECT OF THE NATURAL HERITAGE

Policy Statement No. 02/02

Introduction

1. SNH's Renewable Energy policy statement 01/02, published in February 2001, sets out our approach towards renewable energy development. We endorse the importance of addressing the issues of climate change, and welcome the Government's aim of seeking a 60% reduction in carbon emissions by mid-century. We recognise the valuable contribution which renewable energy can make to such a programme, alongside energy efficiency, better building standards, and other measures such as low carbon transport fuels. SNH therefore supports the development of renewable energy – both for electricity and heat production - as an integral component of Government's climate change programme.

2. Some types of renewable energy development have the potential to make a significant impact on the natural heritage. SNH encourages developers, planning authorities and Government to adopt a strategic approach, in the interests of minimising these impacts. SNH seeks

   "*a strategic approach in which renewable energy development is guided towards the locations and the technologies most easily accommodated within Scotland's landscapes and habitats without adverse impact, and which safeguards elements of the natural heritage which are nationally and internationally important*" (para 43).

   The policy statement sets out a number of principles which should guide the location of renewables so as to minimise effects on the natural heritage. In particular, SNH considers it important that renewable electricity targets are met by a mix of renewable energy types, including marine.

3. Since SNH published that policy, there has been a burgeoning of interest in onshore wind farm development, driven by the Renewables Obligation (Scotland) and recognition that wind energy is currently the cheapest form of renewable energy and which has the greatest development potential in the immediate future. SNH has therefore seen a need to further articulate the principles as they relate to onshore wind farm development.

4. The outcome is this **strategic locational guidance**. It has been written primarily to guide SNH staff and to promote a consistent approach within SNH, but it is also intended to be helpful to planning authorities when preparing development plans and to wind farm developers undertaking site searches. It offers a strategic view of the sensitivities of the natural heritage across Scotland to onshore wind farm development, within the framework established by national planning policy guidelines (particularly

NPPG 6: Renewable Energy[1] and NPPG 14: Natural Heritage[2]). It should be read as guidance on the application of SNH Policy Statement 01/02: Renewable Energy, and supports the Government's policy to increase the generation of electricity from renewable sources in Scotland.

5. SNH is a statutory adviser to Scottish Ministers and planning authorities on natural heritage matters and is a statutory consultee within environmental assessment processes. National planning advice (PAN 45: Renewable Energy Technologies[3]) recommends that wind farm developers seek information from SNH on landscapes, species and habitats which may be affected by any proposed development. SNH will make use of this guidance when offering such advice on onshore wind farm developments.

6. This approach only takes account of natural heritage considerations, which lie within the domain of SNH's knowledge and expertise. SNH recognises that developers, and planning authorities when revising their development plans to guide wind farm development, will need to have regard to other factors such as wind speed, grid connections, low fly training areas, radar interference, cultural heritage interests, and landowner and community interests, but these are matters for others to advise on.

7. The guidance only applies to the consideration of onshore wind farms, and it excludes small wind developments of a domestic or small business scale, typically single turbines of under 50kW capacity, which may be accommodated satisfactorily in most landscapes and in relation to which strategic guidance of this sort is unnecessary. The guidance does not apply to any other forms of development, such as mineral workings or indeed other types of renewable energy.

8. **This guidance provides SNH's broad overview of where there is likely to be greatest scope for wind farm development, and where there are the most significant constraints, in natural heritage terms, in order to safeguard Scotland's most valued natural heritage. At the strategic scale at which it is presented, this locational guidance cannot be prescriptive at the level of an individual site. The maps do not purport to provide guidance on the acceptability to SNH of any particular proposal in any given location. However they provide a starting point for the assessment that SNH will make and the advice that it will offer on individual proposals.**

The Need for Strategic Locational Guidance for Wind Farms

9. Scotland is recognised as having one of the best wind resources in Western Europe, extending right across the country. A 2001 study[4] for The Scottish Executive identified a theoretical potential 11.5 Gigawatts (GW) of wind energy available at under 3p/kWh generation cost. This size of resource is roughly equivalent to Scotland's current energy consumption, and would require just under 2% of Scotland's land area. The past decade has seen wind energy become a mature technology in the UK, with declining costs enabling it to become economically competitive with more traditional forms of generation so that it is now considered the cheapest of the new renewable energy technologies.

[1] NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[2] NPPG 14 Natural heritage, The Scottish Executive, January 1999.
[3] PAN 45 Renewable Energy Technologies, The Scottish Executive, January 2002.
[4] Scotland's renewable resource 2001 – volume I: the analysis, Garrad Hassan and Partners Ltd, 2001

10. Wind energy has therefore been identified by the Government as the form of renewable energy most likely to meet the bulk of new renewable energy generation that will be required under the new Renewables Obligation (Scotland). Targets for the years to 2010 have been overtaken by much higher ones; the Executive has set a target that 40% of Scotland's electricity should be derived from renewable sources by 2020. There are also aspirations for Scotland to contribute significantly towards the wider UK's renewable targets, while the advent of EU trading in 'green energy certificates' may create a further European demand. Future decisions about the replacement of nuclear generation in Scotland may also have implications for renewables, as nuclear generation is substantially free of carbon dioxide emissions; replacing it by fossil fuel generation would therefore be a sharply retrogressive step in terms of greenhouse gas emissions.

11. In the short and medium term the scale of wind energy development is therefore likely to be very substantial. As a measure of the level of interest at present, at the time of this revision, in addition to over 0.8 GW either constructed or approved, there are consent applications outstanding for around 2.6 GW of wind generation capacity, a further 2.6 GW at the stage of scoping an Environmental Impact Assessment, and SNH has been party to informal discussions over at least a further 2 GW. The total capacity of all such proposals – nearly 7.5 GW - is more than double that required to meet the Executive's 2020 objective for renewable generation, without consideration of other types of renewables.

12. Wind farms can however bring about major changes to the Scottish landscape and have significant impacts on important species and habitats. Scotland is renowned internationally for the quality of its natural heritage, particularly the diversity of its landscapes and outstanding scenery. The extensive scale of our valued landscapes is part of their character and attraction. As well as contributing to the quality of life for those who live in Scotland, our landscapes are a major economic asset as a basis for the tourism industry, which is Scotland's largest employment sector. Concern for the future of this industry presents an economic argument to avoid adverse impacts, especially on those wild and dramatic aspects of the Scottish landscape which are most attractive to tourist visitors.

13. While wind power may present advantages in the short to medium term as a technology which is available on the market, SNH's view is that in the longer-term wave and tidal power, and to some extent offshore wind, could in suitable locations provide the opportunity for electricity generation with a lesser overall impact on the environment. In May 2004, SNH published a separate policy statement on 'Marine Renewable Energy and the Natural Heritage'[5].

14. Wind farm development can be seen as the latest driver of extensive change in our rural landscape, following earlier hydroelectric development, afforestation and fish farm development over the past 50 years or so. In some of these cases, action to develop a strategic view to guide change was not taken until after much of the impact had already occurred. With wind farms there is still an opportunity for a well-planned approach which encourages development in the most suitable areas and avoids areas valued for their scenic, recreational and undeveloped qualities or their high biodiversity interest. In Scotland, the proportion of proposals refused planning consent has been lower than in England and Wales, but there remains scope to raise the success rate further by a clearer shared identification of those areas most appropriate for wind farm

[5] Marine Renewable Energy and the Natural Heritage. SNH Policy Statement, May 2004. Available on Website.

development. If a strategic approach can gain the acceptance of the industry and planning authorities, it will be of major assistance in facilitating wind farm development across Scotland and in reducing to a minimum the wastage of resources in preparing, assessing and determining controversial and ultimately rejected schemes.

Input to Local Authority Development Plans

15. Scottish Executive planning guidance on renewables development is laid down in NPPG 6. This sets out how the planning system can make positive provision for renewables while at the same time meeting international and national statutory obligations to protect designated areas, species and habitats from inappropriate forms of development. Planning authorities are required to make positive provision for renewables within their development plans, having regard to environmental and amenity considerations. This includes defining broad areas of search, indicating whether there are areas or sites which would only be considered suitable in exceptional circumstances and identifying the broad criteria for proposals outwith these areas.

16. **This SNH guidance is of an advisory nature only and does not have statutory status. SNH expects that planning authorities (including, where appropriate, national park authorities) will wish to draw from this guidance, along with information on other constraints, when preparing development plan policies. In this way the guidance should be helpful in fulfilling NPPG 6's requirement on planning authorities to plan positively for wind energy development. It is these development plans, including any locationally specific policies that they contain, against which planning authorities will have to assess individual wind farm proposals.**

The Potential Impacts of Wind farms on the Natural Heritage

17. Wind farms can have effects on the natural heritage not only as a result of the wind turbines themselves but also through the ancillary infrastructure requirements, such as grid connections and access tracks. Detailed guidance on the assessment of these at the site-specific level can be found in *Guidelines on the environmental impacts of wind farms and small-scale hydroelectric schemes*[6], published by SNH in 2001. The two main impacts are on landscape and biodiversity.

18. An impact can be defined as any effect on the natural heritage which would not have occurred in the absence of the development. An adverse impact is one which leads to a loss of overall natural heritage value. Judging the significance of an impact requires consideration not only of the magnitude of the impact and its likelihood of occurring but also the value and importance placed on the natural heritage resource. This document is about guiding development in such a way as to minimise significant adverse impacts on the natural heritage.

19. The very nature of wind farms means that they are not easily fitted into the landscape. As yet they are still a relatively novel and unusual form of development. They tend to be sited in prominent and open locations to maximise energy generating potential, although hilltop and skyline locations are not the only option. Their scale and form, consisting of a number of very large structures spaced out over an extensive area, results in complex visual relationships between the turbines and their surroundings.

[6] Guidelines on the Environmental Impacts of Wind Farms and Small-scale Hydro-electric schemes. SNH February 2001. Hard copy only, £10.99 from SNH Publications, Battleby, Redgorton, Perth PH1 3EW.

The movement of turbine blades attracts the eye, and turbines can be highly visible from a long distance in some lighting conditions, given the elevated locations of most developments.

20. Where two or more wind farms lie in the same area, their large visual 'footprint' can result in cumulative impacts over extensive areas. While a landscape may be capable of accommodating a single windfarm, it may not be able to accommodate multiple wind farms without significant change to its character or to the extent to which people value the area. The impact of multiple wind farms on critical bird species may also add up to a level which cannot be sustained in one area. Therefore increasing importance should be placed on the assessment of cumulative effects. Use should be made of such assessments to identify the most appropriate sites and to develop a view on the capacity of the area to accommodate such development. SNH has published guidance on the assessment of cumulative effects[7].

21. The trend is also towards wind farms and individual wind turbines becoming larger – proposals for wind farms of over 50 turbines extending over 12km^2 using turbines of over 120 metres height are now common. Wind farms with well over 100 turbines have been proposed, and larger turbines require greater separation. Hence the scale and impact of these kinds of development has grown significantly of late. There is potential for wide-ranging natural heritage impacts which warrant careful attention during wind farm siting and design.

22. Biodiversity issues include both species and habitat impacts. Turbine and track construction can result in habitat disturbance and loss. Wind farm operation and maintenance may disturb sensitive species, and there is a risk of bird collision with moving blades and any additional overhead wires. Collision risk is greatest where wind farms straddle regular flight lines, such as between roosting and feeding grounds or where birds such as raptors make use of a wind farm site for hunting. Raptors, geese, divers, some seabirds and seaduck are some of the species most likely to be subject to significant risks. Rare species, and those protected under EU and national legislation, require careful risk assessment on a site-specific, and species-specific basis.

SNH's Approach to the Location of Wind Farms

23. Some of the above natural heritage impacts are best avoided by locating away from areas of high natural heritage sensitivity. Others can be mitigated through sensitive detailed siting and design. SNH's locational approach offers a broad steer over which parts of Scotland are most suited to wind farm development, in natural heritage terms, and in which parts significant adverse impacts on the natural heritage are most likely to arise. At a strategic level it identifies the natural heritage sensitivities which should be addressed by developers and by Councils in planning positively for wind energy. It also provides a context within which SNH will respond to proposed wind farm developments.

24. Within SNH's Policy Statement 01/02: Renewable Energy, the guiding principles on the location of renewables which are applicable to wind farm developments and which have been interpreted through this guidance are:

    - Adverse effects should be avoided on the qualities safeguarded by national or international designations;

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[7] Cumulative effects of windfarms. SNH Guidance, August 2003. Available on SNH Website.

- To accommodate the scale of renewable development required, there is likely to be a need to accept change in some of Scotland's landscapes, which should be guided to landscapes which are already developed or visually man-modified and relatively close to centres of population;
- Areas where natural heritage value is associated with limited evidence of human intervention should be safeguarded from development detracting from these values;
- Elsewhere in Scotland, SNH will support renewable development where it can be accommodated without significant adverse impact on landscape character.

25. This locational guidance takes the above principles and seeks to apply them across Scotland. The following maps and accompanying tables show the range of landscape and biodiversity sensitivities at the strategic level to be considered in locating wind farms. Sensitivity has been judged on the basis of the importance of the interest and its susceptibility to impact by wind farms. Maps 1 and 2 describe sensitivity associated with landscape and recreation interests, covering designated areas and wild land issues respectively. Maps 3 and 4 describe sensitivity arising from biodiversity and earth science interests, covering designated areas and non-designated habitats and species respectively. Where areas of different sensitivity overlap, the sensitivity shown is that of the most sensitive interest. The final map, Map 5, combines these sensitivities into three broad zones representing relative levels of opportunity and constraint, adopting the rule that each area is categorised according to the highest sensitivity identified in the tables.

26. In each of these maps, sensitivity is categorised in three broad zones, of lowest, medium and high sensitivity in natural heritage terms as described below. It is stressed that these mapped zones are broad-brush categories. For any particular sensitivity it is important to refer to the detail of the text in the accompanying tables.

- **Zone 1: Lowest natural heritage sensitivity** identifies areas at the broad scale with least sensitivity to wind farms, with the greatest opportunity for development, within which overall a large number of developments could be acceptable in natural heritage terms, so long as they are undertaken sensitively and with due regard to cumulative impact.
- **Zone 2: Medium natural heritage sensitivity** identifies areas with some sensitivities to wind farms. However, by careful choice of location within these areas there is often scope to accommodate development of an appropriate scale, siting and design (again having regard to cumulative effects) in a way which is acceptable in natural heritage terms.
- **Zone 3: High natural heritage sensitivity** identifies areas of greatest sensitivity to wind farms, which place the greatest constraint on their development, and where, in general, proposals are unlikely to be acceptable in natural heritage terms. There may however be some sites in this zone where wind farm development of appropriate scale and careful design could be accommodated if potential impacts on the natural heritage are fully explored and guarded against by employing the highest standard in siting and design.

27. The general approach taken to landscape sensitivity has been to include within Zone 3 areas whose landscape is protected at national or international level, while areas protected at a local or regional level are mapped within Zone 2. A preliminary search area for wild land is also mapped within Zone 3, reflecting the susceptibility of wild land qualities to wind farm development. This search area is provisional and relates to

SNH's invitation to planning authorities to identify their wild land resource and to adopt related policies, as described in paragraph 35. Areas which may only in part be sensitive at either level are shown cross-hatched.

28. The main biodiversity sensitivities identified are the potential impact of wind farms on habitats through disturbance and loss through construction, and impacts on birds. The habitats identified as most sensitive are those with legislative protection and where either the habitat is so rare that any loss is regarded as serious; or where turbine installation or access tracks might interfere with the functioning of the habitat, e.g. peatlands which are dependent on their hydrology and coastal habitats like sand dunes and machair which are prone to erosion. Thus Zone 3 includes all habitats protected at international level, and in addition peatland or coastal habitats protected at national level. Zone 2 includes all other habitats protected at national level, and in addition non-designated areas containing good quality peatland and sand dune and machair habitats.

29. Birds are the main species thought to be potentially vulnerable to wind farms, through disturbance and/or collision risk with turbine blades. Special Protection Areas within which birds are protected at international level are mapped within Zone 3. Other bird sensitivities are mapped within Zone 2, based on a representative selection of breeding species considered most sensitive to wind farms and which are subject to international protection.

Implications

30. The detailed maps and tables which follow provide a broad overview of where there is likely to be greatest scope for wind farm development, and where there are the most significant constraints, in natural heritage terms. As they are drawn at a strategic scale, they cannot be relied upon to provide guidance on the acceptability of any particular proposal in any given location. SNH may not object to a sound and sensitively designed proposal within Zone 3 (high sensitivity); equally SNH may express concern, and in some cases may object, to proposals in Zone 1 if these are inappropriately sited or designed in relation to local natural heritage interests. Rather, the guidance provides a starting point for the assessment that SNH will make and for the advice that it will offer on individual proposals. The guidance assumes that developers will take due care in the siting, scale and design of any wind farm to minimise adverse impacts on the natural heritage. Within zones 1 and 2, in due course cumulative effects arising from the presence of multiple wind farms may increase the level of sensitivity to further development.

31. **Zone 1** includes the 26% of Scotland's land area in which SNH considers that there is the greatest opportunity for development from a natural heritage standpoint. In general terms habitats, species and earth science interest within this area are of lowest sensitivity to wind farm development. Zone 1 encompasses many of the more managed and man-modified habitats, such as agricultural and commercially forested landscapes. In Zone 1, the value placed upon landscape quality and recreational opportunity has not been sufficient to trigger national or local designation. In some parts of this zone, at least, it will be appropriate to accept changes in landscape character in order to meet the need for renewable energy generation, though there will be a need to consider the cumulative impact on the landscape of multiple developments. National planning policy guidance says:

    Most landscapes in Scotland have been subject to incremental change over many years. Many of these landscapes should be able to *accommodate renewable energy developments if these are in appropriate locations and of an appropriate scale and type*[8].

32. Within Zone 1, however, many important local natural heritage sensitivities are found which should be avoided or taken into account in the detailed design. These include local landscape features or sites of recreational importance, or important biodiversity interest with a localised distribution. Many species protected at European level (eg Annex I bird species in the Birds Directive, or Annex IV species in the Habitats Directive)[9] are to be found locally within Zone 1, including concentrations of geese which have been judged incompatible with several wind farm developments in the past – these are so local that no attempt has been made to map them on this broad national scale. There are also localised landscape features or sites of recreational importance which may be too small in scale to be subject to designation but are nonetheless sensitive. The high degree of intervisibility and recreational popularity associated with coastal locations means that they are likely to require particular care. **It is important therefore to recognise that the inclusion of an area in Zone 1 does not imply absence of natural heritage interest.** Good siting and design should however enable such localised interests to be respected, so that overall, within Zone 1, natural heritage interests do not present a significant constraint on wind farm development.

33. Zone 1 also includes most of Scotland's middle and larger sized settlements, and much of the transport infrastructure. Generally there is a need for some separation between wind turbines and residential areas, not only for reasons of noise, safety and flicker, but also to avoid excessive intrusion into visual amenity. Also, the countryside immediately surrounding a settlement often fulfils a valuable function for urban residents, by providing opportunities for informal recreation and access, and as a landscape setting for the town or city. Windfarms should not be sited where they will substantially diminish such benefits. However, a windfarm can de designed such as to retain an appropriate landscape setting for a town, and countryside recreation can co-exist with windfarm development, with new tracks sometimes presenting new opportunities for access. Therefore, while it may be appropriate to protect some areas immediately adjacent to settlements which are of particular value in this regard, SNH does not recommend the general adoption of "windfarm exclusion zones" around towns and cities or indeed a presumption against wind farms in green belts. This would have the undesirable effect of directing windfarm development and its associated natural heritage impacts towards areas of more remote countryside.

34. **Zone 2** comprises 48% of Scotland's land area. Here there are recognised natural heritage sensitivities, though around two thirds of the area is shown hatched to indicate that the sensitivities only affect a proportion of the area indicated. Some of these sensitivities are locationally well identified through designations (eg SSSIs and AGLVs) while others, like the presence of sensitive species, require more detailed investigation in the area in question – only broad distribution data can be used at this scale. It is also important to note that Zone 2 encompasses areas subject to very different levels of planning policy guidance. SSSIs have a strong presumption against adverse natural heritage impacts (notwithstanding that it may be possible to site a wind farm on some types of SSSI without adverse impact) while, for example, the policy guidance relating to Regional Parks is concerned primarily with safeguarding public opportunities for countryside recreation and enjoyment. Thus SNH considers that, while there is often scope for wind farm development within Zone 2 it may be restricted in scale and energy

[8] Para 25-27, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.

[9] See, for example, European Protected Species, Development Sites and the Planning System – Interim guidance for local authorities on licensing arrangements. Oct 2001. Scottish Executive.

output and will require both careful choice of location and care in design to avoid natural heritage impacts.

35. **Zone 3** comprises 26% of Scotland's land area where there are recognised natural heritage sensitivities with which it is judged that wind farm development would in general be incompatible. Zone 3 includes World Heritage Sites, National Scenic Areas, the core parts of National Parks, Natura 2000 sites and peatland and coastal SSSIs. These are all subject to firm planning policy guidance which seeks to avoid adverse natural heritage impacts. Zone 3 also includes an indicative wild land search area. Through its policy statement on 'Wildness in the Scottish Countryside'[10], SNH is inviting planning authorities to identify their wild land resource and to adopt policies which reflect this interest in line with the general planning policy guidance in NPPG 14. The search area has been identified as an initial indication to planning authorities as to where such a wild land resource might be identified. It is expected that the nature and strength of such policies will evolve over time as a result of this dialogue.

36. Subject to the evolution of a more definitive view on the location of wild land, Zone 3 is the area with the greatest natural heritage sensitivity to wind farms. There may well be some sites within Zone 3 where a development of appropriate scale and careful design could be accommodated if potential impacts on natural heritage interests were fully explored and adequately guarded against by employing the highest standard in siting and design. However, SNH considers that this will be the exception rather than the rule: wind farm proposals are only rarely likely to be acceptable in natural heritage terms within Zone 3. Developers should be encouraged to look outwith Zone 3 for development opportunities.

Caveats

37. It should be noted that most natural heritage designations identify only the actual area of special interest, and do not normally include buffer areas to provide protection from potential distant impacts. Associated regulations or policies usually cover this by referring to the need to avoid an adverse impact on the protected interest, even where the development is outwith the designated area. For example, Special Protection Areas designated to protect birds usually only cover core breeding and feeding territory, but the birds may range more widely and therefore be affected by windfarms at some distance from the site. There are a number of SPAs for protected goose species where only the night roosting areas are designated, with the birds feeding during daytime on undesignated farmland; the underlying requirements include that there should be no adverse effect on that goose population. For a protected landscape, a windfarm outwith but close to the boundary may have an impact on the landscape experience within the protected area. The issue is not whether a windfarm is simply visible from within the protected area, but whether it will impact adversely on the landscape experience.

38. Such 'fringe' effects have not normally been included in the mapping except for National Scenic Areas (mapped in Zone 3), where because of the potential range of such impacts, an indicative 10km wide fringe area outwith the boundary has additionally been mapped as a cross-hatched Zone 2. Dependent on the local circumstances of visibility and the character of the NSA, the landscape experience within the NSA could be significantly affected by a windfarm within this range and in some cases at even longer range.

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[10] Wildness in the Scottish Countryside. 2002. Scottish Natural Heritage, in preparation.

39. It should be noted that this broad guidance provides a strategic steer only. Lack of reference to particular habitats or species in this guidance does not mean that SNH does not consider they are relevant when considering the potential effects of a wind farm. Also, while the guidance is based on the best information currently available, our understanding of the impact of wind farms on many biodiversity interests is incomplete. There will be a need to keep this guidance under review as our understanding develops. Where there is uncertainty over impacts on important species and habitats, we will look for a precautionary approach[11].

40. This strategic approach does not set aside – indeed it reinforces – the need for care in the detailed location and site planning of new wind farms. In all cases it will be important that proposed developments are sensitively located with respect to their effects on landscape character or habitats or species. **Appropriate siting, good design and sound implementation are always required to ensure a satisfactory fit with natural heritage interests.**

Developing a more detailed local approach

41. In parallel with the development of these guidelines SNH has supported the preparation of regional wind farm landscape capacity studies. SNH commissioned the first such study in collaboration with Argyll and Bute Council, and further studies have been completed in Ayrshire & the Clyde Valley, North and East Highlands and Western Isles. These studies seek to explore the capacity of individual areas for wind farms based on the landscape's ability to accommodate this form of development, and in some cases explore the potential acceptability of landscape change as a result of large or extensive wind farm development.

Review

42. This guidance has been prepared at a time of change within the wind energy industry. New larger turbines are only beginning to be constructed on an extensive scale, and new energy trading arrangements are still only recently introduced. Our understanding of natural heritage impacts is still evolving as we learn more about the interactions between species and wind farms, and people's perception of these new features in the landscape. We will continue to work with the industry to build on our knowledge and share experience.

43. When this guidance was first published, in May 2002, only 6 wind farms had been constructed in Scotland, and turbines over 100m in height had yet to be deployed. Our understanding of the natural heritage impacts of wind farms has developed considerably, through our involvement in over 400 wind farm proposals to date, and so too has public perception of these new features in the landscape. At the time of publication we indicated that we would review this guidance at an early date, and we have now done so (July 2004). The review has not altered the underlying approach but has led to greater clarification of the sensitivities at a number of points in the text. We will continue to work with the industry to build on our knowledge and share experience and will review this guidance in due course if refinement is needed.

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[11] The Precautionary Principle and the Natural Heritage, 2000, Scottish Natural Heritage Policy Summary 21. Website.

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Contact:

Brendan Turvey
Policy and Advice Directorate
Tel: 01738 458622
E-mail: brendan.turvey@snh.gov.uk

MAP 1: LANDSCAPE AND RECREATION INTERESTS – DESIGNATIONS

This map indicates natural heritage sensitivities relating to areas designated for their landscape or recreational value.

Cross-hatching indicates that the sensitivity does not apply to the entirety of that area, but only to a proportion.

Zone 1 comprises all land not mapped as sensitive below.

1.1 National Parks

National Parks are a national designation, designated by Scottish Ministers, identifying areas of outstanding national importance for its natural heritage or combination of natural and cultural heritage.

Locational Guidance

National Parks are internationally regarded as places of the highest conservation significance, where enjoyment of the natural and cultural heritage is a key function and provides the basis for much of the local economy. National Park aims are: • To conserve and enhance the natural and cultural heritage of the area; • To promote sustainable use of the natural resources of the area; • To promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public; and • To promote sustainable economic and social development of the area's communities. The first of these aims is to be given greater weight in any case where there is a conflict. A National Park comprises an extensive area which taken as a whole is an area of distinctive character and coherent identity and of outstanding natural (or a combination of natural and cultural) heritage importance. However, not all parts of a National Park are necessarily of the highest natural and cultural heritage value, and areas with varying degrees of sensitivity to wind farm development may therefore be encompassed within a National Park. In due course individual National Park Plans will outline the sensitivity to development within and adjacent to different parts of a Park. In core areas of a Park it is unlikely that wind farms can be located without adverse impact on the quality of the natural heritage. In the absence of a National Park Plan at this time SNH has identified only the area covered by the existing NSAs as of the highest sensitivity. Elsewhere, and especially within more peripheral areas, the National Park Plan may identify some scope for wind farm development, but this is likely to be of limited scale and subject to the overall objective of conserving and enhancing the natural and cultural heritage of the Park as a whole[12]. When the Park Plan is prepared by the new National Park Authorities these sensitivities will be reviewed. **Within core areas of a National Park, the nature and scale of most commercial wind farms is such that it is unlikely to be possible to locate them without significant adverse impact on the qualities for**	**Zone 3** – the area mapped as of high sensitivity comprises the four NSAs within the two National Parks. **Zone 2** – the area mapped in Zone 2 is that contained in the respective National Park Orders outwith the existing NSAs.

[12] See, eg, Cairngorms National Park Authority (Aug 2004) 'Interim Planning Policy no 1: Renewable Energy'

which the Park has been designated. There may be scope for small-scale developments aimed primarily at serving individual properties. Wind energy should be given special consideration where it contributes to the sustainability of an isolated community. **Elsewhere within a National Park, a highly sensitive approach to siting and design will still be required to ensure that any wind farms constructed do not have a significant adverse impact on the character and enjoyment of the National Park.**	

National planning policy guidance	Planning authorities are required to take particular care to safeguard the landscapes, flora and fauna of National Parks[13]. Development proposals should avoid significant adverse impact on their character, quality, integrity and setting[14]. A cautious approach to the siting of wind farms should be adopted in relation to them[15]. A National Park Plan will be prepared by the new National Park Authorities to provide a framework for decisions within the Park. The Development Plan should also include policies for the protection and where appropriate enhancement of national designations. The policy test for national natural heritage designations is set out in NPPG14 para 25[16].

[13] Para 33, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[14] Para 21, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[15] Para 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[16] See Annex 1

1.2 National Scenic Areas

National Scenic Areas are a national designation identifying areas of outstanding natural beauty and amenity to be safeguarded as part of the national heritage.

Locational Guidance

Scotland's scenery is internationally renowned, and NSAs identify those areas considered to be of unsurpassed attractiveness. Such scenery provides the key resource for our biggest industry, tourism, and thus forms the basis for many local economies. **The nature and scale of most commercial wind farms means that it is unlikely to be possible to locate them within most NSAs without significant adverse impact on the qualities for which the NSA has been designated. There may be scope for small-scale developments aimed primarily at serving individual properties. Proposals of a modest scale should also be given especially sympathetic consideration where they contribute to the sustainability of an isolated community such as an island.**	**Zone 3** – the area mapped is the 36 NSAs outwith the two proposed National Park areas.
Wind farms outwith but adjacent to NSAs may have an impact upon the landscape experience within them. The range of such impacts is very variable, and depends on topography and intervisibility, landscape character and the scale of the wind farm. The potential for such impacts on the character and enjoyment of NSAs is likely to require particular consideration in the surrounding area up to 10km from the boundary of an NSA. **In locating and designing wind farms adjacent to NSAs, significant adverse impacts on their character and enjoyment should be avoided. Within an area up to around 10km from an NSA careful assessment of any effect on the NSA is required.**	**Zone 2** – areas within 10km from NSA boundaries, shown as cross-hatched to indicate that sensitivity depends on location.

National planning policy guidance

Planning authorities are required to take particular care to ensure development in or adjacent to a NSA does not detract from the quality, character, integrity and setting of the landscape, and that the scale, siting and design are appropriate and of a high standard[17]. A cautious approach to the siting of wind farms should be adopted in relation to them[18]. The Development Plan should include policies for the protection and where appropriate enhancement of national designations. The policy test for national natural heritage designations is set out in NPPG14 para 25[19].

Planning authorities must consult Scottish Natural Heritage on any wind farm within a NSA, and notify the Executive if minded to approve an application contrary to SNH's advice.

[17] Para 26, NPPG 14 Natural Heritage, The Scottish Executive, January 1999; para 21, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[18] Para 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[19] See Annex 1

1.3 Regional Parks

Regional Parks are designated by Councils for the important informal recreation opportunities they provide in attractive countryside close to large population centres

Locational Guidance

Regional Parks are areas identified as providing important opportunities for recreation and enjoyment of the countryside and are managed accordingly. They are usually close to urban population centres. There are currently three Regional Parks in Scotland. Wind farms within or adjacent to a Regional Park may adversely affect peoples' quiet enjoyment of the countryside. **Wind farms should avoid significant adverse impact on the character and enjoyment of a regional park, and will require sensitive siting and design.**	**Zone 2** – the area mapped includes the three Regional Parks – Clyde-Muirshiel, Lomond Hills and Pentland Hills - which remain after Loch Lomond is subsumed within the National Park.

National planning policy guidance

Local authorities are encouraged to safeguard countryside which contributes to existing and predicted future recreation needs[20]. Regional Parks play a valuable role in providing opportunities for urban populations to gain access to attractive areas of countryside for recreation and enjoyment.[21] Development plans should include policies to protect and enhance land of recreational and amenity value[22]. A cautious approach to the siting of wind farms may be adopted in relation to them[23].

[20] Para 28 and 30, NPPG 11 Sport, physical recreation and open space, The Scottish Executive June 1996.
[21] Para 21, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[22] Para 94, NPPG 11 Sport, physical recreation and open space, The Scottish Executive June 1996.
[23] Para 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.

1.4 Areas of Great Landscape Value (and similar designations)

Areas of Great Landscape Value (and similar designations) are a local designation safeguarding locally important areas of outstanding scenic character or quality

Locational Guidance

AGLVs and similar designations such as Regional Scenic Areas identify areas valued locally for their scenic qualities. Although not considered of the highest national merit, these areas have nonetheless been judged to contribute significantly to the quality of people's lives in the part of Scotland where they lie. They also collectively contribute substantially to the overall quality of Scotland's countryside. **Wind farms should avoid significant adverse impact on the character and enjoyment of these areas, and will require sensitive siting and design.**	**Zone 2** – the area mapped includes all AGLVs (and similar designations) based on data complied from local authorities in 1999. NB This **mapping is now substantially out of date in relation to currently adopted local plans. The lack of a consistent approach among planning authorities makes it difficult to present a consistent national view of land considered of local or regional landscape value. Developers should check with currently adopted local plans in each council area. SNH is advising the Scottish Executive on local landscape designations and this mapping will be updated whenever a more consistent approach is possible.**

National planning policy guidance

AGLVs have a potentially valuable role in protecting important local natural heritage interests. However, the level of protection is a matter for the planning authority, which should distinguish between local and national designations. Planning authorities should take account of the economic interests and aspirations of local communities, and ensure that designation does not impose unreasonable restrictions on the ability to work or develop their land[24].

[24] Para 61 - 62, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.

1.5 Gardens and Designed Landscapes

Gardens and Designed Landscapes are historic designed landscapes or extensive planned gardens, often but not always established as the setting for a historic building. They are identified on a national inventory compiled and maintained jointly by Historic Scotland and Scottish Natural Heritage.

Locational Guidance

Gardens and Designed Landscapes identified in the national inventory represent the most important in Scotland and comprise a national resource in cultural heritage terms as well as contributing to the character and enjoyment of the countryside. Most are closely bound up with their surroundings, with adjoining landscape features influencing their design while the designed landscape itself or features within it contribute to the character of the area. Gardens and Designed Landscapes are important in terms of their scenic quality and historic interest and often contain valuable habitats and features of natural heritage interest[25]. A site's sensitivity will vary according to the importance placed on the range of values identified within the Garden and Designed Landscape Inventory. **A cautious approach is required to the siting of wind farms affecting Garden and Designed Landscapes so as to avoid significant adverse impact on their character and value. Any proposals require to be highly sensitive to these interests in their standard of siting and design.** An extension to the inventory is underway. The same considerations should apply to sites identified in this extension.	**Zone 2** – The area mapped includes only those Garden and Designed Landscapes identified in the original inventory. Sites in the inventory extension will be added in due course.

National planning policy guidance

Planning authorities and developers are required to pay special attention to the desirability of preserving or enhancing the character or appearance of Gardens and Designed Landscapes[26]. A cautious approach to the siting of wind farms should be adopted in relation to them[27]. Proposed development should be of high quality and respect its landscape setting[28].

Planning authorities must consult with the Secretary of State and SNH on any proposed development that may affect a site contained in the Inventory.

[25] Para 12, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[26] Para 22, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[27] Para 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[28] Para 16 and 38, NPPG 18 Planning and the Historic Environment, The Scottish Executive April 1999

MAP 2: LANDSCAPE AND RECREATION INTERESTS – WILD LAND

This map indicates natural heritage sensitivities due to the susceptibility of wild land character to wind farm developments.

Cross-hatching indicates that the sensitivity may not apply to the entirety of that area, but only to a proportion.

Areas not mapped within the wild land search area are shown as **Zone 1.**

2.1 Wild land

Wild land is not a designation, but describes uninhabited and often relatively inaccessible countryside where the influence of human activity on the character and quality of the environment has been minimal[29].

Locational Guidance

Many areas, for example in the Highlands & Islands, possess mountain and coastal landscapes which are valued for their quality, extensiveness and wild land character. Some possess an elemental quality from which many people derive psychological and spiritual benefits. SNH will shortly publish a policy statement on 'Wildness in the Scottish Countryside'. Wild land is an increasingly limited resource, not easily re-created and more and more valued for its special and rare qualities, both here and abroad. The remaining larger blocks of wild land therefore represent an important national resource, but one which has not so far been mapped on a national basis. Some of this area is covered by natural heritage designations which reflect aspects of its wild land character, but not all. 'Wildness in the Scottish Countryside' identifies preliminary search areas for wild land. These are relatively remote areas whose nature and extent suggest that they are where the qualities of wildness will be best experienced. SNH will be working with planning authorities, using this search area as a starting point, to encourage identification of wild land and appropriate policies. **Wind farms should avoid significant adverse impact on the character and qualities of wild land. By its nature, wild land is sensitive to all forms of development. Given the likely scale and nature of wind farms, it is unlikely that these can be accommodated without loss of wild land qualities. Wild land can also be affected by developments close to its edge.**	**Zone 3** – the areas mapped are preliminary search areas for wild land. This is the indicative area used within SNH's policy on 'Wildness in the Countryside' when inviting planning authorities to identify a wild land resource and appropriate policies. **It is emphasised that such areas are not designated though there is a high degree of overlap with NSAs.** The areas are cross-hatched to show that not all of the land within these areas is likely to be identified as wild land and considered of the highest sensitivity.

National planning policy guidance

Planning authorities are required to take great care to safeguard areas of wild land character including assessment of proposals for development outwith these areas which might adversely affect them[30]. The recreational qualities of silence, solitude or remoteness should be considered[31]. The Development Plan should include policies for protecting and enhancing the character of landscapes of regional importance, including any areas of importance for their wild land character.

[29] Glossary page 24, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[30] Para 11 and 16, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[31] Para 65, NPPG 11 Sport, physical recreation and open space, The Scottish Executive, June 1996.

MAP 3: BIODIVERSITY AND EARTH SCIENCE INTERESTS - DESIGNATIONS

This map indicates natural heritage sensitivities relating to areas designated as of biodiversity or earth science importance.

Cross-hatching indicates that the sensitivity does not apply to the entirety of that area, but only to a proportion.

Zone 1 comprises all land not mapped as sensitive below.

3.1 World Heritage Sites

World Heritage Sites have been identified for their outstanding universal value under the World Heritage Convention, adopted by UNESCO in 1972 and ratified by the United Kingdom.

Locational Guidance

The Convention provides for the identification, conservation and preservation of cultural and natural sites of outstanding universal value for inclusion in a world heritage list, with inclusion on the UK's tentative list the first step in the nomination procedure. Responsibility for the nomination and subsequent protection and management of sites lies with national governments. No additional statutory controls result from designation but a clear policy framework and comprehensive management plan should be established to assist in maintaining and enhancing the quality of these areas. Scotland currently has one World Heritage Site for its natural value (St Kilda), with two sites (Cairngorms and the Flow Country) proposed by the UK Government on the tentative list for which precise boundaries are yet to be defined. Sites are largely covered by other designations, but World Heritage Site status indicates they are of sufficient importance to be the responsibility of the international community as a whole. **Wind farms should avoid significant adverse impact on a World Heritage Site's interests. It is unlikely that developments of a large scale could be satisfactorily accommodated. Any proposed wind farm developments must be of the highest standard in their siting and design.**	**Zone 3** – World Heritage Site boundaries have not been mapped as the one existing and two proposed sites are largely covered by existing national and/or international designations.

National planning policy guidance

The impact of proposed development upon a World Heritage Site will be a key material consideration in determining planning applications[32], and planning authorities and developers are required to pay special attention to the desirability of preserving or enhancing their character or appearance[33].

[32] Para 15, NPPG 18 Planning and the Historic Environment, The Scottish Executive, April 1999.
[33] Para 22, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.

3.2 Natura 2000 sites

Natura 2000 is a network of sites to maintain or restore the distribution and abundance of species and habitats of interest to the European Community. They comprise **Special Protection Areas** (SPAs) and **Special Areas of Conservation** (SACs)**.**

Locational Guidance

SPAs protect the habitat of rare, threatened or migratory bird species under the EU Wild Birds Directive[34]. This requires measures to conserve the habitats of rare and migratory species and to preserve a sufficient diversity of habitats for all species of wild birds naturally occurring in order to maintain populations at ecologically sound levels. SACs protect rare, endangered or vulnerable habitats or species of Community interest under the EU Habitats Directive [35]. This requires measures to maintain or restore the conservation status of natural habitats or species. While some of these species and habitats appear relatively common in Scotland, they may represent a large proportion of the European resource. The Conservation (Natural Habitats &c) Regulations[36] establish a statutory duty to meet the requirements of the Birds and Habitats Directives, define a procedure for assessing proposals and set criteria for permitting them. All Natura 2000 sites deserve the utmost care in their protection. The requirements for protection within the European Directives and the associated Regulations are stringent. The basic test is that a proposal should not adversely affect the integrity of the site. This includes avoiding adverse impact on the species and habitats for which the site is designated, and avoiding deterioration of or damage to any habitats on which they depend. SNH will seek to ensure the requirements of the Birds and Habitats Directives and the associated Regulations are fulfilled. **Wind farms should avoid significant adverse impact on the interest of Natura 2000 sites. It is unlikely that developments of any significant scale could be satisfactorily accommodated. Any proposed wind farm developments which are able to comply with these tests should be of the highest standard in siting and design in relation to their impacts on biodiversity.**	**Zone 3** – the area mapped comprises all SACs (including candidate SACs) and SPAs (including potential and intertidal SPAs).

National planning policy guidance

Government attaches great importance to its international obligations. Proposed development should avoid significant adverse impact on the character, quality, integrity and setting of international designations[37]. Proposals outwith a Natura site but likely to have a significant effect on an area require the same consideration. Development plans should include policies for the protection and where appropriate enhancement of international designations.

The policy test for Natura 2000 sites is set out in NPPG 14 para 42[38].

[34] EC Council Directive on the Conservation of Wild Birds (79/409/EC).
[35] EC Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EC).
[36] The Conservation (Natural Habitats &c.) Regulations 1994.
[37] Para 21, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[38] See Annex 1

3.3 Ramsar Sites

Ramsar sites identify wetlands of international importance, especially as waterfowl habitat, under the Ramsar Convention on Wetlands of International Importance.

Locational Guidance

The Ramsar Convention requires the UK to promote the conservation of wetland sites and their wise use. Most Ramsar sites are also designated as Natura 2000 sites on account of their wetland habitats or bird species. **SNH's policy in relation to wind farm development is the same as for Natura 2000 sites.**	**Zone 3** – most Ramsar sites are also SPAs and are not mapped separately.

National planning policy guidance	Where Ramsar sites are not already classified as SAC or SPA, as a matter of Government policy they are afforded the same protection as SPAs[39]. Hence the above planning guidance for Natura sites applies.

[39] Para 39, NPPG 14 Natural Heritage, The Scottish Executive, January 1999; paras 40 - 42, Habitats and Birds Directives Circular, The Scottish Executive, June 2000.

3.4 Sites of Special Scientific Interest

Sites of Special Scientific Interest are a national designation, designated by SNH, identifying areas of special interest for their flora, fauna, geological or physiographical features.

Locational Guidance

SSSIs represent a national network of the best examples of all the different habitats, rocks and landforms. SNH has a statutory duty to seek appropriate protection for SSSIs. Not all of the interests identified are equally sensitive to wind farm development. Peatlands are particularly sensitive as turbine foundations or vehicle tracks can disrupt the hydrology on which the habitat depends. Coastal habitats may be particularly sensitive as they are prone to erosion and are often narrow and linear in their geography, making them easily fragmented. **Wind farms should avoid significant adverse impact on the interests of any SSSI. Within some types of SSSI there may be scope to accommodate wind farms if they are of a scale and are sensitively located and designed in such a way to avoid adverse biodiversity impacts.** **Peatland and coastal SSSIs are particularly sensitive, and it is unlikely that large scale wind farms could be satisfactorily accommodated. Any proposed wind farm developments should be of the highest standard in siting and design in relation to their impact on peatland hydrology or coastal habitats.**	**Zone 3** – SSSIs considered most sensitive are peatland and coastal SSSIs, and these are mapped in Zone 3. The peatland SSSIs are those listed in the Scottish Blanket Bog Inventory area portfolios. Coastal SSSIs are those where at least part of the SSSI falls within 200m of the coast. **Zone 2** – Other SSSIs, which may be less sensitive to wind farm development, have been mapped in Zone 2.

National planning policy guidance	
	Planning authorities are required to consult SNH when determining a planning application which might affect a site[40]. Development proposals should avoid significant adverse impact on their character, quality, integrity and setting[41]. The Development Plan should include policies for the protection and where appropriate enhancement of national designations. The policy test for national natural heritage designations is set out in NPPG14 para 25[42].

[40] Para 28 – 29, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[41] Para 21, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.
[42] See Annex 1

MAP 4: BIODIVERSITY AND EARTH SCIENCE INTERESTS – NON-DESIGNATED HABITATS AND SPECIES

This map indicates natural heritage sensitivities outwith designated areas due to habitats and species which are regarded as particularly susceptible to impacts from wind farms.

Cross-hatching indicates that the sensitivity does not apply to the entirety of that area, but only to a proportion.

Zone 1 comprises all land not mapped as sensitive below.

4.1 Sensitive habitats

Sensitive habitats – blanket bog, sand dune and machair, coastal grassland and heathland

Locational Guidance

Scotland is renowned for the extent and high quality of its semi-natural habitats, and the valued species that these support. Not all of these habitats are designated. The EU Habitats Directive requires the habitats listed in Annex 1 of the Directive to be maintained at favourable conservation status, including but not limited to those areas which are designated. Legislation also protects many species outwith designated sites.

SNH has identified peatlands and coastal habitats as important and of particular sensitivity to wind farm development. They are important due to their restricted distribution and high proportion of the global resource held in Scotland. Peatland habitats are sensitive to damage through disruption of the underlying hydrology by the building of turbine foundations and vehicle tracks. Coastal habitats are fragile, often prone to erosion, and as they are often linear features along the coastal edge, are easily fragmented.

Careful siting and design is required to avoid significant impacts on these important habitats and species. Where there is uncertainty about potential impacts, the ability to monitor and adapt the development in the event of significant adverse impacts being detected will be important when considering the acceptability of the proposal.

As our knowledge of the effects of wind farms on biodiversity interests improves, the interests identified as sensitive will be refined.

Zone 2 – Coastal habitats included within Annex 1 of the EU Habitats Directive are mapped in full. These include coastal grassland and heathlands throughout Scotland based on the “maritime grassland” class, and sand dune and machair within the Outer Hebrides, Tiree, Coll and Sanday based on the “dune” class. These are all contained within the Land Cover of Scotland 1988.

Blanket bog is much more widely distributed and only the most important areas (10 x 10 km OS grid squares with at least 50% cover of good quality non-designated bog) have been mapped and shown as a brown-bordered square.

National planning policy guidance

Planning policy recognises that natural heritage interests are found throughout the countryside. Planning authorities are encouraged to safeguard and enhance the wider natural heritage beyond the confines of nationally designated areas (although the level of protection outwith designated sites will not normally be as high as that afforded to sites of national or international importance)[43]. Certain species and habitats enjoy legislative protection outwith designated areas and will need to be carefully assessed and taken into account[44]. The Development plan should provide for the protection and enhancement of the natural heritage outwith designated areas.

[43] Para 46 - 47, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[44] Para 21 and 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.

4.2 Sensitive bird areas

Sensitive bird areas are where there are concentrations of sensitive breeding birds

Locational Guidance

Although wind farms may impact on other species, it is the potential impact on birds which is most commonly of concern, either from disruption of habitat, disturbance to breeding birds, or collision risk[45]. The Birds Directive requires certain bird species identified on Annex 1 of the Directive to have their conservation status maintained. The wide ranging nature and dispersed distribution of several such species means that favourable conservation status is difficult to achieve solely through safeguarding designated sites. The Wildlife and Countryside Act 1981also affords protection to many species outwith designated sites. Given the number of species and their differing distributions and flight behaviour, it is inherently difficult to map bird sensitivities at a national scale. For example, golden eagles forage over unforested moorland, using ridge lines for uplift, but when breeding spend a majority of time within a few kilometres of their nest; red-throated divers make regular feeding trips within well-defined corridors from their hill lochan nest sites to the sea; and Greenland white-fronted geese roost in wetland but make daily flights to and from agricultural land to feed. The acceptability of a windfarm in proximity to these species will depend upon a detailed analysis of such flight patterns with a view to minimising interference. Species such as hen harrier are of particular concern due to the fragile nature of the Scottish population, and some such as red kite and white-tailed eagle are the subject of special reintroduction programmes. This mapping within Zone 2 provides only a very general indication of bird sensitivities, showing those 10km x 10km squares within which there is a concentration of important breeding bird species likely to be sensitive to wind farm development. The distribution of eight representative Birds Directive Annex 1 breeding bird species (black-throated diver, red-throated diver, golden eagle, hen harrier, peregrine, merlin, short-eared owl, dotterel), considered sensitive to wind energy developments has been examined in order to indicate the likely presence of important sensitive bird species. Sensitivity is judged on flight behaviour that may make a species vulnerable to collision, and vulnerability to disturbance. It is important to note that the area is indicative of likely sensitivity, as birds may only occur within part of the area. Also, several sensitive species were not included due either to very localised distributions, or lack of recent digital data on their distribution (other sensitive bird species include: barnacle goose, white-fronted goose, white-tailed eagle, osprey, red kite, marsh harrier, honey buzzard, whimbrel, corncrake and chough). **Careful siting and design is required to avoid significant impacts on important bird species. Where there is uncertainty about potential impact, the ability to monitor and adapt the development will be important when considering the acceptability of the proposal.** As our knowledge of the effects of wind farms on biodiversity interests improves, the interests identified as sensitive will be refined.	**Zone 2** – Areas mapped are where four or more of the eight bird species selected are recorded in the BTO breeding bird atlas within a 10 x 10km OS grid square. The areas are cross-hatched as only a proportion of land within each square is likely to be occupied by these species.

[45] See SNH/BWEA Guidance on "Methodology for Assessing the Effects of Wind Farms on Ornithological Interests" – SNH Intranet.

National planning policy guidance

Planning policy recognises that natural heritage interests are found throughout the countryside. Planning authorities are encouraged to safeguard and enhance the wider natural heritage beyond the confines of nationally designated areas (although the level of protection outwith designated sites will not normally be as high as that afforded to sites of national or international importance)[46]. Certain species and habitats enjoy legislative protection outwith designated areas and will need to be carefully assessed and taken into account[47]. The Development plan should provide for the protection and enhancement of the natural heritage outwith designated areas.

[46] Para 46 - 47, NPPG 14 Natural Heritage, The Scottish Executive, January 1999.
[47] Para 21 and 36, NPPG 6 Renewable Energy Developments, The Scottish Executive, November 2000.

MAP 5 COMBINED NATURAL HERITAGE SENSITIVITY

This map combines the landscape, recreation, biodiversity and earth science sensitivities from maps 1-4 to provide an overview of natural heritage sensitivity to wind farms. It identifies land with the greatest opportunity for wind farm development in natural heritage terms, and areas where natural heritage sensitivities indicate a medium or high level of constraint.

Cross-hatching indicates that the sensitivity does not apply to the entirety of that area, but only to a proportion.

Zone 1 lowest natural heritage sensitivity

Zone 2 medium natural heritage sensitivity

Zone 3 high natural heritage sensitivity

NATIONAL PLANNING POLICY TESTS

National natural heritage designations – NPPG14 para 25

The presence of a national natural heritage designation is an important material planning consideration. This does not mean that development is precluded by the presence of such a designation. Proposals require to be assessed for their effects on the interests which the designation is designed to protect. Development which would affect a designated area of national important should only be permitted where:

- The objectives of designation and the overall integrity of the area will not be compromised; or
- Any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by social or economic benefits of national importance.

Natura 2000 sites – NPPG14 para 42

A development which would have an adverse effect on the conservation interests for which a Natura 2000 area has been designated should only be permitted where:

- There is no alternative solution; and
- There are imperative reasons of over-riding public interest, including those of a social or economic nature.

Where a priority habitat or species (as defined in Article 1 of the Habitats Directive) would be affected, prior consultation with the European Commission is required unless the development is necessary for public health or safety reasons.

Datasets used in the preparation of Maps 1 to 4

Map 1 Designated landscape and recreation interests

- **Cairngorms & Loch Lomond and Trossachs National Parks** – Boundaries shown are those contained in the respective National Park designation orders.
- **National Scenic Areas** – The 40 NSAs are identified in the Countryside Commission for Scotland's report *Scotland's Scenic Heritage*, 1978.
- **Areas of Great Landscape Value** – Areas shown include regional and local landscape/amenity areas identified by local authorities in their development plan, including those given names other than AGLV. Information has been compiled from several sources in 2000, and therefore may be incomplete or contain errors. Further information on these designations can be found in SNH Review no.134 *Review of the role of the NSA and other landscape designations in the Scottish planning system* by Environmental Resources Management, 2000.
- **Gardens and Designed Landscapes** – Sites are identified in the five volume *Inventory of Gardens and Designed Landscapes in Scotland* (Countryside Commission for Scotland, Historic Buildings and Monuments Directorate and Scottish Development Department, 1987). A survey of additional sites to supplement the original Inventory has been undertaken but this information is yet to be digitised and is not shown.
- **Regional Parks** – The three Regional Parks (Pentland Hills, Clyde-Muirshiel and Fife) are shown.

Map 2 Non-designated landscape and recreation interests

- **Search areas for wild land** – Areas identified in SNH's policy statement *Wildness in Scotland's Countryside* (2002) are shown.

Map 3 Designated biodiversity and earth science interests

- **World Heritage Sites** – Three sites of natural interest are shown. One has been inscribed on the World Heritage List (St Kilda). Two sites (the Cairngorm Mountains and the Flow Country) have been identified as likely to be proposed for nomination in the next 10 years (Department for Culture, Media and Sport, *World Heritage Sites. The tentative list of the United Kingdom of Great Britain and Northern Ireland*, 1999). Boundaries for tentative list sites are only indicative at this stage.
- **Natura Sites** – All sites identified as Special Areas of Conservation (including candidate SACs) and Special Protection Areas (including potential and inter-tidal SPAs), which are either designated or accepted by the Scottish Executive for nomination to the EC, as at July 2003.
- **Peatland SSSIs** – All SSSIs notified for peatland interest (listed in the *Scottish Blanket Bog Inventory 2001* area portfolios), designated as of March 2002.
- **Coastal SSSIs** – All SSSIs that lie within 200 metres of the coast, designated as of March 2002. The landward extent of these coastal SSSIs has been cut off at 2 Km from the sea.
- **Other SSSIs** – All other SSSIs, designated as of March 2002.

Map 4 Non-designated biodiversity and earth science interests

- **Sand dune, machair, coastal grassland and heathland** – Areas identified as 'maritime grassland class', and areas within the Outer Hebrides, Tiree, Coll and Sanday identified as 'dune class', within the *Land Cover of Scotland 1988* dataset (Macaulay Land Use Research Institute, 1993).
- **Sensitive peatland areas** – Areas of 10 x 10 km OS grid squares with at least 50% cover of good non-designated bog, identified from the *Scottish Blanket Bog Inventory 2001*.
- **Sensitive bird areas** – Areas of 10 x 10 km OS grid squares used for breeding by four or more of the following species are present: Black-throated diver, Red-throated diver, Honey Buzzard, Red kite, Osprey, White-tailed eagle, Marsh Harrier, Hen harrier, Golden eagle, Merlin, Corncrake, Whimbrel, Dotterel, Short-eared owl, Chough. Species distribution data taken from the British trust for Ornithology *Breeding Bird Atlas*, 1988 – 1991.

Guidance

Scottish Natural Heritage
All of nature for all of Scotland

ASSESSING THE CUMULATIVE IMPACT OF ONSHORE WIND ENERGY DEVELOPMENTS

March 2012

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SECTION 1 INTRODUCTION AND SCOPE OF THIS GUIDANCE

Background

1. Renewable energy is an increasingly important part of Scotland's economic, social and environmental success. The pace of renewable developments has increased rapidly in recent years and windfarms are now familiar sights in many parts of the country. Scottish Natural Heritage (SNH) supports the development of onshore windfarms and recognises the many benefits they bring. However, their cumulative impacts on the natural heritage need to be carefully considered to ensure that these are acceptable.

2. The increasing development of on-shore windfarms has led to concerns about cumulative impacts in some locations as was illustrated in the debate in the Scottish Parliament on 1 December 2011. During the debate Fergus Ewing, Minister for Energy Enterprise and Tourism observed:

   "The Scottish planning system is committed to delivery of increased renewable energy capacity. It also seeks to safeguard communities and the environment…..The main issue has perhaps been cumulative impact, which is already a key consideration in decision making. In determinations, planning authorities and the Scottish Government will continue to draw on planning policy and advice from SNH."

3. Scottish Planning Policy (SPP) highlights that cumulative impacts may present an eventual limit to the extent of onshore wind development and the increased need to consider cumulative impacts in the decision making process (SPP para 189). **This guidance therefore seeks to identify methodologies which can be used to assess cumulative impacts.**

4. **The guidance is aimed at public bodies, developers and consultants involved in onshore wind energy development. It sets out methods to be used to assess cumulative impacts on landscapes and birds.** It is not possible to provide generic advice on the significance of cumulative effects, which need to be assessed on a case by case basis against other guidance.

5. Although the guidance concentrates on the particular issue of assessing the cumulative effects of more than one windfarm development, the methods may also be helpful when considering the cumulative impact of other forms of development. Impacts on other natural heritage interests, such as habitats and protected species require to be addressed on a case by case basis as it is not possible to provide meaningful generic guidance

6. Cumulative impacts are just one of many issues that have to be considered in order to make good development happen in the right places. We have produced guidance on a range of other issues to be considered during the design and assessment of windfarms. Further guidance and information, for example **Siting and Designing windfarms in the landscape** (SNH 2009), can be found on our website.

What are cumulative impacts?

7. Cumulative impacts can be defined as the additional changes caused by a proposed development in conjunction with other similar developments [1] or as the combined effect of a set of developments, taken together. In practice the terms 'effects' and 'impacts' are used interchangeably.

Assessing cumulative impacts

8. A clear, transparent and detailed assessment process is needed to understand the impacts of a proposed windfarm development when it is seen alongside others in the area. The process needs to identify the overall impacts which may arise from a group of projects and distinguish the contribution of each individual project to these. The assessment should take account of existing windfarms, and those which are consented or at application stage. Some examples are provided in Box 1 below.

Box 1 Examples of cumulative effects

Imagine two separate developments, A and B. The cumulative effect of both developments taken together need not simply be the sum of the effect of A plus the effect of B; it may be more, or less. This is best demonstrated using some examples as shown below

- An isolated house A in the countryside has a visual impact, standing out in its natural setting. Another isolated house B has a similar visual impact, taken alone. However if the two houses are sited close together, the visual impact of the two together may be only a little greater than for either house A or B taken alone, as they will appear as a single cluster.

- Windfarm A sited on a ridge on one side of a valley is highly visible but acceptable, providing a single visual focus on an otherwise unremarkable skyline. A second windfarm B on a ridge on the other side of the valley would have a similar effect, if it were on its own. However, the effect of having two windfarms sited on either side of the valley may be to make the observer feel surrounded by development. The combined effect of both may be much greater than the sum of the two individual effects.

- Windfarm A gives rise to a low level of bird mortality, which lies well within the capacity of that bird population for regeneration and hence has little effect on the overall bird population level. The same would apply to a second windfarm B, taken on its own. However, the level of bird mortality caused by windfarms A and B taken together would exceed the capacity of the population for regeneration, in which case the population would go into decline. Whereas the impact of A and B, each on their own, was not of concern, the impact of A + B is to cause population decrease which is of concern.

9. In many parts of Scotland the level of windfarm development is now such that a large number of windfarms will have to be taken in to account. The examples above are necessarily simplified to illustrate the issues, but the principles for multiple developments are the same.

[1] Paraphrased from the Guidelines for Landscape and Visual Assessment (GLVIA), p85, paragraph 7.12.

Legislative context

10. In the Scottish development planning system, the overriding principle is that each application must be determined on its own 'individual merit'. There is also a presumption in favour of development which accords with the relevant development plan, although other 'material considerations' may outweigh the plan's policies. It is increasingly recognised that cumulative impacts may be considered as 'material considerations'. For example, while individual supermarkets may not threaten the viability of a town centre or the capacity of the road network, their combined effect could exceed local spending power or the threshold of existing infrastructure (roads, sewerage etc).

11. In addition, under the terms of the EIA Regulations 2011, the potential for cumulative impacts is one of the aspects to be included in Environmental Impact Assessment (EIA). This is explained in more detail in PAN 58. Consideration of cumulative and synergistic effects is also a requirement of the Strategic Environmental Assessment (SEA) Directive (2001/42/EC) which is transposed into Scottish legislation by the Environmental Assessment (Scotland) Act 2005 and through the Environmental Assessment of Plans and Programmes Regulation 2004 for proposals affecting more than one part of the UK. **Annex A** lists the key references to cumulative effects contained in Government and SNH guidance.

Our approach to renewable energy and cumulative impacts.

12. Our approach to renewable energy is set out in *Renewable Energy and the Natural Heritage* (2010) and is expanded by 02/02 *Strategic locational guidance for onshore wind farms in respect of the natural heritage* (2009). Our approach is a supportive one, recognising the climate change, social and economic benefits that renewable energy can deliver.

13. The Strategic Locational Guidance identifies three broad zones of sensitivity to wind farms. Within these:

    - The zone of lowest natural heritage sensitivity is described as that with *"the greatest opportunity for development within which overall a large number of developments would be acceptable in natural heritage terms, so long as they are undertaken sensitively and with due regard to cumulative impact".*

    - For the zone of medium natural heritage sensitivity, the guidance states that *"by careful choice of location…there is often scope to accommodate development of an appropriate scale, siting and design (again having regard to cumulative effects) in a way which is acceptable in natural heritage terms".*

14. In this way SNH guidance already points firmly to the need to consider cumulative impacts, even in less sensitive locations.

SECTION 2: WHEN TO TAKE ACCOUNT OF CUMULATIVE IMPACTS

15. Cumulative impacts should be considered:

- in **strategic planning** (as part of the preparation of a strategic framework for windfarms) **and**
- in **development management** (in the context of a site specific assessment)**.**

16. Although the two forms of cumulative assessment share common principles, it is important to distinguish between the two distinct processes.

Assessing Cumulative impacts in strategic planning

17. Strategic cumulative impacts assessment should be undertaken as part of a planning authority's preparation of:

- Development Plan policies and Supplementary Planning Guidance;
- Strategic Environmental Assessment; and
- Renewable energy capacity assessments.

18. In all cases, the focus is on forward planning: setting out the vision for windfarm development; and determining the thresholds of acceptable change, where the most suitable locations for development are, and what might be an appropriate design and scale.

19. The strategic plans (often underpinned by a landscape capacity study) should consider a range of specific scenarios, in terms of the numbers, scale and distribution of windfarm developments to be accommodated. It should then make use of the resulting cumulative impact assessment to draw conclusions as to which of these scenarios is acceptable.

20. The area included within a strategic cumulative assessment should not be constrained by administrative boundaries. Effective assessments should cover the whole of a region, straddling more than one planning authority, or that of a natural heritage management unit such as a National Park or Firth Partnership area.

21. Planning authorities are encouraged by Scottish Planning Policy to:

- define broad areas of search suitable for large scale (>20MW) wind farms
- identify the criteria they should meet through the development of Supplementary Planning Guidance.

22. This approach will have enhanced value if it is also associated with a view of the **capacity** of the area for such development and identification of the critical factors which are likely to present an eventual limit to development. We have recently published a review of landscape capacity studies which provides useful advice. Further guidance on critical factors can be found in our guidance 'Siting and Designing windfarms in the landscape' (page 44).

23. Further guidance on cumulative impacts in strategic planning is also provided in:

- Process for preparing spatial frameworks for wind farms (Scottish Government 2011).
- Siting and Designing Windfarms in the Landscape – section 5 (SNH 2009).

Assessing cumulative impacts in development management

24. Cumulative impacts should be assessed where a proposed development involves:

    - a new development in combination with one or more existing or approved but unbuilt development;
    - an extension to an existing or approved but unbuilt development;
    - more than one development proposed at the same time within an area; or
    - any combination of the above.

25. An assessment is most likely to be carried out by the prospective developer, as part of an Environmental Statement or environmental information, and reviewed by the determining authority (the planning authority or the Scottish Government) and consultees (such as SNH).

Which windfarms to include in the assessment

26. An assessment of cumulative impacts associated with a specific development proposal should encompass the effects of the proposal in combination with:

    - existing development, either built or under construction;
    - approved development, awaiting implementation; and
    - proposals awaiting determination within the planning process with design information in the public domain. Proposals and design information may be deemed to be in the public domain once an application has been lodged, and the decision-making authority has formally registered the application.

27. The decision as to which proposals in the planning / consenting system should be included in an assessment is the responsibility of the determining authority. The determining authority may ask a developer to seek advice from SNH on which proposals are likely to have cumulative impacts on bird interests.

28. Our windfarm footprint map[2] can help to identify existing sites initially, but this is only updated every 12 months and may not show an up-to-date pattern. It does not show all small scale windfarm proposals which may also need to be included in a cumulative assessment.

29. We have therefore encouraged Local Authorities and the Scottish Government to log all existing, consented, applied for and formally scoped windfarm proposals on an accessible GIS system. This will allow information to be easily made available to developers and/or neighbouring Planning Authorities to use in consideration of cumulative impacts.

30. The cumulative impact assessment (including illustrative material) needs to distinguish between predicted effects in relation to each of the relevant

[2] available at http://www.snh.org.uk/strategy/renewable/sr-rt01.asp

scenarios. For example, a proposal in combination with existing and consented developments, or proposal in combination with existing, consented and planning application stage developments, etc.

31. Occasionally it may be appropriate to include proposals which are in the early stages of development in an assessment, particularly where clusters of development or “hotspots” emerge. However, a degree of pragmatism is required to enable proposals to progress to determination.

32. Cumulative impact assessment can be expensive and time consuming, as it requires knowledge, at least in outline, of the effects of each existing or proposed development within the vicinity. We therefore only seek cumulative impact assessments where it is considered that a proposal could result in significant cumulative impacts which could affect the eventual planning decision. In some situations a Habitats Regulations Appraisal may be required and this may involve a wider consideration of in combination and other impacts.

33. **The key principle for all cumulative impact assessments is to focus on the likely significant effects and in particular those which are likely to influence the outcome of the consenting process.**

Timing of new proposals entering the planning / consenting system

34. Planning authorities are empowered under EIA Regulation 19 and Article 13 General Development Procedure (S) Order 1992[3] to seek additional information from the applicant at any point in the determination of the application.

35. If an Environmental Statement which includes assessment of cumulative effects is nearing completion when a new planning proposal is submitted for another site in the same area, the decision-making authority may regard the new application as a material consideration.

36. However, a request at such a late stage may conflict with the applicant’s right for a decision within prescribed timescales. Thus, while it might be preferable for the potentially competing applications to be determined together, a planning authority might conclude that it would be unreasonable to defer determination of an outstanding application as successive new applications are submitted.

37. **Once an application has been submitted and is accompanied by a complete and satisfactory Environmental Statement, any further assessment to take account of new proposals is likely to cause delay. The determining authority may consider that it cannot reasonably *require* further cumulative assessment by the applicant. In some locations the level of development is such that cut off dates should be considered to enable applications to progress.**

38. The same circumstances may occur where an application becomes subject to Public Local Inquiry (PLI) proceedings. Because of the time delays inherent in the PLI process, a developer may opt to present new cumulative assessment for the PLI, updated to include all extant proposals at the time of the PLI.

[3] or the relevant section of the Electricity Works EIA regulations.

39. Where an applicant makes a major change to a proposal already within the planning system, and a revised environmental assessment is required, the planning authority may wish to regard this as a revised application with a new submission date, requiring re-notification of consultees. If other proposals have entered the planning / consenting system since the original application date, it may be appropriate to request further cumulative assessment in combination with these new applications. Changes to a proposal which are minor in terms of scale, design or impacts are less likely to be regarded by the determining authority as requiring a resubmission.

Information from competing developers

40. Cumulative impact assessments normally require details of the impacts of each development separately, (e.g. data in respect of all relevant projects in relation to proposed turbine model, dimensions and detailed grid references of proposed turbine locations). Difficulties may arise if developers are unwilling to share information.

41. Environmental Statements, once submitted to the planning authority, are public documents but subject to copyright. The information may be used by other developers but it may not be copied without permission. There is no compulsion on a developer to release any data supporting the ES, unless the planning authority formally requires that information as part of its assessment.

42. The use of confidential annexes containing environmentally sensitive information on birds should be limited to the situations described in our guidance on Environmental Statements and Annexes of Environmentally Sensitive Bird Information (September 2009). Confidential annexes should not be used to 'hide' data from neighbouring developers.

43. **Planning authorities (and the Scottish Government) are encouraged to ask developers to cooperate over the exchange of information where cumulative assessment has been identified as important and data outwith publicly available Environmental Statements is needed in order to make such assessments.**

Our advice to decision-making authorities

44. Given that cumulative impacts can potentially present a significant constraint on wind farm development, it is important that our advice to planning authorities (and to the Scottish Government) conveys not only our views on the proposal in terms of its individual impacts, but also our view on cumulative effects. **Annex B** contains some scenarios of cumulative impacts and provides examples of wording that will be used in SNH responses.

SECTION 3: ASSESSING CUMULATIVE LANDSCAPE AND LANDSCAPE AND VISUAL IMPACTS

Introduction

45. The cumulative impact of windfarm development on landscape and visual amenity is a product of:

- the distance between individual windfarms (or turbines),
- the distance over which they are visible,
- the overall character of the landscape and its sensitivity to windfarms,
- the siting and design of the windfarms themselves, and
- the way in which the landscape is experienced.

46. The combination of single turbines and small clusters of turbines can raise the same issues. Where the cumulative effects of these are significant, they require assessment and this should be agreed at scoping stage.

47. The Guidelines for Landscape and Visual Impact Assessment [4] (GLVIA) refer to both the changes to landscape **and** visual amenity caused by the proposed development in conjunction with other developments, or with actions which occurred in the past, present or are likely to occur in the foreseeable future.

Cumulative landscape effects

48. Cumulative landscape effects can impact on either the physical fabric or character of the landscape, or any special values attached to it. For example

- Cumulative effects on the *physical fabric* of the landscape arise when two or more developments affect landscape components such as woodland, dykes, rural roads or hedgerows. Although this may not significantly affect the landscape character, the cumulative effect on these components may be significant – for example, where the last remnants of former shelterbelts are completely removed by two or more developments.

- Cumulative effects on *landscape character* arise when two or more developments introduce new features into the landscape. In this way, they can change the landscape character to such an extent that they create a different landscape character type, in a similar way to large scale afforestation. That change need not be adverse; some derelict or degraded landscapes may be enhanced as a result of such a change in landscape character.

49. Windfarms may also have a cumulative effect on the character of landscapes that are recognised to be of *special value***.** These landscapes may be recognised as being rare, unusual, highly distinctive or the best or most representative example in a given area. This recognition may take the form of national or local designations (for example, National Scenic Areas or Special Landscape Areas), citations in development plans, community plans or other documents, or be less formally recognised, such as Search Areas for Wild Land.

[4] Second Edition, paragraphs 7.12 and 7.13

Cumulative effects on visual amenity

50. Cumulative effects on visual amenity can be caused by 'combined visibility' and/or 'sequential effects':

    Combined visibility occurs where the observer is able to see two or more developments from one viewpoint. Assessments should consider the combined effect of all windfarms which are (or would be) visible from relevant viewpoints. Combined visibility may either be in combination (where several windfarms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various windfarms).

- *Sequential* effects occur when the observer has to move to another viewpoint to see different developments. Sequential effects should be assessed for travel along regularly-used routes like major roads, railway lines, ferry routes, popular paths, etc. Sequential effects may range from *frequently sequential* (the features appear regularly and with short time lapses between) to *occasionally sequential* (long time lapses between appearances) depending on speed of travel and distance between the viewpoints.

51. Two windfarms need not be intervisible – or even visible from a common viewpoint – to have impacts on the landscape experience for those travelling through an area. For example, it may be necessary to consider the cumulative effects of windfarms on users of scenic road routes, or routes for walkers, along their full length within the agreed study area. The area within which a cumulative assessment is required should relate to the issues involved, and should not be limited by local authority boundaries.

52. Cumulative visual effects are discussed in more detail in the GLVIA. In general, impacts will vary in degree according to:
    - the sensitivity of visual receptors;
    - the landscape context (for example, an open landscape with wide panoramic views or an intimate landscape with enclosed views)
    - the activity of the receptor (e.g. residents, visitors etc) and their number;
    - the magnitude of cumulative change in terms of the scale, nature, duration, frequency of combined and sequential views (glimpses or more prolonged views; oblique, filtered or more direct views; time separation between sequential views);

Perceived cumulative effects

53. Perceived cumulative effects may arise;
    - where two or more developments are present but one or more is never seen by the observer, for example, because they are screened, or the observer is unable or unwilling to gain a viewpoint from where they would be seen. The observer is aware that other developments are present because, for example, they may have learnt about them or seen signs to them. This effect may be significant, but can also be mistaken, where the observer's information or interpretation of it is wrong, or

- where people have formed an opinion about wind farms generally without having seen one, for example through someone else's experience. They may use this perceived effect to express a negative opinion about a development proposal near where they live.

54. Few detailed perception studies have been undertaken to date and although there is a generally good understanding among planners and Local Authority councillors of perceived effects, it is unusual for them to be considered in the context of an individual decision. This issue is therefore most appropriately addressed within the scope of strategic environmental assessment or spatial planning.

Undertaking a Cumulative Landscape and Visual Impact Assessment

55. The purpose of a Cumulative Landscape and Visual Impact Assessment (CLVIA) is to describe, visually represent and assess the ways in which a proposed windfarm would have additional impacts when considered in addition to other existing, consented or proposed windfarms. It should identify the significant cumulative effects arising from the proposed windfarm.

56. The main requirement is an assessment which is proportionate to the impacts. All CLVIA should accord with the methodology outlined in the GLVIA. The emphasis, when undertaking CLVIA should always be on the production of relevant and useful information, highlighting why the proposals assessed have been included and why others have been excluded.

57. The flow chart in Figure 1 summarises the recommended CLVIA process for windfarms. The process is described in more detail below. **This is generic guidance only. The number of proposals in an area and the timing of applications give rise to development scenarios of varying complexity. Professional judgement should inform the scope of the study to be undertaken. SNH and Planning Authorities may also require different or additional information to assist in their assessment of cumulative landscape and visual impacts.**

Figure 1. Flow chart summarising CLVIA for windfarms

Production of **SEARCH AREA** BASE PLAN

Maximum 60km radius from proposed site, but may be reduced for applications for single turbines or small turbine groups.
Showing footprint of proposed windfarm, all built windfarms, consented and undetermined applications, proposals subject to scoping requests and any other proposals deemed relevant in the public domain.
Justification to be given for the choice of base plan area size if less than 60km and choice of windfarm footprints shown.

Production of
DRAFT CUMULATIVE ZTVs
For relevant built, consented and undetermined applications in search area to assist in defining detailed scope of study.

Identification of
KEY LANDSCAPE AND VISUAL RECEPTORS which will require detailed investigation

Definition of **STUDY AREA AND SCOPE OF DETAILED ASSESSMENT**

Generally 35km radius from outer boundary of proposal but may be extended due to the nature of likely cumulative effects identified above. It is good practice to agree the **extent of assessment to be agreed with LA at Scoping stage**.
Extent of study area **relative to anticipated cumulative visual and potential effects on landscape and visual amenity**, **focussing on significant effects.**
All proposals visible from significant viewpoints (eg Munros) to be assessed
Consider **sequential effects** from transport and recreational routes - may go beyond 60km search area and may result in a non-circular study area.

Preparation of
DETAILED ZTVs
for all key projects in the study area with which the proposed windfarm is considered likely to interact.

Identification of
KEY VIEWPOINTS
based on cumulative ZTVs and preparation of
WIRELINES AND PHOTOMONTAGES
to illustrate the nature and degree of cumulative visual effects

Identification of
KEY ROUTES AND JOURNEYS
based on cumulative ZTVs and preparation of
JOURNEY SCENARIOS
using plans, diagrams, tables and/or timelines

CUMULATIVE LANDSCAPE IMPACT ASSESSMENT

Assessment of cumulative landscape impacts, in terms of scale, nature, duration and significance on landscape character, landscape designations, designed landscapes, wildness and remoteness, and special landscape interests

STATIC CUMULATIVE VISUAL IMPACT ASSESSMENT

Assessment of combined/simultaneous visibility and successive visibility,

SEQUENTIAL CUMULATIVE VISUAL IMPACT ASSESSMENT

Assessment of cumulative visual impact along routes.

58. It is important to have a clear view of the context for a cumulative impact assessment in order to focus on those windfarms and/or issues where there is potential for a significant cumulative effect. A phased approach to defining the study area for a cumulative impact assessment is recommended.

59. The starting point for the assessment is preparation of a **search area base plan**. This should identify all the windfarm projects which are relevant for the subsequent CLVIA. The projects to be considered in the detailed assessment will be selected from the base plan.

60. A clear and legible search area base plan should be produced to show all of the following within a radius of up to **60 km** (depending on the individual proposal, smaller developments should use a smaller radius in agreement with the Planning Authority):

    - any constructed or consented windfarm;
    - any undetermined windfarm application;
    - any windfarm proposal which has been subject to an EIA scoping request to the relevant authority; and
    - any other windfarm proposal that the Planning Authority, and/or SNH, considers relevant for study and which is within the public domain (eg as a result of a public announcement or community meeting).

    Note – due to the very large number of small scale (fewer than 3 wind turbines) proposals currently in the system it may not be practical to include all of these in the search area base plan. The Planning Authority should be consulted for the most up to date information and to confirm which sites should be included

    Note – installed, consented and proposed offshore windfarms should also be presented on the base plan to enable a decision on whether to include these in the assessment.

61. The precise **study area** should then be selected **from within** the search area base plan and agreed with the planning authority. The applicant must consider what the **key effects** will be within the search area, using these to propose the study area for more detailed assessment. Key considerations will include:

    - Sequential effects on key routes
    - Intervisibility with other developments
    - The existing pattern of development

62. **The onus is on the applicant and their consultants to use the base plan and initial assessment to identify the likely key effects and use these to define an appropriate study area and methodology before approaching SNH for a view.**

63. Generally, for the current generation of turbine size, the study area should extend to a minimum of 35km from the outer margin of the windfarm in question. Our "Visual Representation of Windfarms Good Practice Guidance" suggests appropriate ZTV distances for smaller turbines[5].

[5] Table 2, Page 36 – note this guidance is currently under review

64. The size of the study area should also be influenced by the locations and ZTVs of other windfarms likely to interact with the new proposal; and by transport routes to be assessed for sequential effects. The study area may not be circular in shape but could be larger in some directions than others. Sequential impacts may need to be assessed for a distance of more than 60km from the proposed windfarm. This should be agreed at the scoping stage.

Scope of detailed cumulative assessment

65. The list of projects to be included in the detailed assessment should be clearly set out with an explanation of how the detailed scope has been determined (e.g. ZTV analysis, checking on site, previous applications). A checklist could be used to explain this: it would set the projects against a "menu" of priorities, including distance from the proposal, certainty of construction, etc. The relevant receptors (landscape character areas, designated landscapes, designed landscapes, visual receptors, including sequential routes through the study area) should also be listed.

66. The resulting scope should be discussed with the determining authority and SNH and agreed at the scoping stage. **At every stage in the process the focus should be on the key cumulative effects which are likely to influence decision making, rather than an assessment of every potential cumulative effect.**

67. The assessment should clearly describe the baseline conditions by identifying existing windfarms and the extent to which these have altered landscape character and affected sensitivity to windfarm development. This information should be produced as part of the baseline LVIA and then considered as part of the CLVIA. However, the CLVIA should then focus on the key cumulative changes likely to be brought about by the new proposal, i.e. on key routes, views or character areas.

68. The assessment should also identify the **sensitivity of the landscape and visual amenity** resource and the predicted magnitude of cumulative change arising from each of the relevant scenarios, for example:

    – the proposed windfarm with existing operational windfarm developments and those under construction;
    – the proposed windfarm with existing and consented but unbuilt windfarm development;
    – the proposed windfarm with any application stage proposals, which could include those at scoping stage;
    – the proposed windfarm with any other windfarms, along with other proposals in the planning system.

69. Predicted visibility of cumulative windfarm development should be described, informed and depicted by supporting **wireline drawings** and, where relevant, **photomontages** which should clearly distinguish between each individual project and its status within the planning system. This is best done by annotation or illustration using a different colour for each individual windfarm. These and other illustrative tools are described further below.

70. The magnitude of cumulative change may be different from the magnitude of change brought about by the development when considered on its own. The aim

of the cumulative assessment is to identify the magnitude of additional cumulative change which would be brought about by the proposed development when considered in conjunction with other windfarms. A range of parameters should be considered, including:

- the number of other windfarm projects which would be visible in the landscape in each of the different scenarios (existing, consented or application stage);
- direction to each of the projects;
- distance to each of the projects;
- the number and height of turbines at each of the projects – which may also be expressed as the horizontal and vertical angle occupied by turbines – and any access tracks and grid connections; and
- duration of the change (i.e. age of constructed windfarms and the planning status of the projects).

'Zone of Theoretical Visibility' studies

71. 'Zone of Theoretical Visibility' (ZTV) analysis is the process of determining the visibility of an object in the surrounding landscape, using computer modelling and digital terrain mapping. It has a number of limitations, described within Visual Representation of Windfarms Good Practice Guidance (SNH 2006).

72. Cumulative ZTVs should be produced for all existing and consented developments as well as undetermined applications in the initial search area **with which the proposed windfarm is likely to interact to cause significant cumulative effects.** ZTVs provide a useful tool to assist in the refinement of the scope of a cumulative assessment. There are various ways in which the ZTVs can be presented, including the baseline and:

    - proposed site ZTV;
    - landscape character types and proposed site ZTV;
    - landscape designations and proposed site ZTV;
    - sequential routes and proposed site ZTV;
    - paired ZTV (i.e. application windfarm plus one other);
    - ZTVs which show a sub-set of projects: the proposal under consideration plus selected others – which may be chosen according to geographic proximity to one another, similarity in ZTV or in relation to status, i.e. both consented, or both at application stage;
    - comparative ZTV which illustrates the extent of additional visibility of new turbines where they are being proposed as part of a windfarm extension, or an alteration to an application.

73. Cumulative ZTVs should clearly show those areas from where one or more windfarms are likely to be seen. Each windfarm and its ZTV should be shown in a different colour and be clearly named. In the case of a ZTV showing three windfarms it will be possible to illustrate the overlapping areas using separate colours e.g. red, blue and yellow to represent each development (with corresponding overlaps of orange, green, purple etc.) or hatching in different directions.

74. Where four or more windfarms are involved, ZTVs may become difficult to interpret and a series of additional, separate cumulative ZTVs may be required to show the cumulative effects clearly.

75. **Agreement on groupings of windfarms for separate cumulative ZTVs should be reached with the relevant planning authority(ies) and SNH.**

76. Early drafts of ZTVs can help the Planning Authority and SNH to advise on the selection of viewpoints for stationary cumulative impact assessment and routes for sequential cumulative assessment. **These should be provided for pre-application requests for advice and/or meetings, and included in scoping requests where possible, even if some sites are missing.**

Selecting viewpoints and assessing fixed positions for cumulative visual effects

77. Locations for viewpoints should be identified by the applicant and agreed with the Planning Authority in consultation with SNH. Detailed guidance on viewpoint selection is contained in Visual Representation of Windfarms Good Practice Guidance (SNH 2006).

78. The selection of cumulative viewpoints should be based on an analysis of the draft cumulative ZTVs, ideally at the initial scoping stage of the LVIA so that, as far as possible, viewpoints are selected which will serve **both** the LVIA and CLVIA. All relevant data may not be available at the outset. Additional viewpoints may be required once such data are available and have been analysed. In areas where there have already been a number of windfarm proposals it may be useful to select viewpoints that have been used for previous windfarm CLVIAs. In many locations the level of development is such that most viewpoints will now be cumulative in nature.

79. Viewpoints should be chosen to represent the following fixed position cumulative visual impact scenarios:

   – *Combined or simultaneous visibility* occurs where the observer is able to see two or more developments from one viewpoint, without moving his or her head. A 90 degree arc of view should be shown and the effects represented as described below; and

   – *Successive or repetitive visibility* occurs where the observer is able to see two or more windfarms from one viewpoint but has to move his or her head to do so. Visualisations, such as 180 or 360 degree arc of view wirelines, will be useful in assessing these effects. Supporting text or tables to describe the effects will be needed.

80. A degree of pragmatism is required to limit the number of viewpoints to those which are likely to provide useful information to inform decision making.

Sequential visual assessment and selection of routes for analysis

81. *Sequential cumulative effects on visibility* occur when the observer would see the proposed windfarm with other developments, either simultaneously or in succession, when moving through the landscape.

82. Routes to be assessed should be defined and agreed with the Planning Authority as part of the baseline LVIA. The extent of these study routes should be informed by the 60km search area base plan drawing and the cumulative ZTVs.

They may extend beyond this in some situations, for example particularly important or busy travel routes, or particularly sensitive locations.

83. A "**journey scenario**" should be considered for routes that may have significant cumulative effects, and the description of available views and how these may be affected by the proposal may note:

- direction of view ('direct', 'oblique', 'aligned on route', or 'looking NW of route' etc.); and
- distance from nearest turbine; and
- distance over which the effect would occur.

84. It can also be helpful for the assessment to identify the likely duration of the predicted effect. For example, 'assuming an average driving speed of 'x', this effect will be apparent for approximately ten minutes between 12 and 8 km from the nearest turbine'. The journey scenario can be illustrated in various ways as described below.

Cumulative assessment of single turbines, or small groups of turbines

85. Single or small groups of 2 or 3 commercial scale wind turbines raise specific issues for cumulative effects and their appraisal. These include:

- when cumulative issues occur with both larger windfarm development and/or other single/small scale development;
- multiple small scale and single turbine developments being proposed in a particular region, with complex cumulative effects arising; and
- introduction of development to landscape types which have not yet been subject to larger windfarm development.

86. SNH guidance on the preferred approach to cumulative assessment of single or small groups of turbines can be found in "Assessing the impact of small scale wind energy proposals on the natural heritage" (SNH, March 2012). This sets out indicative levels of information to be submitted by developers which, although less than that expected for larger proposals, should be of a suitable standard to enable easy appraisal by consultees.

87. Assessment of micro renewables proposals (<50kw) is detailed in our guidance "Micro renewables and the natural heritage" (SNH, October 2009). Applications at this scale are unlikely to require, or be included in CLVIA.

88. Further guidance on the siting and design issues related to small to medium turbine development (15-50 metres height to blade tip) is also available on our website.

Illustrative Methods

89. The predicted cumulative effects should be clearly portrayed in accordance with GLVIA (2002) and Visual Representation of Windfarms Good Practice Guidance (SNH 2006). All relevant proposals should be depicted (where practical) in all of the relevant illustrative material (i.e. wireframes, photomontage, study area map).

90. The range of illustrative tools which can help in cumulative landscape and visual impact assessment is constantly evolving. Some of the available tools which have been found to be of particular value are described below.

- **Wireline views** are most commonly used to show installed, consented and as yet undetermined applications in combination. It is important that the turbines, or clusters of turbines, are clearly presented and numbered, using different colours to distinguish between windfarms as necessary. Interpretive text and data should be positioned carefully to avoid cluttering the wirelines. A separate appendix showing wirelines with numbered turbines may be appropriate.

- **Photomontages** will usually be of most value for views within 15km of a windfarm site. However this will depend on the specific windfarm design and environmental conditions and consequently this parameter should usually be discussed and agreed with the determining authority and consultees.[6]

91. In some circumstances it may be useful to show more distant developments in both wirelines and photomontages. Where these are so distant that they cannot meaningfully be displayed on the illustration, a note showing the location and approximate extent of the development will suffice.

92. Where the baseline has changed, it will often be necessary to provide up to date photographs from viewpoints. For example, if other windfarms (or indeed other forms of development) have been built since the original photography was taken.

93. A **'wind rose'** diagram, shaded to show the direction (arc of view) and distance of windfarms visible for 360 degrees, can often be helpful, especially from important summit viewpoints.

94. Sequential effects can also be illustrated in several ways:

    - **plan** showing visibility of different projects from a route denoted by coloured arrows on mapped base;
    - **diagram** showing visibility of different projects from a route. This could take the form of a colour-coded timeline linked to the colours used in the ZTV;
    - **table** showing predicted visibility by length of route affected by each project, including commentary text on every 10km explaining where each project is visible and the nature of this visibility;
    - colour coded **sequential bar chart** or "timeline**"** showing distance, duration of view and whether it is direct, oblique, screened, etc., with the colours for each windfarm matching those used in the ZTV. An analysis of the significance of such quantitative data is needed.

95. Computer generated moving images ("drive throughs") or **videomontage** techniques may also be appropriate to assist CVIA, particularly in respect of cumulative sequential effects. This technique may be particularly applicable to assessment from moving receptors such as trains or ferries or in assessing windfarm extension applications where different turbines with different heights and rotor speeds are being used. Alternatively, a series of static images could be produced and viewed in time sequence.

[6] Visual Representation of Windfarms Good Practice Guidance (SNH 2006), paragraph 205 – note this guidance is currently under review

Description and assessment of cumulative landscape impacts

96. The study of potential cumulative landscape effects and related impacts should include the description and assessment of the following issues:

- **Effects on landscape character.** The cumulative (i.e. additional) effect of proposed development on existing landscape character should be described, particularly in relation to key landscape characteristics. It is likely that as more windfarms are developed they will begin to be perceived as a key landscape characteristic and will therefore change the landscape character. These effects should be objectively assessed in accordance with standard landscape character assessment guidelines (Land Use Consultants for SNH and Countryside Agency, 2002, GLVIA 2002).

  Consideration should also be given to related effects on sense of distance, scale and focal points in the landscape. Relative scarcity of Landscape Character Type may also be considered as part of the assessment, especially where there are few examples of a certain Type which remain unaffected by windfarm development.

- **Effects on sense of remoteness or wildness.** The existing experience of remoteness and wildness should be described and the cumulative effects of development analysed. This should include effects on the peripheries, and therefore the setting of any wild land areas, to ensure that their extent is not diminished. Useful reference can be made to SNH's policy on 'Wildness in Scotland's Countryside' (SNH, 2003) and 'Assessing the Impacts on Wild Land' (SNH 2007). We are currently revising our wild land mapping and updated mapping and information is expected to be available later in 2012.

- **Effects on other special landscape interests** . The effects of additional development on the objectives, key characteristics, qualities and integrity of any relevant landscape designation should be analysed and described as should effects on other interests in the landscape. For example, this may include consideration of the effects on the landscape setting of settlements or other cultural interests (such as designed landscapes) and associations with the landscape (GLVIA 2002).

97. Other issues that are not identified above may also be relevant for assessment of cumulative landscape effects depending on the location and these should be agreed with the Planning Authority.

Description and assessment of cumulative visual impacts

98. The study of potential cumulative visual effects and related impacts should include the description and assessment of:

- **Effects on range of visual receptors in the study area.** This may include residential settlement; outdoor recreational facilities (informal and formal) and routes through the study area.

- **Effects on views of the landscape.** For each of the relevant receptors, consider if any additional impacts on visual amenity derive from the new turbines and how this relates to other wind farms visible from the same location. For example, would the new turbines be seen above the skyline, whilst existing wind farms are backclothed by landform? if so, what is the relationship between the turbines and the skyline?.

- **Relationships between windfarms**. Consideration should be given to the relationship between the various windfarms in the view in terms of layout, turbine hub height, rotor dimensions and related rotation speed.

99. In presenting the findings of the assessment there is a risk of focussing on a quantitative assessment of the effects. **This will be helpful, but a qualitative analysis of these is required to fully appraise the effects**. The production of extensive quantitative analysis alone is not sufficient.

Offshore windfarms

100. There are proposals for offshore wind farms in Scottish Territorial Waters and within two 'Round 3' zones off the east coast. In some locations it may be necessary to consider onshore and offshore wind farms in the same CLVIA. This is due to both the scale of the offshore proposals and their potential to affect the same views, receptors and landscapes as onshore windfarms.

When will cumulative impacts on landscape lead to an SNH objection ?

101. The decision on whether to object to a proposal on the grounds of cumulative impacts is complex. The key consideration for SNH is whether or not the impacts of the proposal(s) on the natural heritage raise issues of national interest, as set out in our guidance on Identifying natural heritage issues of national interest in development proposals.

Summary

102. This guidance has been updated to address the fact that in many areas of Scotland, CLVIA will require the assessment of large numbers of windfarms. In some cases more than 40 windfarms have been included in the assessment. The level of information generated can distract attention from the most significant cumulative effects which are likely to influence the consenting decision. **Assessments should therefore focus on the most significant cumulative effects and conclude with a clear assessment of those which are likely to influence decision making**.

SECTION 4: ASSESSING CUMULATIVE IMPACTS ON BIRDS

Background to wind farm impacts on birds

103. Operational wind farms are known to have a number of impacts on birds and bird populations. These impacts have been documented at wind farms both onshore and offshore, and can apply to one or more bird species. These are well described in the scientific literature and include:

   - collision with turbine blades (moving and stationary);
   - displacement of birds due to loss of suitable feeding and/or breeding/wintering habitat;
   - disturbance within and around the turbine envelope; and
   - creating a barrier to dispersal, regular movements or migration.

104. These impacts are usually addressed in Environmental Impact Assessments (EIA) for all sensitive bird species that are present on, or adjacent to, the proposed wind farm site. Guidance published on the SNH website identifies which species should be prioritised for assessment. This is mainly based on species' conservation and legal status, both nationally and internationally.

105. However, the issue of cumulative impacts of multiple developments on sensitive species populations has received limited attention. There are many reasons for this including a lack of clear, agreed methodologies by which to undertake such assessments. A range of difficulties have been encountered which makes the process both complex and difficult to interpret.

106. The purpose of this guidance is to set out a biologically robust approach to making cumulative assessments which satisfy both planning and legal concerns. The guidance is restricted to onshore wind farms. Similar principles apply in offshore settings but these are being addressed by COWRIE[7] for the offshore environment. The Department of Energy & Climate Change (DECC) have also commissioned work to produce guidance on assessing cumulative impacts of onshore wind farms. Our guidance will be reviewed and amended as knowledge, understanding and practice develops.

The nature of cumulative impacts

107. Cumulative impacts result from effects arising from two or more developments. Effects may be:

   - **additive** (i.e. a multiple independent additive model), or
   - they may interact in ways that lead to cumulative impacts that are **antagonistic** (i.e. the sum of impacts are less than in a multiple independent additive model) or
   - **synergistic** (i.e. the cumulative impact is greater than the sum of the multiple individual effects e.g. CEFAS (2001), Foden, *et al.* (2010)).

108. While antagonistic or synergistic models may occur in real-life settings, the approach adopted in this guidance is the simpler additive model which sums impacts from different developments. However, summing impacts can lead to individual errors being compounded and in some cases (such as collision

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mortality) correction may need to be made when receptor populations are small.

109. It is important that cumulative impacts on birds are quantified in Environmental Statements. This provides comparable data that can be combined to investigate cumulative impacts. For example, impacts on golden plover might be quantified in terms of the number of presumed territories lost (either from displacement or from habitat loss) and assessing cumulative impact simply becomes a matter of summing the individual development impacts across the geographical range being considered.

110. In practice some effects, such as levels of disturbance or the barrier effect, may need considerable additional research work to assess impacts quantitatively. A more qualitative process may need to be applied until this quantitative information is available, e.g. from post-construction monitoring or research.

Types of cumulative impacts

111. **Collision risk** for sensitive species is frequently calculated for onshore wind farm applications in Scotland. This uses the Band Model (Band *et al.* 2007) as part of the assessment process.

112. Collision Risk Modelling (CRM) produces indicative figures for annual losses (individuals per annum) or a total sum over the lifetime of the wind farm (typically 25 years). CRM values are summed for each species across all the wind farms where calculations have been made. It is important that comparison is made on **annual** rates of collision mortality and not total estimated mortality, to adjust for the different timescales over which wind farms will be developed.

113. Birds encountering wind farm developments may take avoidance action. This can be divided into two very different behavioural responses:

- **Behavioural avoidance** is when a bird close to an operational wind farm reacts to prevent a collision. Such behaviour implies that a bird sees a moving turbine blade, evaluates the potential risk and takes action to prevent what might be a fatal collision.

- **Behavioural displacement** operates at a different level, in that a bird may, over time, change its range use, territory use or flight pattern between roosting areas and feeding areas, so that the range use (or flight paths) no longer brings birds into the vicinity of an operational wind farm.

114. It is the result of these behaviours which determine what, if any, impacts are likely to arise from a wind farm development proposal:

- **Displacement** effects result in a loss of habitat for a species, and this is likely to be long term unless birds habituate to the development. Displacement is different to disturbance, the latter being short term and may occur primarily during construction, though operational disturbance should not be discounted.
- The level of **disturbance** caused to birds is more difficult to assess because it relies on predictions of how birds will respond behaviourally.

Scenarios which assume 100% disturbance within a pre-determined distance of turbines can be derived for key species using conservative threshold disturbance distances (Whitfield & Ruddock, 2007). Empirical evidence is lacking for most species but some indication of real displacement distances can be taken from Pearce-Higgins *et al.* (2009).

- Assessments rarely address issues of **habituation** so may exaggerate actual losses from the development area. Disturbance effects may also be non-linear in their impact, with birds tolerating levels of disturbance up to a critical threshold above which they will avoid the development area. Qualitative assessments (see later) may be all that is possible in these situations.

The barrier effect

115. There have been few attempts to quantify the risks to bird movements from the **barrier effect**.

116. Wind farms may act as a barrier to species that commute between a nocturnal roost site or breeding area and a feeding locality (for example wintering geese, breeding red-throated divers and colonial breeding gulls). Under this scenario birds may be forced to move round the wind farm (e.g. Masden *et al.* 2009), or gain altitude and fly well above turbine height. Regularly undertaking such movements clearly has an energetic cost.

117. Increasing numbers of turbines (resulting from several developments along such routes) could act either as an impermeable barrier to movement (as the energetic cost of going round the turbines is too high), or may force birds to fly through the turbine envelope, thus exacerbating the collision risk.

118. Wind farms placed across migration corridors, or at key landfall sites for migrants, may also act as a barrier. Many migrants that fly at turbine height during migration (for example species of waterfowl), may have limited reserves of energy to climb above, or pass round, wind farm sites on route.

Habitat loss

119. The amount of habitat lost to tracks, hard-standings, buildings, quarries and other infrastructure associated with the development, is relatively simple to calculate. There will, however, be indirect habitat loss that arises from disturbance and displacement. This may be more difficult to quantify, especially if effects develop over time.

120. Behavioural effects, such as a reluctance to hunt within the turbine footprint (e.g. Walker *et al.,* 2005; Fielding & Haworth 2010) may lead to effective habitat loss even though the habitat remains suitable. It will also be important to determine the loss of habitat that might occur over time through management or hydrological changes as well as possible impacts from disturbance by both site-based operations and improved access by visitors.

121. It is important to note that, although direct habitat loss may be small for all but the biggest wind farms, indirect habitat loss may be a significant factor.

In combination impacts

122. Cumulative impact assessments should not be restricted to other wind farm developments but should include all plans or projects in the area, such as mineral extraction, built development, power lines, telecommunications masts, forestry or recreational pressures. Any associated development (i.e. grid

connections or track construction) should be considered within the cumulative impact assessment.

123. Long term or chronic impacts may be difficult to factor in but, where such impacts have an adverse impact on the species conservation status, they must be considered as part of the assessment process. For species subject to hunting pressure, levels of shooting mortality may also be relevant, although the poor quality of data on hunting bags may mean that such assessments are limited in their value.

Species Priorities

124. Information on which species should be considered when assessing impacts is set out in guidance on *Assessing significance of impacts from onshore wind farms on birds outwith designated areas.* A list of sensitive species is given at **Annex C**.

125. The cumulative assessment within most wind farm Environmental Statements should be limited to the species which use the site at some point during their lives. All the species in Annex C are sensitive to impacts arising from wind farm construction and receive a high level of national and international legislative protection. **It is important at scoping stage that the developer seeks advice to confirm that there are no other species present in the area that might, exceptionally, also merit assessment.**

126. Where there is connectivity between the development and the qualifying interests of a Special Protection Area (SPA), these qualifying interests must be assessed in the Environmental Statement to inform a Habitats Regulations Appraisal (HRA). Further guidance will be published early 2012 on the SNH website to assist with this but advice should be sought from SNH at an early stage as to whether there is potential for connectivity with any SPA interests.

127. The Environmental Statement (ES) must include cumulative impact assessment for the full range of species that may be affected. Identifying the range of species likely to be present and likely to be affected is best done at scoping as there may be species for which an individual wind farm appears to be relatively unimportant but, when considered in combination with others nearby, could have an impact that is significant on a wider scale.

128. Cumulative assessments should be considered as part of the overall EIA and HRA processes and not as a *post hoc* assessment. However, survey work can always uncover different species on or adjacent to the site and these may need to be factored in at a later stage.

129. Data collection and presentation should be standardised as far as possible in accordance with SNH guidance on wind farm survey methodology. However, where new information on avoidance rates becomes available, a degree of *post hoc* analysis may be need, using standard and up-to-date avoidance rates.

Scale at which impacts should be assessed

130. The issue of the scale at which impacts are assessed has been dealt with in other SNH guidance, and will not be discussed in detail here. In summary, the impacts of wind farm (and other) developments on any species population can be assessed at a number of scales, ranging from the very local (e.g. on the

wind farm site); at a regional scale, such as a Natural Heritage Zone (NHZ); and at a national (i.e. Scottish), scale.

131. Given that our prime concern is to maintain the conservation status of the species population at the national scale, we aim to assess impacts upon a species' population size, its population trend and its natural range within Scotland. Therefore, we are interested in how wind farms (individually and cumulatively) are likely to affect the species either nationally, or regionally where regional impacts have national implications (where a specific region holds the majority of the national population for example). Impacts on designated sites such as SSSI or SPAs are considered separately, according to existing guidance.

132. Developments that are likely to have an effect on a SPA or Ramsar site, either alone or in combination with other plans or projects, need to be subject to a Habitats Regulations Appraisal.

133. For wind farms which do not have an impact on designated sites, SNH guidance on 'Assessing significance of impacts from onshore windfarms on birds outwith designated sites' (known as the 'Wider Countryside Guidance') highlights the relevance of the Natural Heritage Zone (NHZ) as the basis for the geographical range selection. We are currently[8] undertaking a review of the population status of key, priority species for assessment in each of the 21 Natural Heritage Zones, which will support the assessment of impacts and their magnitude within EIA.

When will cumulative impacts on birds lead to an SNH objection?

134. The decision to object to a proposal on the grounds of cumulative impacts is complex. The key consideration for SNH is whether or not the impacts of the proposal(s) on the natural heritage raise issues of national interest, as set out in our guidance on Identifying natural heritage issues of national interest in development proposals.

Assessing Cumulative Impacts

135. Consideration of the cumulative impact assessment should begin at the scoping stage. In addition to identifying and addressing the impacts on species found in significant numbers on or near the proposed development site, the process should also identify species that may be affected by other developments within the area of cumulative assessment. For example, a site may have low numbers of a particular species. Effects on the site itself may be minimal but, because neighbouring sites host significant numbers of the species, an assessment of the additional impact is required.

136. It may help to prepare a **Key Features Table** at an early stage. This summarises the species and sites potentially affected by the proposed development. The concept of this Table is developed in the COWRIE Guidance on assessing cumulative impacts of offshore wind farm developments (King *et al.* 2009).

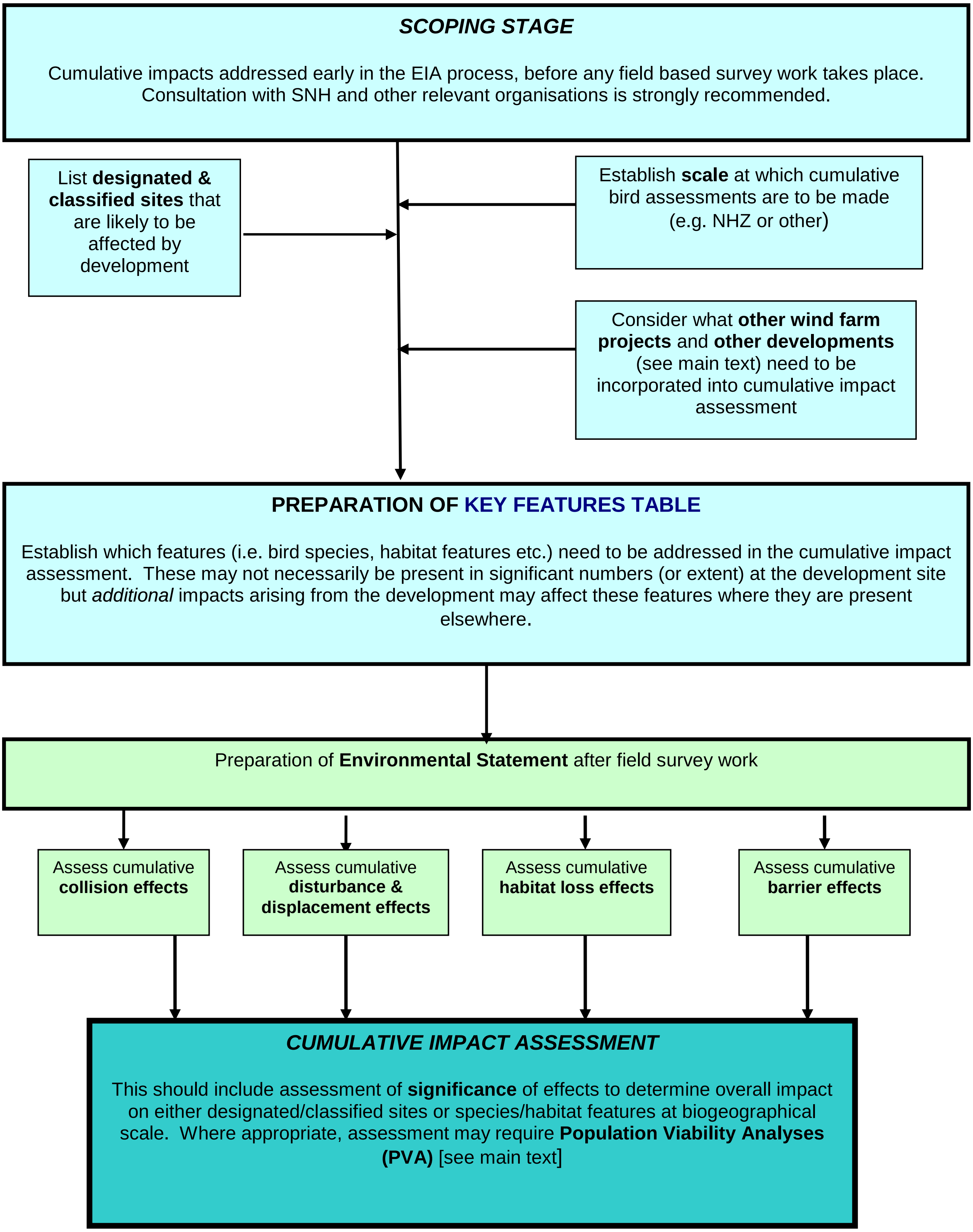
[8] The review is currently in progress for a range of species. For the latest situation readers are recommended to contact the SNH ornithological contact point.

137. Agreement on key species and features likely to be at risk will include:

- identification of key sites (SPAs and SSSIs) which may be affected;
- definition of the relevant biogeographical population (e.g. NHZ or national level);
- agreement and guidance on key methods used to assess impacts; and
- guidance on data collection and analysis, particularly the treatment of 'risk' and the precautionary approach for collision risk modelling.

138. To assist with a standardised approach to scoping, parameters for early discussion could be easily defined. The flow chart below sets out the process in outline.

Figure 2. Flow chart summarising cumulative assessment for birds



Assessing the significance of cumulative impacts

Impacts on birds within or affecting designated sites

139. The need to consider the impacts of proposals on European sites is described in detail in The Habitats Regulations and Revised Guidance Updating Scottish Office Circular 6/1995 (SEERAD June 2000).

140. Any development that may affect a Natura site (including any Special Protection Area) requires a Habitats Regulations Appraisal (HRA). This Appraisal considers whether the work is related to management of the site for nature conservation but, as wind farm developments do not come into this category, the key steps in a HRA are:

- to consider whether a proposal is likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and, if so;
- whether it can be determined that the proposal will not have an adverse effect on site integrity (this is the stage at which the Appropriate Assessment (AA) is undertaken).

141. Para Information to inform the HRA should be provided by developers within the Environmental Statement.

142. For an Special Protection Area (or a Ramsar site), cumulative impacts arising from other wind farm proposals and projects that could affect the site, must be incorporated into the overall assessment. The principle of this assessment is to determine that the proposal will not have an adverse effect on site integrity, including species' conservation status, whether singly or in combination with other developments. The assessment of significance, and process of determining any impact on site integrity, is described in detail in our online guidance on habitats regulations appraisal.

Impact on birds outwith designated sites

143. The concept of favourable conservation status (FCS) should be used outside designated sites to determine whether an impact on a sensitive species is likely to be significant. The concept of FCS is articulated in European Directives, such as the Habitats Directive and the Environmental Liability Directive[9]. The conservation status of a species includes consideration of the sum of the influences acting on it, which may affect its long-term distribution and abundance, within the geographical area of interest.

144. A species' conservation status is favourable where:

- a species' population dynamics indicate that the species is maintaining itself on a long-term basis as a viable component of its habitats; and
- a species' natural range is not being reduced, nor is likely to be reduced for the foreseeable future; and
- there is (and will probably continue to be) a sufficiently large habitat to maintain its population(s) on a long-term basis.

145. A cumulative adverse impact should be judged as significant at the national level where it would adversely affect the favourable conservation status of a

[9] See Environmental Liability (Prevention and Remediation) (Scotland) Regulations 2008: A Quick Guide http://www.scotland.gov.uk/Publications/2008/05/14161737/50

sensitive species or prevent a sensitive species that is recovering from reaching favourable conservation status. The premise here is that impacts from a number of developments, when assessed cumulatively, may exceed some threshold value (e.g. for loss of habitat or loss of breeding birds from collision), beyond which the impact becomes unacceptable.

146. Information on additional mortality, any loss of habitat, nesting or feeding territory, and any expected loss resulting from displacement in the population likely to arise from the development should be available from all relevant environmental statements, or from developers directly. These impacts should be set out in the context of information on the total population number and distribution (where known), current annual mortality and the area of suitable habitat for the species within the Natural Heritage Zone (NHZ).

147. SNH will assist developers in obtaining relevant information *where possible*, especially in circumstances where changes in outcomes from modelling work have been identified or (for example) where parameters such as avoidance rates have changed.

148. The effects of **disturbance** can be difficult to quantify. Birds may either move from the area or they may remain, and if they do move, then effects may be transitory or they may be sufficiently severe for long term impacts to arise (e.g. causing birds to abandon an area) but assessing the transition point at which dispersal behaviour changes will be a matter of judgement unless there is previous research or experience.

149. The SNH report on disturbance distances provides a basis for these judgements. Most disturbance will arise during construction but some operational disturbance is also possible, although habituation may also occur. Assessing disturbance on the basis of disturbance distances is therefore likely to offer a precautionary approach.

150. For a species that is prone to **displacement** by wind turbines, the main impact may be a loss of habitat which will translate into a reduction in the number of birds in the area. This on its own may not affect favourable conservation status (which reflects viability, range and adequacy of habitat to keep the population viable) if birds are displaced into other areas with sufficient capacity to absorb them. However, if the cumulative loss of habitat is significant and widespread, then it should be regarded as reducing the natural range of the species.

151. Direct **loss of habitat** should be considered and, while this may be relatively easy to quantify, the difficulty arises in assessing at what level habitat loss becomes significant. Setting arbitrary thresholds is not considered appropriate (such as the loss of 1% or more of the available habitat) and it will require case-specific judgements to be made, as part of the EIA to assess the significance of any impact. This type of habitat loss does not include indirect loss of habitat (i.e. through displacement).

152. Where mortality from **collisions** can be assessed, simple deterministic population modelling (or where appropriate stochastic modelling such as Population Viability Analysis (PVA)) can be used to model population trends. In many cases, the quality of data for sophisticated analyses may not be available, but simple deterministic models, for example those based on Leslie Matrices, are often relatively easy to construct to examine different scenarios or likely impacts of additional mortality. COWRIE has provided detailed

assessment of PVA models (McLean *et al*., 2007), which may be used in making such assessments.

153. For a species that is prone to collision risk, the main impact may be added mortality. At low levels, the effect of such collision risk may be negligible in comparison with natural mortality. However, when considered in conjunction with other sources of additional mortality, especially from other wind farms, it may initiate a population decline that cannot be reversed unless the impact is removed.

154. When assessing cumulative mortality from multiple developments, it is important to note that simply summing collision mortality across all developments may **overestimate** cumulative mortality, as once a bird has been removed from a population due to collision with one development, it cannot collide again. This is particularly pertinent where population sizes are small (i.e.≤ 50 breeding pairs) and mortality can represent a significant proportion of the population. Mortality tends to be proportionately lower for larger populations and, under these circumstances, summing mortalities may provide a valid approximation.

155. Further information on how to correct cumulative mortality calculations for losses is available in Maclean & Rehfisch (2008). For example if we have a population of 20 breeding pairs of a particular species in an area with multiple wind farm developments, then if one pair is lost due to collision mortality with one wind farm, that will mean that there are fewer birds remaining in the population that are then subject to a risk of further collision mortality.

156. Where a species is already in decline, the test of significant adverse impacts should be whether the proposal would add *significantly* to the factors driving the decline and to the difficulty of taking action to reverse the decline to achieve favourable condition. In some circumstances, minor adverse impacts from a wind farm proposal, while theoretically adding to existing impacts that may lead to a decline in a species' population, may in themselves be so trivial in comparison with existing mortality or habitat changes that they may be deemed not to add significantly to the existing impact.

157. In considering distribution, it is important to be aware of the wider distribution within the geographical area. These may include both strongholds and gaps, both of which add complications in using the change of distribution as an indicator of significant loss at a very local level. Stronghold areas should not be prioritised for special protection unless they are designated sites for the species in question, or are recognised as productive, source areas that are important for the maintenance of the species within the NHZ. A stronghold area will usually withstand a level of impact on the species but impacts that jeopardise the status of the strongholds might constitute an impact on the natural range. On the other hand marginal populations outside the main stronghold areas may have a special ecological importance, e.g. being a location that facilitates immigration into, or emigration from, the region. In such areas, any adverse impact may translate into an impact on the NHZ as a whole.

Measuring cumulative impacts

158. The purpose of this guidance is to provide advice on cumulative impacts that apply in the longer-term. Short-term impacts during the construction phase may add to operational impacts but, because they are by their nature

temporary, they should be assessed separately. In many cases, management approaches will mitigate construction related impacts. Only where construction-related impacts turn out to be longer term should they be included in the assessment of impacts from operational wind farms. For example, short-term disturbance may lead to long term loss of a species from an area if it is slow to re-colonise vacant habitat.

159. Cumulative impacts are best assessed quantitatively for each eligible species. The four main impacts described earlier can be quantified:

- **Collision mortality** expressed as the number of birds of a particular species killed (usually per annum) for any particular development.
- **Disturbance** can be expressed as the number of territories lost, or number of birds displaced, from the wind farm footprint. It can also be the extent of habitat that is (indirectly) lost as a result of disturbance. Units of measurement must be standardised across all wind farms included in the cumulative impact assessment. Displaced birds cannot collide with wind turbines and acceptance of a collision risk implies limited displacement (even if birds manage to evade moving turbine blades).
- The **barrier effect** is more difficult to quantify. One approach is to identify the proportion, or percentage, of a species' dispersal or migration route that is occupied by wind farm developments. For individuals of a species that move within a narrow, predictable corridor, e.g. between a roost and a specific feeding location, even a single wind farm placed along the route will (or could) act as a virtual barrier (e.g. see Masden *et al.*, 2009) For species moving along a broader front such as a migration front, a combination of wind farms set roughly perpendicular to the migration axis could act as a barrier for birds migrating at turbine blade height. A shift in a migration route may be trivial in terms of increased energy expenditure (e.g. Masden *et al.* 2009) but a daily 'detour' may add significantly over time to the overall expenditure of energy.
- **Displacement** due to direct habitat loss is relatively easy to quantify, as this can be measured in terms of hectares of habitat lost. Using data from the Environmental Statement on putative densities for the species concerned, loss of numbers can be calculated, where appropriate with confidence intervals. It is more difficult to calculate impacts arising from indirect habitat loss, such as habitat change or behavioural displacement, as these effects are less predictable without a solid foundation using individual-based modelling (e.g. Kaiser *et al.* 2006), species–habitat modelling, or radio tracking of individuals.

160. Cumulative impacts should be summarised in a table or a spreadsheet, with a separate worksheet for each species. An example is given in **Annex D**. The benefit of a spreadsheet is that the table of impacts will automatically be updated as additional wind farms are added, and various permutations of wind farm order can be developed (see later). We hold some of the required data, but it will be for developers to source and verify all data required from SNH and other sources.

161. Additional information, such as the date the consent was given or planning application was formally submitted, the turbine number, total turbine area (with buffer) should be included in the table Other parameter values could be added where these would add value to the utility of the spreadsheet.

162. Tabulations of cumulative impacts are 'living' documents which must take account of new information or changes in important parameters (such as

avoidance rates). As post-construction studies are completed and published, generic conclusions should also be factored in where these have a material effect on earlier cumulative assessments (for example, we have revised the default avoidance rate from 95% to 98%). Earlier proposals for which CRM figures were based on 95% will require re-evaluation.

163. A critical issue when considering cumulative impacts is the order in which developments are factored in.

- Developments that are already operational, and those that are consented, and likely to be built should be considered first as the impacts arising from these are unavoidable (once mitigation has been factored in). These are the critical projects that must be included.
- Applications that have been formally submitted to a planning authority or Scottish Government but have yet to be determined, and applications that are awaiting submission (i.e. there is an environmental impact assessment) should be factored in last of all. It should be recognised that data from such assessments will not necessarily be in the public domain unless an application has been submitted but has yet to be determined.

164. The same principles apply to other developments though their impacts will not necessarily include all of the range of impacts identified by wind farms. For example, a new power line may increase collision risk but would probably present little additional disturbance or habitat loss (unless birds avoid the power line altogether).

165. Cumulative assessment is an ongoing process. As new wind farms are proposed, or applications are determined, the spreadsheet can be updated as appropriate, until the point of submission of a valid application for consent.

166. Judgements on cumulative impacts may also be affected by mitigation or enhancement measures which are provided to offset some of the resulting adverse impacts arising from wind farm construction. Assessments need to be undertaken once tabulation of cumulative impacts have been carried out, though any such benefits that are factored in need to be demonstrable, or subject to a high degree of confidence that they will, in fact, lead to such benefits.

Data needs

167. Under normal circumstances, we will expect the developer to undertake the cumulative impact assessment as part of the EIA process. However, it is recognised that developers will need access to data for such assessments, and that access to such data will not always be possible.

168. Data for cumulative impact assessments will generally be derived from environmental statements. Unless there is good reason not to do so, figures will be accepted as presented in the various source environmental statements. Developers should also refer to the SNH response letters to ensure they have the agreed figures, as there are occasions where we disagree with the information presented in Environmental Statements.

169. Data from environmental statements for most wind farm developments will, in general, have been lodged with SNH. We will make such data available to other developers, bearing in mind issues such as commercial confidentiality and environmental sensitivity, when this will materially assist a developer in undertaking a cumulative assessment. However, data from other

developments (such as non EIA developments which we have not commented on) may need to be gathered from other sources.

170. We can also help to identify those developments that need to be incorporated in to the cumulative assessment. Assessment of which developments should be included will be part of the scoping exercise.

171. In some cases, it may be necessary to consider **offshore** wind farms, where these may have an impact on terrestrial species populations (e.g. some gulls that use inland and coastal habitats).

172. During the SNH 2009 Cumulative Impact Assessment Sharing Good Practice Event, it was suggested by some participants that a centralised database be established to summarise impacts from different wind farms. In relation to consented wind farms, we have recently issued guidance on post-consent monitoring of wind farms that addresses this issue. However, it will be more difficult to incorporate data from wind farms that have not yet received consent and, for this, data may have to be sourced from the relevant developer.

173. The Scottish Windfarm Bird Steering Group has also recently been established. The group aims to gather, collate and assess data from constructed windfarms across Scotland and it is hoped that this will greatly assist in cumulative impact assessments in the future by providing greater access to data as well as reduced uncertainty over impacts. The group can be contacted through the research co-ordinator Gina Martin[10]. It is therefore essential that other wind farms and developments that should be included in any cumulative assessment are identified as early as possible (during the scoping process) so that relevant data can be acquired. This can be reviewed as part of the development process but, again, reinforces the importance of cumulative assessments as part of the overall assessment process and not as a *post hoc* exercise once the work for the EIA is complete.

Summary

174. Cumulative impacts are an essential component of any environmental assessment of a windfarm's impact on bird populations. Cumulative impact assessment begins at scoping, when issues of scale, sensitive species and effects to assessed should be discussed and agreed with SNH.

175. It is assumed that cumulative impacts are additive, though there are circumstances (one is identified in this guidance) where this will not be the case. However, the simple additive approach is the key starting point for cumulative impact assessment for birds.

176. A cumulative impact that is considered to compromise a species status nationally (as defined in the SNH guidance - Identifying natural heritage issues of national interest in development proposals) – may raise concerns sufficient to trigger a SNH objection to the development.

A full list of references from section 4 is available in **Annex E**

[10] gina.martin@swbsg.org

Further Information and contact points

Contacts:

Cumulative landscape and visual impacts
Joanna Duncan
joanna.duncan@snh.gov.uk

Cumulative impacts on birds
Andy Douse
andy.douse@snh.gov.uk

SNH Policy
Brendan Turvey
brendan.turvey@snh.gov.uk

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Annex A: Key references to cumulative effects in Government and SNH publications

DTI (2000) *Cumulative Effect of Windfarms.* (Prepared by ETSU)

Dumfries and Galloway Council (1999) *Structure Plan Technical Paper (1999)*

Land Use Consultants on behalf of SNH and the Countryside Agency (2002) *Landscape Character Assessment: Guidance for England and Scotland*

Scottish Executive (1999) *Environmental Impact Assessment Regulations 1999 Circular 15/99* (http://www.scotland.gov.uk/library2/doc04/eia-00.htm)

SNH (2010) *Renewable Energy and the natural heritage*

SNH (2002) *Policy Statement 02/02; Strategic Locational Guidance for Onshore Wind Farms in Respect of Natural Heritage*

SNH (2002) *Search Areas for Wild Land* (map) (available at http://www.snh.org.uk/pdfs/polstat/wsc-m3.pdf)

SNH (2003) *Policy Statement 02/03: Wildness in Scotland's Countryside*

SNH (Nov 2003) *Guidance on Scoping Issues for EIA 3rd draft*

SNH (2009) Siting and *Designing Windfarms in the Landscape*

SNH (2006) *Visual Representation of Windfarms – Good Practice Guidance*

SNH (2007) *Assessing the Impacts on Wild Land*

SNH (2008) *Natural Heritage Assessment of Small Scale Wind Energy Projects which do not require formal EIA*

The European Parliament (1992) *Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.* (Habitats Directive)

The European Parliament (2001) *Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment*. (SEA Directive)

The Landscape Institute and Institute of Environmental Management and Assessment(2002) *Guidelines for Landscape and Visual Impact Assessment* 2nd Edition Spon Press

The Scottish Government (1998*) Planning Advice \Note 58 – Environmental Impact Assessment.* (http://www.scotland.gov.uk/Publications/1999/10/pan58-root/pan58)

The Scottish Government (2005) Environmental Assessment (Scotland) Act 2005 (www.opsi.gov.uk/legislation/**scotland**/**act**s**2005**/pdf/asp_**2005**0015_en.pdf)

United Kingdom Government (1992) *The Town and Country Planning (General Development Procedure) (Scotland) Order 1992*

United Kingdom Government (2004) *Environmental Assessment of Plans and Programs Regulations 2004.*

Annex B: Example SNH wording on cumulative effects

Five examples illustrate SNH advice on cumulative effects may be presented to the planning authority or other decision-maker. These examples do not set out preferred model wordings, but indicate the logic underlying the advice. Where the below examples refer to SNH objections, the assumption has been made that the impacts of the proposal(s) raise natural heritage issues of national interest and SNH has applied its balancing duty as appropriate. The examples are simplified to illustrate the approach.

(a) A is an existing wind farm. B is proposed at application stage. We would not object to B on its own, but in combination with A, the cumulative impact is such that we would object.

SNH advises against B on the grounds of the cumulative natural heritage impact of B when combined with A.

(b) A is an existing wind farm. B is proposed at application stage. We would object to B on its own. Moreover, in combination with A, the cumulative impact(s) of A and B is also significant enough for us to object.

SNH objects to B on the grounds of

(i) the natural heritage impacts of B; and
(ii) the cumulative natural heritage impact which would result from the combined presence of A and B.

In such a circumstance, it will be important to clarify whether the cumulative impact involves any *additional impact*, further to the impacts of A and B taken separately.

(c) A and B are proposed windfarms, at application stage. We would not object to either A or B on their own. However, the combined effect of A and B is such that we would object.

SNH does not object to either development A on its own or development B on its own; however SNH advises against both A and B being given consent, on the grounds of the cumulative natural heritage impact of A and B.

(d) A is a proposed windfarm at planning application stage. B is a windfarm at design stage, not yet a planning application but in the public domain through a scoping or screening request. SNH would not object to A. Early appraisal suggests however that B would have less impacts on the natural heritage than proposal A. However, SNH would object to A+B because of cumulative impacts.

SNH does not object to development A, though we highlight any natural heritage impacts. SNH would object to A+B because of cumulative impacts. SNH may recommend that there is a need for a strategic view of preferred areas and appropriate scales of renewables development within the area.

The terms of any advice by SNH should be based solely on the natural heritage impacts of the proposed development, with reference as relevant to the supporting policy context. Given that development B is in the public domain, it may be regarded as a material consideration and the weight to be accorded to it by the planning authority will depend upon how advanced that proposal is. SNH should encourage a more strategic view by the planning authority as a basis for decisions.

(e) A is a proposed windfarm, at application stage. Before A is determined, a second windfarm proposal B is lodged as a planning application. SNH would not object to A. Appraisal suggests however that B would have less natural heritage impacts. However SNH would object to A+B because of cumulative impacts.

SNH does not object development A, though we highlight any natural heritage impacts. SNH recommends that decisions on A and B should be taken concurrently.

Any advice by SNH will be based solely on the natural heritage impacts of the proposed development A, with reference as relevant to the supporting policy context. SNH will not oppose application A as a means of seeking deferral of a decision on the grounds that the later proposal, yet to be considered by the planning authority, might have less impacts on the natural heritage. However, the new application is a material consideration, and the potential cumulative effect of the two proposals should be considered by the determining authority. SNH may encourage the determining authority to consider both applications together, at which point SNH would confirm its position regarding cumulative effects and indicate which proposal would have the least natural heritage impacts.

These five examples are not intended to be comprehensive. In many locations, cumulative assessments must now consider large numbers of proposals. Where this is the case, it may no longer be feasible to present our advice in this manner. If this is the case we will offer clear advice on what the key cumulative impacts are (i.e. those which are likely to determine the outcome of a consenting decision). In other situations, the respective developments may be subject to decision by different decision-making bodies – for, example, adjacent planning authorities or one planning authority and the Scottish Government.

We will aim to be clear about our views on the current proposal, taking into account the cumulative effects with existing or consented windfarms. We will also advise on the cumulative effects of the current proposal in association with new proposals in the planning system, and be clear as to the likely natural heritage impacts of each proposal.

Annex C: Widespread species potentially at risk of impacts from onshore wind farms.

Widespread Species	Breeding / wintering	EU Birds Directive: Annex I	EU Birds Directive: Migratory	WCA Schedule 1	BoCC Red List	Notes
Red-throated diver	Br	*	*	*		
Black-throated diver	Br	*	*	*		
Whooper swan	W	*	*	*		
Greylag goose	Br/W		*			
Pink-footed goose	W		*			
Greenland white-fronted goose	W	*	*	*		
Barnacle goose	W	*	*	*		
Red kite	Br/W	*		*		
Hen harrier	Br/W	*		*	*	
Goshawk	Br/W	*		*		
Golden eagle	Br/W	*		*		
Osprey	Br	*	*	*		
Merlin	Br/W	*		*		
Peregrine falcon	Br/W	*		*		
Black grouse	Br/W				*	
Golden plover	Br	*				
Dunlin	Br	*	*			*C.a. schinzii*
Curlew	Br					On priority BAP list
Greenshank	Br		*	*		
Short-eared owl	Br/W	*				

Restricted range species potentially at risk of impacts from onshore wind farms.

Restricted Range Species	Breeding / wintering	EU Birds Directive: Annex I	EU Birds Directive: Migratory	WCA Schedule 1	BoCC Red List	Notes
Slavonian grebe	Br	*	*	*		
Bewick's swan	W	*	*	*		
Bean goose	W		*			
Light-bellied brent goose	W	*	*			
Honey buzzard	Br	*	*	*		
White-tailed eagle	Br/W	*		*	*	
Marsh harrier	Br/W	*	*	*		
Corn crake	Br	*	*	*	*	
Whimbrel	Br		*	*		
Arctic skua	Br		*			
Great skua	Br		*			
Nightjar	Br		*		*	
Chough	Br/W	*		*		
Scottish crossbill	Br/W	*		*	*	

Annex D: Cumulative impact assessment for bird species - Example matrix

Cumulative Impact Assessment for Wind Farm: {name}											
Species						NHZ					
						Designated Sites(s)					
Site	Date	Collision mortality		Displacement effects		Barrier effects		Habitat loss		Turbine number	Turbine Area
			Σ		Σ		Σ		Σ		
Cumulative Effect (Σ)											

Annex E References from section 4 Cumulative impacts on birds

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Scottish Natural Heritage

Siting and Designing windfarms in the landscape

Version 1

December 2009

Contents

Part 1

Introduction

1.1 Good design principles for windfarms are becoming established following more than a decade of windfarm development in Scotland and with more than fifty windfarms constructed and operating. Design is a material consideration in the planning process and SNH believes that good siting and design of windfarms is important for all parties involved, helping to produce development which is appropriate to a landscape whilst delivering Scottish renewables targets.

1.2 In 2001, SNH published '*Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydroelectric Schemes*', which included guidance on the siting and design of windfarms. Since this time, however, our understanding of the effects of windfarm siting and design has developed further and some new issues have come to the forefront, such as the cumulative impacts of multiple developments. This guidance, which supersedes the landscape sections of the original guidelines, reflects this advance in our understanding of the key landscape and visual issues relevant to windfarm development. Nevertheless knowledge and understanding in this area is evolving quickly and it is expected that this guidance will need to be regularly reviewed and updated to reflect this.

1.3 This is guidance on landscape issues, building upon areas of SNH renewables policy. It does not refer to wider technical design considerations (such as wind speed, access to grid) or to other natural heritage issues (such as impacts on birds, other wildlife and habitats) which are also of importance in relation to both siting and design. A range of other considerations such as noise, archaeology, access and transport are also relevant to the design of windfarms and guidance on these topics is available elsewhere. It should be used alongside other SNH guidance, including our *Strategic Locational Guidance for Onshore Windfarms* (2002, updated March 2009), *Cumulative Effects of Windfarms* (2005), and *Visual Representation of Windfarms Good Practice Guidance* (2006), available on the SNH website.

1.4 Developers and those involved in windfarm design should also refer to the Spatial Frameworks for Windfarms being developed by Local Authorities in response to Scottish Planning Policy (SPP) 6[1]. This guidance has been written during the period that Local Authorities are developing their Spatial Frameworks, with a view to providing guiding principles at a strategic level. However, when considering an individual application, the adopted development plan and supplementary planning guidance as well as SPP6 provide the framework within which the application should be considered.

1.5 The guidance is structured in two parts. Part 1 provides siting and design guidance for windfarms. Part 2 provides guidance on strategic siting and design considerations for windfarms in relation to the requirements of SPP6.

1.6 This guidance is being written at a time of change, not least the proposed revision of currently separate SPPs into a single document. It is intended to review the guidance periodically so this document, Version 1, will gradually benefit from subsequent updates and amendments. Comments will be sought via the SNH website.

1 Scottish Planning Policy 6: Renewable Energy, Scottish Executive 2007 – to be superseded in 2010 by a new consolidated SPP.

1.7 The views expressed in this document are drawn from the experience of SNH staff who have advised on windfarm applications across Scotland in many different landscape settings and at many different scales of development. They have also been informed by a public consultation exercise and a workshop held at Battleby in March 2009.

Background

1.8 SNH supports the adoption of renewable energy technologies, including windfarms, to address the effects of climate change and supports the Scottish Government's adopted policy in SPP6[2]. Windfarms have an important role to play, taking advantage of the good wind resource in Scotland. However, our support for renewables has to be balanced with the Scottish Government's commitments and aspirations to conserve and enhance the natural heritage, including the quality and diversity of Scotland's landscapes. The purpose of this guidance is to help guide windfarms towards those landscapes best able to accommodate them and to advise on how windfarms can be designed to best relate to their setting and minimise landscape and visual impacts.

1.9 Scotland is renowned, at home and internationally, for its diversity and quality of landscape and scenery, particularly its distinctive coast, mountains and lochs. This contributes to the overall quality of life for all who live in or visit Scotland, and provides a setting for our economic activity, including tourism. It also means that landscape is the basis for many of our social, community and cultural values. The European Landscape Convention applies to all landscapes, and recognises landscape character assessment as a way of informing decisions. The Convention promotes integrated policies for landscape protection, management and planning, and encourages the involvement of the public in developing these. SNH's Landscape Policy Framework (2005) recognises both the importance of landscape to Scotland's natural heritage and people's lives, while acknowledging that this relationship will change as landscapes evolve.

1.10 Wind turbines are generally large structures with the potential to have significant landscape and visual impacts. The development of windfarms, including associated infrastructure such as tracks, power-lines and ancillary buildings, has already had a major impact on many of Scotland's landscapes – arguably the biggest change since that resulting in some parts of Scotland from commercial afforestation in the 1970s and 80s. Thus far most of this change has occurred in landscapes considered more suitable for windfarm development. This guidance aims to learn from current experience to inform the future siting and design of windfarms.

1.11 It is therefore important that care continues to be taken to ensure that further windfarms are sited and designed so that adverse effects on landscape and visual amenity are minimised, and that areas which are highly valued for their landscapes and scenery are given due protection. If windfarms are sited and designed well, the capacity of our landscape to incorporate this type of development will be maximised. Conversely, if they are poorly located and designed the scope for further development in the future will be greatly reduced.

2 SNH Policy Statement 01/02 SNH's Policy on Renewable Energy.

2

Landscape and Visual Assessment of Windfarms

What is Landscape and Visual Impact Assessment?

2.1 Landscape and Visual Impact Assessment (LVIA) is a standard process for examining the landscape and visual impacts of a development. The methodology for this is set out in the 'Guidelines for Landscape and Visual Assessment' (GLVIA), produced by the Landscape Institute and the Institute of Environmental Management and Assessment[1].

2.2 LVIA follows an iterative process by which alternative sites and designs for a development are proposed, assessed, and amended (a process often referred to as mitigation). Through this process, LVIA identifies the preferred siting and design option for a development, balancing different environmental issues as well as functional, technical and economic requirements. Ultimately, the final scheme is assessed for predicted residual impacts on the landscape and visual resource. LVIA is usually carried out by Chartered Landscape Architects who apply professional judgements in a structured and consistent way based on landscape design principles. The LVIA should assist decision makers, members of the public and other interested parties by providing a clear and common understanding of the predicted effects of windfarm proposals in an impartial and professional way.

Context for Landscape and Visual Impact Assessment

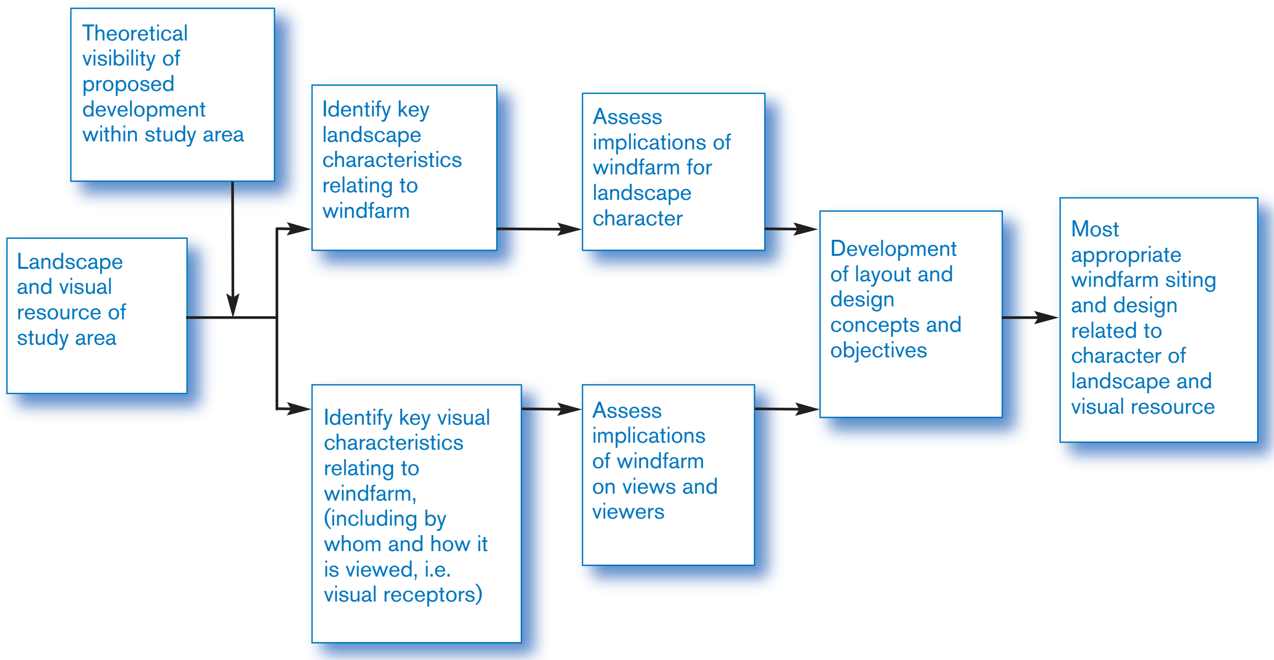
2.3 LVIA is a standard process of assessment that may be presented as a separate report or form one part of an Environmental Impact Assessment (EIA) within an Environmental Statement (ES). While a LVIA will usually be required for every windfarm proposal, an EIA is only a statutory requirement for wind energy proposals where the proposal is likely to have significant effects on the environment. Circular 8/2007[2] sets out when EIA may be required for windfarms.

Landscape and visual impacts of Windfarms

2.4 LVIA comprises two separate parts, Landscape Impact Assessment (LIA) and Visual Impact Assessment (VIA), although these are related processes as described within the GLVIA. LIA considers the effects of the proposal on the physical landscape, which may give rise to changes in its character, and how this is experienced. VIA considers potential changes that arise to available views in a landscape from a development proposal, the resultant effects on visual amenity and people's responses to the changes.

2.5 The flow diagram below indicates the process of LVIA, which commences with determining the key characteristics of the landscape and visual resource.

1 Guidelines for Landscape and Visual Impact Assessment, 2nd Edition, (Spon Press), Landscape Institute and Institute of Environmental Management and Assessment.
2 Scottish Planning Series Planning Circular 8-2007: The Environmental Impact Assessment (Scotland) Regulations 1999. Scottish Government.



2.6 Early in the LVIA process it can be determined which landscape and visual characteristics are particularly relevant or sensitive to the development proposal. Focussing on these, the designer can explore what the potential impact of a windfarm will be if it is sited and designed in different ways, and determine what the main design aims should be to create a windfarm that relates well to the landscape.

2.7 Clearly other technical and economic factors will also be important in the decision-making process, as will other environmental impacts such as effects on wildlife and habitats. Cumulative effects with other windfarms will also be a consideration[3].

Design Statements

2.8 Design Statements help communicate the issues, constraints and decision making processes behind development of a design. They document the design process of a development, whether it requires a LVIA and/or EIA or not, so they are not a wholly additional piece of work. Their relevance to windfarm or wind turbine applications is notable. A design statement need not be a lengthy or complex document and diagrams can be used to summarise the design process. They are a useful way for designers to explain why an application has a particular layout or appearance to consultation bodies, Local Authorities and the public. Further guidance on producing design statements is provided in PAN 68[4], and an example of a windfarm design statement for Clyde windfarm is included in Appendix 1.

2.9 Design Statements are also helpful in establishing design objectives. These may need to be referred to in the future if the scope of a scheme changes: for example for a windfarm extension, amendment of the type of wind turbines, or even for another windfarm nearby. Design objectives can help to

– maintain the integrity of a scheme in changing circumstances;

– explain the design background of windfarm extensions; and

– indicate how existing nearby windfarms or cumulative impacts have influenced the design and layout of a new proposal.

3 For further discussion on cumulative effects see ‘Cumulative effect of windfarms’, version 2, SNH 2005, available on the SNH website.

Presentation of information within landscape and visual impact assessment

2.10 A number of methods are used to illustrate the potential landscape and visual impacts of a proposal. In LVIA, illustrations are used by landscape and planning professionals in four main ways.

- To record site assessment, in the form of photographs and sketches, as an aide-memoire:
- To provide computer generated Zone of Theoretical Visibility maps (ZTVs) to show the area from which a proposal may be visible;
- To provide visualisations that show potential visibility from a specific viewpoint and aid an assessment of the magnitude of impact, typically in the form of computer-generated wireline diagrams and photomontages, and;
- To illustrate key concepts and design principles using line drawings and diagrams.

2.11 When used on site, these illustrative tools are typically sufficient to make judgements of predicted landscape and visual impact for the LVIA. However, in addition, other illustrative techniques may be useful, such as computer generated simulations, fly-throughs and video-montage. Further guidance on the selection, production methods and use of illustrative techniques is available in the 'Visual Representation of Windfarms: Good Practice Guidance' (2006)[5].

Small windfarms and the need for assessment

2.12 In addition to large windfarm developments, there continues to be interest in developing single turbines and small windfarms in Scotland, particularly in lowland settings, typically including between one and three turbines. If there are more than two turbines, or the turbines are more than 15m in height, they are Schedule 2 developments under the Environmental Assessment Regulations. It is then a matter for the Planning Authority to decide whether they are likely to have significant environmental effects and therefore require EIA.

2.13 Even if an EIA is not required, there is usually a need for submission of a LVIA in support of a planning application. This assessment should be carefully scoped so that it is appropriate to the size and scale of the development and the likelihood of significant landscape and visual impacts, including cumulative effects. SNH's guidance note on 'Natural Heritage assessment of small scale wind energy projects which do not require formal Environmental Impact Assessment'[6] provides advice on the level of landscape and visual assessment likely to be appropriate for different scales of turbines (although it is important to highlight that the landscape and visual impacts of turbines are not directly proportional to their size). SNH will be producing more detailed guidance on the installation of micro wind turbines (<50kw) later in 2009.

Duration of impacts and decommissioning

2.14 The expected lifetime of wind turbine generators is typically around 25 years, and planning permission is usually granted for this period. Decommissioning of the turbines at the end of this operational phase is often a specific condition of planning permission and is an important consideration when designing and assessing a windfarm.

2.15 Decommissioning commonly proposes that turbines and ancillary buildings are removed, leaving their foundations and access tracks in situ, but covered over and

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4 Planning Advice Note 68: Design Statements (2003) The Scottish Government.
5 SNH, Scottish Society of Directors of Planning and Scottish Renewables Forum (2006) Visual Representation of Windfarms: Good Practice Guidance. Table 2, pp.36.
6 available at www.snh.org.uk

re-vegetated, thus reducing the need for further ground disturbance. There is therefore potential for some residual visible change to the landscape, even when restored, although this can be minimised through thoughtful design and consideration of how decommissioning will proceed at the project outset. The use of carefully worded legal agreements or planning conditions to ensure delivery of appropriate removals and restoration of site conditions at the end of a project's lifespan will also be of benefit. In some locations, however, it may be assessed that it is possible to remove foundations and access tracks without unacceptable environmental disturbance and this approach should be an aspiration in the design of any windfarm site.

Partial restoration of access tracks to grass

2.16 There is likely to be continued demand for renewable energy generation in Scotland for many decades ahead. Thus it is possible that existing well-designed windfarms may remain in use well beyond 25 years, with turbines either refurbished or replaced and a planning consent renewed. However, a time limited consent does provide the opportunity for decommissioning to be required should it be judged, for whatever reason, that the windfarm development was inappropriate.

3

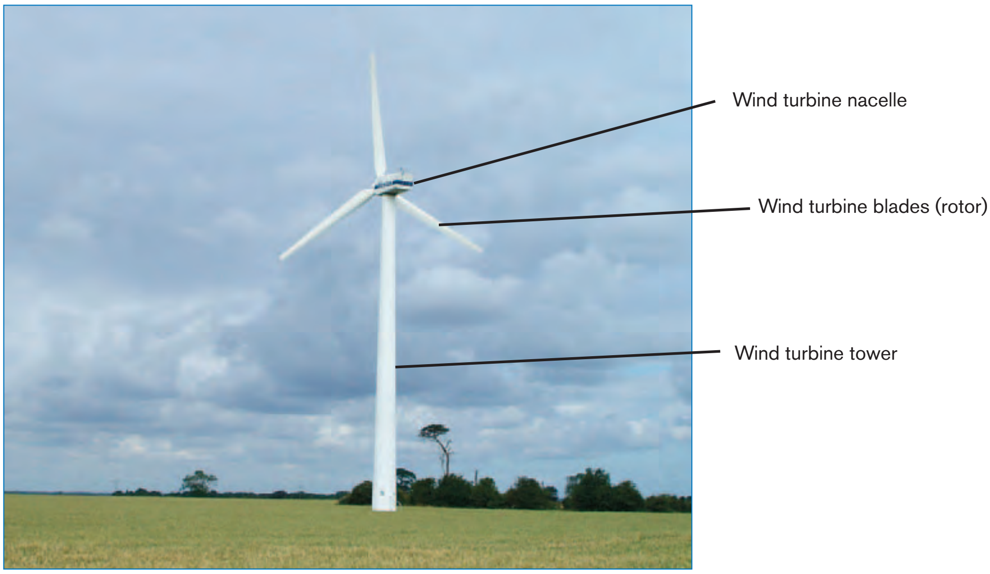
Wind Turbine Design and Layout

3.1 The landscape and visual impacts of a windfarm are strongly influenced by the design and layout of wind turbines. This section focuses upon the different types of wind turbine and their layout or array, while the following section considers how these principles relate to landscape and visual characteristics.

3.2 Impacts also result from infrastructure serving the development, such as access tracks and borrow pits, anemometers, control building, and substation (where necessary). Design and siting of this ancillary infrastructure are also referred to in this section.

Turbine form and design

3.3 A wind turbine comprises a tower that supports a nacelle, that is the main shell containing the electric generator and to which the turbine blades attach via a hub. The nacelle has an anemometer attached so that the direction in which the blades face can be altered to maximise wind capture. Further guidance on wind turbines is available in Planning Advice Note 45[1].



3.4 The landscape and visual impacts of a wind turbine vary not only with its size, but also with the make and model of the turbine proposed. Turbines of the same height may have varying visual appearances due to their different design and technical characteristics.

3.5 Windfarm developers are often reluctant to be specific as to the actual model of turbine to be used because market availability, costs, and turbine technology may

1 Planning Advice Note 45, Renewable Energy Technologies, Scottish Executive, 2002, www.scotland.gov.uk

change during the period between submitting an application and actual construction. However, they will usually have a shortlist of preferred models for consideration and applications should include details of these. The LVIA and EIA should assess, as far as is possible, impacts of the model within the shortlist that represents the 'worst case scenario'.

3.6 Turbine properties, in addition to height, colour and individual design, which may be important when choosing the most appropriate model for a particular site, are:

– the proportion of blade length to tower height; and

– the dynamic impact resulting from rotation of the turbine blades (larger, slow moving blades will have a very different impact from shorter, faster moving blades which may give the impression of increased clutter).

Alternative wind turbine proportion – these images show the contrast between blade length and tower height, which affects the overall visual range.

Turbine colour

3.7 Selecting the most appropriate colour for a turbine(s) is an important part of detailed windfarm design and mitigation. It has previously been assumed that wind turbines could be painted a colour that would camouflage them against their background. However, experience has shown that no single colour of wind turbine will consistently blend with its background and it is more important to choose a colour that will relate positively to a range of backdrops seen within different views and in different weather conditions.

3.8 When determining the most appropriate colour for wind turbines, key considerations are:

– the immediate landscape context and anticipated backcloth against which the turbines will be viewed predominantly (for example sky, heather moorland, woodland);

– the direction the turbines will most frequently be viewed from (including the angle of the sun and how it is likely to reflect on the wind turbines);

– the predominant weather conditions (which will dictate typical sky colour and will vary for different parts of the country);

– seasonal variation in landscape colours;

– the proposed design and layout of the windfarm; and other windfarms within the area.

Variable colouring of turbine bases typically does not correspond with the skyline from most viewpoints and increases contrast when seen against the sky. From some viewpoints, this effect can also make the turbines seem to 'float' above the land.

Different colour of wind turbine components creates a more complex image and means the visibility of different sections varies

White turbines will look bright in certain light conditions, but will tend to convey a positive image. This may be associated with cleanliness and existing white foci in our landscape such as white-washed cottages.

Grey wind turbines will appear less prominent when seen against a grey sky, although they will rarely match the shade. When visible, a grey colour may appear 'dirty' and be associated with an industrial, urban or military character

3.9 As a general rule for most rural areas of Scotland:

– A single colour of turbine is generally preferable;

– The use of graded colours at the turbine base should be avoided;

– A light grey colour generally achieves the best balance between minimising visibility and visual impacts when seen against the sky;

– The use of coloured turbines (such as greens, browns or ochres) in an attempt to disguise wind turbines against a landscape backcloth is usually unsuccessful;

– Paint reflection should be minimised;

– For multiple windfarm groups or windfarm extensions, the colour of turbines should generally be consistent; and

– Precise colour tone and the degree of paint reflectivity should be specified at the application stage.

Turbine transformer colour

3.10 It is preferable for wind turbine transformers to be housed within the turbine towers, to minimise the number of elements and visual complexity of a windfarm scheme. However, where transformers are housed separately near the base of turbines, the colour of their housing requires careful consideration. This should be site specific, relating to the surrounding land cover, not the wind turbines, as transformers are rarely viewed against the skyline. Such an approach ensures that their visibility is reduced, and they are seen as a separate element to the wind turbine so that they are less likely to detract from the simplicity of its form. Browns, khakis and 'earth' colours are generally the most successful colour choices for transformers, with greens often appearing too bright.

In variable light conditions and against different backgrounds, wind turbines of the same colour can appear to have contrasting visual effect

Turbine lighting

3.11 In some locations it may be necessary to light wind turbines for reasons of civil or military aviation safety. Such lighting, typically at the top of the tower of the wind turbine, may appear prominent in night views and may be incongruous in predominantly un-lit rural areas. Where lighting is necessary, this should be designed to minimise landscape and visual impacts whilst satisfying health and safety or navigation requirements. This may, for example, be achieved by incorporating shields so that the lights can only be seen from above.

3.12 As yet there has been little experience of lighting turbines in Scotland. However, it is likely to become more of an issue as more sites are being explored within flight paths. SNH is collating information to develop our understanding of these impacts with a view to developing further guidance in due course.

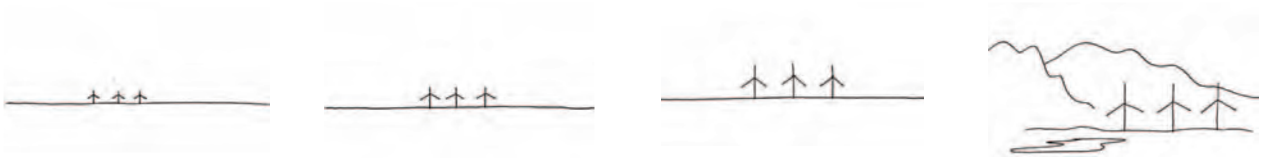
Turbine size

3.13 As wind energy technology has developed, larger wind turbines have become available. Currently machines typically consist of 60 – 100 metre high towers with blades of 40 metres or more, so their overall height to blade tip is typically 100 – 140 metres, although some higher turbines are now available. Longer blades result in a greater rotor area and, combined with the fact that they will likely extend upwards into higher wind velocities, their wind capture and energy production tends to be proportionally larger than smaller turbines.

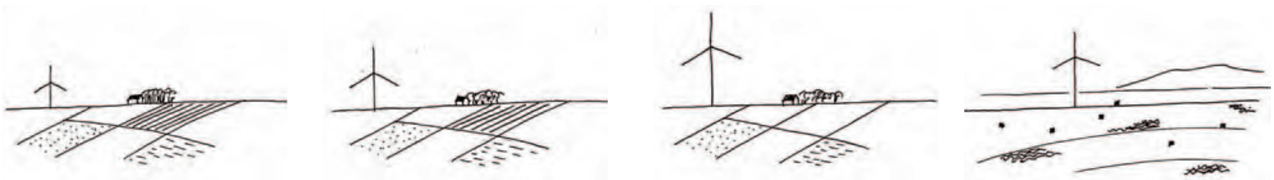
The size of these wind turbines is difficult to perceive, located in open moorland with no definite scale indicators

The buildings adjacent to this windfarm act as scale indicators, and emphasise the large scale of the wind turbines

3.14 Choice of turbine size is an integral part of the design process of a windfarm in relation to key landscape and visual characteristics. Identification of the key landscape characteristics, their sensitivity and capacity to accommodate change will inform this. Generally speaking, large wind turbines may appear out of scale and visually dominant in lowland, settled, or smaller-scale landscapes, often characterised by the relatively 'human scale' of buildings and features. On the other hand, the longer blades of larger turbines often have slower rotation speeds and this can be less visually distracting than the faster speeds of smaller blades.



Increase of wind turbine height is not very noticeable within moorland landscape, due to lack of size indicators; nevertheless, there may be a threshold at which larger wind turbines no longer seem to directly relate to the local area of moorland but, rather, relate more closely to the neighbouring high mountains



The size of wind turbines is clearer within a distinct landscape pattern that includes definite scale indicators. Although older/domestic wind turbines may relate to the scale of buildings, most commercial wind turbines commonly used now, over 60m in height, will seem to dominate elements of landscape pattern. There may be, however, a threshold in some landscapes at which a larger wind turbine would no longer seem associated with the underlying landscape pattern and seem 'elevated' above it, by appearing to relate to larger components.

3.15 Wind turbine size is also a key issue in upland landscapes that are viewed against or from landscapes which are more intricate in scale and pattern, or where it is otherwise difficult to discern scale and distance. By illustrating the scale of an upland landscape, wind turbines may seem to compromise the perceived expansive nature of some of these areas.

3.16 As the experience of different landscapes varies greatly, it is not appropriate to provide strict guidelines on turbine sizes that should be used for particular landscapes. Site-specific assessment and design is essential for each development proposal.

3.17 It is understood that procurement of 'smaller' turbines is becoming increasingly difficult as turbine manufacturers move towards larger models. However, some smaller models remain available and may be particularly appropriate near or adjacent to an existing development comprising of small turbines as well as in smaller scale landscapes. It is important to highlight that a 'one size fits all' approach will not respond to the great variation of landscape scale and windfarm requirements; thus it is important that a market for different sizes of wind turbines, including medium and small sizes, is maintained.

Turbine scale

3.18 Size comparisons between wind turbines and other tall structures may help people to be able to visualise how tall a proposed development would appear in the landscape. Table 1 shows the heights of some tall elements in the Scottish landscape that may provide useful scale comparisons. It is important to appreciate, when making comparisons of this sort, that wind turbines are typically not viewed in the same way as monuments or landmarks, which generally have much greater 'solidity'. In addition, although the visibility extent of turbines will obviously increase with their greater height, the relationship between visual impact and turbine size is not directly proportional. Principally, this is because a windfarm is viewed within a surrounding context, which varies; and also because the actual size of a wind turbine is usually difficult to perceive.

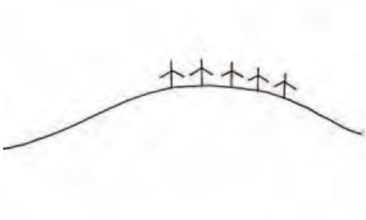
Electricity pylon acts as scale reference in relation to wind turbines

Table 1 Landscape elements which may be used as scale comparisons

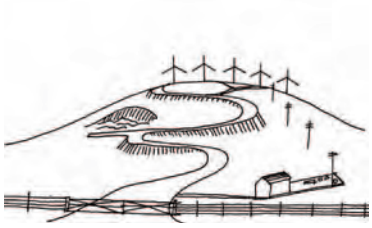
Landscape Element	Typical Height (in metres)
Metal Pylons	25 to 50
Telecommunications Masts	15 to 20
Television Transmission Masts	300
MoD Masts	70 to 80
Cockenzie Power Station Chimney	149
Inverkip Power Station Chimney	212
Forth Road Bridge Towers	150
Domestic Buildings (1.5–2 storey)	6–10
Mature Deciduous Trees (depending on species)	10–20

Ancillary infrastructure

3.19 Ancillary elements for a windfarm development should also be designed to relate to the key characteristics of a landscape. It is essential that these elements do not confuse the simplicity of the windfarm design, or act as a scale indicator for the turbines themselves. Undergrounding power lines within the windfarm, using transformers contained within tower bases (where possible), and careful siting of substations, connecting transmission lines, access tracks, control buildings and anemometer masts will all help to enhance a windfarm design. Simplicity of appearance and use of local, high quality materials will further enhance this.



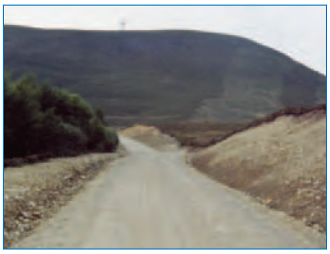
Windfarm creates simple image in the landscape



Insensitive siting and design of windfarm infrastructure creates complex image and conflicts with underlying landscape character

3.20 There may also be practical constraints in delivering large turbine components to site, because of, for example, the limitations of rural bridges, road junctions or corners. Additional landscape and visual impacts, associated with widening of roads, access tracks and corners in order to enable transport of long turbine blades, should be taken into account.

Small windfarm substation



Windfarm access track across slopes

Junction of windfarm access track and public road

3.21 Detailed advice on the siting and design of tracks can be found in the SNH publication 'Constructed tracks in the Scottish Uplands' (SNH Natural Heritage Management Series, 2006).

Turbine layout / array

3.22 Turbines can be arranged in many different layouts within a windfarm. The layout of a windfarm should relate to the specific characteristics of the landscape. This means that the most suitable layout for every development will be different. The development process for a windfarm typically begins with a layout that responds mainly to wind speed and wind turbine specification, sited within defined land ownership / tenure boundaries. For a small windfarm, this might comprise a single row of wind turbines along a ridge; while, for a larger development, a grid of wind turbines is often taken as the starting point, with the turbines spaced at minimum separation distances to avoid turbulence (often equating to 4–5 rotor diameters).

3.23 From this starting point, turbines will typically be moved or removed due to physical constraints, such as watercourses, areas of deep peat and steep slopes, and in response to sensitive habitat or wildlife species. During this process of modification, landscape and visual issues will also inform the layout. Although landscape and visual concerns – such as the need to avoid visibility from a particularly sensitive viewpoint - may present an absolute constraint, many landscape and visual sensitivities can be addressed through good design in windfarm layout. This commonly involves a number of changes to create the most appropriate windfarm to fit the design objectives of the project.

3.24 There are a number of common types of layout, chiefly divided into regular or irregular formats. Generally, the fewer the number of wind turbines and the simplest of layout upon the most even of landform, the easier it is to create a positive feature - visually balanced, simple and consistent in image as it is viewed from various directions. This is most easy to achieve with a simple line upon level ground. As soon as there is deviation from this, the visual image becomes more complicated.

Single wind turbine forms point feature with simple and direct relationship to surrounding landscape

Single line of wind turbines. These posses a visual relationship to each other as well as to the landscape.

Double row of wind turbines. Wind turbines within each group have visual relationship to each other and landscape. The two groups also have a separate and collective visual relationship to each other and the landscape.

Grid layout reveals simple visual relationship when looking down rows, but appears more complex when looking across rows.

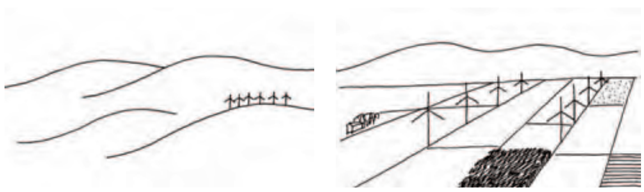
3.25 A regular shape, such as a double line, a triangle, or a grid can appear appropriate within a wide open and level space where there is a regular landscape pattern, such as within agricultural fields. However, as soon as you move through the landscape and see it from different directions and elevations, views of the grid change and reveal a variable effect, seeming ordered along some rows, but in others overlapping. In addition, the rationale of the position of turbines is confused if they appear at variable elevation.

Informal layout. However regular spacing between wind turbines and direct link to landscape pattern gives layout visible rationale and sense of order.

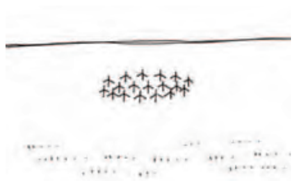
Informal layout with no obvious rationale. Creates chaotic image that contrasts with the underlying simplicity of the hills.

3.26 Irregular layouts can be more appropriate in landscapes of variable elevation and pattern, as is most common in Scotland. However, irregular forms pose an even greater challenge in terms of creating a simple image as the turbines will interact in varying ways with each other as well as with the underlying landscape. This can result in effects that do not correspond to good design principles, such as varying visual density of wind turbines, overlapping turbine rotors (often termed ‘stacking up’), partial screening behind a skyline and turbine outliers separate from the main group.

Two different views of the same windfarm. The layout appears simple from one direction, but complex from another

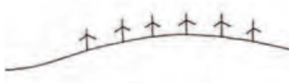


A windfarm layout appears simplest where it relates directly to the underlying landscape characteristics



Where a landscape does not include any obvious elements or features to which a windfarm could relate directly, it may be most appropriate for a windfarm to form a distinct feature in its own right. However, for this approach to appear clear, it will usually require the windfarm to be surrounded by an area of open space.

Wind turbines relate to small scale undulations at a local level. However, if the key views are distant, these undulations would not be obvious and the wind turbines would alternatively appear in closest association with the broad scale landform



Alternatively, the windfarm can be designed to relate to the broad scale landform

3.27 Windfarms should directly relate to underlying landscape characteristics of a similar scale and/or prominence. This design principle also means that wind turbines may be able to be accommodated within areas of complex pattern. Odd numbers of turbines often present a more balanced composition than even numbers.

Micrositing

3.28 Micrositing is the movement of wind turbines by small distances within the overall windfarm layout, typically involving distances of up to 100m. The process is used at two main stages of windfarm development:

- Firstly, during the design stage to ensure that turbine layout is satisfactory from key viewpoints and achieves the design objectives. It can also be used to maximise the screening benefits of landform or landcover from key viewpoints.
- Secondly, during the construction phase of a project where previously unexpected conditions are encountered on site. This may happen, for example, where a turbine needs to be located away from an area of peat that is deeper than predicted on the initial survey.

3.29 Developers should seek to minimise the need for micrositing by conducting thorough site investigation during the design process.

3.30 Micrositing during construction can obviously have an effect on the nature and extent of the appearance of a windfarm as previously assessed and illustrated within an ES, especially those set out in regular patterns such as grids or evenly spaced lines. Any significant changes in layout should be assessed to ensure that the overall design objectives for the site are not compromised. Decision makers should also consider the extent of micrositing that it is appropriate to allow when consenting development. Where, for reasons of design coherence, there is a clear need to maintain turbine layout in accordance with submitted plans, then the permissible micrositing distances may need to be strictly limited. This is particularly important for sites of limited numbers of turbines, where there is a strongly formal layout or where micrositing may result in changing the altitude of turbines and therefore affect the windfarm's design relationship with surrounding topography.

A line of wind turbines, where slight alterations of position and elevation have disrupted the image of consistency and rhythm.

3.31 Planning permissions should therefore contain a condition limiting the distance that turbines can be microsited without requirement for further permission. It is important that such micrositing conditions are tailored to be specific to the nature and scale of the proposed developments, and have particular regard to the possible effects on design layout and the overall visual coherence of the scheme.

4

Windfarm Siting and Design

4.1 This section deals with siting and designing windfarms within the landscape. It applies similar design principles to those outlined in Section 3 and develops them further in relation to landscape and visual effects. Experience has shown that the application of these principles will have an important influence on reducing the overall landscape and visual impacts of a windfarm.

4.2 The chapter begins with generic issues in relation to windfarm LVIA, and then highlights specific aspects of siting and design. It offers general guidance only and for any windfarm would need to be supplemented by more detailed design objectives, established through the LVIA process. Cumulative landscape and visual impacts, which also form part of LVIA, are addressed by section 5 of this Guidance.

4.3 Reference is made to generalised categories of windfarm size as listed below. This grouping is for the sake of simplification, and it should be noted that landscape and visual impacts are not directly proportional to wind turbine numbers.

Windfarm size	Number of Turbines
Small	1–3
Medium	3–20
Large	20–50
Very Large	50+

Landscape character

4.4 The first step to carrying out the Landscape Impact Assessment (LIA) section of a windfarm LVIA is typically to assess the landscape character of the study area to identify the key characteristics relevant to windfarm development. Different places have different 'landscape character', comprised of distinct and recognisable patterns of elements. These relate to underlying geology, landform, soils, vegetation, land use and settlement. Taken together these qualities contribute to regional distinctiveness and a local 'sense of place'. Understanding a landscape's key characteristics and features is vital in considering how new development will affect it or, with appropriate design, contribute to it.

4.5 Landscape Character Assessment (LCA) can assist in designing development which best respects a location's distinctive character. It is a tool to help understand what the landscape is like today, how it came to be like this and how it may change in the future. LCA helps to ensure that change and development does not undermine whatever is characteristic or valued about a particular landscape, and that ways of improving the character of a place can be considered.

4.6 At a regional scale, SNH Landscape Character Assessments may inform this assessment. SNH's National Programme of LCA comprises 27 studies and an overview report[1]. These LCAs highlight key landscape characteristics across the country, and also identify the main forces for change in these landscapes and relevant guidance. It should be noted that many of the LCAs were produced during the 1990s and, although they remain relevant as descriptors of landscape character, do not necessarily address the sensitivity of particular landscape character types to windfarm development.

4.7 In addition to the broad-scale information offered by LCAs, LIA should include an assessment of local landscape characteristics, and how they are experienced, in relation to the specific proposal. There should also be an assessment of the extent and distribution of predicted visibility within relevant character areas.

Landscape and scenic value

4.8 A landscape may be valued for many reasons, such as for its specific landscape quality, scenic beauty, tranquillity or wildness, recreation opportunities, nature conservation or historic and cultural associations. A windfarm will not necessarily be incompatible with valued qualities of a landscape; this will depend on the nature of the development and the nature of the landscape qualities that are valued.

4.9 LCAs do not place value on one landscape type over another, but they may point to the reasons why a landscape might be valued, because of special characteristics or the experience the landscape offers. In contrast, landscape and scenic value is recognised at national and local levels through development plan policies and designations such as National Parks, National Scenic Area (NSA) or local landscape designations including Areas of Great Landscape Value (AGLV). Designations are usually supported by legislation and associated with specific planning policies at a national and regional level. The lack of any designation does not imply that a landscape has no value[2]. Some landscapes are strongly linked to cultural heritage, for example, while others may be valued for their perceived lack of human influences. In line with the European Landscape Convention[3] SNH promotes an 'all-landscapes approach', founded on the recognition of value in all landscapes.

4.10 In addition to recognition of landscape and scenic value through an accolade, value may be placed on a landscape due to its rarity or novelty within a particular area. Although landscape assessments do not place value on the distribution or frequency of landscape character types, national or regional maps showing the occurrence of different types clearly indicate where this may be an important issue.

4.11 For the LVIA of windfarms, the key challenge with respect to landscape value is to ascertain for what a landscape is valued and by whom, and then to assess the predicted impacts of the proposed development on this valued landscape. Establishing the quality of a valued landscape is best informed by a clear description or citation, for example as provided for NSAs in 'Scotland's Scenic Heritage'[4], and for local landscape designations within many Local Authority Development Plans. However, for some valued areas, this information may not be available, and thus the LVIA needs to first establish the quality of the valued landscape through landscape and visual assessment of the baseline conditions and how it is used, for example through consultation, visitor information and user websites. For areas of wildness and wild land (see section below), SNH has established a method for this assessment as detailed within SNH interim guidance 'Assessing the impacts on wild land' (2007). The key test applied in relation to NSAs, but often employed for other valued landscapes too, is not whether impacts would be significant, but whether these would affect the *integrity* of a valued landscape.

1 These Landscape Character Assessments are available to download from SNH's website under the 'Landscape Character of Scotland' series on the publications page at http://www.snh.org.uk/pubs/results.asp?Q=landscape
2 SNH and Historic Scotland Guidance, SNH 2005, para.2.2, p.8
3 The European Landscape Convention and information about its implications can be viewed at http://www.coe.int/t/dg4/cultureheritage/conventions/Landscape/florence_en.asp
4 Scotland's Scenic Heritage, Countryside Commission for Scotland (1978)

Wild land and places with a strong sense of remoteness

4.12 Areas of Scotland which are very remote, inaccessible, rugged and with little evidence of human influence are widely referred to as 'wild land'; however, even those areas that possess only some of these characteristics or in a slightly degraded way may have qualities of wildness. These characteristics and the value they receive are discussed in SNH policy statement 'Wildness in Scotland's Countryside' (2002). A recent study by SNH has revealed that the majority of Scottish residents think it important for Scotland to have wild places[5]. Some of the areas possessing qualities of wildness lie outside designated areas and are therefore not protected by statute, although NPPG14 recognises their sensitivity and asks Planning Authorities to take great care to safeguard their character through specific policies in Development Plans[6]. No detailed mapping of Scottish wild land has yet been undertaken, although SNH has identified 'Areas of Search' which represent the broad areas where wild land is likely to be present[7]. SNH's Strategic Locational Guidance for Onshore Windfarms, states that the mapped Areas of Search for Wild Land have high sensitivity to windfarms and proposals in such areas are unlikely to be compatible with their wild land qualities[8].

4.13 Wild land areas, due to their remoteness and poor grid connections, tend not to attract windfarm proposals.

4.14 However, because perception of wild land relies on there being no or minimal visibility of human features, windfarms, like any built structure, will be out of character in these areas – and scope for mitigating impacts will be very limited. In addition, the potential visibility of windfarms, individually and cumulatively, from within wild land areas can be a concern. This is a particular issue in relation to windfarms because of the long distances over which they can be seen. Therefore, proposals likely to affect an area of wild land merit careful consideration. SNH interim guidance[9] sets out a method for this assessment.

4.15 There may be rare situations where there are isolated built elements already within a landscape perceived to be wild land, such as bothies, shepherds' cottages, or shooting lodges, where small-scale wind turbines may be sited in a way that relates to these structures.

Experiencing windfarms in the landscape

4.16 Compared to pylons or roads, a windfarm is still a relatively unusual feature in the landscape. People's responses vary – to some a windfarm may seem to threaten its surroundings, while others may view it as an exciting, modern, or even futuristic addition with symbolic associations with clean energy and sustainability. Our understanding of people's responses to windfarm development over recent years has also been informed by a number of public attitude studies that have been undertaken[10]. These suggest that the majority of people are in favour of wind power, although visual impact issues are often highlighted as a concern to those surveyed.

4.17 The impact of a windfarm will depend on how and where it is experienced; for example, from inside a residence, while moving along a road, or from a remote mountaintop. These factors are taken into account through LVIA when determining

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5 Public Perceptions of Wild Places and Landscapes in Scotland. SNH Commissioned Report No. 291. (2008)
6 NPPG14 – Natural Heritage, paragraphs 16, 47, 69 and 71.
7 SNH map of Search areas for Wild Land, available at http://www.snh.org.uk/pdfs/polstat/wsc-m3.pdf
8 SNH Strategic Locational Guidance for Onshore Windfarms with respect to the Natural Heritage. SNH 2002, updated March 2009
9 Assessing the impacts on wild land, interim guidance note SNH 2007
10 Renewable Energy Awareness and Attitudes Research Management Summary URN08/657, BERR (June 2008).
Public Attitudes to Windfarms: A survey of Local Residents in Scotland, The Scottish Government (2003).
Tourist Attitudes to Wind Farms. Mori Scotland (September 2002)
Economic Impacts of Wind Farms on Scottish Tourism, The Scottish Government (March 2008)

the sensitivity of the landscape and visual resource, and those people that will be affected by the development (receptors). Typically, LVIA includes assessment of impacts upon the key users of the landscape, including residents, motorists, workers, those partaking in recreation and tourists. Impacts of a windfarm on local residents require particular attention as, unlike visitors, residents will experience a windfarm from different locations, at different times of the day, usually for longer periods of time, and in different seasons. Conversely, impacts on tourists and those taking part in recreation may be relatively brief, but their sensitivity to landscape change is regarded as high because their purpose is specifically to enjoy their surroundings.

4.18 Through LVIA, it is important to take account of how a windfarm will be experienced from surrounding roads, transport, and recreational routes. Views will vary depending on proximity to the road, the angle of view, and intervening landscape features. The first glimpse of a windfarm is important, and careful consideration should be given to the design of the windfarm layout in relation to such views.

Perception of a windfarm depends on how it is viewed and the duration of a view

4.19 As larger numbers of windfarms are built in Scotland, it has been increasingly necessary to consider their cumulative effects, as seen sequentially, from main transport and recreational routes. Of particular importance are: how these developments relate to each other in design and relationship to their settings; their frequency as one moves through the landscape; and their visual separation to allow experience of the character of the landscape in-between. Further detail on this aspect of LVIA can be found in SNHs 'Cumulative Effect of Windfarms' guidance[11].

4.20 The visibility and visual impacts of a windfarm are affected by the distance from which it is viewed, as well as other aspects such as weather conditions and siting. In the past, guidance notes such as Planning Advice Note 45 have offered generic categories of visibility and visual impact in relation to distance, suggesting the following: that in an open landscape at distances of up to 2 km, a windfarm is likely to be a prominent feature; between 2–5 km it will be relatively prominent; between 5–15 km only prominent in clear visibility when it is seen as part of the wider landscape; and over 15 km it will only be seen in very clear visibility and as a minor element in the landscape[12]. However, in practice these guidelines are limited in their application:

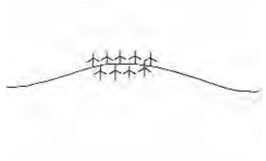
- firstly, because it is unclear what height of turbine these distances were based upon[13]; and,
- secondly, because visual impacts are not directly proportional to distance, as the nature of a view (e.g. a framed / open view or backclothed/skyline view) and its context are as important as the size of a development within that view.

11 Cumulative Effect of Windfarms, SNH (2005).
12 PAN 45 figure 8
13 A study in 2002 for SNH by the University of Newcastle suggests that for the current 3rd generation turbines of 100m+ the distances used by PAN45 should be increased by 20%

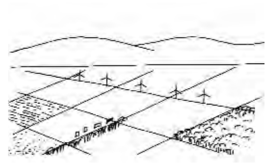
Windfarm siting and design in relation to landscape and visual characteristics

4.21 Like any built structure, the impacts of a windfarm depend on both the characteristics of the development and how these relate to the characteristics of its surroundigs. The most distinctive characteristics of a windfarm are typically its collection of tall, often uniformly spaced turbines, each with moving blades that change orientation according to wind direction. Windfarms are most appropriate in a landscape where their presence and design appear rational. They are usually sited in exposed places that are open, high and relatively prominent, in order to take advantage of maximum wind capture. However, other factors influencing their siting include land ownership, access, grid connection, site topography, location in relation to other natural or cultural heritage interests and/or statutory designations, aviation constraints, proximity to settlement and the need to avoid excessive turbulence.

4.22 It is important to site and design a windfarm so that it relates directly to the qualities of a specific site. As discussed previously within this section, this involves being able to determine the key characteristics of the landscape and visual resource, and then considering the relationship of all aspects of the windfarm in direct relation to these. This will range from the overall siting of the windfarm as a whole, to turbine size, location, pattern, and associated elements such as access tracks, powerlines or buildings.

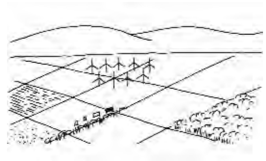


Cluster of wind turbines relates to open hill

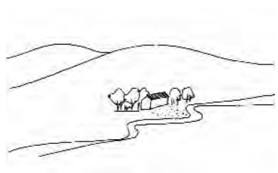


Line of wind turbines relates to landscape pattern

Line of wind turbines appears irrational across open hill

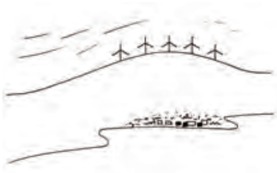


Cluster of wind turbines appears irrational in relation to linear elements of landscape pattern



Siting of house appears to relate to conditions favourable for inhabitation, principally shelter, water, access and well-drained ground

Woodland appears to relate to conditions favourable for growth, principally shelter and well-drained ground



Windfarm appears to relate to conditions favourable for wind energy generation, principally exposure

4.23 With regards to windfarm design in relation to key characteristics, the main variables addressed through LVIA are likely to include the following:

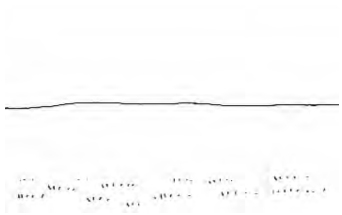
- Layout and number of wind turbines;
- Size, design, and proportion of wind turbines;
- Route and design of access tracks, including the junctions with public roads;
- Location, design and restoration of temporary borrow pits;
- Location, design and restoration of temporary construction compounds;
- Location and size of wind monitoring masts;
- Positioning and mitigation of turbine lighting (if required);
- Visitor facilities, including paths, signs, parking and visitor centre (if proposed); and
- Land management changes, such as muirburn, woodland management, fences, and stock grazing.

4.24 Through the process of design and assessment of various scenarios, regard should be given to the general principles summarised within the following section.

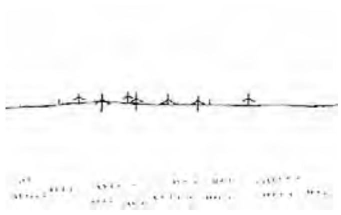
Landform

4.25 Landform is a key characteristic of many landscape character types, affecting whether it is rugged, flat, undulating or rolling, and upland or lowland. In flat landscapes, physical relief tends to become accentuated so that even low hills appear substantial.

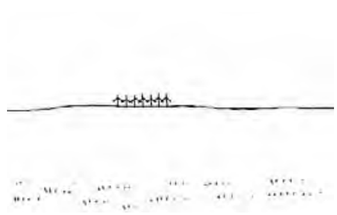
4.26 It is very difficult to site and design a windfarm upon a variable landform, such as undulating moorland or hills, without presenting a confusing image. This is because the wind turbines will be seen from different directions at varying elevations and spacing, and against varying backdrops. To avoid this effect, it is generally preferable for wind turbines to be grouped upon the most level part of a site so the development appears more cohesive, rather than as a collection of disparate individuals.



At a broad scale, moorland appears fairly simple in landform and pattern

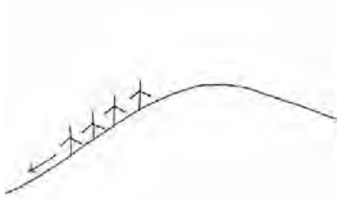


Relative positions of wind turbines illustrates landform undulations that actually exist and, consequently, create complex image



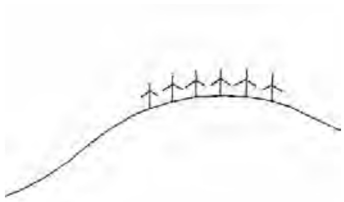
One option is to cluster wind turbines close together upon a local area of flatter ground, so that the variation is less obvious than the image of a single collective feature

4.27 It is important to site and design a windfarm so that it appears visually balanced in relation to the underlying and surrounding landform. Turbines seen upon steep slopes often appear to be 'unstable'. It is also important that the scale and extent of a windfarm does not seem to overwhelm the distinctive character and scale of the landform.



Wind turbines upon slope create a visually dynamic image, seeming unstable

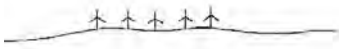
Windfarm appears visually unbalanced upon hill



Windfarm relates to underlying landform, creating a balanced image

4.28 Skylines are of critical importance. This is illustrated by the contrast between the simple horizontal skylines of wide flat landscapes and the more complex vertical and diagonal skylines where there are mountains and hills. The viewer's eye is naturally drawn to skylines, although the extent to which this happens depends on the nature of the skyline and the distribution and type of other elements and foci within the landscape. The character of a skyline may be particularly valued if it conveys a sense of wildness, if it forms the backdrop to a settlement, if it comprises a particularly distinctive landform, or where distinctive landmarks and/or cultural features appear on it.

4.29 Given the prominence of skylines, it is particularly important that a windfarm is sited and designed to relate to this feature. A key challenge of this is, however, that the skyline will vary in relation to the position and elevation of a viewer and visibility conditions, such as weather. Nevertheless, design of a windfarm from key viewpoints and sequential routes should ensure a windfarm does not detract from the character of a distinctive skyline. Care should be taken to ensure that the windfarm does not overwhelm a skyline. If the skyline is 'simple' in nature, for example over moorland and hills, it is important that wind turbines possess a simple visual relationship to this feature, avoiding variable height, spacing and overlapping of turbines and, also, visibility of blade tips intermittently 'breaking' the skyline.



Windfarm relates simply to skyline

Windfarm contrasts in character to skyline

Windfarm seems to overwhelm visible extent of skyline

Windfarm appears as isolated and minor feature on skyline

4.30 During the design of a windfarm, there may be opportunities to take advantage of the landform to limit visibility of wind turbines and site infrastructure. For example, when sited on hill ridges, turbines may be set back from the edge and placed such that the slopes preclude visibility from below, even if they may be clearly visible from adjacent hills.

When only part of a turbine is visible on the skyline, it can create a confusing image.

Landscape scale

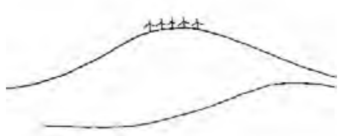
4.31 The scale of a landscape affects the sense of openness and enclosure. The term 'scale' does not refer to a definite dimension, but describes the perception of relative size between elements, for example a large scale open moorland or mountainous landscape and a small scale sheltered glen. To perceive scale, we rely on elements whose size and extent are recognisable to us – common features such as trees and houses. We use these as scale indicators to gauge the size and distance of other elements and make spatial judgements.

4.32 Landscape scale and openness are particularly important characteristics in relation to wind turbines because large wind turbines can easily seem to dominate some landscapes. For this reason, landscape scale can dictate the ability of an area to accommodate windfarm development, both horizontally in terms of its extent, and vertically with regard to wind turbine height.

Windfarm relates well to the scale of the landform and the skyline

4.33 A key design objective for a windfarm will be finding an appropriate scale for the windfarm that is in keeping with that of the landscape. To achieve this, the siting and design of the development will need to ensure that the windfarm in relation to the following aspects, is:

- Of minor vertical scale in relation to the key features of the landscape (typically less than one third);
- Of minor horizontal scale in relation to the key features of the landscape – the windfarm surrounded by a much larger proportion of open space than occupied by the development;
- Of minor size compared to other key features and foci within the landscape; or separated from these by a sufficiently large area of open space (either horizontally or vertically) so that direct scale comparison does not occur.



Windfarm appears as minor feature, both horizontally and vertically in relation to the surrounding landscape

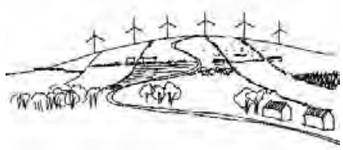
Windfarm appears as minor feature horizontally, but overwhelming vertically in relation to the surrounding landscape

Windfarm appears as minor feature vertically, but overwhelming horizontally in relation to the surrounding landscape

Perspective

4.34 Size indicators within a landscape affect our judgement of visual perspective and thus our recognition of whether a feature is small or far away, large or near. The introduction of turbines into a landscape can confuse this sense of perspective, however, as they are typically of undefined size, yet much larger than any other man-made structures that would help us judge how large and how near they are. Careful consideration is therefore needed in the siting and design of windfarms, and between windfarms, to avoid confusing our sense of perspective. This is particularly the case where different turbine sizes are used and / or where there are gaps between groups of wind turbines at varying distances to viewers.

Windfarm relates to key characteristic of the landscape, yet it is difficult to perceive scale and distance within moorland



Visual link between windfarm and elements of known size, aid perception of scale and distance, emphasising the height of the wind turbines

Perception of scale and distance seems distorted due to variable sizes of wind turbines combined with an absence of reference points and size indicators

Land use

4.35 Land use is also an aspect of landscape character, reflecting the past and current activity of an area. In turn, land use influences landscape pattern, texture, colour, foci and the framework of these elements within an area, which may be simple or complex and affect how people move and view a landscape. Land management can also affect the condition of a landscape and the perception of its value, e.g. whether it seems neglected or well-maintained.

4.36 Wind energy generation may form one part of many different land uses. Existing developments vary in their setting from urban areas, industrial and harbour areas, agricultural ground, woodland, and moorland. Wind energy is typically able to relate to other land uses, apart from within areas such as wild land areas and sensitive residential locations. A key design objective should be to either relate directly to the specific characteristics of the land use or, alternatively, to appear separate and removed from these, avoiding the incongruity of something in-between that conflicts in nature and function.


Windfarm related to harbour land use


Windfarm related to agricultural land use


Windfarm relates to scale of landscape and land use


Relationship between windfarm and land use not clear

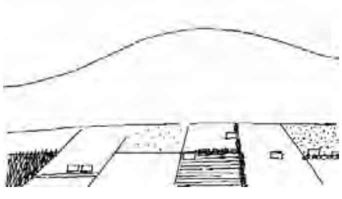
4.37 Where appropriate, the development of a windfarm can act as the stimulus for restoration and/or improvement of land use within or around a windfarm site, which are typically assured through the planning process by legal agreements.

Landscape and visual pattern

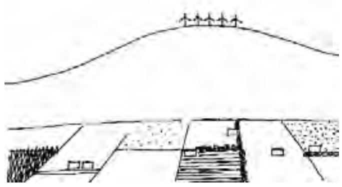
4.38 Strongly influenced by land use and physical features, landscape and visual pattern relates to the configuration of key elements. It is a product of the arrangement of repeated or corresponding features, be they a network of drystane dykes, hedgerows, shelter-belts, drainage channels, the distribution of drumlins along a valley, or repeated rock formations.

4.39 Developments should typically be designed to relate to landscape pattern where this contributes to landscape character and visual composition. However, the elements of landscape pattern to which a windfarm should relate will be strongly affected by their scale and prominence. The location of tall wind turbines, for example around 100 m high, in relation to small elements of pattern, such as 1.5 m high fences or 25 m high knolls, would represent a disparate relationship that would not appear rational from most viewpoints. Wind turbines that do not relate to elements or features of similar prominence and/or scale within the underlying or adjacent landscape pattern, such as a forest plantation, will seem equally discordant.

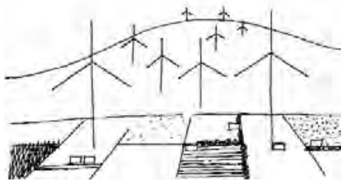
4.40 The distinctive character of some landscapes relies on strong contrasts of pattern, for example an intricate arrangement of fields and regular spacing of croft houses seen against a simple moorland hill backcloth. In these locations, it is important that the addition of a windfarm neither compromises the simplicity of the backcloth hills, or the hierarchy or pattern of the lowland landscape below.



Distinction of lowland landscape pattern relies partly on simple backcloth that highlights this in contrast



Windfarm detached from landscape pattern. Creates a focal feature that will distract slightly from lowland landscape, but distance maintains most of simple hill backcloth.

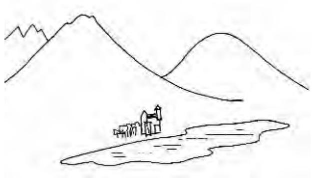


Windfarm not only contrasts to lowland landscape pattern, but reduces distinction by crossing over into neighbouring area of simple hill.

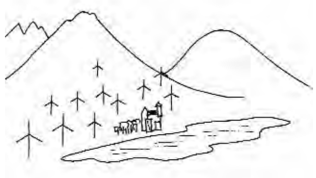
Focal features

4.41 Focal features can be natural features, such as mountain peaks, ridges, rock outcrops or clumps of trees; or they may be man-made structures like hill-forts, masts and towers; they can also be formed by existing wind turbines / windfarms. They may form part of landscape pattern or be seen as isolated features within a landscape. Often, where the landscape panorama is complex, there will be a hierarchy of foci that will be influenced by the relative size, distribution, position, prominence and cultural value placed upon them.

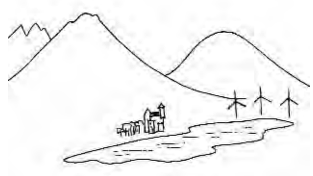
4.42 Windfarms, because of their very nature and typical location within open landscapes often become major focal points. Thus their interaction with the existing hierarchy of foci needs to be considered in their siting and design, in order to minimise potential visual conflicts or compromise the value of existing foci. In some instances, however, the introduction of a windfarm as a focal feature may have beneficial effect, helping to distract from negative prominent features.



Existing focal points within landscape



Windfarm reduces focal prominence and distinction of original foci



Windfarm creates prominent focal feature, but does not seem to intrude upon or reduce distinction of existing foci due to separation

Settlements and urban / industrial landscapes

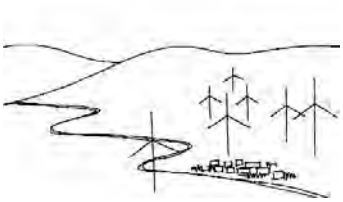
4.43 Settlements and buildings within a landscape tend to be sensitive to the development of a windfarm for three main reasons:

- by being places from which people will view a windfarm and within which a key quality may be the provision of shelter and a sense of refuge that may seem impinged upon by the movement and proximity of a wind turbine;
- because buildings act as a size indicator in views that may emphasise the much greater scale of wind turbines in comparison; and
- because the settlement itself often forms a focal feature / landscape pattern to which a development would need to relate.

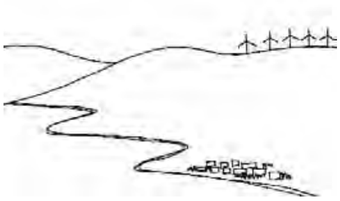
Turbines seen against other features

4.44 It is important that windfarms should not dominate or negatively affect settlements. The threshold for this effect will vary in different landscapes, for different settlements and with different windfarm and wind turbine designs.

4.45 Individual domestic-scale turbines can be located nearer to buildings for small-scale industry, agriculture or for residential use. These may be relatively noticeable due to the faster blade rotation of smaller machines. SPP6 and PAN45 recommend that any proposals within 2 km of a settlement should be considered individually to asses their suitability.



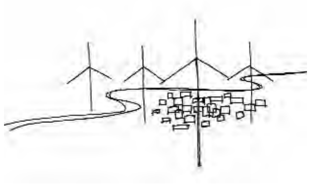
Windfarm appears to impinge upon neighbouring settlement



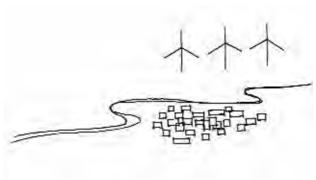
Windfarm separated from settlement by open space

4.46 There may be some locations where larger wind turbines can be accommodated near to or within urban and industrial locations. Additional key issues to address in these situations will be residential amenity, noise and shadow flicker. In these settings, large wind turbines typically appear most appropriate where they are separated slightly from buildings; are seen set back against an area of open space and visual simplicity; or are marginal to the urban/industrial area, for example, along a river edge, road corridor, the coast or large open space. The aim should be to minimise the sense of imposition upon buildings and more intimate spaces. This might be achieved by the turbines mainly being seen against an open background, and avoiding the creation of a visually complex image. In these circumstances, careful consideration of the nature of views in and out of these areas is needed, along with appreciation of the nature of impacts from recreational areas and residences.

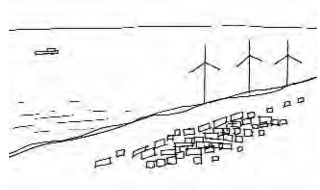
Wind turbines can relate well to urban features such as a harbour wall



Windfarm impinges upon space and views of adjacent settlement



Windfarm prominent in views from settlement but does not seem impinging because of separation space



Windfarm near to settlement, but seems less impinging due to adjacent open space offered by sea

4.47 In some places, larger turbines with slower rotation of blades may be preferable to smaller turbines with faster speeds. However, there will always be a need to relate the size of the turbines to the local context, taking account of the existing buildings and foci.

4.48 Landscape value, which may be reflected by designations such as World Heritage Sites, Conservation Areas or areas with Tall Building Policies, will also need to be considered.

4.49 Other factors to consider within urban situations, and which should be addressed through LVIA are;

– intervisibility and setting of turbines;

– lines of sight between well known viewpoints;

– views of existing focal points; and

– the relationship between wind turbines in urban areas and those in the surrounding landscape and seascape.

Wind turbines in an urban setting

Coast

4.50 Scotland has a great diversity of coastal landscapes, ranging from low-lying beaches with dunes, to craggy intricate cliffs and headlands. An assessment has been undertaken for SNH that characterises the coastline of Scotland into 33 seascape units[14].

4.51 Windfarms should relate to the sense of openness and exposure within coastal areas. However, as views are typically drawn to the coast, these areas will be sensitive to the location and design of a windfarm. This occurs both in relation to the inland and offshore land/seascape character and views, and includes views from boats and ferries. Simple, open, flat coastal areas can probably better accommodate windfarms than complex coastal landscapes, such as those with inlets and islands.

14 An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms, SNH Commissioned Report No. 103. (2005)




Wind turbines can relate well to some coastal landscapes

4.52 Due to the focus of views along coastlines and the typical concentration of settlements within these areas, a windfarm will often create a new focal feature or landmark near to the coast. For this reason, it will be important that they do not detract from existing landmarks, such as historical or navigational features, or coastal settlements and areas valued for recreation.

4.53 Cumulative impacts may occur between onshore and offshore wind energy developments, and this is likely to become an increasingly important design consideration in the future as leases are granted to develop windfarms in Scottish inshore and offshore waters. From inland areas, offshore developments may not even be perceived as being offshore if their immediate setting within the sea is screened by inland features. Views of offshore windfarms may also be affected by onshore developments. It may, for example, be undesirable to view off-shore development with onshore development in the foreground.

An offshore windfarm, 1km off the coast

4.54 Further guidance on this aspect of windfarm LVIA can be found in 'Guidance on the Assessment of the Impact of Offshore Windfarms – Seascape and Visual Impact Report'[15] and 'Guide to Best Practice in Seascape Assessment'[16].

15 DTI in association with SNH, CCW and The Countryside Agency (2005)
16 Maritime Ireland/Wales INTERREG 1994–1999. Countryside Commission for Wales, Brady Shipman Martin and University College Dublin (March 2001)

Woodland

4.55 Where turbines are seen from a distance in combination with woodland, their large scale can be difficult to discern. However, where windfarms are sited immediately adjacent to, or within woodland areas, trees may act as a scale indicator accentuating turbine size in comparison.

4.56 Trees are only likely to have a screening effect if they occur within the fore or midground of views looking towards turbines in the distance. If this occurs, the screening effect may change or be lost as one moves through the landscape.

4.57 Large-scale conifer plantations, particularly when seen from a distance and upon slopes, can create distinctive lines, colour, texture and shape. Ordinarily, the design objective would be to relate to this distinctive landscape pattern. However, in contrast to native woodland, forest plantations tend to be more temporary features of the landscape. For this reason, through LVIA, the designer needs to consider future plans for a forest and consider whether this, or the underlying and surrounding landscape, is of greater relevance in defining the character of the landscape to which the windfarm should relate.

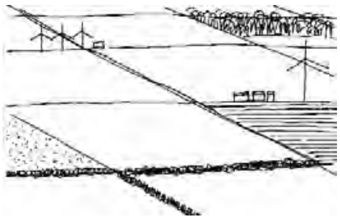
4.58 If a windfarm is located within a forest, the clearance of trees to create open spaces for the turbine bases and access tracks can create a pattern of spaces, lines and shapes that may increase the complexity of the windfarm from distant views.

The relationship between windfarms and forestry requires careful consideration

Small / Community Windfarms

4.59 Small scale community owned windfarms can make a positive contribution to rural economic development. However, it should be noted that single turbines or small windfarms do not necessarily result in less landscape and visual impact than a larger development. As the efficiency of wind turbines increases this may lead to proposals with fewer yet relatively large turbines in landscapes which have limited capacity to accommodate them. Whilst a community development may be preferred within an area due to its contribution to a local economy, the ownership of a development does not mitigate landscape and visual impacts, it affects the judgement of acceptability of impacts in line with planning policy. All windfarm development should be carefully assessed through LVIA (albeit scoped to fit the scale and nature of the development), including cumulative effects.

4.60 Cumulative impacts of multiple individual wind turbines and / or small windfarms are a particular concern, especially where these are randomly located or of different designs. This issue may become more widespread as opportunities and incentives to generate electricity for on-site or community use, or to generate community income, become more widespread. There is a need for developments to be sited and designed in relation to each other in order to avoid negative impacts on landscape character and visual amenity. It is therefore recommended that Local Authorities have suitably robust spatial and design policies to minimise landscape and visual impacts where small windfarm development is likely to occur outside their Broad Areas of Search.



Single and small windfarms fitted to agricultural landscape pattern

Although individual developments are all small scale and fitted to local characteristics, developments cumulatively become defining element of character type – a 'windfarm landscape'

5

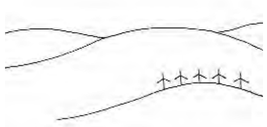
Designing in landscapes with multiple windfarms

5.1 The previous section highlighted the factors to be considered when designing individual windfarms. In many parts of Scotland, however, the issue is how best to plan for and accommodate multiple windfarms. This is complicated by the fact that, at any one time, many developments may be consented but not built, or submitted but not determined. This means that planning, siting and designing windfarms tends to be based on constantly changing baseline conditions.

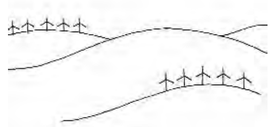
5.2 Cumulative impacts occur when one windfarm is proposed in the vicinity of another existing or already proposed windfarm. SNH has published guidance on assessing the Cumulative Effects of Windfarms[1] which sets out when and how cumulative effects should be considered. This section contains design guidance in circumstances where such cumulative effects are expected to arise. It also touches on aspects which Local Authorities may need to consider when drawing up spatial frameworks and Supplementary Planning Guidance for windfarm development to fulfil the requirements of SPP6 and PAN45 Annex 2. This is dealt with in more detail in Part 2.

5.3 As part of the design process where other windfarms exist or are proposed, it will be important to undertake an assessment at a strategic level of the potential cumulative landscape and visual impacts. The impact of smaller windfarms, and in some cases individual turbines, will also require consideration. The methodologies contained with the Cumulative Effects of Windfarms guidance should be helpful, as may Topic Paper 6 'Techniques and criteria for judging capacity and sensitivity'[2].

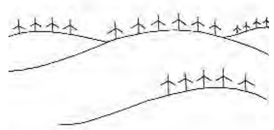
5.4 When designing an individual windfarm, key design objectives should be developed as stated previously in section 4. Where cumulative impacts are likely to occur within an area, design objectives should also be established that can be consistently applied to all proposed developments. This should result in a similarity of design and windfarm image within an area that limits visual confusion, and also reinforce the perceived appropriateness of each development for its location. Cumulative design objectives should relate to ancillary infrastructure as well as wind turbines.



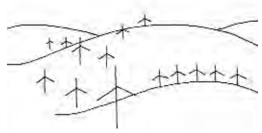
Individual windfarm relates directly to landform characteristic as single line upon horizon



Numerous developments relate consistently to key characteristic of the landscape, but not prevalent and thus remain as isolated features.

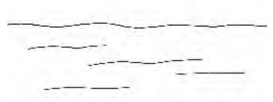


Multiple windfarms relate to same characteristic, to create consistent image and reinforce perceived appropriateness of each windfarm. However, by occupying every incidence of specific characteristic, will become key characteristic that changes overriding character

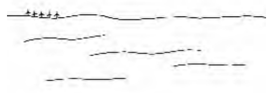


Additional windfarms contrast in pattern, scale and relationship to key characteristics, creating a confusing image and questioning relationship of original development to its surroundings.

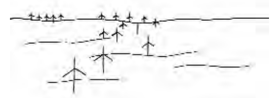
1 'Cumulative effect of Windfarms'. SNH 2005 (currently under review)
2 Landscape Character Assessment Guidance for England and Scotland – Topic Paper 6:Techniques and Criteria for Judging Capacity and Sensitivity. SNH and The Countryside Agency (2005)



The key characteristics of the landform are often illustrated most clearly by the skyline. In this open landscape, the skyline has a horizontal emphasis and uninterrupted character.



Windfarm acts as a prominent focus. Although it does not occupy a major proportion of the skyline, it contrasts to the horizontal emphasis at a local level as a single collective feature.



Additional development results cumulatively in major proportion of skyline being occupied by windfarms. In addition, its siting and shape does not relate to the skyline feature, nor horizontal emphasis.

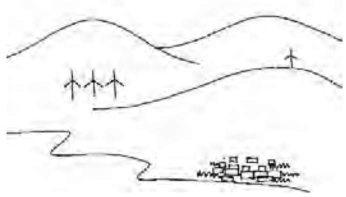
Windfarms cumulatively dominate the skyline feature, although they relate to its horizontal emphasis and simplicity of line.

5.5 The development of multiple windfarms within a particular area may create different types of cumulative effect, such as where:

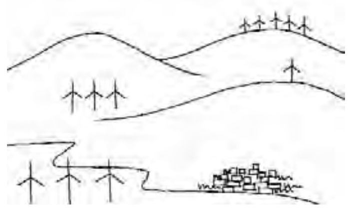
– The windfarms are seen as separate isolated features within the landscape character type, too infrequent and of insufficient significance to be perceived as a characteristic of the area;

– The windfarms are seen as a key characteristic of the landscape, but not of sufficient dominance to be a defining characteristic of the area;

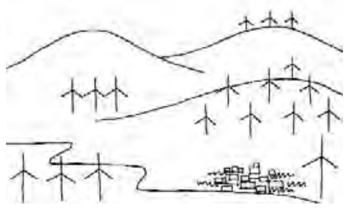
– The windfarms appear as a dominant characteristic of the area, seeming to define the character type as a 'windfarm landscape character type'.



Separate isolated features

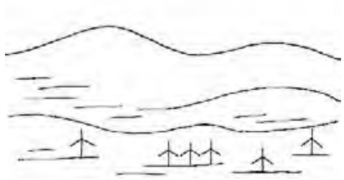


Windfarms become key characteristic of the landscape

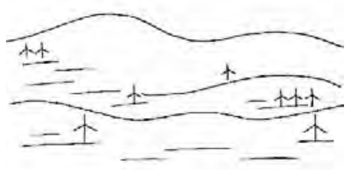


Windfarms become dominant characteristic of the area, creating a 'windfarm landscape'

5.6 These effects can occur at varying scales, for example affecting just a local character type, or prevailing over much of a character type at a regional level. The appropriateness of these different effects will depend on the character and value of a landscape and defined objectives for change. There will be differing circumstances where windfarm development would be welcomed – as landscape enhancement or accepted as part of the usual trend for landscape diversification and evolution – or else be considered undesirable, being contrary conservation aims.



Dominance of landscape character by windfarms occurs at local level only. Other areas of similar character not affected.



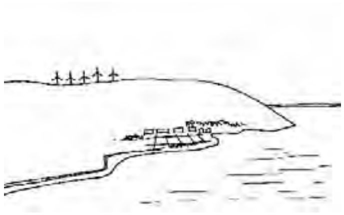
Dominance of landscape character at wider scale, but local pockets perceived as unaffected

5.7 An opportunity may be taken in some instances to use windfarm landscapes to improve areas which have been considered lacking in defining character. It is important to stress that this approach is only appropriate in certain locations where study has revealed that capacity exists for further turbines – elsewhere it will be important to retain areas free from development to maintain landscape diversity.

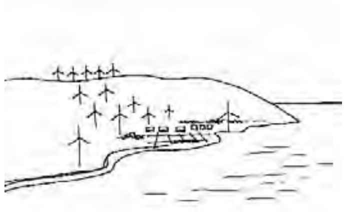
Relating to landscape character

5.8 If windfarm development extends over several different landscape character types within an area, this can lead to a reduction in the distinction between these different types. If windfarms already exist within a particular landscape character type, further windfarm development should be limited to the same or similar types within the neighbouring area. An exception could be where these developments are of distinctly different character themselves, for example if they strongly contrast in scale.

Distinct combination of contrasting character types – open hill, settlement and firth

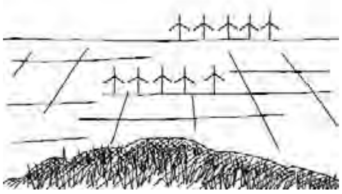


Windfarm creates new feature. This distracts from existing focus of view; however, distinction between character types is maintained.

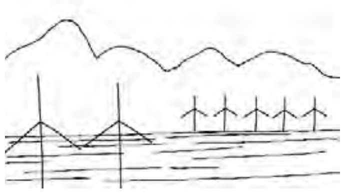


Windfarms cross different character types, reducing the distinction between these.

5.9 The relationship of multiple developments to neighbouring landscape character types is very important, especially where developments are located near the boundary of these or will be highly visible from neighbouring landscape character types.



Windfarm siting and design relates to simple landform and appears distant enough not to impose on nearby hills



From alternative viewpoint, looking over agricultural ground, visibility of wind turbines is highlighted by backcloth. The turbines also compete with the visual prominence of the hill range.

Complementing landform

5.10 Multiple windfarms should not obscure distinctive landforms, either by 'flattening' out the varying relief (due to their relative magnitude) or by 'filling' up or crowding an enclosed or flat area.

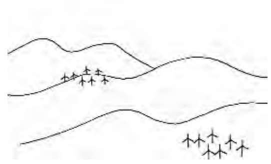
Establishing new patterns

5.11 The opportunity to introduce a new, characteristic landscape pattern through consistent design of turbine arrays will be important where a 'windfarm landscape' has to be established. Existing landscape scale and pattern should be respected, as they may assist in designing a new landscape. Where a new spatial pattern is proposed it will be important to identify key design prompts or cues within the landscape (which may be existing windfarms) and work with these. Consideration needs to be given to how the new pattern relates to any existing neighbouring windfarms, and adjacent landscape character.

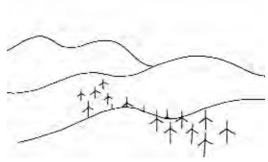
Relationship between windfarms

5.12 Where two or more windfarm proposals which would be inter-visible enter the planning system in parallel, or alongside existing or consented windfarms, this should be a material consideration in the planning process.

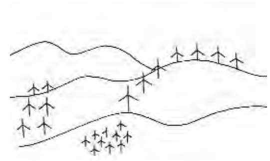
5.13 A key factor determining the cumulative impact of windfarms is the distinct identity of each group of windfarms, typically related most closely to their degree of separation and similarity of design. This applies whether they are part of a single development, a windfarm extension, or a separate windfarm in a wider group. A windfarm, if located close to another and of similar design, may appear as an extension; however, if it appears at least slightly separate and of different design, it may conflict with the other development. In these cases, and if a landscape is not able to accommodate the scale of a combined development, windfarm groups should appear clearly separate. It is critical to achieve a balance between windfarms and the undeveloped open landscape retained between them. Adequate separation will help to maintain windfarms as distinct entities. However, the separation distance required will vary according to the landscape characteristics.



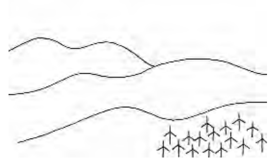
Distinct windfarm groups. Similarity of design and relationship to the landscape. With large areas of open space in between, character of underlying landscape prevails.



No clear distinction between group(s). Extending beyond skyline, it is not possible to confirm whether the groups link.

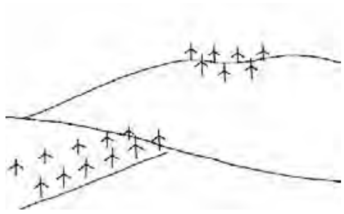


Although no clear area of space between windfarm groups, distinction highlighted due to contrasts of turbine scale and layout (variety of development type creates visual complexity).

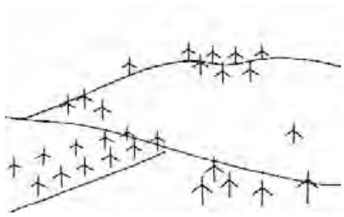


Extension to original development creates larger single windfarm. This has increased impacts in the local area, but limits the extent of impacts through the wider landscape.

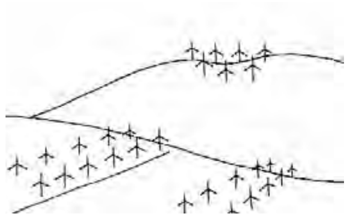
5.14 In some locations the existing pattern of windfarm development may be complex. Relating further development to a complex pattern will be challenging, but the same key principles should apply, focusing on improving the overall pattern and character of development rather than exacerbating existing conflicts between designs.



Existing windfarm developments of contrasting design and relationship to the landscape.



Additional windfarm designs amplifies adverse cumulative impacts



Additional windfarm reinforces character of one original windfarm, although increases the sense of incongruity of the other.

5.15 In some circumstances, intervening topography may limit visibility and reduce the need for visual compatibility between neighbouring proposals, although site design should always be compatible with landscape character.

Focal point pattern and scale

5.16 As multiple windfarms are built, they are more likely to 'compete' with the landscape's original foci and it may lack a sole dominating focal point as a result. The design aspiration should be to avoid visual confusion and to maintain focal point pattern and hierarchy.

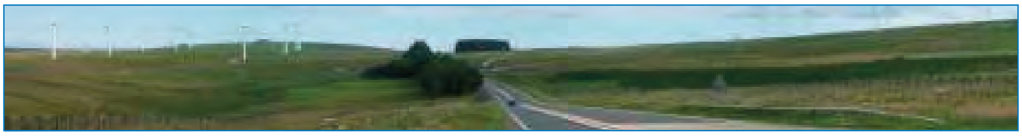
Settlements

5.17 Care should be taken to avoid multiple windfarms dominating the landscape setting of a settlement. Windfarms may do this if they are close to it at high elevation, surround or enclose the access and main approaches, dominate approaches through sequential cumulative effects (through the presence of several windfarms in succession), or are physically too close. How a 'windfarm landscape' relates to a settlement will depend on the design of the windfarms and their spatial relationships with each other, and how the settlement relates to its hinterland.

Windfarm extensions

5.18 Recent windfarm development has included numerous extensions to existing windfarms. These give rise to similar issues of consistency as those arising from adjacent windfarm developments, and similar design principles should apply. Layout and site design objectives and principles should echo those of the original windfarm. Extensions should use turbines which are compatible with those in the existing windfarm, including aspects of scale, form, colour, and rotation speed. Such compatibility issues will be more important the closer the windfarms are.

Extensions should not compromise the landscape setting of neighbouring windfarms and should respect existing focal points in the landscape. The potential for a windfarm extension to 'outlive' the existing windfarm (if this is decommissioned), and therefore stand on its own, should also be considered in the design process.



Windfarm as two distinct groups. This creates a complex image due to interactions between each wind turbine with the landscape and all the other wind turbines within its group as well as between the two groups of turbines. This is complicated further by the fact that most people view the development while travelling through it. In addition the windfarm has an irregular layout over a variable landform and there are a number of other prominent landscape features within the area, including forest blocks and powerlines.

Designing in landscapes with multiple windfarms – summary of key principles

- Multiple windfarms will result in different types of cumulative effect. For each windfarm or strategy concerning potential windfarms, the most appropriate cumulative design objectives should be established, while also taking into account existing developments
- Some landscape character types will be able to accommodate multiple windfarms, while this may be inappropriate within others. Generally, it will be preferable for windfarm development to be limited in its range of landscape character type within a particular area, to avoid reduction in the distinction between types
- Individual windfarms should generally appear visually separated from one another in a landscape, unless specifically designed to create the appearance of a single combined windfarm
- Different forms of windfarm development should respond to different landscape character types, to ensure windfarm landscapes complement the landform in their positioning, extent and density
- Windfarms should not unacceptably dominate settlements
- Windfarms should take account of existing focal points in the landscape, which may be neighbouring windfarms
- Multiple windfarm development should not change distinctive skylines or occupy the major proportion of a skyline from key viewpoints or receptors
- Extensions should consolidate the scale, size and mass of the existing development; if the new turbines are compatible with the existing ones the resulting windfarm should relate to the area's landscape character in extent and scale

Part 2

Strategic planning for windfarms

Introduction

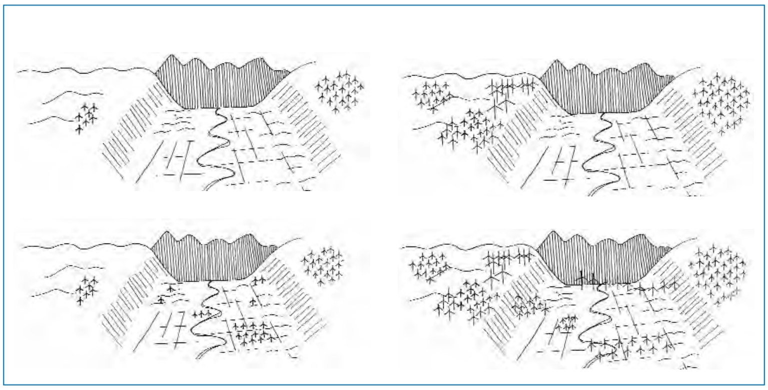
1. This section provides guidance to Planning Authorities. It does not replace or override the policy principles stated in SPP6, but seeks to compliment and expand upon the landscape and visual considerations as identified in Planning Advice Note (PAN) 45 Annex 2[1], published in November 2008. This guidance is being issued at a time of change within the planning system. The existing SPP / NPPG series is being replaced by a single, consolidated Scottish Planning Policy statement, to be published later in 2009. This section may require revision once the new SPP is published.

2. SPP6 requires planning authorities to set out a spatial framework for the consideration of windfarm proposals over 20MW, with broad areas of search identifying areas where proposals are likely to be supported, areas to be afforded significant protection from windfarm development, and the criteria to be followed in the remainder of the area. In most areas the pattern of existing windfarm development will strongly affect the scope of a framework.

3. Planning for multiple windfarms is a complex and sensitive issue. SNH seeks only to express key principles in relation to landscape within this guidance to help Planning Authorities produce a clear and robust spatial policy. At this strategic scale Planning Authorities will benefit from working together to consider the broader impacts of windfarms on neighbouring areas

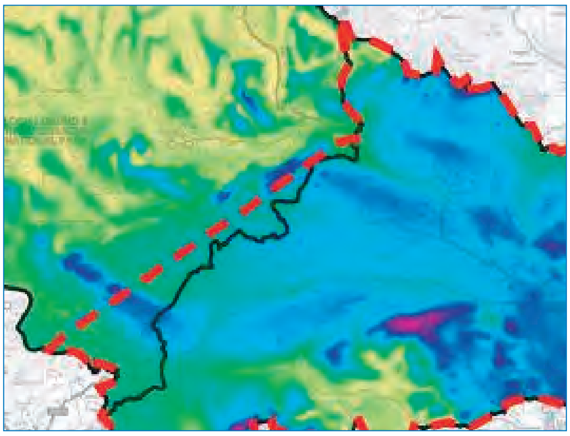
4. Landscape considerations are just one aspect of the process of identifying a spatial framework. Other constraints and natural heritage issues will also have to be taken into account to develop a robust and coherent framework. This guidance works on the assumption that other areas of natural heritage sensitivity will either have been sieved out earlier in the process of developing a spatial framework, or that these sensitivities are carried forward for consideration alongside landscape and visual and other issues. In an area with multiple windfarms there is potential for the overall landscape character to be significantly changed. The presence of a number of windfarms may make them a key characteristic of the landscape, or even a dominant characteristic such that it becomes a 'windfarm landscape'. There may be some loss of tranquillity and some aspects of naturalness may be lost. In any of these circumstances good design remains an important objective, even if the landscape has changed from its original character. The design principles outlined earlier in this guidance remain relevant.

1 Planning Advice Note (PAN) 45: Annex 2: Spatial Frameworks and Supplementary Planning Guidance for Wind Farms, Scottish Government, November 2008



Example of exploration of design concepts for multiple windfarms within a distinct region. The first diagram represents the existing cumulative situation with two windfarms upon upland hill areas. A key issue to address was whether all further windfarms should be restricted to the same character type to avoid reducing the distinction between this type and the flat bottomed valley below.

5. Potential cumulative visual impacts are difficult to address through strategic planning. The process can be assisted by viewshed mapping and analysis of representative viewpoints, key views and important tourist routes across the area, informed by 'dead ground' ZTVs[2] and viewpoint visualisations.



Example of visual exposure analysis. Pink represents places within which a wind turbine would be seen from the most extensive area within the study area, Yellow represents the where it would be seen from the least extensive area.

Plan showing sample viewpoint locations that informed the development of a windfarm capacity study. For each viewpoint, site assessment was carried out in addition to the production of visualisations that showed sample wind turbines of different height in various hypothetical locations in relation to the viewpoints across the region.

Identifying landscapes suitable for multiple windfarms

6. One of the potential consequences of considerable windfarm development across Scotland could be that few landscapes might be left unaffected by windfarms. This would diminish the diversity which is one of the key characteristics of the Scottish landscape. Good strategic planning can help to avoid this by ensuring that windfarms are sited within those areas best able to accommodate them. It should also mean that areas less suitable for such development, or more valued for the present character or qualities of the landscape, can be kept free of windfarm impacts. Views of windfarms from within these areas may also be affected, and will therefore require careful consideration. This has been shown by some planning exercises[3].

7. Landscape capacity studies can help to inform and identify where development would be preferable in landscape terms. They can be particularly helpful when spatial frameworks are being developed.

8. As the landscape and visual impacts of windfarm development can extend over a wide area and across Planning Authority boundaries, it is important to consider the

2 ZTV maps that show the area within which an element of defined height and extent would be visible from a specific viewpoint.
3 Such as those undertaken in Ayrshire and the Clyde Valley

current pattern of development in a regional and national context. SNH has developed a windfarm footprint map[4] which identifies the location and size of most of the windfarms which are already installed, approved or being considered. The map demonstrates that windfarm development is currently clustered in those areas which are generally of lower constraint (in natural heritage terms) and with access to the national grid. Further development activity is likely to continue to focus on those areas with good access to the grid and close to areas of existing development or land use change. This has led to a pattern of 'clustering' of windfarms which crosses Planning Authority boundaries and which reflects the range of constraints on windfarm development. In considering which areas are suitable for further windfarm development this existing pattern of development must form a key consideration.

A large windfarm in a large scale, open landscape.

9. The intrinsic characteristics of a landscape also render some landscape types more suitable for multiple windfarms than others. Analysis of landscape character information at a strategic level can help in identifying those landscape types best suited to large scale and multiple windfarm development.

10. Impacts on recreational interests also need to be considered at a strategic level. This will include the effects on users of Long Distance Routes where relevant, impacts on popular destinations for recreation such as National or Regional Parks, and also on important recreational resources such as rivers and mountains. Summits and other elevated viewpoints are often popular destinations that are likely to be particularly affected by views of multiple windfarms.

Different landscapes – different approaches

11. In judging whether or not an area should be kept free of windfarm impacts it is helpful to develop a clear view about which of three possible landscape objectives should apply[5]: landscape protection, accommodation, or change. These should not be seen as rigidly distinct objectives. They seek only to illustrate the different approaches that are relevant to different landscapes.

A large windfarm in a rolling managed upland landscape.

4 Available at http://www.snh.org.uk/strategy/renewable/sr-rt01.asp
5 For further discussion on landscape objectives see SNH's Landscape Policy Framework. Policy Statement No. 05/01

12. **Landscape Protection:** where the aim is to maintain the existing landscape and visual resource, retaining or reinforcing its present character and protecting its quality and integrity. It is likely to be difficult to accommodate windfarms in such areas. Small-scale development may nonetheless be possible where it relates well to the existing landscape in terms of both scale and design. Micro generation may be acceptable where this relates well to the existing built environment. Where a landscape designation is in place, it is important to understand the special qualities for which the area is designated and to consider how the proposal could affect these. In National Scenic Areas, for example, landscape protection will be the most appropriate objective, reflecting the high degree of protection afforded to these areas by SPP6 and NPPG14[6].

Nationally and internationally designated areas where landscape protection is an appropriate approach are likely to be afforded 'significant protection' in Planning Authority Spatial Frameworks.

13. **Landscape Accommodation:** where the aim is to retain the overall character of the landscape, yet accepting that development may be allowed which will have an impact on the landscape locally; development fits within the landscape and does not change its character on a large scale. Landscape accommodation implies that there may be important landscape-related constraints in terms of the siting and scale of windfarms, but that suitably designed windfarms can be compatible with this objective. Within local landscape designations the degree of landscape protection will be less than for National Scenic Areas. In some local landscape designations an appropriate objective may be to accommodate windfarms, rather than seek landscape protection. Where this approach is chosen the justification will need to be clearly articulated in relevant planning policy.

Landscape accommodation may be an appropriate approach within the 'other' areas in Planning Authority Spatial Frameworks, where other constraints and policy criteria will apply. A landscape accommodation approach could also be relevant to 'Broad Areas of Search' if the associated criteria make it clear that overall landscape change is to be avoided.

14. **Landscape Change:** where it is accepted that the area is one whose landscape character may be allowed to change, which could result in a perception of a windfarm landscape. Landscape change does not imply that 'anything goes': good landscape design principles still need to be followed to ensure that the development is appropriate for the scale and character of the landscape.

Areas where landscape change is an appropriate approach are likely to be consistent with 'Broad Areas of Search' in Planning Authority Spatial Frameworks.

SNH Strategic Locational Guidance

15. SNH has published Strategic Locational Guidance for Onshore Windfarms[7] to guide planners, practitioners and others in respect of natural heritage constraints at the strategic level. It identifies three zones of natural heritage sensitivities and aims to promote a consistent approach to windfarm development. It is important to note that the zones identified within the Strategic Locational Guidance are mainly designations-based and do not take account of landscape character or potential visual effects.

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6 National Planning Policy Guideline 14 Natural Heritage, Scottish Government 1999
7 Strategic Locational Guidance for Onshore Windfarms with respect to the Natural Heritage. SNH 2002, updated March 2009, www.snh.org.uk.

16. To date, the majority of windfarm development has been in Zone 1 – the zone of least natural heritage sensitivity. Areas where landscape change is an appropriate objective, and where multiple windfarm development might be encouraged, are most likely to be found within Zone 1. However, it should not be assumed that all of this zone should be open to landscape change. The scale and detail of some landscapes will always make it difficult for them to accommodate windfarms satisfactorily, and there are many areas within Zone 1 which are valued locally for the character, quality and amenity value, for example on account of the recreation opportunities they provide close to towns. In some locations, the concentration of proposed developments in Zone 1 is leading to the potential for undesirable cumulative impacts.

Identifying capacity and the limits to development

17. Within areas identified as being suitable for multiple windfarms there will still be a limit on the number or extent of windfarms which can reasonably be accommodated. SPP6 states that '*Development plans should identify those areas where there are existing windfarm developments and set out, in relation to the scale and proximity of further development, the critical factors which are likely to present an eventual limit to development*'[8]. Within Broad Areas of Search, Planning Authorities are encouraged to complete a landscape capacity study to determine how much development can be accommodated and what the critical factors might be that will define an eventual limit to development. The critical factors will be specific to the landscape involved, but could include the factors summarised below.

8 SPP6, Annex A, paragraph 3

Critical factors relating to capacity for windfarms

This box lists key factors that ought to be taken into account when considering capacity for windfarms. It was developed in response to a need identified in SPP6 (paragraph 3 Annex A, cumulative impacts).

– Effects on landscape designations – or landscape value
Effects of additional development on the qualities, integrity and objectives of any relevant landscape designation should be analysed and described.

– Effects on landscape character
The effect of development on existing landscape character should be described. It is likely that as more windfarms are developed, and / or at closer distances to each other, they will begin to be perceived as a key landscape characteristic and will therefore change landscape character.

– Effects on sense of scale
Tall structures are likely to dominate and alter the perception of vertical scale in the landscape. This will be the case particularly when larger turbines are seen in comparison with developments using smaller turbines or when proposed turbines are viewed in comparison with other landscape features.

– Effects on sense of distance
Effects on distance may be distorted with additional windfarm development. For example, if larger turbines are located in the foreground of smaller turbines or vice versa.

– Effects on existing focal points in the landscape
An existing windfarm development may act as a focal point in the landscape and the effects of other windfarm development on this should be considered.

– Effects of skylining
A viewer's eye tends to be drawn towards the skyline. Where an existing windfarm is already prominent on a skyline the introduction of additional structures along the horizon may result in development that is disproportionally dominant. The ratio of developed to non-developed skyline is therefore an important landscape consideration.

– Effects on sense of remoteness or wildness
The existing experience of remoteness and wildness should be assessed, and the effects of development on it analysed.

– Effects on other landscape interests
Effects of additional development on other interests in the landscape should be considered. For example, this may include consideration of the effects on the landscape setting of settlement or other cultural interests and associations with the landscape.

Surrounding areas

18. Where an area is identified for multiple windfarm developments, it will be important to establish a clear boundary to that area. This is in order to achieve visual separation, such that those travelling through the landscape will perceive a clear distinction between the windfarm landscape and the landscape outwith. Otherwise, the perception of being within a windfarm landscape may become extended, or may only peter out gradually, thus losing diversity in the landscape experience. There may be some benefit in maintaining the current development pattern – of clustering and gaps – that has evolved in some areas due to a range of opportunities and constraints. This approach should also help to address cumulative impacts[9].

19. The scale required of such landscape planning is necessarily large, given the extent of a typical large windfarm which may extend across Local Authority boundaries. Surrounding areas to be kept free of windfarms may have to be substantial to be effective, considering intervisibility and sequential impacts. They

9 SPP6, Annex A, paragraph 3

also need to take account of the distance necessary to provide an area of undeveloped ground in between. Perception of this will typically depend on factors such as the concealment offered by landform and windfarm size. In very open landscapes larger separation distances may be required than in hilly areas where the landform may provide more effective visual separation. It may not be necessary to preclude small windfarm developments within such separation areas, e.g. farm-scale developments or single turbines, where these are clearly of a smaller size or scale than the large-scale windfarm developments within the windfarm landscape itself. However, there will be a limit to the number of smaller developments that can be accommodated in this way.

In developing Spatial Frameworks for windfarms Planning Authorities should consider identifying areas that should be afforded significant protection in order to reduce the potential for further cumulative impacts[10]. These areas may be required between very large individual windfarms, clusters of windfarms, and Broad Areas of Search.

10 Para 33, Planning Advice Note 45, Annex 2, 2008

Appendix 1

Design Statement for Clyde Windfarm

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Please note that the references to other chapters/tables are not included within this guidance.

Design Strategy

1 Requirements for a 'design strategy' stem from national policy[1], and were reinforced in the scoping responses from the Royal Fine Arts Commission for Scotland and Scottish Natural Heritage. In addition, it has now become accepted best practice in the design of windfarms, to consider how the windfarm will relate to the landscape, its landform, scale and other landscape features.

2 The overall aim of the design strategy was to create a windfarm with a cohesive design that relates to the surrounding landscape. The inherent nature of turbines as bold, modern structures means that the form of the windfarm as a whole is important, and a strong, clear cut design strategy is necessary. The strategy therefore considered the appearance of the windfarm as an object or composition in the landscape as the primary factor in generating the layout.

3 The objectives of the design strategy were as follows:

- to produce a cohesive layout which would be legible in views from the surrounding landscape and be easy to understand;
- to develop a layout that reflects the landform and topography of the landscape;
- to develop a layout that seeks to match the scale of the turbines, and the scale of the overall development, with the scale of the landscape.

4 The background to the design strategy also included an examination of alternative patterns for the layout in relation to the topography.

Scope of the Strategy

5 The design strategy sets out the overall approach to the design development of the windfarm. Subsequent alterations to the layout were made in response to, for example, ecological, hydrological, archaeological and energy yield considerations, as well as to reduce visual impacts arising from these alterations. With the design strategy in place, however, these latter changes could be reviewed with an understanding of the appearance of the windfarm within the landscape.

6 The design strategy did not consider site selection, with the site already having been selected by Airtricity using their site selection methodology. The design strategy therefore focussed on considering layout options for the Clyde site in response to the site conditions. The design strategy did, however, influence the site boundaries of the development. Both extensions and reductions to the original site boundary were consequences of the implementation of the design strategy.

7 In the development of the designed layout, computer modelling was used as a tool to aid design. In particular, wireframes were generated for views from key locations around the site and photomontages produced for viewpoints used in the assessment of landscape and visual impacts (see **Chapter 6**).

8 The major development components considered in the design were turbines and deforestation/replanting. Forestry design issues have been progressed alongside this design strategy and are set out below.

9 Cumulative issues with other windfarms have not been considered as part of the design strategy, as the closest other, existing or known potential, windfarms are unlikely to be seen as part of the same windfarm, although some views from the surrounding area will include more than one development (see **Chapter 6**).

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1 Scottish Executive (2001) *Designing Places: A Policy Statement for Scotland.*

Topography

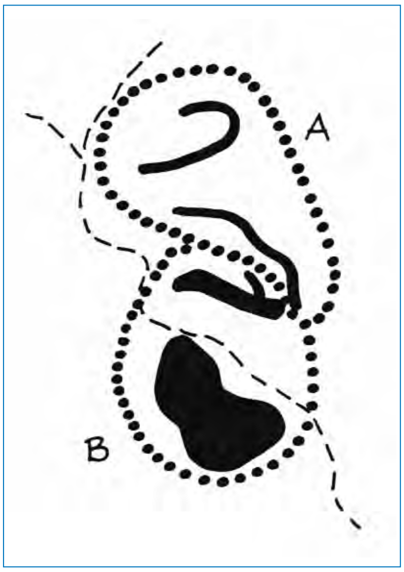
10 The general topography of the windfarm area is one of undulating hills of the Southern Uplands. Valleys divide the hills such that the site is not seen as a whole from valley locations. This has the effect that in views from much of the surrounding landscape, only part of the site is visible, and turbines will often not be seen in full, and are likely to be seen against the sky. The experience is very different in views from hill tops, where the full extent of the windfarm may be appreciable.

11 These different viewing conditions exclude options for layouts that are dependant on full visibility of most turbines. Instead, there are opportunities for different strategies for different parts of the windfarm that are not seen together in the same view.

12 The site can be divided into two parts that have different landform types. The design strategy that has been developed for each of these is described below.

Sketch 1: Topography of the site. The northern part of the site is made up of ridges, whilst more plateau-like areas lie to the south.

Sketch 2: Design approach A is used for the northern part of the site, and design approach B is used for the southern part of the site.

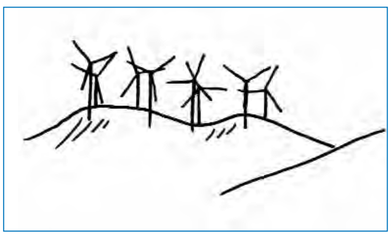


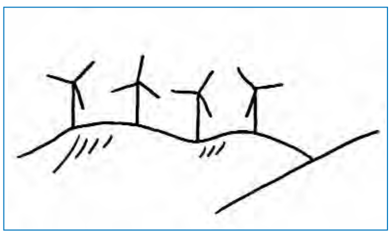
Design Approach A

13 The northern part of the site has many strong hill and ridge features to which the layout responds. In particular, the ridges of Ewe Hill to Hardrig Head, Tewsgill Hill to Rome Hill to Duncangill Head and Normangill Rig to Yearnhill Head and Hare Cleuch Head form strong topographic features. Lady Cairn, Rodger Law, Harleburn Head, Pin Stane and Clyde Law form a broader area with spurs to the north (for example Mid Hill), and therefore form an area of transition to plateau.

14 This overwhelming characteristic of the landform has been used as the basis for the design in this part of the site. At the scoping stage, a layout with many more turbines along the ridges and down the slopes was used as an initial layout, but this was found to be unsuitable given the lack of clarity of the relationship with the local topography. Visual analysis of the scoping layout further confirmed that the layout should be designed as lines of turbines that related more closely to the ridges.

15 Another design option placed double rows of turbines on the ridges, but this was found not to result in a clear reflection of the ridges in views from the surrounding area. The strategy adopted was therefore *to place single lines of turbines along the ridges, with closer spacing and centred upon the ridges*. The visual effect of this is that the hubs of the turbines reflect the profile and topography of the landform when viewed from the surrounding area. In view of the transition from single ridges to broader plateau, design approach B was used for Lady Cairn to Clyde Law.



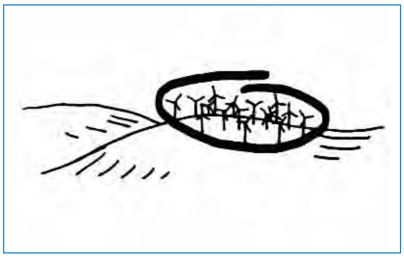


Sketches 3 and 4: A double line of turbines hides the profile of a ridge, while a single line relates to it.

Design Approach B

16 Across the southern part of the site, immediately north of the M74, and the whole area to the south of the M74, the topography is less distinct than the northern part, and there is broad undulating moorland without distinct ridges.

17 The design principles applied for the northern part of the site were found to be unsuitable for this part of the site, given that they are developed for more distinct landform types. An alternative layout, based on a grid was also found to be unsuitable, given the smooth contours and irregular plateau form when seen from viewpoints around the area. For this part of the site, therefore, the strategy was *to develop groupings, using the subtle ridges to orientate them*.



Sketch 5: A group of turbines on an undulating plateau.

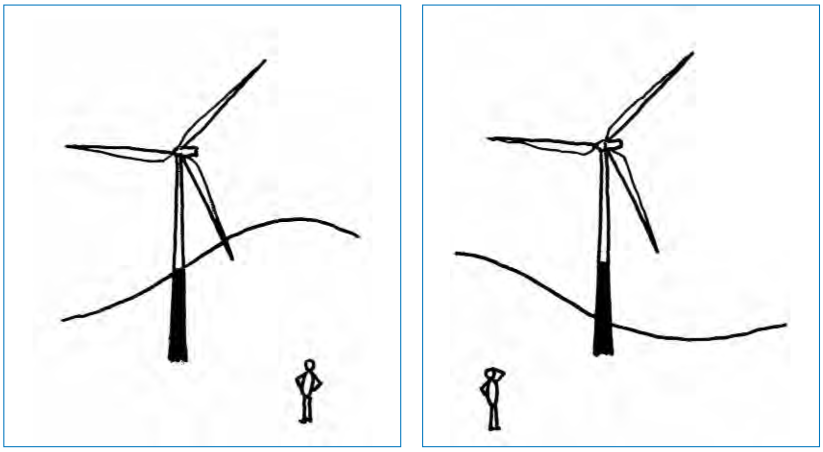
Infrastructure

18 Alternative designs for the substation buildings were considered in the design of the windfarm. Should the Scottish Executive be minded to grant consent for the windfarm, a detailed architectural design brief for the substations will be drawn up. This will consider the relative design merits of both traditional buildings (for example, with a slate pitched roof and painted roughcast walls, in the style of existing local farmhouses) versus a more modern design, which more closely reflects the function of the buildings.

19 The access tracks that serve the turbines have been routed so as to follow the ridge tops wherever possible. This is to minimise their visibility in the surrounding landscape. Where tracks cannot follow ridges, they follow other features such as existing farm tracks, valleys, or field boundaries wherever possible.

20 The grid connection for the windfarm does not form part of this application for consent. However, the design strategy for the windfarm aims to avoid the potentially confusing design impacts of additional pylons in the site area, by supporting the underground routing of the grid connection.

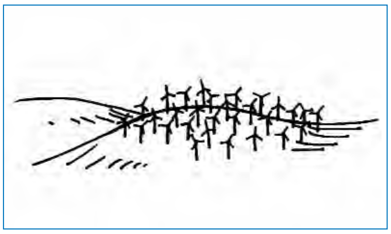
21 The colour of turbines and transformers has been considered, and it is judged that a non-reflective pale grey should be used for all elements. This is because it would not be possible to use other colours for the lower parts of towers (where they are seen against the land rather than against the sky), or turbines in forested areas, for any one viewing angle, without increasing the impact on other views. In addition, the introduction of more than one colour would reduce the overall visual coherence of the windfarm.



Sketches 6 and 7: Bicoloured turbines are difficult to match up with the horizon..

Scale

22 Larger numbers of smaller turbines compared with smaller number of larger turbines would generate similar yield but have different grouping and visual impacts. A comparative analysis confirmed that greater numbers of smaller turbines have broadly similar ZVIs to fewer larger turbines. However, the greater number of smaller turbines would result in more frequent 'bunching' or 'overlapping' of turbines in views from the surroundings. This 'bunching' or 'overlapping' adversely affected the design objective of reinforcing ridgelines. As a consequence, it was concluded that larger turbines (and fewer) was preferred.



Sketches 8 and 9: Comparison of small and large turbines.

Outcome

23 The application layout is based on the design strategy described above. In particular, the strategy seeks to create a design that reads coherently with the landscape, and is not reliant on arbitrary boundaries that are not present in the landscape (i.e. the site or administrative boundaries).

24 The layout also considers issues of energy yield and incorporates further changes resulting from mitigation of other impacts (see **Table 3.1** below). As a consequence of these other factors, consistent spacing of the turbines has not always been possible along the full length of some ridges. Whilst this may be noticed in some views from the surrounding landscape, on the whole, it is judged that the development will appear to relate to the topography, and that the design objectives have not been compromised.

Modifications to Scheme Design

25 As a consequence of the EIA process, there have been a number of modifications to the design to avoid and minimise environmental impacts without compromising the overall design strategy. These are set out fully in **Table 3.1** below and have included the relocation or removal of turbines, access tracks, borrow pits and associated infrastructure to:

– comply with the overall design strategy;

– reduce visual impacts from key viewpoints;

– increase distances between development components and watercourses;

– avoid key habitats of nature conservation interest;

– increase distances from bird breeding locations;

– reduce noise impacts on residential properties;

– avoid Scheduled Ancient Monuments (SAMs) and other areas of archaeological interest;

– minimise transport impacts;

– remove turbines from the MOD's low fly zone;

– avoid the lines of sight for telecommunications installations.

To illustrate the extent of change, the scoping, baseline and assessment layouts are included as **Appendix 3.2**.

Appendix 2

GLOSSARY

Ancillary infrastructure	The built elements and structures of a windfarm, apart from the turbines, which serve the development, such as access tracks, borrow pits, the control building and substation.
Anemometer mast	A mast erected on a windfarm site, usually the same height as the turbine hubs, to monitor wind speed.
Broad Area of Search	Area(s) to be specified by a Planning Authority within their Spatial Framework for Windfarms where proposals are likely to be supported, subject to specific proposals satisfactorily addressing all other material considerations.
Borrow pit	A quarry within a windfarm site excavated to provide stone for site infrastructure.
Capacity Study	Research which attempts to identify the acceptable limits to development in a given area.
Decommissioning	The process by which a windfarm is dismantled and the site restored.
Design Statement	A document which records the design process that is undertaken for a development.
EIA	Environmental Impact Assessment, the process by which the identification, prediction and evaluation of the key environmental effects of a development are undertaken, and by which the information gathered is used to reduce likely negative effects during the design of the project and then to inform the decision-making process.
European Landscape Convention	Also known as the Florence Convention, the ELC promotes the protection, management and planning of European landscapes and organises European co-operation on landscape issues. It is the first international treaty to be exclusively concerned with all dimensions of European landscape.
LCA	Landscape Character Assessment, a documented process which describes and categorises the landscape, highlighting key landscape characteristics and the main forces for change.
LIA	Landscape Impact Assessment, part of the LVIA process which explores the potential effects on the landscape of a proposed development (see below).
LVIA	Landscape and Visual Impact Assessment – a standard process for examining the landscape and visual effects of a development.
Micrositing	The movement of wind turbines by small distances within the overall windfarm layout, either at the design or construction stages of development.
NSA	National Scenic Area – area designated for its outstanding scenic value and beauty in a national context.

PAN	Planning Advice Notes provide advice on good practice and other relevant information, e.g. PAN45 on Renewable Energy Technologies.
Planning Authority Spatial Frameworks	Frameworks set out in Development Plans by the Local Authority, supported by broad criteria, for the consideration of windfarm proposals over 20 megawatts.
Strategic Locational Guidance (SLG)	SNH Policy Statement which sets out a number of principles that should guide the location of onshore wind farm projects so as to minimise effects on the natural heritage. Provides broad overview at a Scottish level of where, in natural heritage terms, there is likely to be greatest scope for windfarm development, and where there are the most significant constraints.
SPP	Scottish Planning Policy. A statement of Scottish Government planning policy on nationally important land use and other planning matters, supported by a locational framework, e.g. SPP6 focusses on 'Renewable Energy'.
VIA	Visual Impact Assessment, part of the LVIA process, which considers potential changes that arise to available views in a landscape from a development proposal, the resultant effects on visual amenity and people's responses to the changes.
ZTV	Zone of Theoretical Visibility – a mapped visualisation of the areas over which a development can theoretically be seen.

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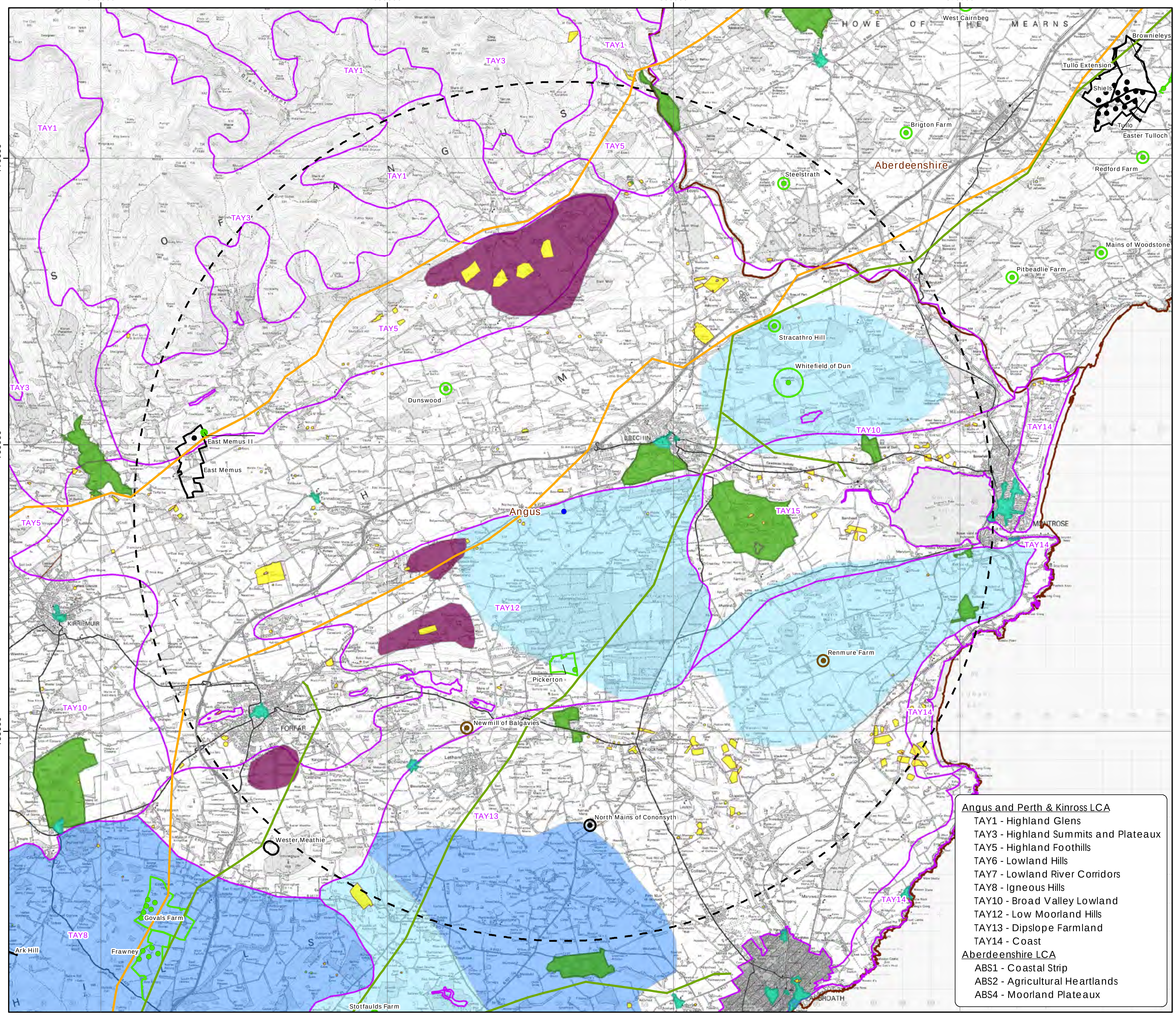
ITEM 12



Netherton Wind Turbine

Polar Energy (Netherton) Ltd

Figure 1 - Landscape Character, Setting and Constraints

Key
- Turbine location
- 15km turbine buffer
- 132 kV transmission line
- 275 kV transmission line
- Scheduled Monument
- Hill Forts (indicative area)
- Conservation Area
- Garden or Designed Landscape
- Landscape Character Areas

Cumulative Wind Farms (above 50m tip)
- Wind farm at appeal
- Approved wind farm
- Operational wind farm
- Turbine at appeal
- Approved turbine
- Operational turbine

Wind Energy Landscape Capacity
(as defined in TLCA figure 6.1)
- No Capacity
- Low Capacity
- Medium Capacity
- Urban

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0 1.25 2.5 5
Kilometres

N

Scale @ A3:
1:125,000

09/10/2014 TL01c 4611/LS/016a
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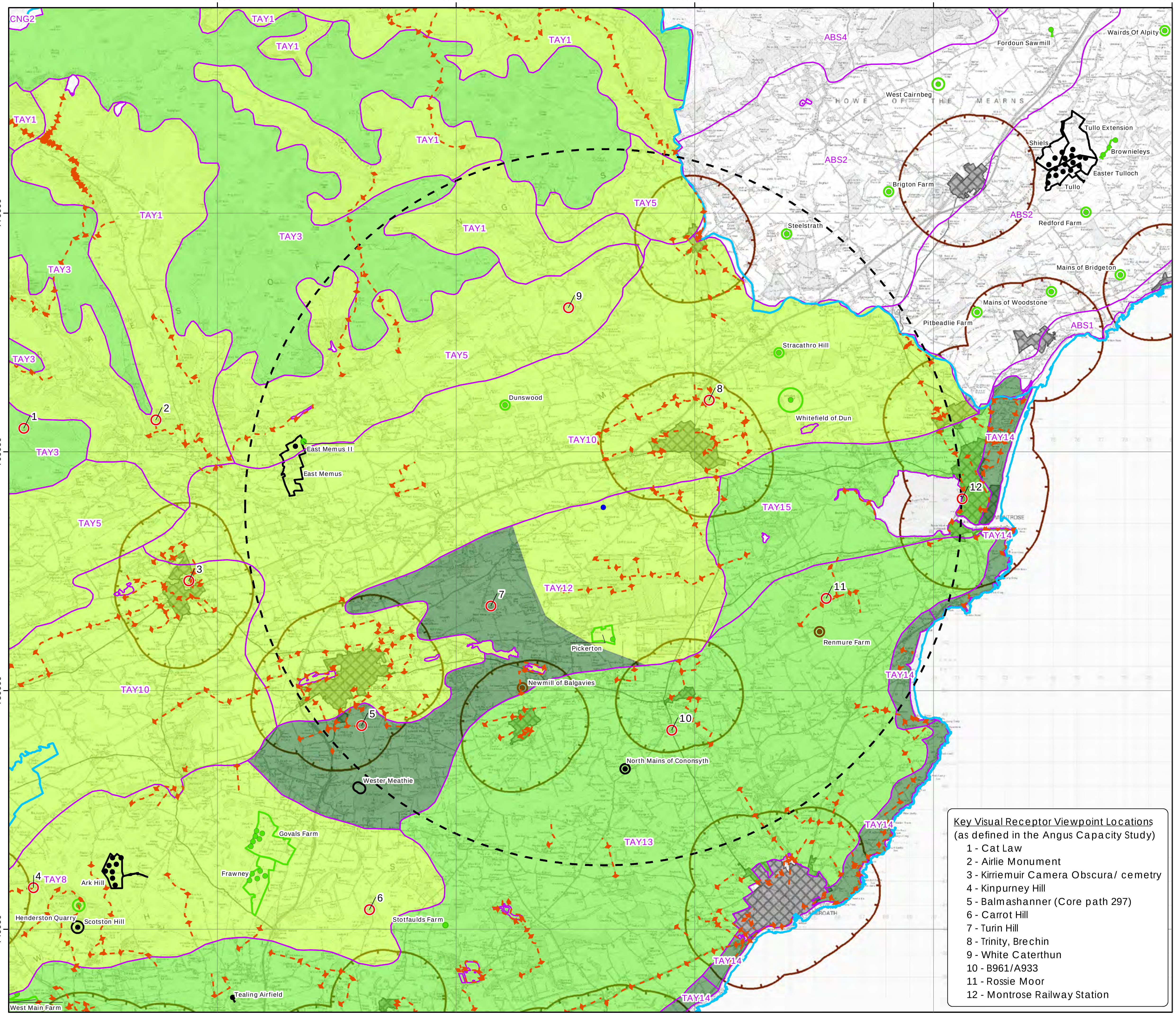

Netherton Wind Turbine

Polar Energy (Netherton) Ltd

Figure 2a
Visual Sensitivity as defined in the Angus Wind Farms Capacity Study

Key
- Turbine location
- 15km turbine buffer
- Key Visual Receptor Viewpoint Locations (as defined in the Angus Capacity Study)
- SNH Corepaths
- County boundary
- Landscape Character Areas
- General Register of Scotland Settlements
- 2km settlement buffer

Visual sensitivity
(Angus Wind Farms Capacity Study)
- Medium
- Medium - High
- High

Cumulative Wind Farms (above 50 m tip)
- Wind farm at appeal
- Approved wind farm
- Operational wind farm
- Turbine at appeal
- Approved turbine
- Operational turbine

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0 2.5 5 10
Kilometres

N

Scale @ A3:
1:150,000

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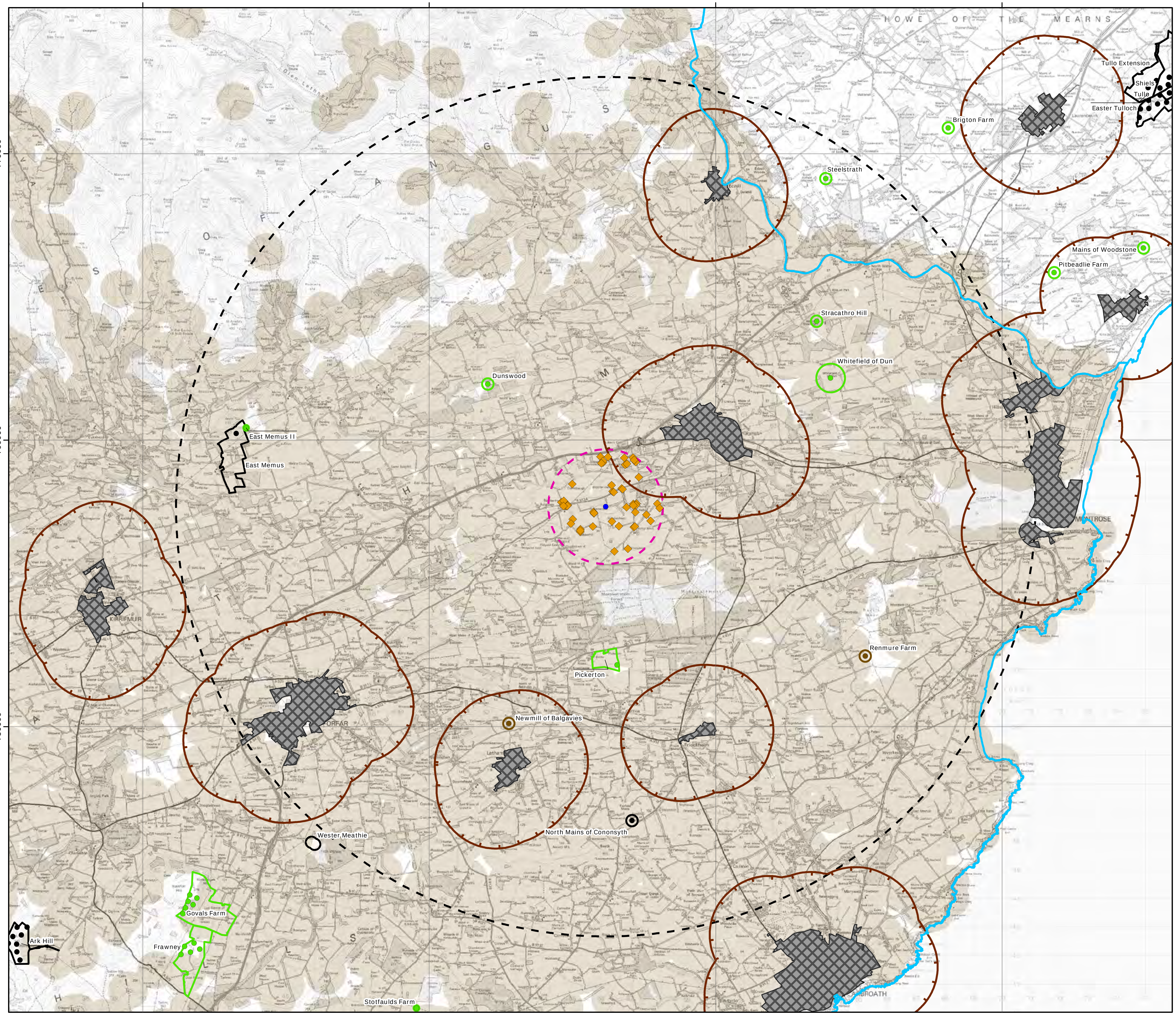

Netherton Wind Turbine

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Figure 2b
Residential Amenity

Key

- Turbine location
- 2km turbine buffer
- 15km turbine buffer
- Building (contains no information on building use)
- 650m building buffer (contains no information on building use)
- General Register of Scotland Settlements
- 2km settlement buffer
- County boundary

Cumulative Wind Farms (above 50m to tip)

- Wind farm at appeal
- Approved wind farm
- Operational wind farm
- Turbine at appeal
- Approved turbine
- Operational turbine

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0 1.25 2.5 5
Kilometres

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Scale @ A3:
1:125,000

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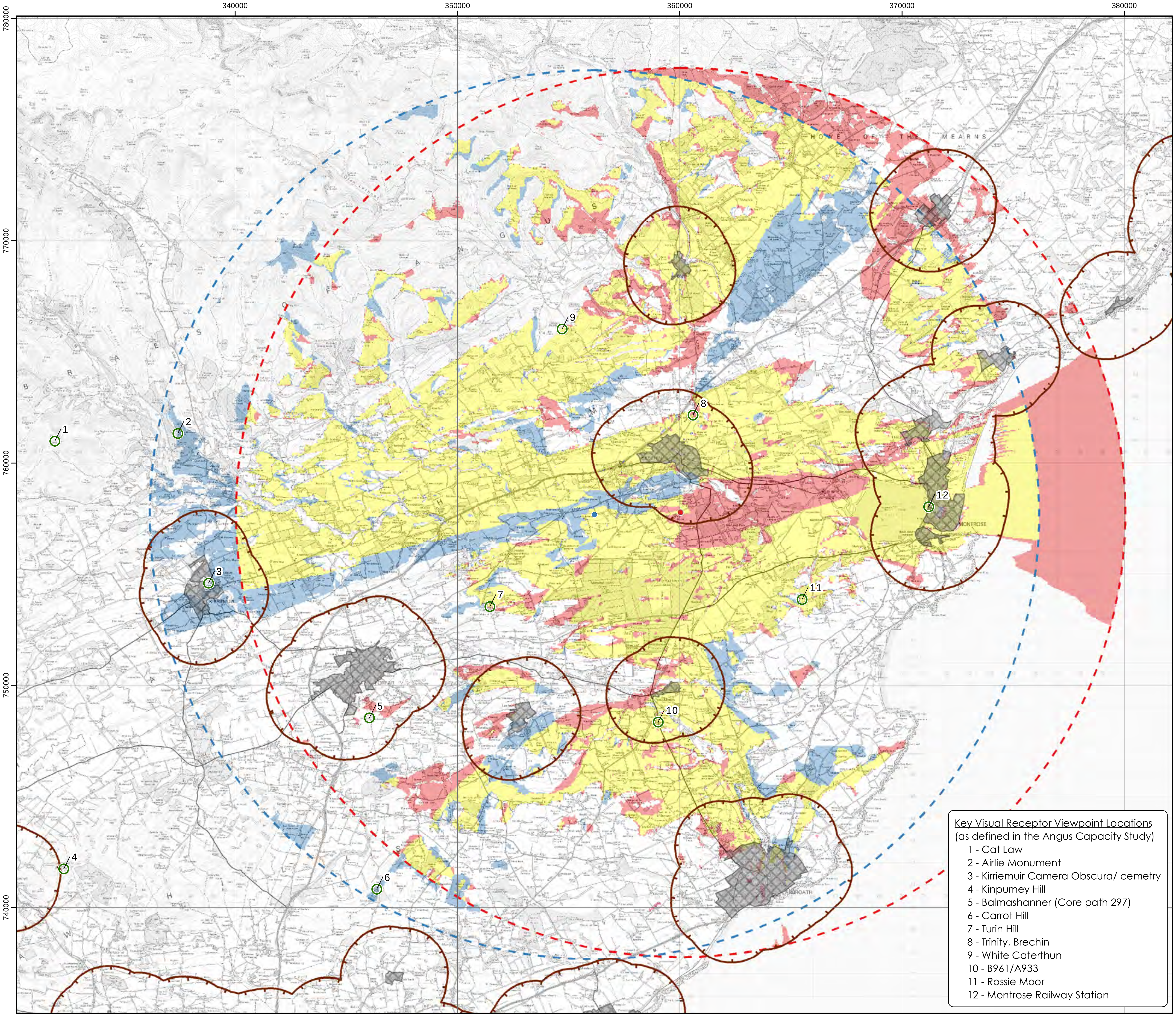
Netherton Wind Turbine

Polar Energy (Netherton) Ltd

Figure 3
Cumulative ZTV - In planning - Netherton with East Drums



Key

- Netherton turbine (67m)
- Netherton 20km turbine buffer
- East Drums turbine (67m)
- East Drums 20km turbine buffer
- Key Visual Receptor Viewpoint Locations (as defined in the Angus Capacity Study)
- General Register of Scotland Settlements
- 2km settlement buffer

East Drums
Netherton

Generated using Ordnance Survey's Terrain50 dataset which does not take in to account the screening effects of buildings or vegetation.

ZTV calculated using ArcGIS 10.1 Viewshed tool with observer eye height 2m above ground and corrections for earth curvature and atmospheric refraction applied.

Distance of ZTV calculations based on SNH guidelines

Up to 50m tip - 15km	51 to 70 m tip - 20 km
71 to 85 m tip - 25 km	86 to 100 m tip - 30 km
101 to 130 m tip - 35 km	131 to 150 m tip - 40 km
Above 150 m tip - 45 km	

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0 2.5 5
Kilometres

N

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1:160,000

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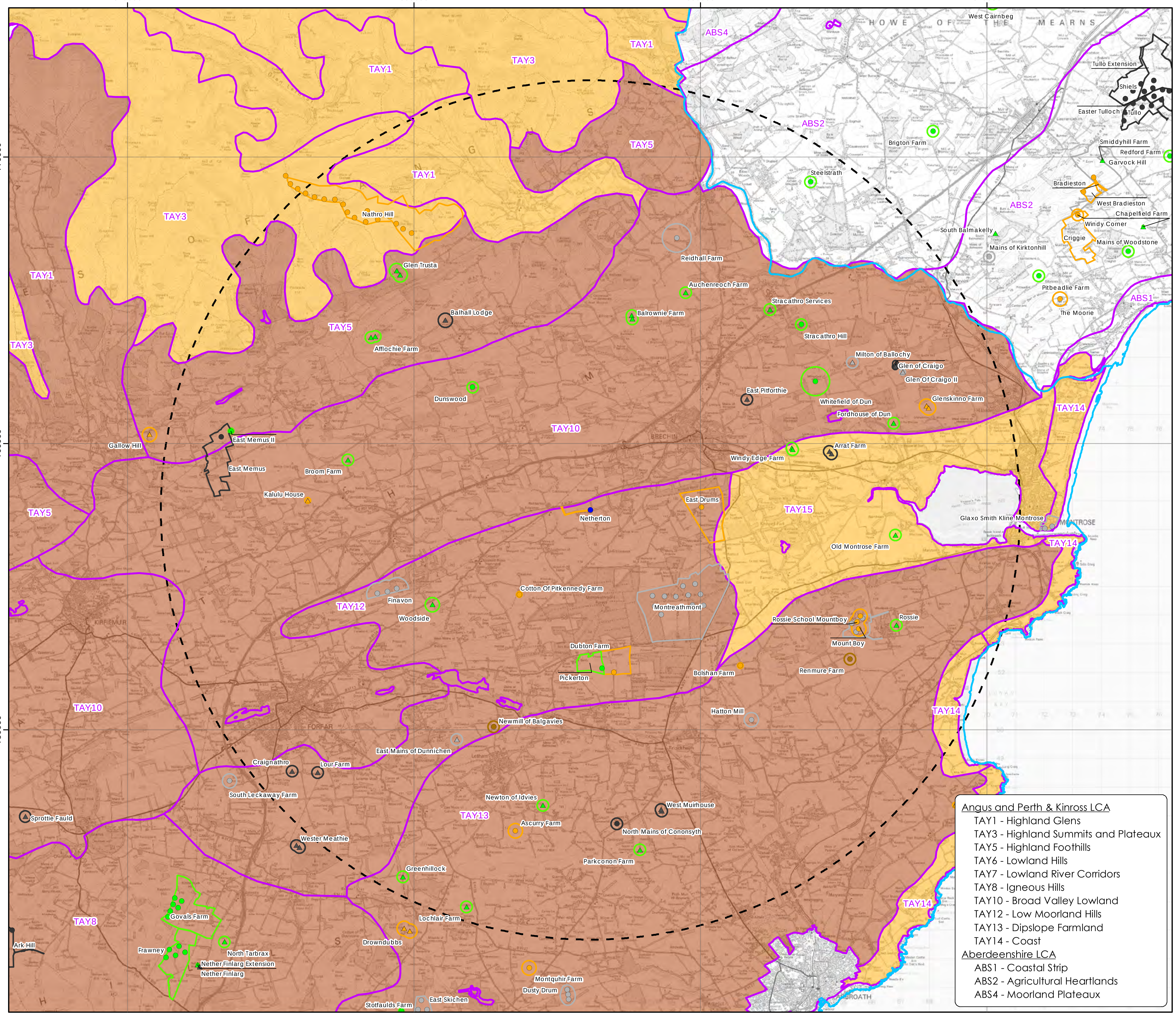

Netherton Wind Turbine

Polar Energy (Netherton) Ltd

Figure 4 – Levels of Acceptable Landscape Character Change (as defined in the Angus Implementation Guide)

Key

- Turbine location
- 15km turbine buffer
- Landscape Character Areas
- County boundary

Cumulative Sites

- Wind farm in planning
- Turbine at appeal
- Refused wind farm
- Approved wind farm
- Operational wind farm

Cumulative Turbines above 50m

- Turbine in planning
- Turbine at appeal
- Refused turbine
- Approved turbine
- Operational turbine

Cumulative Turbines sub 50m

- Turbine in planning
- Turbine at appeal
- Refused turbine
- Approved turbine
- Operational turbine

Levels of Acceptable Landscape Character Change (as defined in the Angus Implementation Guide)

- Landscape with views of Wind Farms
- Landscape with occasional Wind Farms

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0 1.25 2.5 5 Kilometres

N

Scale @ A3: 1:125,000

09/10/2014 TL01c 4611/LS/022a

Drawn by: JM Checked by: TH Approved by: NT

ITEM 16

4611

Netherton Wind Turbine Appeal

14/00281/FULL Netherton Wind Turbine

Polar Energy (Netherton) Ltd

11 December 2014

Contents

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Document Prepared For

Polar Energy (Netherton) Ltd

Document Prepared By

Nike Thompson
Consultant
nike.thompson@atmosconsulting.com

Document Approved By

Philip Lewis
Regional Director
philip.lewis@atmosconsulting.com

Version	Date	Reason
V1		Submission to Angus Council

1 Introduction

This Notice of Review is submitted by Polar Energy (Netherton) Ltd, West Cairnbeg Farmhouse, Laurencekirk, Aberdeenshire, AB30 1SR. It relates to planning application reference 14/00281/FULL validated on the 18th of April for the erection of a single wind turbine of 40m to hub height and 67m to blade tip and ancillary development, situated on a field 200m northeast of Balnacake Farm, Aldbar, Brechin. This application was refused on 5th December 2014 and this notice of review has been prepared for submission to the Local Review Body.

Atmos Consulting Ltd (Atmos) is acting for Polar Energy (Netherton) Ltd in this review. Please send all relevant materials to us. Our contact details are:

Philip Lewis, Regional Director, Atmos Consulting Ltd, Rosebery House, 9 Haymarket Terrace, Edinburgh, EH12 5EZ philip.lewis@atmosconsulting.com

This report sets out the applicant's reasons for requiring the review, which we wish to be undertaken by written representations and a site visit. The documents and materials which we rely upon are included in this submission.

2 Planning

2.1 Background

The application subject to this request for review is for a single wind turbine (67m to tip) with an installed capacity of 500kW and therefore is a Local Development as defined in The Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009.

The route of determination for the planning application was confirmed by the Planning Case Officer at Angus Council who intimated to Atmos Consulting during a telephone correspondence that the application would be determined by delegated powers.

The Netherton turbine planning application, 14/00281/FULL, which was due to be determined initially by Angus Council by 17 June 2014 was eventually refused on 5 December 2014 for the following reason:

That the proposed turbine by virtue of its height and location close to the top of the escarpment which separates the Low Moorland Hills and the Broad Valley Lowland would result in unacceptable landscape and visual impacts and as such the proposal is contrary to policies ER5, ER34 and S6 of the Angus Local Plan Review (2009).

It is noted that there are two pending applications within 5km of the Netherton proposal. One is a single turbine application (East Drums, Planning application reference 14/00110/FULL) approximately 3.9km east of the proposed Netherton application with similar dimensions and the other a medium sized turbine of 45.9m tip height at Bellahill Melgund at 4.1km to the south-west. Within the range of 5km, there is one operational small-medium size turbine of 20m tip height at 3.1km at Melgund Muir.

2.2 Description of Development

The proposed development would comprise a single three-bladed horizontal axis wind turbine up to 67m tip height, with a rated output of 500kW. The development includes all associated infrastructure including a control building, underground cabling, crane hardstanding, new and upgraded access tracks and temporary laydown area. The scheme design is shown on Planning Application Figure 1-1.

In total, approximately 0.6ha of land would be needed for the development. The proposed turbine is designed to have an operational life of 25 years at the end of which it will be decommissioned.

2.3 Site Description

The proposed turbine is located at NGR 356161, 757678 on part of Balnacake Farm on land which is currently used for agriculture. The site lies approximately 6km southwest of Brechin and approximately 12km northeast of Forfar.

There are no properties located within 400m of the proposed turbine location. The closest property is the financially involved Balnacake residential property approximately 450m southwest of the proposed turbine location. The closest non-residential property is a derelict building opposite Broomknowe Cottages approximately 570m northeast of the proposed turbine location.

River South Esk (designated as a Special Area of Conservation (SAC)) flows approximately 780m north of the proposed turbine location. There are no other designated areas for natural heritage within 5km of the site. The closest SSSI to the site is the Montrose Basin SPA/SSSI/Ramsar approximately 10km to the east of the site designated for its non-breeding bird assemblage.

The closest operational wind turbine is a 20m tip high turbine approximately 3.1km south at Melgund Muir. At Guthrie Hill site, 5.6km to the south there is a 77m tip high single operational wind turbine.

The closest wind energy sites currently in planning to the proposed Netherton turbine are at Cotton of Pitkennedy Farm (74m tip) and East Drums (67m tip) approximately 3.8km southwest and 3.9km east.

2.4 Project History

2.4.1 Site Selection

The opportunity for onshore wind energy development at a significant scale is very limited in Angus due to the current policy steer away from the Highland or Coastal areas and the various technical and environmental constraints which exist within the Lowland region.

The proposed Netherton Wind turbine is located within the Low Moorland Hills character type (subtype-Montreathmont Moor). This area is identified in the Council's guidance as having a medium capacity for small/medium (15 to 30m tip) and medium (30 to 50m tip) turbine schemes and a low capacity for medium to large (50m to 80m) (Windfarms Landscape Capacity and Cumulative Impacts Study Ironside Farrar, 2008)[NDPP03]. This is demonstrated on Figure 1 of this submission.

This LCT extends to cover much of its surrounding context up to 5km to the east, 10km to the west and 7.5km to the south. However, further analysis of the LCT within Angus Council's SLCA, defines "*two clearly different subtypes: the lower, flatter and significantly afforested Montreathmont Forest and Moor and surrounding farmland to the east of Turin Hill and north of Guthrie and the area of widely separated steep sided Low Moorland Hills in rolling farmland to the west, surrounding the east and south sides of Forfar*".

The proposed turbine is located within sub landscape character area (LCA) ii) Montreathmont Moor. Here the character is defined as distinctly different in character from the Forfar Hills sub area. The SLCA notes that:

"*The landform is predominantly gently undulating and gradually slopes down to the lower Montrose Basin LCA to the east. There are no distinctive hill landforms, although the northern edge forms an escarpment of some 100m descending to the River South Esk. It is a medium to large scale farming and forestry landscape dominated by Montreathmont Forest which is a distinctively large mature lowland forest dominated by coniferous planting. It is well populated by scattered properties and farmhouses in the farmland areas outside the forest, with a network of small roads.*"

The summary of landscape capacity and sensitivity is defined in the SLCA. It notes that "parts of the Low Moorland Hills have capacity for small groups of larger turbines up to 80m" This includes the proposed site, which lies within a defined area (Figure A of SLCA) which has the highest underlying capacity in Angus for wind energy development. This stretches from the sites context to the south across area 3) Montreathmont Forest and farmland to the south of Brechin. The capacity study defines these areas as having "the capacity to accommodate larger sizes of turbine and/or greater numbers and concentrations relative to other areas of landscape in Angus"

The landscape sensitivity of this sub LCT to change is considered to be Medium in the SLCA, with the simple topography, medium to large scale rectilinear pattern and extensive commercial forestry making it an area of a Medium to Low Landscape Character sensitivity. Views within are often screened by mature coniferous forestry although the area is highly visible from higher ground within and surrounding it giving it a Medium Visual Sensitivity.

The Forfar Hills sub-type of the Low Moorland Hills LCT lies at around 5km to the west. It has a much more complex and "varied landscape of small steep hills and ridges set within a wider area of medium scale rolling/undulating farmland". This sub area also has "higher visual sensitivity and complex, modest scale landforms compared with the sub-area further to the east". The SLCA note that it is of medium-high landscape sensitivity to wind energy development.

The site selection process and the detailed work undertaken for the application have confirmed the site is suitable for a wind turbine development because it meets the following criteria:

- A high predicted annual mean wind speed across the site;
- Available grid connection to the site;
- Suitable road access;
- The site itself does not support any international or national, ecological, landscape or cultural heritage designations; and
- The site can accommodate the development without significantly affecting the current agricultural operations.

The proposed turbine and associated infrastructure layout of the development is the result of detailed consultation, technical and environmental surveys and assessment work. The proposed development has evolved in order to avoid, reduce or mitigate potential effects as far as reasonably practicable and to address matters raised by the planning authority. Specific environmental and technical drivers have been:

- Landscape character and visual amenity;
- Proximity to noise sensitive receptors;
- Presence of watercourses, private water supplies and related infrastructure;
- Presence of cultural heritage features;
- Proximity to woodland; and
- Presence of power lines, pipelines and telecommunication links.

2.4.2 Planning Application Responses

The application was validated on 18th April 2014 and subject to the usual consultation processes.

All statutory consultee responses to application 14/00281/FULL were positive, with no objections raised as confirmed in the report of handling [REF NP08]. The consultation responses are set out below in Table 1.

Table 1: Summary of Consultation Responses to Planning Application 14/00281/FULL

Consultee	Date	Comment
Angus Council (Roads)	12/05/14	No objection. Recommendations made on conditions to be followed if consent is granted.
Atkins	22/04/14	No objection in relation to UHF Radio Scanning Telemetry communications.
Archaeology	23/04/14	No archaeological mitigation is required.
CAA	13/05/14	No comments. Refer to general guidance.
Dundee Airport	22/04/14	No objection. Proposal will not infringe the safeguarding surfaces for Dundee Airport at its given position and height.
Historic Scotland	30/04/14	No comments to make. The council should proceed to determine the application without further reference to them.
Joint Radio Company (JRC)	25/04/14	No objection. The proposal is cleared with respect to radio link infrastructure operated by Local Electricity Utility and Scotia Gas Networks.
Ministry of Defence (MOD)	07/05/14	No objection.
NATS	22/04/14	No safeguarding objection to the proposal
RSPB	05/05/14	No specific comments to make. Post construction monitoring linked to some form of cumulative impact assessment should be carried out.
Scottish Natural Heritage (SNH)	22/04/14	No comments. The proposal falls below threshold for consultation as outlined in their service statement for Planning and Development.
Spectrum Licensing	03/05/14	One link identified for Mobile Broadband Network Limited as Agent of Everything Everywhere and Hutch.

These consultation responses are collated and submitted with this notice of review [REF NPA04].

The Council Landscape Officer commented on 18th August 2014 that the visual and landscape effects of the proposal would be significant taking sensitive areas within the LCA, residential impacts and cumulative impacts with the proposed East Drums turbine into account. This was not an objection to the proposal however.

There were no public comments uploaded to the Angus Council's planning website objecting to application 14/00281/FULL as confirmed in the report of handling.

3 Planning Context

3.1 Development Plan

The planning application includes a review of relevant planning and energy policy as set out in Chapter 3 of the EA. The planning policy context for these documents has not changed to any significant effect since the application was submitted and in the interests of brevity, they will not be repeated in full in this appeal statement.

In terms of the assessment of the application under Section 25 of the Town and Country Planning (Scotland) Act 1997, the proposed Netherton Wind Turbine is situated within Angus where the current Development Plan comprises:

- TAYplan-Strategic Development Plan' approved 2012 [REF NDPP01]; and
- Angus Local Plan Review adopted in 2009 [REF NDPP02].

The Tayplan, approved in June 2012, includes Policy 6: Energy and Waste/Resource Management Infrastructure. Policy 6 relates to the aim of delivering a low/zero carbon future for the city region to contribute to meeting Scottish Government energy targets and indicates that, in determining proposals for energy development, consideration should be given to the effect on off-site properties, the sensitivity of landscapes and cumulative impacts. Policy 6 does not add any new assessment criteria to the existing Angus Local Plan Review policies and it is contended that the Local Plan Review wind and renewable energy policies should be the starting point in the determination of the application.

The Angus Local Plan Review dates from 2009 and was prepared in the context of SPP6 (predating the present SPP). The key Local Plan policies are 'Policy ER34 Renewable Energy Developments' and 'Policy ER35 Wind Energy Developments'. These specific policies relating to renewable energy and onshore wind development should be the starting point in the assessment of the application. 'Local Plan Policy ER34' sets out that proposals for all forms of renewable energy development will be supported in principle and will be assessed against a number of criteria. 'Local Plan Policy ER35' sets out that wind energy proposals must meet the requirements of Policy ER34 above and must also demonstrate that a number of criteria are met. Policy S6 Development Principles (Schedule 1) sets out that proposals for development should where appropriate have regard to the relevant principles set out in Schedule 1 which includes reference to amenity considerations; roads and parking; landscaping, open space and biodiversity; drainage and flood risk, and supporting information.

Policy ER5 states that Development proposals should have regard to the Landscape Character of the local area as set out in the Tayside Landscape Character Assessment (SNH 1998).

The Planning Authority has refused this application stating that it is contrary to policies ER5, ER34 and S6 of the Angus Local Plan Review (2009) therefore a discussion of the application against the criteria in the key local plan policies is set out below.

3.1.1 Policy ER34 Renewable Energy Developments

Policy ER34: Renewable Energy Developments states the following:

"Proposals for all forms of renewable energy development will be supported in principle and will be assessed against the following criteria:

(a) the siting and appearance of apparatus have been chosen to minimise the impact on amenity, while respecting operational efficiency;

(b) there will be no unacceptable adverse landscape and visual impacts having regard to landscape character, setting within the immediate and wider landscape, and sensitive viewpoints;

(c) the development will have no unacceptable detrimental effect on any sites designated for natural heritage, scientific, historic or archaeological reasons;

(d) no unacceptable environmental effects of transmission lines, within and beyond the site; and

(e) access for construction and maintenance traffic can be achieved without compromising road safety or causing unacceptable permanent and significant change to the environment and landscape."

The first criterion (a) sets out a broad balancing exercise between the benefits of a renewable energy proposal and potential environmental effects, through minimising the impact upon amenity whilst respecting operational efficiency. The determination of the application therefore should include an assessment of the benefits against any harm caused.

In respect of the other criteria, the plan does not define what 'unacceptable' means and it is therefore a matter of judgement for the decision maker, as to whether the proposal complies with this policy and the criteria. It would not be correct however to equate potential significant environmental effects of a proposal as assessed in the EA process to be 'unacceptable' as the EA process in itself is not concerned with the acceptability or otherwise of a project overall. A further discussion of this is set out in the residential amenity section of this statement.

In terms of criterion (a), it is clear that the application has been designed so as to balance potential effects on amenity with the generation of renewable energy, with careful design end embedded mitigation so that the application as proposed will not give rise to unacceptable effects.

Criterion (b) is concerned with landscape and visual effects. These have been considered fully in the application submission in Chapter 5 of the EA and this statement in Section 4.

In respect of criterion (c) it is demonstrated in the application that the proposal will not give rise to unacceptable effects upon the natural environment or the historic environment (EA Chapters 6, 7 and 8) and it is noted that there are no objections to the application from consultees concerned with these matters.

The grid connection for the wind development site will require consent under Section 37 of the Electricity Act 1989 which is the subject of a separate consenting process and therefore, criterion (d) is not considered relevant.

The site access can be easily achieved without significant adverse effects and will not compromise road safety (EA Chapter 12). Transport consultees have no objections to the proposal.

3.1.2 Policy ER35: Wind Energy Development

Wind energy developments must meet the requirements of Policy ER34 and also demonstrate:

(a) the reasons for site selection;

This is set out in section 2.3.1.

(b) that no wind turbines will cause unacceptable interference to birds, especially those that have statutory protection and are susceptible to disturbance, displacement or collision;

It is demonstrated in the EA that the proposal will not have significant effects upon ornithology. There is no objection from statutory consultees in this regard.

(c) there is no unacceptable detrimental effect on residential amenity, existing land uses or road safety by reason of shadow flicker, noise or reflected light;

The EA considers the potential effects of the development on residential amenity, existing land uses or road safety by reason of shadow flicker, noise or reflected light and the development has been designed so as to minimise potential effects.

Potential effects upon residential amenity are considered further in this submission. As stated above, there are no issues with the scheme in respect of road safety.

In terms of shadow flicker (considered in Chapter 9 of the EA), there's one residential property located within 540m of the proposed turbine (10 x rotor diameter) and a shadow flicker assessment was carried out in line with the web based guidance (Scottish Government,2011). Assuming a worst case scenario, no more than 30 minutes of shadow flicker is predicted to occur at the identified property in any one day. These predicted worst case effects do not exceed the guidance limits. The EHO's consultation response on 23rd May 2014 [REF NPA04] requested that additional shadow flicker calculations were carried out to a 1km radius. This was done and the results were presented to show that there were no unacceptable impacts from shadow flicker predicted on any residential properties within 1km of the proposed scheme. In any event, significant shadow flicker impacts are capable of being addressed by way of a planning condition.

The EA in Chapter 4 sets out the results of the noise assessment for the application. It is concluded in the EA that the operational noise from the turbine will not exceed the quiet daytime or night-time noise level limits at any receptor. There are no known wind turbine schemes, either operational, in planning or at a scoping stage, which could impact on the calculated noise immission levels at the identified NSRs. The effect of cumulative noise impacts has, therefore, not been considered within the assessment. The EHO requested for additional information and questioned the data used in the noise assessments on 23rd May 2014 [REF NPA04]. A response letter to the EHO's comments along with the additional information requested for was submitted on 11th June 2014 [REF NPA07]. Correspondence with the planner confirmed that the EHO was satisfied with the responses received and had no further queries. The proposal therefore meets accepted standards for wind farm noise both on its own and cumulatively.

(d) that no wind turbines will interfere with authorised aircraft activity;

The potential effect of the proposal upon aviation interests is considered in the EA in Chapter 10 where no significant issues were identified. This has been confirmed by the consultation responses where no objections are raised.

(e) that no electromagnetic disturbance is likely to be caused by the proposal to any existing transmitting or receiving system, or (where such disturbances may be caused) that measures will be taken to minimise or remedy any such interference;

The proposal was designed following consultation with communications link operators in order to design out the potential for disturbing communication links. A JRC objection was received during the pre-planning stage consultation and further correspondence with JRC and site design taking all their links into account led to them withdrawing their objection [REF NPA04]. No objections have been made by link operators to the application. This is not an issue for the determination of the application.

(f) that the proposal must be capable of co-existing with other existing or permitted wind energy developments in terms of cumulative impact particularly on visual amenity and landscape, including impacts from development in neighbouring local authority areas;

The EA considers potential cumulative effects of the proposal with other wind energy development in the area and concludes that the proposal would be acceptable in this regard. This matter is considered further in the landscape section of this statement.

(g) a realistic means of achieving the removal of any apparatus when redundant and the restoration of the site are proposed.

The decommissioning of the scheme is discussed in Section 2.6 of the EA, which sets out details of potential decommissioning of the scheme. This matter can be dealt with by way of suitable planning conditions.

3.1.3 Policy ER5: Conservation of Landscape Character

Development proposals should take account of the guidance provided by the Tayside Landscape Character Assessment and where proposals will be considered against the following criteria:

- *Sites selected should be capable of absorbing the proposed development to ensure that it fits into the landscape;*
- *Where required, landscape mitigation measures should be in character with, or enhance, the existing landscape setting;*
- *New buildings/ structures should respect the pattern, scale, siting, form, design, colour and density of the existing development; and*
- *Priority should be given to locating new development in towns, villages or building groups in preference to isolated development.*

The EA in chapter 5 addresses all the relevant criteria above in Section 5.5.1 and concludes that the effects on the landscape and its characteristics would be limited in extent and significance. Where they do occur they are limited to the immediate open, farmland on the north side of Montreathmont Moor LCA, within 2km and then transitional fringes slopes connected with the Broad Valley Lowland within 3-4km between the A90 and Brechin. At these points the turbine would provide an intermittent focus, but would not dominate the underling balance of elements in the Strath landscape, with a range of other tall built influences in this section of the strath sides. As a result, there would be no adverse effect on the wider scale, focus, integrity or setting of key features in the surrounding landscape and it would not, be out of scale with other elements in the landscape. This is further discussed in Section 4.5 and 4.8.1 of this report.

3.1.4 Policy S6: Development Principles (Schedule 1)

The points noted in the report of handling relate to Amenity which states the following:

- *The amenity of proposed and existing properties should not be affected by unreasonable restriction of sunlight, daylight or privacy; by smells or fumes; noise levels and vibration; emissions including smoke, soot, ash, dust, grit, or any other environmental pollution; or disturbance by vehicular or pedestrian traffic; and*
- *Proposals should not result in unacceptable visual impact.*

Chapter 5 of the EA reviews residential amenity and concludes that the visual change as a significant effect in principal views from property would, therefore, be experienced by a relatively small number of people. When considered together, in line with GLVIA to help reach an overall conclusion on the community as a whole, the overall extent of effect on residential amenity is not considered to be significant. This is further discussed in Section 4.7 of this report.

3.1.5 Compliance with the Development Plan

It can be seen therefore from the above assessment that the proposal does not conflict with the specific policies of the local plan for the determination of wind energy applications.

3.2 Other Material Considerations

Relevant to the determination of the application are the Angus Windfarms Landscape and Cumulative Impacts Study 2008 [REF NDPP03] which has informed the Implementation Guide for Renewable Energy 2012 [REF NDPP04] which has been prepared as supplementary guidance to the Local Plan Review policies ER34 and ER35.

The Implementation Guide identifies the area as having scope for turbines circa 80m in height which do not disrupt the principal ridgelines or adversely affect the setting of important landscape features monuments such as Balmashanner Monument and Finavon and Turin hillforts. The proposed development has been designed with this guidance in mind and it is demonstrated in the application and appeal documents that it does not conflict with this guidance.

3.3 Benefits

As stated above, the assessment of the application in the context of local plan review policies requires a balancing exercise to be undertaken between the potential benefits and harm that the application may cause.

The proposal also needs to be considered in the context of climate change and renewable energy policy as set out in Section 3 of the EA.

3.4 Key Determining Issues

In terms of Local Plan Review Policies S6, ER5, ER34 and ER35, the above assessment and documents referenced it is demonstrated that the proposal clearly complies with the various assessment criteria set in the policies in contrary to the response provided in the report of handling.

The key issues raised in the refusal response relate to:

- Potential landscape and visual effects; and
- Potential effects upon residential amenity.

These are considered below in Section 4.

4 Landscape and Visual Matters

4.1 Introduction

This section looks at the key issues related to landscape and visual matters in line with the comments by the case officer, the Council Landscape Officer (CLO) and information provided in the report of handling which accompanied the refusal decision on the 5th of December 2014 and provides responses to the issues raised.

This statement should be read in conjunction with the Landscape and Visual Impact Assessment (LVIA) that formed part of the Environmental Appraisal (EA) [REF NPA02] submitted in support of the planning application for the proposed development provided in April 2014. This statement will briefly:

- summarise the LVIA process undertaken to date;
- summarise the conclusions of the LVIA;
- comment upon the key issues relating to landscape and visual matters including residential amenity; and
- draw conclusions as to the acceptability of the landscape and visual effects.

4.2 The LVIA process undertaken to date

Scoping for the LVIA was undertaken in August 2013. The assessment methodology, representative viewpoint locations and the potential cumulative wind farm sites to be included in the LVIA were agreed with SNH and Angus Council during this process.

The LVIA was prepared by a Chartered Landscape Architect in accordance with best practice methodologies including Guidelines for Landscape and Visual Impact Assessment (GLVIA), 3rd edition, 2013 [REF NLV01]. The key distinction between this edition and preceding editions, is the greater importance on professional judgement, emphasising the need for well-argued narrative text to assess whether an effect is significant or not, with tables and matrices to support this judgement. The LVIA and Cumulative LVIA (CLVIA) also draws on other sources of information, listed in the references at the end of the report.

The LVIA and CLVIA were based on baseline information available at the time of writing. A LVIA was submitted as part of the EA in support of the application.

4.3 Landscape Related Responses to the application

The Council Landscape Officer commented on the application on 18th August 2014 [REF NPA04] stating that "*Due to the exposed location of the site and it close vicinity to the escarpment slope above the River South Esk Valley, both visual and Landscape effects of the development would be significant. The scale of the proposed development would have adverse effects on the landforms of the low Moorland Hills and their northern escarpment. Although large areas of the low Moorland Hills can accommodate large to medium-large turbines, the escarpment is one of the most sensitive areas within the LCA.*

For views from within Strathmoor, from Brechin and views from within the Low Moorland Hills the turbine would create a dominant visual focus with strong skyline effects and no *back-clothing. The turbine would adversely affect several scenic landscape views over the South Esk River Valley from within the less frequented area of the Low Moorland Hills, and also skyline views of the Moorland Hills from receptors at further distance such as Brechin, with a high number of residents that would be exposed to these views of the turbine.*

The turbine would have a cumulative relationship with the turbine at East Drums if the latter was consented, however the adverse visual and landscape effects would mainly arise from the development proposed at Balnacake, regardless of cumulative effects. However if the proposed turbine at Balnacake was consented, the advantages of grouping visual and landscape effects where they are already established would increase the chances for the development proposed at East Drums Farm to be considered favourably in terms of Landscape and Visual Impact."

A response was sent to the council [REF NPA05] on 20th August with the summary below addressing all the points raised by the CLO in his response.

"*Although the proposed turbine lies close to the escarpment slopes that define the northern edge of the Low Moorland Hills LCA at Montreatmont Moor, the Netherton turbine has been set back and sensitively scaled, to restrict clear visibility from the nearest sensitive areas. It is therefore in line with the key determining issues defined in the current SLCA guidance for avoiding domination of the landscape character and of views from residential properties. Although some effects are anticipated, they are fairly localised and they are not considered to result in an unacceptable level of change on the wider landscape and visual resource*".

During a telephone conversation with the application case officer on 15th September 2014, it became apparent that the officers were minded to refuse the application based on unacceptable landscape and visual impacts and cumulative impacts with the nearby East Drums scheme currently in planning and also undetermined. In light of this, a cumulative ZTV was prepared and sent to the Council on 16th September 2014 [Ref NPA06]. The aim of this was to show that the Netherton proposal does not have a more prominent ZTV over larger sensitive landscape areas (like the Montrose Basin area). A response was received from the Council on 18th September 2014 [Ref NPA06] noting that the figure which was sent via an online portal was inaccessible and had to be attached to an e-mail or sent on a disk. The mail also stressed the CLO's conclusions relating to significant landscape and visual impacts of the proposal. The conclusion of the mail was that the proposal was considered to have significant landscape impacts and would be contrary to policies ER34 and ER35 of the Angus Local Plan review 2009 (ALPR). Advice was given that the application could not be supported and should be withdrawn within 7 days.

The comments from the planner regarding the landscape impacts of the proposal as detailed in [Ref NPA06 and Ref NPA07] and responses to the comments can be seen below:

Planners Comment:

Due to the exposed location of the site and it close vicinity to the escarpment slope above the River South Esk Valley, both visual and landscape effects of the development would be significant.

Appellants Response:

The site would lie close to the escarpment slopes. However, the potential for notable clear views at points where Key Sensitive Receptors are present would be fairly limited. The site location would also sit within an area defined in the SLCA as having the highest underlying capacity in Angus.

Planners Comment:

The scale of the proposed development would have adverse effects on the landforms of the Low Moorland Hills and their northern escarpment. Although large areas of the Low Moorland Hills can accommodate large to medium-large turbines, the escarpment is one of the most sensitive areas within the LCA.

Appellants Response:

The turbine would lie at a point where the low moorland hills are flat topped within the Montreathmont Forest sub area of the Low Moorland Hills LCT. As a result it would lie at a separate point away from context and setting of the distinctive hill slopes and landforms within the more sensitive sections of the Forfar Hills sub area of the Low Moorland Hills LCT which lie to the west.

Planners Comment:

For views from within Strathmoor, from Brechin and views from within the Low Moorland Hills the turbine would create a dominant visual focus with strong skyline effects and no back-clothing. The turbine would adversely affect several scenic landscape views over the South Esk River Valley from within the less frequented area of the Low Moorland Hills, and also skyline views of the Moorland Hills from receptors at further distance such as Brechin, with a high number of residents that would be exposed to these views of the turbine.

Appellants Response:

Views within Strathmore where Key Sensitive Receptors are present would be generally limited to more distant points. This includes isolated fringe points of Brechin and open farmland to the north. Although visibility would be clear at these points the turbine would be seen in the context of other tall features and urban fringe elements in the view to the southwest.

We do not agree with the comments made on the effects of scenic landscape views over the South Esk River Valley. It is also not clear where the "less frequented areas of the Low Moorland Hills" are. The basis of any LVIA should consider who will view and pause to appreciate the view. If it is from a remote section of the landscape where nobody is likely to go to appreciate the view then the effects cannot be considered to be significant. This necessarily should include appraisal of receptor value, susceptibility and sensitivity along with frequency. Where views of the South Esk valley are more clearly available and appreciated, they are from the lower north side of the turbine where the turbine would sit beyond the context of the view, substantially to the rear of intervening escarpment slopes

Planners Comment:

The turbine would have a cumulative relationship with the turbine at East Drums if the latter was consented, however the adverse visual and landscape effects would mainly arise from the development proposed at Balnacake, regardless of cumulative effects. However if the proposed turbine at Balnacake was consented, the advantages of grouping visual and landscape effects where they are already established would increase the chances for the development proposed at East Drums Farm to be considered favourably in terms of Landscape and Visual Impact.'

Appellants Response:

We do not agree that adverse visual and landscape effects would mainly arise from the development proposed at Balnacake, regardless of cumulative effects. The East Drums site sits on the east slope of the Low Moorland Hills and will be prominent in skyline views over more sensitive landscapes across Montrose basin. This includes the more sensitive Principal Geographic Area along the Coast, which the Angus Windfarms Study considers to be most sensitive to wind farm developments. It also includes the adjacent Kinnaird Park GDL. As the C-ZTV also demonstrates there are clear zones of separate visibility with Netherton to the North and East Drums to the East.

Planners Comment:

The landscape character of the location of the site is generally considered an area with no capacity for turbines of this size. Although the Montreatmont Moor area is generally considered to have the capacity to accommodate medium-large and large turbines, the escarpment towards the South Esk River Valley is not considered to have a capacity for turbines of this size.

Appellants Response:

The proposal is located within Tay12- Low Moorland Hills LCT as shown on Figure 5-2 in the EA and within sub-type 12a. The Landscape Capacity Study report [NDPP03] clearly states that the landscape sensitivity of this area is medium to low and also confirms that overall the Lowland Forest and Farmland area subtype (Tay 12a) has a medium to high capacity for windfarm development due to forest cover and extensive area with little habitation. The report also points out that Tay-12b which refers to the Low Moorland Hills sub-type adjacent to the proposed turbine has a low capacity for windfarm development.

4.4 Landscape Character and Setting

The effects on the landscape resource were considered by the Appellant, in the EA in Chapter 5. It assessed the effects on elements of landscape fabric, landscape character and the landscape setting of important features were assessed. The conclusions found that:

- Both the scale of the turbine proposed and its location, within the Montreathmont Forest and Moor LCA are both appropriate;
- While it would introduce a wind turbine element into the open farmland on the north side of the forest area and would be seen from the nearest section of the adjacent strath, it would largely form a modest built element which is comparable to other tall built elements in this section of the landscape and would be seen against a large simple pattern of topography and landcover elements;
- The location and character of the receiving environment, has the ability to accommodate this change with a reasonable effect on the wider landscape and visual resource, whilst limiting the potential for effect from more valued, low lying settled areas and more remote highland areas to the north; and
- Whilst there will be acknowledged changes in the local landscape, these will be completely reversible and temporary given the turbine's anticipated life span.

4.5 Tayside and Angus Wind Farm Guidance and the Acceptability of the Landscape Effects

The proposed wind turbine would be located within the Low Moorland Hills LCT (Montreathmont Moor LCA). This expansive LCT extends to cover most of the immediate landscape context, principally to the south. It is therefore the LCT most directly susceptible to the effects of the proposal.

As the ZTVs submitted as part of the planning application (Figures 5-3 to 5-4) indicate, there would be high theoretical visibility from the host LCT within 3-4km, extending across open farmland to the north of Montreathmont Forest. This is clearly focused on the local LCA of Montreathmont Moor, with notable forest cover screening visibility from wider sections of the LCA to the south.

While there would be some isolated points of extended visibility from hill summits to the west, the opportunity for notable visibility would be limited within the more sensitive sub LCA of the Forfar Hills area and its more complex, modest scale and distinctive characteristics. As a result there would be limited potential for notable effects on the landscape characteristics of this LCA and sub area of the Low Moorland Hills LCT.

Where the turbine would be visible, it would typically be seen across the open, gently undulating farmland and against a simple palette of medium to large scale characteristic elements within an expansive lowland area. While it would provide a notable new element in the immediate context along the north side of this LCT, and across the escarpment descending to the River South Esk "*the simple topography, medium to large scale rectilinear pattern and extensive commercial forestry*" as noted in the SLCA, all help to accommodate the profile of the turbine. It would, therefore, not be out of scale with the nature of its setting and would not fundamentally alter the balance of landscape characteristics within the wider context of the LCT. Nor would it notably affect the more sensitive visual points of the LCT or their setting, including the defined viewpoints at Finavon Hill, Angus Hill layby and Turin Hill, as noted in the SLCA.

The magnitude of change on the characteristics of the LCT is therefore considered to be Medium within 2km to the south and Low to Negligible elsewhere. When combined with a baseline sensitivity of Medium for the landscape the Montreathmont LCA, the extent of effect on the Montreathmont LCA is judged to be Moderate in EIA terms within 2km. Elsewhere, and from the adjacent Forfar Hills LCA, the extent of effect would be Minor to Negligible, with no significant effect on the general scale, simplicity and wider pattern of key characteristics of moderate value.

These tie in with the sensitivities and capacities noted in the SLCA and the guidelines which define the area as having "the highest underlying capacity in Angus for wind energy development" with " the capacity to accommodate larger sizes of turbine (up to 80m) and/or greater numbers and concentrations relative to other areas of landscape in Angus.

The assessment concluded that effects on the landscape and its characteristics would be limited in extent and significance. Where they do occur they are limited to the immediate open, farmland on the north side of Montreathmont Moor LCA, within 2km and then transitional fringes slopes connected with the Broad Valley Lowland within 3-4km between the A90 and Brechin. At these points the turbine would provide an intermittent focus, but would not dominate the underling balance of elements in the Strath landscape, with a range of other tall built influences in this section of the Strath sides. As a result, there would be no adverse effect on the wider scale, focus, integrity or setting of key features in the surrounding landscape and it would not, be out of scale with other elements in the landscape.

For these reasons, it is considered that the proposed turbines would be in scale with the nature of their setting and would comply with relevant policy and guidance for development in this location.

4.6 Visual Resource

The extent of effects on the visual resource was considered in the EA Chapter 5. The conclusions found that:

- Geographically, the extent of significant visual effect is relatively low, being restricted to isolated points within 1-2km;
- In EIA terms, there would be significant effects of Moderate to Major, at just one viewpoint at White Myre to the south. Moderate significant effects were noted from three viewpoints. One from a minor road as it passes the site, one from an isolated stretch of the a local core path and the third from a point on the approach to isolated residential properties on the north side of Brechin, with no significant effect on the key focus of views from within the property anticipated. No significant effects are predicted on key receptors at the remaining six viewpoints assessed; and
- When considered together in line with GLVIA to help reach an overall conclusion on the level of significance on all relevant key receptor groups "*by aggregating properties as a way of assessing the effect on the community as a whole*", the overall effect on visual amenity is not considered to be significant. This is due to the relative sensitivity of the site context within the lowland area, the dispersed nature of receptors, as well as the size and location of the turbine within it

Given the above conclusions, the proposal would not give rise to unacceptable adverse impacts due to the limited effects and therefore complies with Policy ER34(b).

4.7 Residential Amenity

Comments relating to residential amenity in the notice of review are covered here.

The LVIA presented in the EA Chapter 5 considered the assessment of effects on residential amenity is an additional measure of visual effect, which can be related to LVIA. The usual approach to establishing the level of effect on residential amenity is to define the key orientation and focus of principal views for each property (or group of properties) within 1-2km, as these are fixed, constantly available views with a greater degree of amenity or value attached to them. This is recognised in GLVIA (3rd edition) which describes the susceptibility (or sensitivity) to visual change as a function of "*the occupation or activity of people experiencing the view at a particular location and the extent to which their attention or interest may be focused on the view*".

GLVIA also addresses residential amenity as "*residents at home, especially using rooms normally occupied in waking or daylight hours, that are likely to experience views for longer than those passing through*". Views from other points away from the principal, constant focus, and within the wider curtilage or from the general approach to the properties would, therefore, be less susceptible, as these views are secondary or peripheral to the amenity value and at sequential or transitory points.

Given the dispersed nature of the settlement pattern within the site context, only a very small number of residents would experience any notable direct views of the proposed turbine in key views from their property. These are likely to be greatest from isolated points within 1-2km, principally to the south, where direct, level, open views are available. They include properties at Whte Myre (Viewpoint1), House View House, Wandersheill, Balnacake, within 1km and at further points, Blibberhill, Stonybrigs. It would also include an ascending partial view from Broomknowe Cottages to the north.

While there is also likely to be potential for some effect away from the principal aspect of houses, within the wider curtilage and general approach to the properties at other points within 2km including Chapel Cottage, The Old School House, Mains of Aldbar and then from the north at Broomknowe, Balnabreich, Wesr Kintrockat and the north side of Netherton, as demonstrated by the viewpoint assessment (VP9), within views from the closer points being more restricted by landform and vegetation screening the view. Elsewhere views would be restricted from most other settlement clusters at Aberlemno, Tannadice and within Brechin.

The visual change as a significant effect in principal views from property would, therefore, be experienced by a relatively small number of people. When considered together, in line with GLVIA to help reach an overall conclusion on the community as a whole, the overall extent of effect on residential amenity is not considered to be significant. It is considered that no receptor would experience overbearing or dominating effects resulting from the development which would make them undesirable places to live.

Beyond these points the potential for notable visibility would be limited on property clusters and settlement, including Aberlemno and Tannadice and the main settlements of Brechin, Forfar and Kirriemuir. Where views are available at these further points, the turbine would be seen in more distant, peripheral expansive views alongside a range of other natural and built elements in the view. The effect from these more distant points would, therefore, not be significant.

4.8 Cumulative Matters

The cumulative assessment within the EA Chapter 5 considered the effects on the cumulative sites at the time of writing (in April 2014). The assessment results are presented below.

"Collectively, should all of the identified wind farms be built (Figure 5-15, REF NPA02), they would provide an intermittent built influence at elevated points in the surrounding landscape. The emerging focus of this pattern within 10-15km, lies at elevated points within or adjacent to the Strathmore area. They include key locations, on the elevated north strath slopes or higher Menmuir Foothills section of the highlands to the north. They also include the Muir of Pert to the east of Brechin and at isolated points within the Montreathmont Forest and Moor Area as shown in Figure 5-15 [REF NPA02]. This links in with the SLCA guidance for steering development in this area. The SLCA also notes that the site context has "the highest underlying capacity in Angus for wind energy development" with "the capacity to accommodate larger sizes of turbine (up to 80m) and/or greater numbers and concentrations relative to other areas of landscape in Angus;

As the ZTVs indicate (Figures 5-16a-b) [REF NPA02], the theoretical cumulative exposure of existing wind farm developments, will be varied. The four developments at Balhall Lodge, North Mains of Conosyth, Arrat Farm and East Pitforthie, will all be visible across the open farmland that surround the development site on the north side of Montreathmont Forest. Their visibility will also be, at times more extensive than the proposed turbine and stretch to more sensitive highland and lowland areas, including the coast and highland geographical areas. In addition there will be intervisibility across the Strathmore valley areas to the west of Brechin. The proposed turbine would therefore, rarely add to the existing extent of visual exposure and seldom provide a new defined element into the landscape resource. It would, however, sit at a sufficient distance from the nearest operational turbines, in excess of 7km, so as not to significantly change or alter the underlying balance of elements in the landscape and visual resource. The cumulative landscape and visual effect of the proposed turbine, in combination with other existing developments would not, therefore be significant, with no extensive visible overlap or complexity in developments from the vast majority of views in the surrounding landscape and only a moderately strengthened element locally;

When considered further with the consented schemes (Figures 5-17a-b)[REF NPA02], there would be higher potential for combined theoretical visibility with the two schemes at Dunswood and East Memus, with all three schemes visible across key sections of the Montreathmont Moor LCA and surrounding Strathmore valley along the Lower South and North Esk River Valleys. Combined theoretical visibility would then be reduced with the developments at Balrownie and Pickerton, given the more notable influences of intervening landform and landcover features. The proposed turbine would, therefore, contribute a modest addition to the pattern of individual wind turbine elements that sit at the upper strath slopes or just within the fringes of adjacent landscapes. The potential for notable change in the balance of characteristics and change in the nature of the view would again be limited though, given the broad, open context of the underlying landscape and clear separation of developments at a minimum of 6km.

This is evidenced by the cumulative wireframes, which demonstrates a clear separation of single wind turbine elements in expansive views along or across the strath landscape and cumulative views being successional rather than combined from the majority of places. The overall cumulative effect of the proposed turbine, in combination with other existing and consented developments is not, therefore, considered to be significant with no overlap, complexity or concentration in developments from the vast majority of the surrounding landscape.

There are then several further single turbine schemes in planning with one or two in the Montreathmont Moor LCA and several scattered at further elevated points of the Broad Valley Lowland along Strathmore. Of note to the development there would be a higher potential combined theoretical exposure with the developments to the south at Cotton of Pitkennedy Farm, Bolshan Farm. However, the potential for notable conflict in the local character of Montreathmont Moor and change in the balance and nature of views, with these turbines would be limited. This is due to the clear separation and focus of these developments within a landscape defined by "simple topography, medium to large scale rectilinear pattern and extensive commercial forestry".

The potential for additional effect on the landscape and visual resource arising from the proposed single turbine at Netheron, would not therefore be significant, with a clear separation to other developments, limited visual complexity and overlap and a *location which fits with both the emerging pattern of operational and approved development and is in accordance with the capacity guidance in the SLCA."*

The proposal itself, would not give rise to unacceptable adverse cumulative effects and complies with Policy ER34 (b) in this regard. This is due to the nature of the site setting and its compliance with the site specific guidelines

4.8.1 Level of Acceptable Landscape Character Change

Table 4 in ALPR sets out Angus Council's view on the level of acceptable landscape character change within the various landscape types. For the Montreathmont Moor LCA, the Acceptable Future Character is defined as "Landscape with Occasional Wind Turbines". The accompanying guidance for the Montreathmont Moor LCT states that "Turbines can be located in most parts of this undulating landscape; the farmland area or the forest, with the key determining issues being the need to avoid domination of the landscape character and of views from residential properties. The size of turbines should relate to the scale of the landscape, which is principally determined by the pattern of field boundaries and forestry but also by proximity to features such as buildings and small tree groups. To the north the escarpment above Strathmore forms a taller and steeper landform than elsewhere in the sub-area."

As noted above and demonstrated in the EA, while the turbine is close to the escarpment slopes it has been sensitively scaled and positioned to sit where the escarpment terrain flattens out across the more level Montreatmont Moor sub area of the Low Moorland Hills LCA. As a result the turbine would be set back from the main escarpment and the opportunity for clear or notable visibility would be restricted at most points directly to the north. At these points the turbine would be observed at varying points behind the escarpment slopes and extensive pattern of forestry plantation woodland. This has helped to positively screen most sections of the turbine from the key sensitive sections of the landscape within the South Esk valley directly to the north such that the turbine would not dominate or significantly impose upon the landscape character at these nearest points.

It should be noted that the landscape is defined as medium to large scale in the SLCA (not medium as asserted by the CLO). This includes the farming and forestry landscape areas of the Montreatmont Moor sub area. It is also defined at this point by "simple undulating landform with no distinctive hills" (REF NDPP03 – Table6.1f).

The turbine would, therefore, lie at a separate point away from more distinctive and prominent landform features along the northern boundary of the Low Moorland Hills LCA where it adjoins the Strathmore valley. These are found more clearly at further points to the west, within the separate Forfar Hills (12i) sub area of the Low Moorland Hills LCA. This is noted in the SLCA which states that this separate section of the LCA (Forfar Hills 12i) "has higher visual sensitivity and complex, modest scale landforms compared with the sub-area further to the east.

At this point within the Low Moorland Hills LCA the turbine would not, therefore, be out of scale with the nature of its setting and would not fundamentally alter the balance of landscape characteristics within the wider context of the LCA. It also ties in with the sensitivities and capacities noted in the SLCA.

The development site also lies within (albeit on the boundary of) an area defined in the SLCA as having the highest underlying capacity in Angus. The northern boundary of this area runs east to west across the Balnacake hillside and the through the development site. This is indicated on Figure 6.4 of the SLCA guidance [REF NDPP03].

From the more sensitive Lower South Esk sub area of the Broad Valley Lowland LCT the potential for clear visibility and effect on key defining characteristics is limited. The proposed turbine would be observed at varying degrees to the rear of the escarpment slopes that form an adjacent backdrop to this LCA and frequently at substantial points behind intervening forestry plantation. The turbine would not therefore be viewed from this neighbouring landscape "from most places" as asserted by the CLO "as comparable to those represented in VP3 but without the screening of the woodland". The turbine would, therefore, be observed within a separate section of surrounding landscape beyond the strath and importantly away from the focus and orientation of key characteristics within the strath farmland so as not to significantly impose on them. From the south side of the River Esk, where the key defining characteristics of the river corridor and its setting is more evident and appreciated more fully, the turbine would sit more substantially to the rear of the notable change in landform associated with the adjacent LCA.

4.9 Landscape and Visual Conclusions

It is considered that both the scale of the turbine proposed and its location, within the Montreathmont Forest and Moor LCA are both appropriate. While it would introduce a wind turbine element into the open farmland on the north side of the forest area and would be seen from the nearest section of the adjacent strath, it would largely form a modest built element which is comparable to other tall built elements in this section of the landscape and would be seen against a large simple pattern of topography and landcover elements. The location and character of the receiving environment, therefore, has the ability to accommodate this change with a reasonable effect on the wider landscape and visual resource, whilst limiting the potential for effect from more valued, low lying settled areas and more remote highland areas to the north.

Furthermore, whilst there will be acknowledged changes in the local landscape, these will be completely reversible and temporary given the turbine's anticipated life span.

5 Conclusions

There are no objections from key consultees to the Netherton application which is presented as a sensitively designed and located scheme which will not give rise to significant environmental effects overall.

The assessment of the application as set out in the application and this statement endorsed by consultee responses demonstrates that this is an acceptable form of development which complies with key development plan policies.

In terms of other material considerations, the proposal will give rise to various benefits as detailed in the application and accords with the locational guidance as set out in the Councils Implementation Guide.

The proposal is an acceptable form of development which both complies with the specific policies in the development plan for renewable energy proposals and is supported by other material considerations. The Local Review Body is respectfully asked to review the refusal decision taking all the information presented into account and approve the application.

Appendix A. Angus Council Scheme of Delegation

Extract from Angus Council Standing Orders – Scheme of delegation to officers

http://www.angus.gov.uk/ccmeetings/standingorders/StandingOrdersCouncil.pdf

6c. Head of Planning and Transport

The Head of Planning and Transport is authorised-

(1) In respect of the Council's Development Standards functions:-

(i) to approve planning applications, with the exception of:-

(a) applications defined as being National or Major;

(b) applications which attract five individual objections (i.e. excluding five letters of objections from an individual, individual household, or organisation);

© applications which are significant departures from the Development Plan which are recommended for approval;

(d) applications which attract objections from statutory consultees, including Community Councils;

© applications which are submitted by any Angus Council department or Division, or where Angus Council owns the land, subject to application or where Angus Council has a financial interest in the land;

(f) applications which are submitted by elected members of Angus Council, senior members of staff employed by Angus Council or those staff working closely with elected members; or

(g) applications that are subject to Environmental Assessment Regulations.

For the avoidance of doubt, planning applications for determination by the Head of Planning and Transport, will include:-

(a) the refusal of applications which are contrary to the Development Plan;

(b) applications attracting up to four individual letters of objection but excluding objections from Statutory consultees;

© applications which are not progressing satisfactorily due to protracted delays in the submission of essential information e.g. Retail assessments, traffic impact assessment, by the applicant or agent; or

(d) applications requiring a Section 75 Agreement of the Town and Country Planning (Scotland) Act.

Appendix B. Appeal Documents

Table 2: Appeal documents

REF	Documents
Planning application documents	
NPA01	Scoping opinion
NPA02	Planning application 14/00281/FULL
NPA03	Correspondence re determination of the application
NPA04	14/00281/FULL Netherton application consultation responses
NPA05	Response to CLO's comments
NPA06	Additional Information sent to council and response
NPA07	Response to EHO's request
NPA08	Decision letter and report of handling
Development plan and policy documents	
NDPP01	TAYplan-Strategic Development Plan' approved 2012
NDPP02	Angus Local Plan Review adopted 2009
NDPP03	Angus Windfarms Landscape and Cumulative Impacts Study 2008
NDPP04	Angus Council Renewable Energy Implementation Guide 2012
NDPP05	Angus Council Standing Orders
NDPP06	Representation to Angus Council 16/09/14
Landscape and visual	
NLV01	Landscape Institute/IEMA (2013). Guidelines for Landscape and Visual Impact Assessment, Spoon Press, 3rd edition.
NLV02	SNH (1999). Tayside Landscape Character Assessment. SNH Review No.122, LUC
NLV03	SNH (2002). Visual Assessment of Windfarms Best Practice, University of Newcastle. SNH Commissioned Report F01AA303A.
NLV04	SNH (2007). Visual Representation of Windfarms: Good Practice Guidance, SNH Commissioned Report F03AA3082.
NLV05	SNH (2002). The Strategic Locational Guidance for Onshore Wind Turbines in respect of the Natural Heritage, SNH Policy Statement No 02/02, updated 2009
NLV06	SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments
NLV07	SNH (2009) Siting and designing windfarms in the landscape

Figure list

Figure 1 – Landscape Character, Setting and Constraints

Figure 2a – Visual Sensitivity

Figure 2b – Residential Amenity

Figure 3 – Cumulative ZTV, East Drums and Netherton- overlay key receptors

Figure 4 – Levels of Acceptable Landscape Character Change