East Anglia ONE North Offshore Windfarm

Appendix 28.7

Offshore Windfarm Visibility

Preliminary Environmental Information
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Glossary of Acronyms

km	Kilometer
SLVIA	Seascape, Landscape and Visual Impact Assessment
USA	United States of America

Glossary of Terminology

Applicant	East Anglia ONE North Limited.
East Anglia ONE North project	The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia ONE North windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Construction, operation and maintenance platform	A fixed structure required for construction, operation and maintenance personnel and activities.
Horizontal directional drilling (HDD)	A method of cable installation where the cable is drilled beneath a feature without the need for trenching.
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land, and connect to the onshore cables.
Met mast	An offshore structure which contains metrological instruments used for wind data acquisition.
Monitoring buoys	Buoys to monitor in situ condition within the windfarm, for example wave and metocean conditions.
Offshore cable corridor	This is the area which will contain the offshore export cable between offshore electrical platforms and landfall jointing bay.
Offshore development area	The East Anglia ONE North windfarm site and offshore cable corridor (up to Mean High Water Springs).
Offshore electrical infrastructure	The transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall..
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall, these cables will include fibre optic cables.
Offshore infrastructure	All of the offshore infrastructure including wind turbines, platforms, and cables.
Offshore platform	A collective term for the construction, operation and maintenance platform and the offshore electrical platforms.
Platform link cable	Electrical cable which links one or more offshore platforms, these cables will include fibre optic cables.
Safety zones	A marine area declared for the purposes of safety around a renewable energy installation or works / construction area under the Energy Act 2004.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.

28.7 Offshore Windfarm Visibility

28.1 Introduction

1. There are a number of factors that influence the degree to which the East Anglia ONE North windfarm site would be visible and how this is defined and assessed. These are set out in the following sections.

28.2 Visibility Range

2. The Met Office sets out definitions for the different ranges of visibility on its website at https://www.metoffice.gov.uk/guide/weather/symbols#visibility ranging from 'very poor' to 'excellent' as follows:

- Very poor visibility - range is less than 1 km;
- Poor visibility - range is 1 to 4 km;
- Moderate visibility - range is 4 to 10 km;
- Good visibility - range is 10 to 20 km;
- Very good visibility - range is 20 - 40 km; and
- Excellent visibility - range is over 40 km.

3. This suggests that the East Anglia ONE North windfarm site would require 'very good' or 'excellent' visibility conditions for it to be visible from the Suffolk, south Norfolk and Essex coastline.

4. The assessments made in the SLVIA are based on optimum viewing conditions with clear visibility of the turbines and as such assess the 'worst case' or maximum visual effect in optimum or 'excellent' visibility conditions.

5. It is reasonable to conclude that the prevailing visibility and weather conditions combine to reduce the duration and potential for significant effects to periods when clear views of the East Anglia ONE North windfarm site are available. In views from the land visibility would often be limited to the nearer rows of turbines, and the full depth of the East Anglia ONE North windfarm site would often not be seen or would be less visible.

6. Whilst this 'visibility' analysis is a useful indicator, other factors such as contrast (largely influenced by lighting by the sun) scale, orientation and movement of the structures also need to be considered when determining the likely impact of optimum visibility at a certain range.

28.3 Offshore Wind Turbine Visibility

7. There has been some informative research undertaken relatively recently by a group based in the USA. This is entitled Offshore Wind Turbine Visibility and

Visual Impact Threshold Distances (2012) and is based on fieldwork and reporting of observations carried out in the UK in relation to a number of offshore windfarms located in the Irish Sea and the English Channel.

8. The study observed that 'Past assessments of offshore wind turbine visibility were based on smaller turbines and facilities in use at the time and underestimate the visibility for current projects, which use more and larger turbines.'

9. The objectives identified for the study 'included identifying the maximum distances the facilities could be seen in both daytime and night-time views and assessing the effect of distance on visual contrasts associated with the facilities.'

10. It should be noted that the study does not attempt to assess whether such potential visibility would be significant or not but instead provides a useful aid to ascertaining the likely potential for visibility and the magnitude of change at various distances.

11. As referred to in the study there is a trend towards the development of larger turbines and groups of turbines, which has continued since 2012. The study was based on offshore windfarms of 25-140 turbines of heights ranging between 107m and 153m tall. Some of the findings are helpful, particularly in relation to turbine lighting.

12. The effect of turbine distance to ratings of visibility (measured between 1 and 6 within the study) provides a useful gauge to potential visibility of large-scale offshore windfarms. Although it is noted that 'Caution is warranted because of the relatively small number of observations' it found that in relation to moderately sized offshore wind facilities analysis of the visibility rating data indicated the following:

> '*a gradual drop-off in ratings with distance; the change is non-linear, perhaps because of variability in lighting, contrast of the wind turbines with the background, facility size and layout, blade orientation and rotation rate, and various other factors the affect visibility of real landscape/seascape settings.'*

13. It should be noted that the reference to lighting above is to light from the sun rather than from artificial sources.

14. Reference is made to a graph within the study, which shows the 'relationship between distance and the visibility rating for all daytime assessments, regardless of weather and atmospheric conditions.' The graph shows that at distances of between 22 and 30km the rating of visibility (of moderately large offshore windfarms) was found to be between levels two and four (mainly between levels two and three) which are defined and described as follows:

- 'Visibility level 2. Visible when scanning in the general direction of the study subject: otherwise likely to be missed by casual observers.
    - Description: an object/phenomenon that is very small and/or faint, but when the observer is scanning the horizon or looking more closely at an area, can be detected without extended viewing. It could sometimes be noted by casual observers; however, most people would not notice it without some active viewing.
- Visibility level 3. Visible after a brief glance in the general direction of the study subject and unlikely to be missed by casual observers.
    - Description: An object/phenomenon that can be easily detected after a brief look and would be visible to most casual observers, but without sufficient size or contrast to compete with major landscape/seascape elements.
- Visibility level 4. Plainly visible, so could not be missed by casual observers, but does not strongly attract visual attention or dominate the view because of its apparent size, for views in the general direction of the study subject.
    - Description: An object/phenomenon that is obvious and with sufficient size or contrast to compete with other landscape/seascape elements, but with insufficient visual contrast to strongly attract visual attention and insufficient size to occupy most of an observer's visual field.'

15. The graph also shows that at distances of 30-40 km, the rating of visibility (of moderately large offshore windfarms) was found to be between levels one and three which are defined and described as follows:

- 'Visibility level 1. Visible only after extended, close viewing; otherwise invisible.
    - Description: An object/phenomenon that is near the extreme limit of visibility. It could not be seen by a person who was unaware of it in advance and looking for it. Even under those circumstances, the object can be seen only after looking at it closely for an extended period.
- Visibility level 2. Visible when scanning in the general direction of the study subject: otherwise likely to be missed by casual observers.
    - Description: an object/phenomenon that is very small and/or faint, but when the observer is scanning the horizon or looking more closely at an area, can be detected without extended viewing. It could sometimes be noted by casual observers; however, most people would not notice it without some active viewing.
- Visibility level 3. Visible after a brief glance in the general direction of the study subject and unlikely to be missed by casual observers.

- Description: An object/phenomenon that can be easily detected after a brief look and would be visible to most casual observers, but without sufficient size or contrast to compete with major landscape/seascape elements.'

16. The graph also shows that at distances of 40km and greater, the rating of visibility (of moderately large offshore windfarms) was found to be reduced to between levels one and two.

17. The Greater Gabbard offshore windfarm, which consists of 140 turbines of 131.5m to tip was included and observed at ranges of up to 41km.

18. A maximum distance of offshore windfarm visibility was recorded for Gunfleet Sands (at a range of 44km). It consists of 48No 128.5m to tip turbines. The study describes this incidence of visibility as 'barely visible'. It is also noted that:

> '*when atmospheric conditions and lighting angles resulted in higher contrasts between the turbines and the sky backdrops, the facilities were judged likely to be seen easily by casual observers as a far away as 29 km for a relatively large wind facility (100 turbines). Smaller wind facilities (25-48 turbines) were generally judged to be easily visible at distances of 22-25 km.'*

19. The difference between these windfarms and the East Anglia ONE North windfarm site is the size of the turbines themselves and the degree to which this makes them more visible over distance. The horizontal extent of turbine visibility tends to be a major factor in determining magnitude of change and relative to the scale of the horizontal effect the larger vertical extent of the turbines visible is a relatively minor factor. Much of the effect is defined by whether the turbines are there (and visible) or not and how much of the view they affect. Turbines of larger sizes are also less densely spaced than smaller turbines, which will reduce their density and visual confusion across the extent of the view affected.

20. A factor of the larger turbine size is, however, the greater 'widths' of the components and the movement of the larger, rotating blades. The study found that '*Turbine blade movement was visible at distances as great as 42km……. and was routinely observed at distances of 34km or less' and 'blade motion was visible at distances beyond 30km regardless of sun angle, lighting conditions, or contrast levels.'*

21. Helpful reference is made within the study to Bishop and Miller (2007) who found that in all atmospheric and lighting conditions, impact declined with distance and increased with rising levels of contrast. This is relevant to the visibility of the East Anglia ONE North windfarm site in that the prevailing wind will most often mean

that the rotating blades will most often be seen turned towards the south-west, i.e. partially oblique to the closest parts of the Suffolk coasts.

22. Due to the angle of the sun and its movement between the east, south and west throughout the day, along with the relationship of the coast to the turbines, the turbines would be mostly 'lit' by the sun in the afternoon, which in turn may increase their likely contrast when the sun is very bright (which has been found through observation does not generally coincide with the best long range visibility over the sea). The pale coloured turbines would be mostly backclothed by the pale colour of the distant sky at the horizon and therefore the contrast is not generally high.

23. In relation to the visibility of offshore turbines at night the researchers observed red, flashing, medium intensity lights mounted on the nacelles of moderately sized offshore wind facilities at night. It found the aviation obstruction lighting to be visible at just under 40km. This would imply that visibility of the lights at just over 40km would be limited. At a distance of 21km both red aviation obstruction lighting and amber marine navigation lighting were visible at one facility, as seen from an elevated viewpoint.

24. The Greater Gabbard turbines and London Array turbines were observed by OPEN at night in very good visibility conditions at a range of 33.8 km and 31.4km respectively, from Felixstowe. Whilst the flashing, red aviation lights were visible intermittently the low intensity navigation lights were not visible.

25. Relatively early work carried out on behalf of SNH (University of Newcastle (2002). Visual Assessment of Windfarms Best Practice. Scottish Natural Heritage Commissioned Report F01AA303A) includes helpful information on the visibility and perception of wind turbines which considers the theoretical and actual visibility of objects located at a distance from observers.

26. Whilst it is noted that a 100m structure could theoretically be seen from near to sea level at a distance of 46km (i.e. it would not be fully screened beyond the horizon formed due to the earth's curvature) it is also advised that:

> *'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 100mm diameter will become difficult to see at 1km and a pole of 200mm diameter will be difficult to see at 2km. 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) 5000mm (5m) in diameter (a representative figure for a*

60m+ high tower) will be of the order of 50km; and the absolute limit of visibility imposed by the limit of the horizon viewed across a flat plane is similar at approximately 46km.'

27. This finding corresponds with OPEN's observations of onshore windfarms in the field where occasionally, in clear conditions, it is possible to observe wind turbines at distances in excess of 50km. Turbines of larger size, such as those at Whitelee (107-140m to tip) are occasionally visible in excellent weather conditions at even greater distances (e.g. from the Merrick to the south-south-east at a distance of approximately 57km and from the west on the Isle of Arran at similar distances).

28. The cylindrical towers of the worst-case scenario, development turbines would have a larger maximum diameter of 9m. Assuming the same linear relationship of visual acuity suggested above this would suggest that in the clearest of conditions it would be difficult to see a 9m wide structure at a range of 90km. However, whilst this may theoretically be the case from elevated locations it would not be possible to see the East Anglia ONE North windfarm site at this range, from heights of less than 40m AOD CHECK, due to the screening effect of the earth's curvature.

29. The Best Practice Guidance (University of Newcastle (2002)) provides further detail on how human perception is also a factor in how a windfarm will be seen. Importantly it states at 3.4.5 that:

'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.'

30. Two further factors of depth perception and size constancy are also discussed as being fundamental to perception and the following conclusions drawn:

'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.'

31. Other factors of relevance to the understanding of the seascape, landscape and visual effect of the East Anglia ONE North windfarm site include:

- **Lighting** – It was observed that direct light shining on the turbines 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) were said to experience this effect whereas back-lit effects occurred at viewpoints to the north (in the arc from east through north to west). It was also noted that:
    - *'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** – It was found that the movement of the blades, in all cases where this was visible, increased the visual effect of the turbines because it tended to draw the eye. Movement was more perceptible when backdropped against dark vegetation compared to grey sky. In addition, due to the fact that 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, experience the longest periods of exposure to visible movement. It was also judged that rotors seen in the plane oriented at 180 degrees to the viewpoint appear relatively nearer.
- **Distance, Colour and Contrast** - At short distances the study found that 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. Light coloured (lit) turbines appeared 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.'
- **Landscape character and receptors** - The character of the landscape and especially elements within it was found to 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 the author's judgements of their magnitude.

28.4 Frequency and Likelihood of Visual Effects – Weather Conditions

32. The judgements made in the SLVIA are based on optimum 'very good' to 'excellent' visibility of the East Anglia ONE North windfarm site. This assumption is assessed as the worst-case scenario in the SLVIA, but in reality, the degree and extent of visual effects arising from the East Anglia ONE North windfarm site will be influenced the prevailing weather and visibility conditions. Viewing conditions and visibility have been found to vary in the study area. The varied clarity or otherwise of the atmosphere will reduce the number of days upon which views of the East Anglia ONE North windfarm site will be available from the coastline and hinterland, and is likely to inhibit clear views, rendering the wind turbines more visually recessive within the wider seascape. The effects of the East Anglia ONE North windfarm site will vary according to the weather and prevailing visibility. This means that effects that are assessed to be significant in the SLVIA under very good or excellent visibility conditions, may be not significant under moderate, poor or very poor visibility conditions.

33. A description of visibility frequency is provided in the SLVIA, using METAR visibility data from the nearest Met Office stations that record visibility (Weybourne and Shoeburyness), to highlight potential trends in the visibility conditions of the study area. Both GLVIA3 (8.15) and SNH guidance (SNH, 2017, para 39) refer to use of this Met Office visibility data to assess typical visibility conditions within an area. Although there are limitations to how this data can be applied to judgements about windfarm visibility, the visibility data provides some understanding and evidence basis for evaluating the visibility of the wind turbines against their background.

34. Met Office visibility data is mapped in ***Figure 28.20*** in the context of the East Anglia ONE North windfarm site and visibility frequency over a 10 year period at different distance ranges, based on Met Office visibility definitions: < 1km Very Poor; 1 - 4km Poor; 4 -10km Moderate; 10 - 20km Good; 20 - 40km Very Good; 40km > Excellent. The visibility range is shown in bands extending offshore and these can be correlated against the percentage visibility frequency graph (in ***Figure 28.20*** and in ***section 28.5*** and ***section 28.6*** of this Appendix) to show the frequency of visibility at different ranges. The East Anglia ONE North windfarm site will only be visible in 'very good' or 'excellent' visibility, since it is located km from the coast at its closest point and extends beyond 50km from the coast at its more distant points. Based on visibility from the closest point (36.2km), the Met Office visibility data for Weybourne indicates that the East Anglia ONE North windfarm site will have a visibility frequency of approximately 26% i.e. 95 days of

the year on average (or approximately one-quarter of the year) with visibility over 36.2km. Based on visibility from Shoeburyness the East Anglia ONE North windfarm site will have a visibility frequency of approximately 15% i.e. 55 days of the year on average (or less than one fifth) with visibility over 36.2km.

35. The Met Office visibility data allows more specific quantification of the likely frequency of visibility of the East Anglia ONE North windfarm site from individual viewpoints, based on the distance of each viewpoint location from the East Anglia ONE North windfarm site. The Met Office visibility frequency data is used to inform an assessment of the 'likelihood of effect' from each viewpoint, in order to qualify any significant effects assessed in optimum visibility conditions with how likely they are to actually occur given the prevailing weather/ visibility conditions. The viewpoints included in the SLVIA range from 38.8 km to 55.8 km from the East Anglia ONE North windfarm site, with assessments of likelihood of effect varying from 33% at the closest viewpoint (Viewpoint 2, Kessingland), to 15% at the more distant viewpoints (such as Viewpoint 16, Bawdsey), with assessments varying between a medium-low likelihood of effects occurring at the closest viewpoints to a low likelihood at the more distant viewpoints.

28.5 Met Office Visibility Data (Weybourne)

37. Met office visibility data from Weybourne met office station is summarised as follows.

Visibility (km)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ALL	Visibility Range	Visibility Definition	Visibility over 10 years %
0.00 => 0.99	0.94	1.81	1.90	3.06	1.29	2.22	0.85	0.29	1.31	0.94	1.14	1.11	1.40	< 1km	Very Poor	1.4
1.00 => 1.99	0.61	1.36	1.91	1.90	0.70	0.77	0.43	0.46	0.82	0.45	1.11	1.01	0.96			
2.00 => 2.99	1.39	2.25	2.21	1.77	1.09	1.03	0.74	0.79	1.18	1.15	2.04	1.43	1.42	1 - 4km	Poor	4.22
3.00 => 3.99	2.09	2.86	2.50	2.06	1.34	1.33	0.80	0.90	1.71	1.96	2.59	2.15	1.85			
4.00 => 4.99	2.52	2.72	2.49	2.42	1.59	1.30	0.86	1.00	2.33	2.27	2.81	2.39	2.05			
5.00 => 5.99	3.01	3.35	3.06	2.16	1.52	1.72	0.91	1.31	1.87	2.32	2.91	3.00	2.25			
6.00 => 6.99	3.00	3.45	3.29	2.25	1.55	1.65	1.19	1.05	1.98	2.56	3.04	3.11	2.33	4 - 10km	Moderate	14.47
7.00 => 7.99	3.16	3.82	3.55	2.59	1.77	1.80	1.17	1.28	2.03	2.49	3.02	3.14	2.47			
8.00 => 8.99	3.89	3.48	3.43	3.31	2.23	1.69	1.51	1.20	2.13	2.60	3.11	3.36	2.65			
9.00 => 9.99	3.94	3.55	3.44	3.10	2.51	1.89	1.69	1.28	2.09	2.70	3.05	3.40	2.71			
10.00 => 10.99	3.85	3.13	3.77	3.72	2.40	1.94	1.56	1.43	2.47	3.13	3.28	3.72	2.86			
11.00 => 11.99	3.71	3.35	2.89	3.16	2.18	1.86	1.88	1.39	2.24	3.07	3.18	3.98	2.74			
12.00 => 12.99	3.04	3.13	3.03	3.58	2.48	2.04	1.80	1.50	2.29	3.13	3.78	2.98	2.72			
13.00 => 13.99	3.25	3.23	3.14	2.69	2.29	2.05	2.07	1.71	2.22	2.89	3.25	3.36	2.67			
14.00 => 14.99	3.05	3.19	2.88	2.62	2.12	2.08	2.06	1.71	2.66	3.26	3.28	3.05	2.66	10 - 20km	Good	26.11
15.00 => 15.99	2.71	2.81	3.05	2.76	2.35	2.04	2.21	1.73	2.91	2.86	3.02	2.90	2.61			
16.00 => 16.99	2.63	2.71	2.65	2.72	2.48	1.98	2.10	1.62	2.90	3.24	3.13	3.19	2.61			
17.00 => 17.99	2.33	2.37	2.95	2.68	2.47	1.86	2.26	1.80	2.66	2.94	2.95	2.73	2.50			
18.00 => 18.99	2.17	2.31	2.58	2.51	2.16	2.22	2.17	2.17	2.63	3.00	2.78	2.41	2.42			
19.00 => 19.99	2.71	2.21	2.16	2.49	2.02	2.35	2.25	2.17	2.27	2.50	2.78	1.96	2.32			
20.00 => 20.99	2.56	2.03	2.28	2.55	1.98	2.17	2.37	2.28	2.75	2.96	3.09	2.21	2.43			
21.00 => 21.99	2.58	1.80	2.12	2.39	2.08	2.42	2.65	2.38	2.19	2.70	2.95	2.04	2.36			
22.00 => 22.99	2.33	1.89	2.24	2.04	1.87	2.42	2.31	2.68	2.29	2.35	2.71	1.79	2.24			
23.00 => 23.99	2.16	1.83	2.16	1.90	2.17	2.36	2.33	2.47	2.13	2.02	2.39	1.39	2.11			
24.00 => 24.99	2.01	1.63	1.99	2.23	1.97	2.53	2.70	2.91	1.78	1.62	2.11	1.65	2.10			
25.00 => 25.99	2.04	1.62	2.09	1.49	2.32	2.19	2.40	2.61	2.22	1.75	1.97	1.33	2.01	20 - 40km	Very Good	34.00
26.00 => 26.99	1.69	1.60	2.06	1.77	1.92	2.52	2.26	2.28	1.76	1.81	1.55	1.47	1.89			
27.00 => 27.99	1.58	1.33	2.01	1.77	2.14	2.47	2.40	2.47	1.94	1.92	1.35	1.33	1.90			
28.00 => 28.99	1.61	1.63	1.75	1.42	2.24	1.97	2.22	2.68	1.64	1.51	1.60	1.36	1.81			
29.00 => 29.99	1.50	1.44	1.41	1.76	2.10	2.46	2.42	2.39	1.85	1.41	1.17	1.08	1.75			
30.00 => 34.99	5.13	5.73	6.43	6.45	9.86	9.87	10.42	9.64	7.99	6.62	5.36	5.34	7.42			
35.00 => 39.99	4.54	4.88	4.64	5.32	8.02	8.14	7.82	8.00	6.30	5.44	3.73	4.48	5.96			
40.00 => 44.99	3.55	3.76	3.29	4.27	7.13	6.37	7.48	6.70	5.35	4.66	3.55	4.63	5.08			
45.00 => 49.99	4.09	4.82	3.33	4.11	6.11	6.92	8.30	8.85	6.29	5.35	3.82	4.66	5.57			
50.00 => 59.99	8.60	6.92	5.28	6.96	9.41	9.27	11.28	14.87	10.82	8.43	6.40	10.84	9.12	40km >	Excellent	19.80
60.00 => 69.99	0.03	0.00	0.04	0.00	0.12	0.08	0.10	0.00	0.00	0.00	0.03	0.03	0.04			
>= 70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			

Plate A28.1 Visibility Frequency

Visibility Range	Visibility Definition	% Visibility Frequency (over 10 years)
< 1km	Very Poor	1.40%
1 - 4km	Poor	4.20%
4 - 10km	Moderate	14.50%
10 - 20km	Good	26.10%
20 - 40km	Very Good	34.00%
40km >	Excellent	19.80%

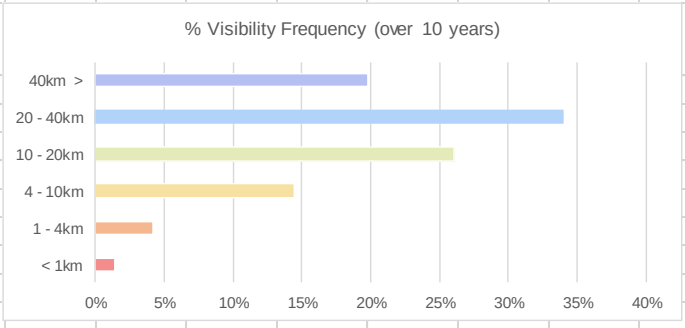

Plate A28.2 Visibility Frequency Graph

% VISIBILITY FREQUENCY (10 YEARS)		SPRING	SUMMER	AUTUMN	WINTER
Visibility Range	**Visibility Definition**	**%**	**%**	**%**	**%**
< 1km	Very Poor	0.53	0.28	0.28	0.31
1 - 4km	Poor	1.31	0.61	1.07	1.23
4 - 10km	Moderate	3.91	2.06	3.72	4.79
10 - 20km	Good	6.84	4.89	7.12	7.26
20 - 40km	Very Good	8.55	10.67	7.97	6.80
40km >	Excellent	4.24	6.77	4.50	4.28
		25	**25**	**25**	**25**

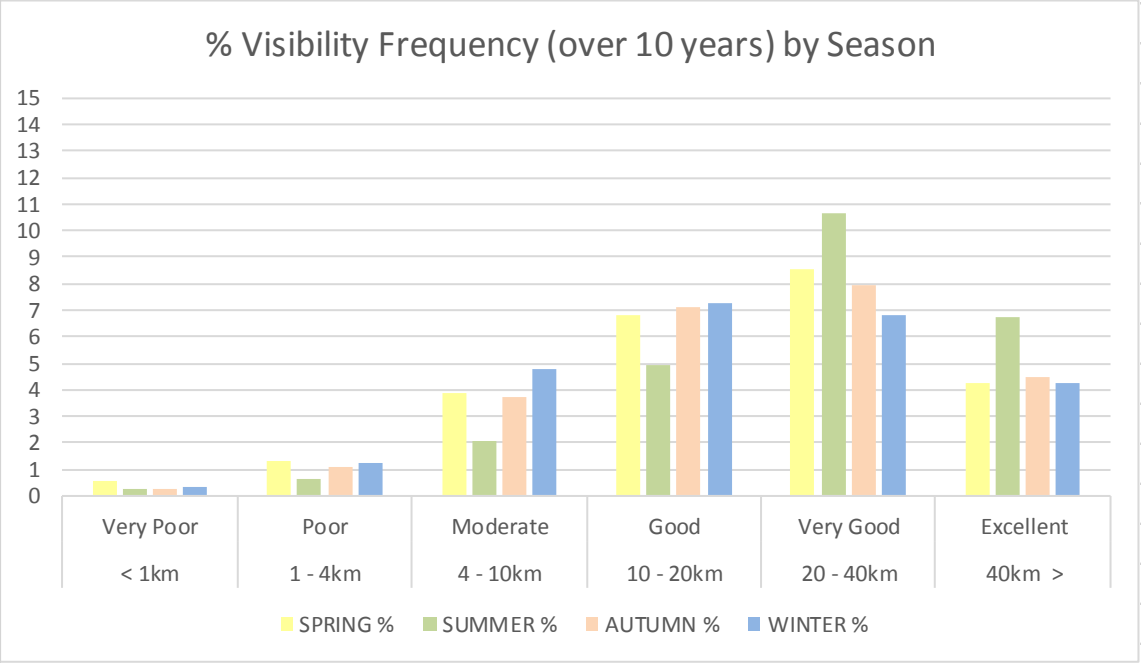

Plate A28.3 Visibility Frequency by Season

28.6 Met Office Visibility Data (Shoeburyness)

38. Met office visibility data from Shoeburyness met office station is summarised as follows.

Visibility (km)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ALL	Visibility Range	Visibility Definition	Visibility over 10 years %
0.00 => 0.99	1.90	2.33	3.35	2.03	0.60	0.76	0.37	0.71	1.68	1.95	2.33	3.18	1.76	< 1km	Very Poor	1.76
1.00 => 1.99	0.83	1.47	2.51	2.03	0.77	0.66	0.35	0.30	1.42	1.21	1.27	1.36	1.18			
2.00 => 2.99	1.37	2.87	2.49	2.80	1.18	1.09	0.56	0.61	1.52	1.62	1.81	1.83	1.63	1 - 4km	Poor	4.84
3.00 => 3.99	1.96	2.73	3.37	2.84	1.76	1.17	0.64	0.90	1.89	2.34	2.33	2.46	2.03			
4.00 => 4.99	2.42	3.49	3.63	3.21	1.54	1.48	0.94	1.09	2.20	2.28	2.39	3.07	2.30			
5.00 => 5.99	2.59	3.21	3.54	2.86	1.89	1.75	1.03	1.38	1.93	2.21	3.08	2.81	2.35			
6.00 => 6.99	3.66	2.98	4.16	3.37	2.69	1.85	1.10	1.48	2.23	2.05	3.65	3.31	2.70	4 - 10km	Moderate	15.63
7.00 => 7.99	3.69	3.15	3.32	3.24	2.83	2.06	1.09	1.57	1.72	2.47	3.45	2.97	2.62			
8.00 => 8.99	4.10	3.43	3.64	3.26	2.57	2.35	1.17	1.70	1.51	2.69	3.71	3.73	2.81			
9.00 => 9.99	4.07	3.37	3.43	3.40	2.68	2.59	1.62	1.53	2.10	2.64	3.55	3.40	2.85			
10.00 => 10.99	0.83	1.47	2.51	2.03	0.77	0.66	0.35	0.30	1.42	1.21	1.27	1.36	1.18			
11.00 => 11.99	4.47	4.34	3.37	3.47	2.40	2.39	1.58	1.61	1.93	2.50	3.11	4.04	2.92			
12.00 => 12.99	4.62	4.42	3.51	3.30	2.79	2.78	2.20	1.84	1.63	2.98	3.68	4.08	3.14			
13.00 => 13.99	5.45	4.52	3.40	3.26	3.09	2.44	2.05	2.06	2.19	2.96	3.68	4.25	3.26			
14.00 => 14.99	5.73	4.28	3.85	3.10	3.35	3.39	3.14	2.57	3.34	3.30	3.42	3.91	3.60	10 - 20km	Good	32.92
15.00 => 15.99	5.53	4.48	4.31	3.47	3.56	3.87	4.02	3.57	2.91	3.22	3.54	4.15	3.88			
16.00 => 16.99	4.69	4.28	4.32	3.70	4.05	4.06	4.45	3.41	3.23	3.11	3.44	3.18	3.82			
17.00 => 17.99	3.96	3.69	3.63	3.49	5.18	3.72	4.45	3.23	4.01	3.45	3.25	2.64	3.72			
18.00 => 18.99	2.92	2.93	3.92	3.07	5.30	3.86	4.46	3.85	3.91	3.81	3.90	2.45	3.71			
19.00 => 19.99	2.96	2.29	3.77	3.00	5.00	4.03	4.31	4.05	3.85	4.34	4.12	2.35	3.69			
20.00 => 20.99	2.92	2.56	2.89	3.31	4.67	3.84	3.93	3.87	4.05	4.14	4.00	2.28	3.55			
21.00 => 21.99	2.10	2.38	2.53	2.37	3.72	3.31	3.77	3.45	3.99	3.89	3.37	2.70	3.14			
22.00 => 22.99	2.26	2.04	2.89	2.61	3.20	3.58	3.14	3.36	3.37	3.66	2.76	2.35	2.94			
23.00 => 23.99	1.72	2.21	2.59	2.31	2.86	2.59	2.86	3.42	3.41	3.77	2.67	2.17	2.72			
24.00 => 24.99	1.27	1.78	2.36	1.84	2.03	2.59	2.72	3.36	3.07	3.18	2.32	1.77	2.37			
25.00 => 25.99	1.37	1.62	1.72	1.81	1.89	2.44	2.32	2.71	2.90	3.30	2.25	1.66	2.17	20 - 40km	Very Good	35.41
26.00 => 26.99	1.11	1.31	1.46	1.59	1.67	2.42	2.07	2.48	2.57	2.02	1.98	2.13	1.91			
27.00 => 27.99	1.27	1.30	1.22	1.17	1.41	1.87	2.23	2.40	2.26	1.77	1.75	1.99	1.73			
28.00 => 28.99	1.14	1.31	0.88	1.20	1.65	1.64	1.81	2.29	1.79	1.88	1.40	2.28	1.61			
29.00 => 29.99	1.43	1.42	0.95	1.06	1.14	1.91	1.73	1.93	1.79	1.50	1.27	1.55	1.47			
30.00 => 34.99	5.46	6.70	3.43	5.84	5.96	7.18	8.73	9.18	7.18	6.93	4.87	8.73	6.69			
35.00 => 39.99	4.03	3.30	2.49	5.14	5.16	6.70	8.32	7.91	6.03	3.68	3.49	4.79	5.11			
40.00 => 44.99	1.74	2.27	1.61	3.74	4.02	5.07	6.06	6.10	4.38	2.76	2.08	1.61	3.47			
45.00 => 49.99	1.66	1.93	1.40	2.23	3.77	4.20	5.37	4.96	3.30	2.43	2.29	1.32	2.92			
50.00 => 59.99	2.79	2.16	1.57	2.84	2.87	3.70	5.07	4.84	3.30	2.71	2.48	2.13	3.05	40km >	Excellent	9.44
60.00 => 69.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00			
>= 70.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			

Plate A28.4 Visibility Frequency

Visibility Range	Visibility Definition	% Visibility Frequency (over 10 years)
< 1km	Very Poor	1.78%
1 - 4km	Poor	4.89%
4 - 10km	Moderate	15.82%
10 - 20km	Good	33.31%
20 - 40km	Very Good	35.83%
40km >	Excellent	9.55%

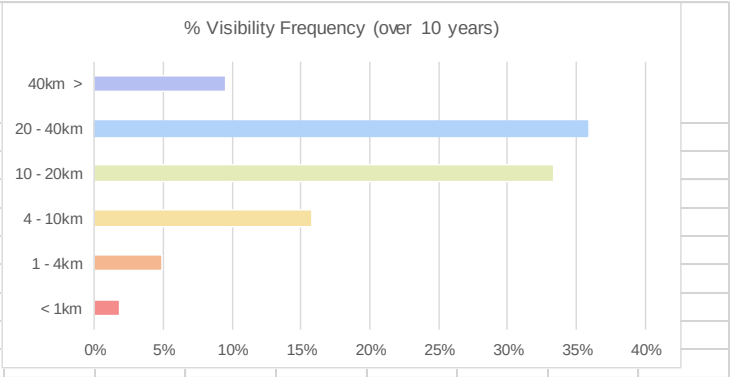

Plate A28. 5 Visibility Frequency Graph

% VISIBILITY FREQUENCY (10 YEARS)		SPRING	SUMMER	AUTUMN	WINTER
Visibility I	Visibility Definition	%	%	%	%
< 1km	Very Poor	0.51	0.16	0.50	0.60
1 - 4km	Poor	1.67	0.53	1.28	1.36
4 - 10km	Moderate	4.66	2.35	3.82	4.80
10 - 20km	Good	8.78	7.52	7.72	8.90
20 - 40km	Very Good	7.68	11.04	9.52	7.20
40km >	Excellent	2.02	3.86	2.14	1.42
		25	25	25	24

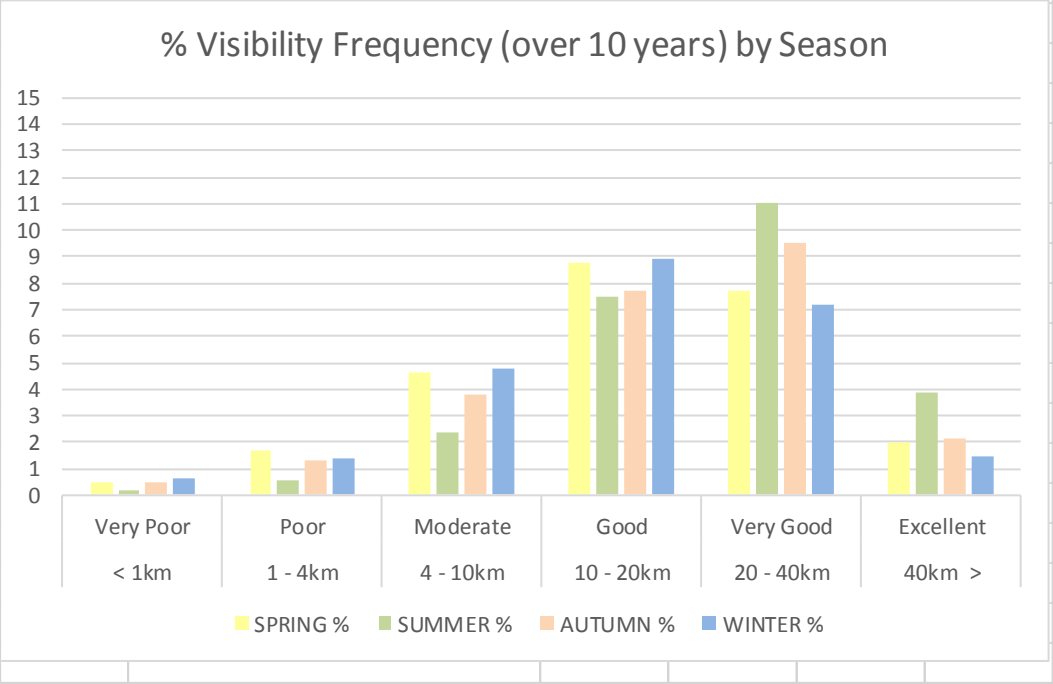

Plate A28.6 Visibility Frequency by Season