Scottish Power
Proposed West of Duddon Sands Wind Development

Communications Link Survey and Analysis

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2 December 2005

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Introduction

Scottish Power, based in Glasgow, is proposing the development of West Duddon offshore wind farm, located approximately 14km west-south-west from the coastline of Walney Island.

Two HRL / Centrica Microwave links have been identified that cross through the proposed development.

Pager Power has been invited to analyse the link ends and determine exclusion zones using Ofcom guidelines. Scottish Power provided Pager Power with three proposed layout schedules of up to 139 turbines, with tip heights of up to 183m.

The link ends were surveyed to provide accurate location and heights of the link-end antennas, and this data used for the subsequent analyses. The Offshore antenna data was provided by Fugro. This data was cross-checked by theodolite from the mainland.

The links and the proposed layout were then analysed in 2-dimensions (horizontally) and an exclusion map produced.

Turbines found to impinge on the Fresnel Zones have been identified and advice on overcoming potential interference issues has been provided.

Proposed Wind Farm

Background

Scottish Power, based in Glasgow, is proposing the development of West Duddon offshore wind farm, located approximately 14km west-south-west from the coastline of Walney Island. Scottish Power currently have three proposed layout schedules of up to 139 turbines, with tip heights of up to 183m.

Wind farm location.

The lease agreement with Crown Estate states that the area must not exceed 66.43 km^2 and the installed nominal power must not exceed 500 MW.

Site Location and Height

	UTM 30N, WGS84		WGS84	
Corner	**Easting**	**Northing**	**Longitude**	**Latitude**
C1	463,386.5	5,983,950.0	-3^o 33’ 30.95’’	54^o 00’ 09.19’’
C2	470,886.5	5,986,906.0	-3^o 26’ 40.08’’	54^o 01’ 46.54’’
C3	475,075.3	5,980,522.5	-3^o 22’ 48.01’’	53^o 58’ 20.78’’
C4	472,241.0	5,977,380.2	-3^o 25’ 22.5’’	53^o 56’ 38.6’’
C5	467,913.5	5,977,547.2	-3^o 29’ 19.9’’	53^o 56’ 43.1’’

The water depth in the area ranges between 17 m and 23 m LAT being shallowest in the SW and deepest in the NE.

Wind Turbines

There are three proposed schedules of turbines for the West Duddon Sands development

	3.6 MW turbine	4.5 MW turbine	6.0 MW turbine
Number of turbines	139	111	83
Rotor diameter (m)	104 - 110	118 - 125	135 – 145
Hub height (m above LAT)	83 - 95	90 - 100	100 – 110
Tip height (m above LAT)	137 - 150	149 - 163	167 – 183
Min tip height over MHWS	22m	22m	22m
LAT to MHWS on site?	9.0m (@ halfway shoal)	9.0m (@ halfway shoal)	9.0m (@ halfway shoal)
Nacelle dimensions (l,h,w)			
Tower diameter (top, bottom)	3.5m , 5m	4m , 5.5m	4.5m , 6.5m
Rotor	3-bladed upwind	3-bladed upwind	3-bladed upwind
Blade material	Glass/carbon fibre reinforced epoxy	Glass/carbon fibre reinforced epoxy	Glass/carbon fibre reinforced epoxy
Tower material	Steel	Steel	Steel
Color	Marine grey, lower tower part yellow	Marine grey, lower tower part yellow	Marine grey, lower tower part yellow
Operating wind speeds (m/s)	3 - 30	3 - 30	3 – 30
Operational noise (max)	113 dB(A)	113 dB(A)	113 dB(A)
Rotational rotor speed (RPM)	<16	<14	<12

Wind Farm Layout

For details of the three proposed schedules of turbines, please see Appendix 1.

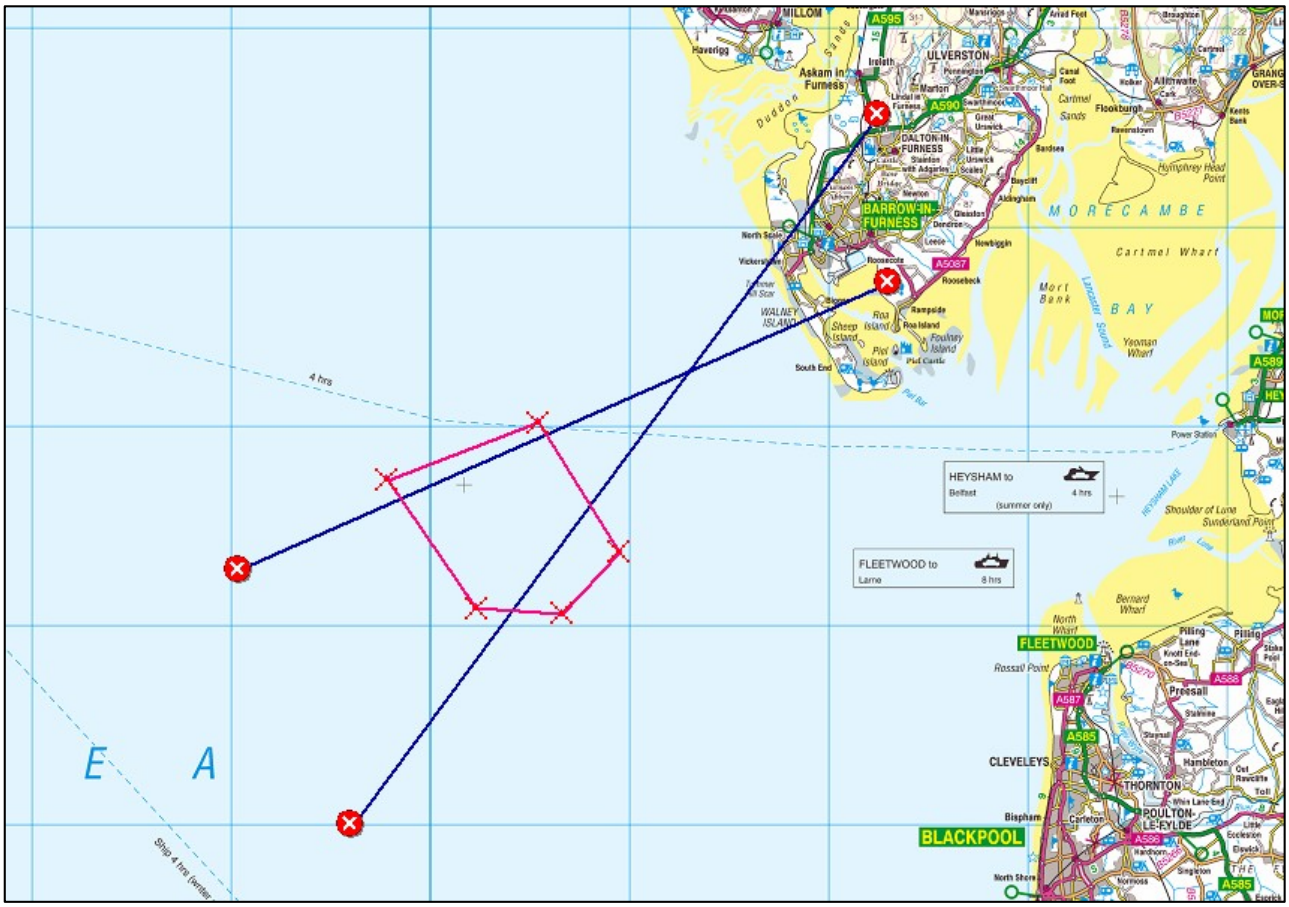
Communications Links

HRL / Centrica Microwave links crossing the site were identified in consultation conducted by Scottish Power. HRL / Centrica supplied locations for the link ends. Link frequency information was obtained from Pager Power's database of microwave communications links.

The links were surveyed. The survey sheets are shown in Appendix 2. Details of the offshore aerial positions are shown further in Appendix 4. The measured end positions are shown in the following table.

Link	Offshore End			Onshore End		
	OSGB 36	**WGS 84**	**UTM 30N**	**OSGB 36**	**WGS 84**	**UTM 30N**
14173 (Upper)	290383E 452815N	-3 40 20.04 53 57 35.33	455893E 5979260N	322726E 467510N	-3 10 59.38 54 05 51.76	488022E 5994409N
14173 (Lower)	290365E 452829N	-3 40 21.05 53 57 35.77	455875E 5979274N			
26376 (Upper)	295922E 440016N	-3 35 00.57 53 50 45.48	461611E 5966542N	322444E 475646N	-3 11 22.44 54 10 14.80	487625E 6002539N
26376 (Lower)				322441E 475645N	-3 11 22.60 54 10 14.76	487622E 6002538N

Map of Communications Link Ends



Calculation Basis

Exclusion Zone

The Exclusion Zone is calculated, based on the Second Fresnel Zone, as described in the Radio Communications Agency paper “Fixed-link wind-turbine exclusion zone method”.

It should be noted that:

- This is the approach recommended by the Radio Communications Agency when the exact antenna locations are known.
- Page 4 of the above paper states that this is a conservative approach.

Each link operates on two discrete frequencies. Calculations use the lower of the two link frequencies, resulting in a wider exclusion zone.

The above method does not specifically account for GPS errors which occur when measuring the antenna locations, or when siting the turbines. To allow for this Pager Power suggest developers apply an additional fixed exclusion width of 25 meters, beyond the Second Fresnel Zone.

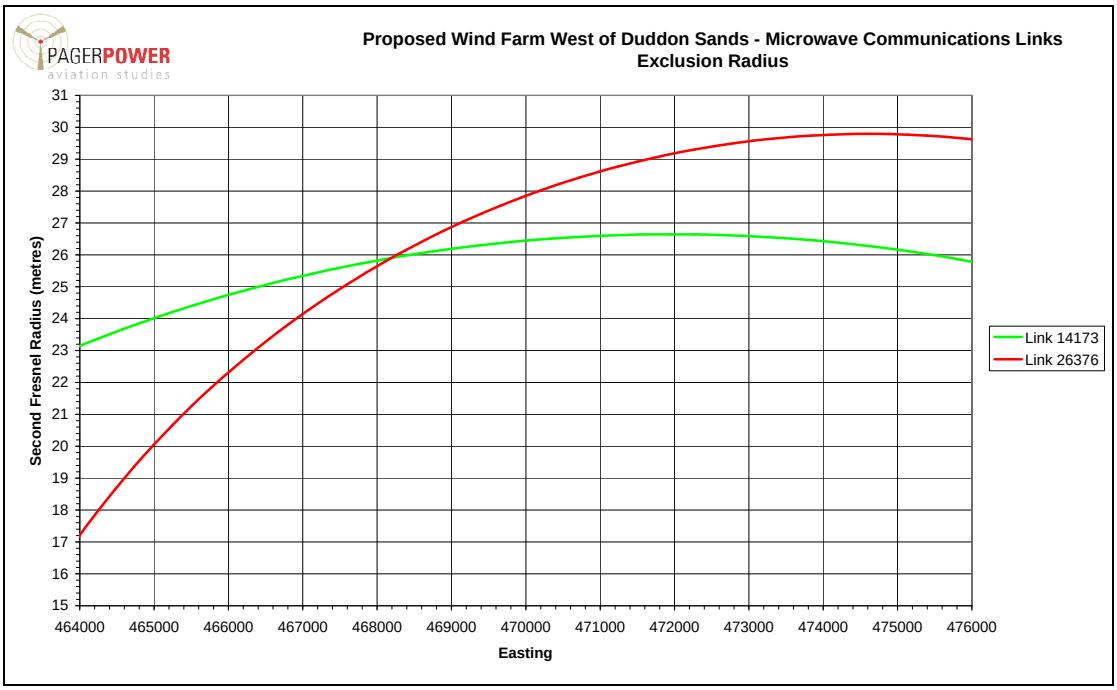
PagerPower Ltd also suggests that wind turbines be sited more than 250 meters beyond communications masts, to avoid multi-path and near field effects.

Analysis

From the survey data, the link paths were analysed in order to assess the minimum horizontal distance from blade tips to the link paths and associated Fresnel Zones.

Determination of safe clearance for a specific turbine

The chart below shows the calculated second fresnel zone radius for the two links at specific WGS84 UTM Eastings. A full size chart is shown in Appendix 6.



Calculate the safe clearance between a turbine tower and the link centre-line as follows:

1 – Determine the Easting of the turbine.

2 – Determine the link of concern.

3 – Use the graph above to determine the Exclusion Radius.

4 – Add all of the following to obtain the safe clearance distance:

- Exclusion Radius
- Rotor Radius
- 25 metres

Exclusion Zone Charts

The 2-dimensional (horizontal) exclusion zone charts are shown below for each of the three layouts, based on the surveyed transmitter locations. The plotted boundaries allow for the length of the rotor blade and the recommended 25 metre additional clearance distance to allow for measurement inaccuracies.

The full size charts are shown in Appendix 3.

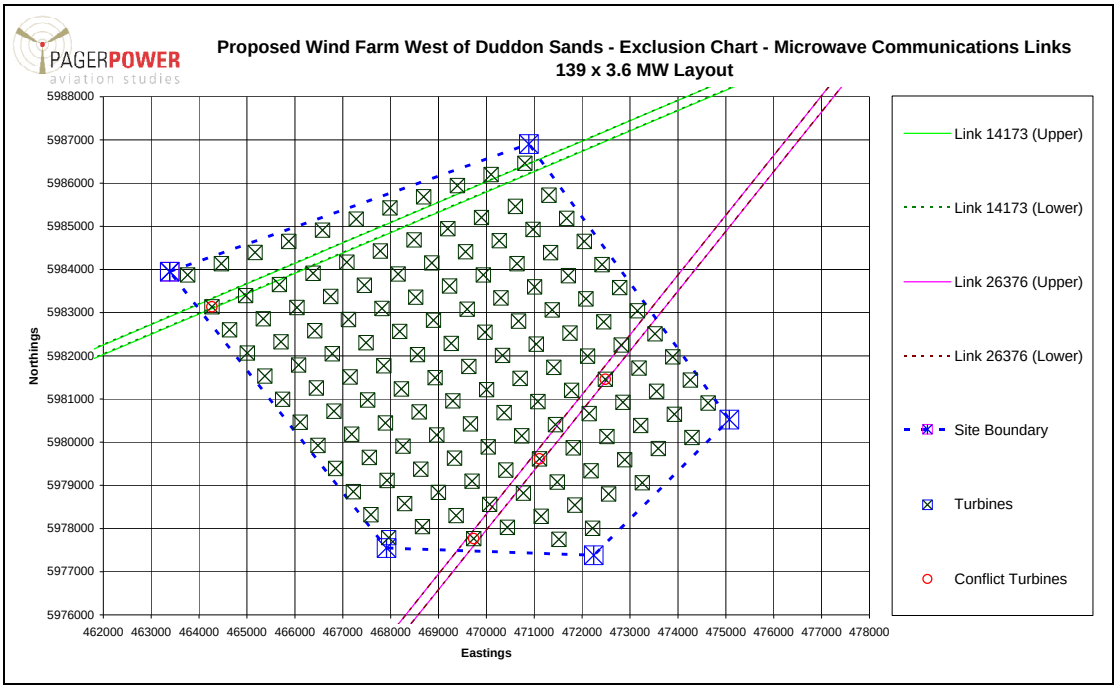


Chart 2 - 3.6 MW Layout

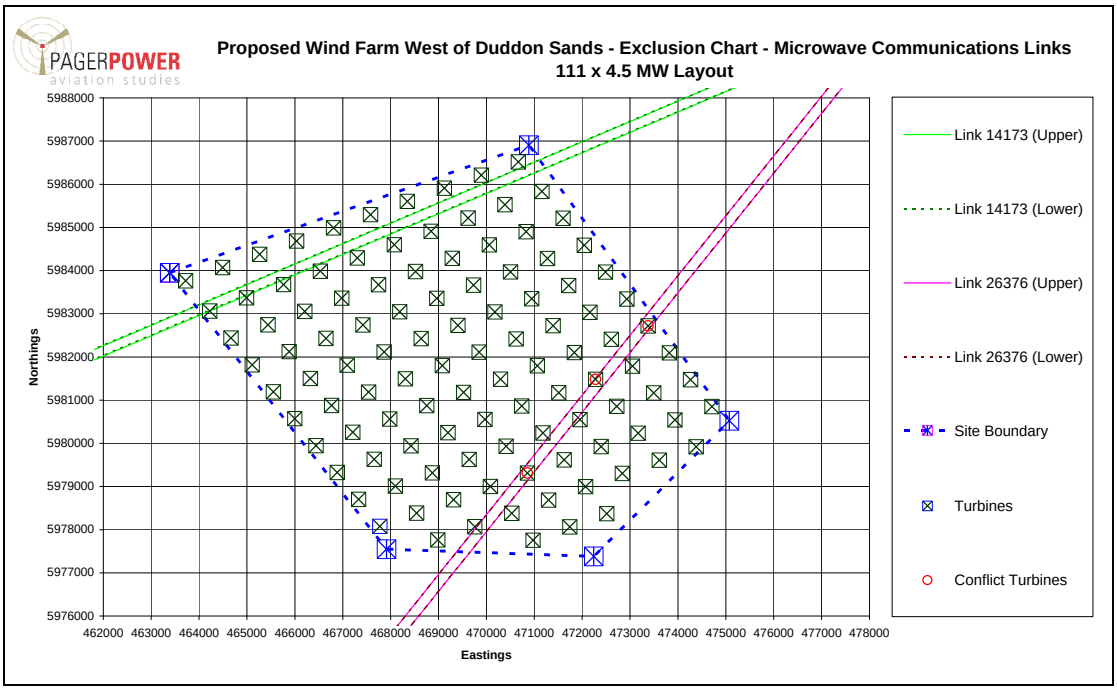


Chart 3 – 4.5 MW Layout

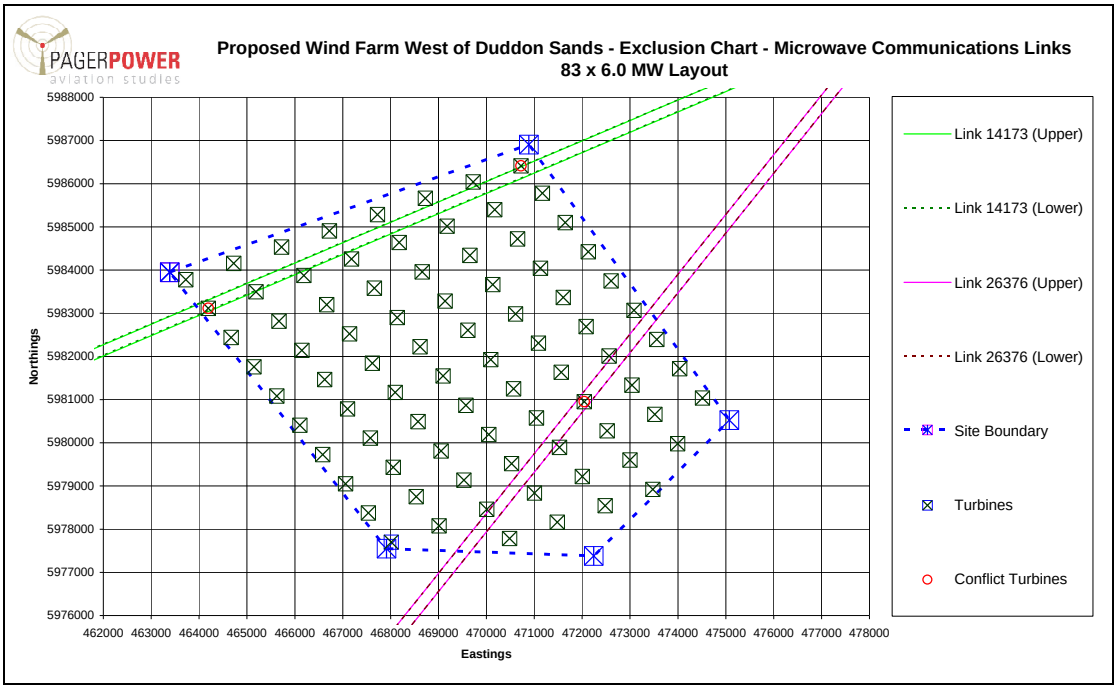


Chart 4 – 6.0 MW Layout

The conflict turbines are detailed in the following section.

Turbine Clearances

Clearances between specific turbines and the links are shown in the table below. Calculation details are shown in Appendix 5. These turbines were identified by studying the exclusion charts.

Link	Layout	Turbine	Calculation Number	Distance – Tower to Path Centre (m)	Clearance – Tip to Second Fresnel Zone (m)	Clearance Assessment
14173	3.6 MW	11	1	65.5	**-12.8**	**Breach**
26376	3.6 MW	23	2	10.3	**-72.3**	**Breach**
26376	3.6 MW	63	3	42.8	**-41.0**	**Breach**
26376	3.6 MW	100	4	75.8	**-8.6**	**Breach**
14173	4.5 MW	9	5	112.8	**26.9**	**Fully Clear**
26376	4.5 MW	43	6	13.7	**-77.4**	**Breach**
26376	4.5 MW	76	7	101.6	**9.8**	**Just Clear**
26376	4.5 MW	96	8	61.1	**-31**	**Breach**
14173	6.0 MW	9	9	53.4	**-51.5**	**Breach**
14173	6.0 MW	18	10	134	**37.4**	**Fully Clear**
14173	6.0 MW	83	11	148.5	**-49.4**	**Breach**
26376	6.0 MW	52	12	13.7	**-88.0**	**Breach**

Clearances between turbine tip and second fresnel zone are assessed as follows:

Clearance (metres)	Assessment	Description
Negative	Breach	Turbines may interfere with links.
0 – 25 metres	Just Clear	Turbines unlikely to interfere with links, but little allowance for GPS errors.
> 25 metres	Fully Clear	Turbines very unlikely to interfere and turbines at a safe distance from links.

For the three layouts the assessments and potential mitigations are as follows:

Layout	Assessment	Mitigation
3.6 MW	Turbines 11 breaches link 14173. Turbines 23, 63 and 100 breach link 26376.	Turbines should be moved away from link path by the following minimum distances, and ideally by a further 25 metres. T11 – 12.8m T23 – 72.3m T63 – 41.0m T100 – 8.6m
4.5 MW	Turbine 9 is fully clear of link 14173. Turbines 43 and 96 breach link 26376. Turbine 76 is just clear of link 26376.	Turbines should be moved away from link path by the following minimum distances, and ideally by a further 25 metres. T43 – 77.4m T96 – 31.0m Turbine 76 should ideally be moved a further 15.2m from link 26376.
6.0 MW	Turbine 18 is fully clear of link 14173. Turbines 9 and 83 breach link 14173. Turbine 52 breaches link 26376.	Turbines should be moved away from link path by the following minimum distances, and ideally by a further 25 metres. T9 – 51.5m T83 – 49.4m T52 – 88.0m

Vertical Analysis

The exact height of the offshore antennae is unknown. Approximate heights of the onshore antennae have been measured. Heights have been determined for calculation purposes. These are shown in the following table:

Antenna	Approximate Height aod (m)
14173 Offshore	51.4
14173 Onshore	41.0
26376 Offshore	64.8
26376 Onshore	138.0

The approximate height of the two links has been calculated at the wind farm. These calculations allow for earth curvature and standard refraction.

Link	Approximate Height aod (m)
14173	33
26376	64

This height has been assessed against the dimensions of the proposed turbines.

Turbine	Link 14173	Link 26376
3.6 MW	Boresight passes through bottom of swept area. Fresnel zone passes through lower swept area.	Boresight approximately 15m below hub.
4.5 MW		Boresight approximately 21m below hub.
6.0 MW		Boresight approximately 31m below hub.

Whilst link 14173 passes low, and in some cases the boresight may not pass through the turbine rotor, the protected zone around the boresight will pass through the rotor.

The exact height of the link is dependent on atmospheric conditions (due to variations in the refractive properties of the atmosphere).

Due to the above, uncertainties regarding height of the offshore end and the scope for resolving issues using horizontal clearances, it is recommended that no allowances are made for vertical clearances.

Conclusions

Two microwave communications links that pass through the proposed West of Duddon Sands offshore wind farm have been surveyed.

Both horizontal and vertical analysis has been carried out.

Exclusion zones have been determined in accordance with Ofcom guidelines.

A procedure for ensuring turbines will not interfere with the microwave communications links has been outlined.

Three specific turbine layouts have been considered. For each layout three or four turbines will have to be moved by between 15 and 113 metres to ensure they do not interfere with the relevant link.

Appendix 1 – Turbine position document

Report

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Rochdale Envelope - Turbine positions and amount

1. Location and size of the development

The West Duddon offshore wind farm is located approximately 14 km from the coastline of Walney Island in a West-South-Westerly direction. The total area of the wind farm is 66.43 km incl. buffer/restriction zones around the turbines.

The corner coordinates of the development area, see Figure 1, are:

	UTM 30N, WGS84		WGS84	
Corner	**Easting**	**Northing**	**Longitude**	**Latitude**
C1	463,386.5	5,983,950.0	-3° 33' 30.95''	54° 00' 09.19''
C2	470,886.5	5,986,906.0	-3° 26' 40.08''	54° 01' 46.54''
C3	475,075.3	5,980,522.5	-3° 22' 48.01''	53° 58' 20.78''
C4	472,241.0	5,977,380.2	-3° 25' 22.5''	53° 56' 38.6''
C5	467,913.5	5,977,547.2	-3° 29' 19.9''	53° 56' 43.1''

The water depth in the area ranges between 17 m and 23 m LAT being shallowest in the SW and deepest in the NE.

Figure 1- Wind farm location.

The lease agreement with Crown Estate states that the area must not exceed 66.43 km^2 and the installed nominal power must not exceed 500 MW.

2. Wind turbines

Turbine technology is continuously advancing and the chosen machine for the development could well be up to 6 MW, which compared to the commercially available turbines of today is twice or more the size.

In order to have a competition between potential wind turbine suppliers it is of paramount importance that the span of potential turbine sizes is kept as open as possible. For the present development it is believed that turbines in the range 3.6 MW – 6 MW are likely to be offered. With a maximum installed capacity of 500 MW it means a total installation of 139 turbines of 3.6 MW at one end or 83 turbines of 6 MW at the other end.

All impact assessments, being visual, hydrographical or others, have been performed for three turbine sizes of 3.6 MW, 4.5 MW and 6 MW respectively. The table below lists the estimated characteristics of these turbines.

	3.6 MW turbine	**4.5 MW turbine**	**6.0 MW turbine**
Number of turbines	139	111	83
Rotor diameter (m)	104 - 110	118 - 125	135 – 145
Hub height (m above LAT)	83 - 95	90 - 100	100 – 110
Tip height (m above LAT)	137 - 150	149 - 163	167 – 183
Min tip height over MHWS	22m	22m	22m
LAT to MHWS on site?	9.0m (@ halfway shoal)	9.0m (@ halfway shoal)	9.0m (@ halfway shoal)
Nacelle dimensions (l,h,w)			
Tower diameter (top, bottom)	3.5m , 5m	4m , 5.5m	4.5m , 6.5m
Rotor	3-bladed upwind	3-bladed upwind	3-bladed upwind
Blade material	Glass/carbon fibre reinforced epoxy	Glass/carbon fibre reinforced epoxy	Glass/carbon fibre reinforced epoxy
Tower material	Steel	Steel	Steel
Color	Marine grey, lower tower part yellow	Marine grey, lower tower part yellow	Marine grey, lower tower part yellow
Operating wind speeds (m/s)	3 - 30	3 - 30	3 – 30
Operational noise (max)	113 dB(A)	113 dB(A)	113 dB(A)
Rotational rotor speed (RPM)	<16	<14	<12

Table 1 - Turbine characteristics

The turbines will have a principal design as illustrated in Figure 2.

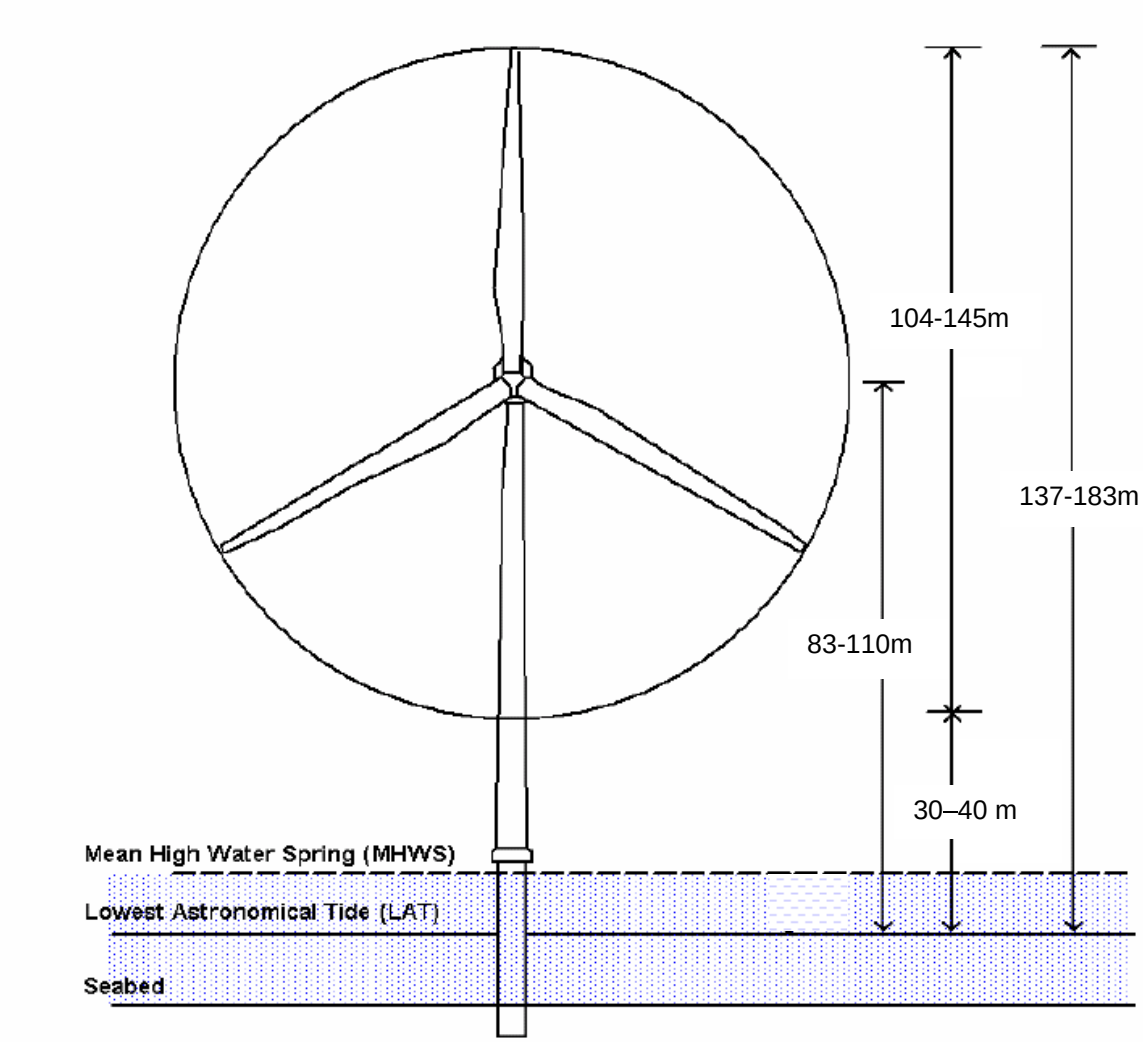


Figure 2 - Principal design of the turbines – realistic interval of dimensions.

2.1 Aviation obstacle lights

Offshore turbines must, because of their height, be provided with visible lights. Aviation obstacle lights will be installed as per the recommendations of the Civil Aviation Authority. In order that rotating blades does not obscure lights, each turbine will have 2 lights on the roof of its nacelle. Such lights would not normally all be switched on at any one time, but that facility would be available during air/sea rescues.

2.2 Lights for shipping navigation

Generally every corner turbine and every 3'rd turbine along the wind farm boundary will have flashing yellow lights, which will be positioned approximately 12m above HWL. Corner turbines will flash with 5 sec intervals whereas the turbines in between will flash with 2.5 sec intervals.

2.3 Foghorns

Each corner turbine will be fitted with a foghorn. These are estimated to be required for 3.2% of the time or 12 days of the year when visibility is reduced to below 2nm. They will be automatically operated and sound the Morse letter 'U' every 10 seconds in fog.

2.4 Turbine identification

Each turbine will have a unique identification number. At 120^{o} intervals around each tower it will be light-reflective to facilitate night time identification.

3. Wind farm layout

The wind farm layout is in the following described using three sizes of turbines, representing the minimum and maximum as well “medium” size in the expected interval that is relevant for the development. These three turbine sizes and the positions shown in here are only for illustrative purposes, since the the application generally aims for a consent to erect any size of turbine within the interval 3.6MW – 6.0 MW and within the limitations stated in Figure 2. Whatever turbine selected the nominal installed capacity will maximum be 500 MW.

3.1 Turbine positions

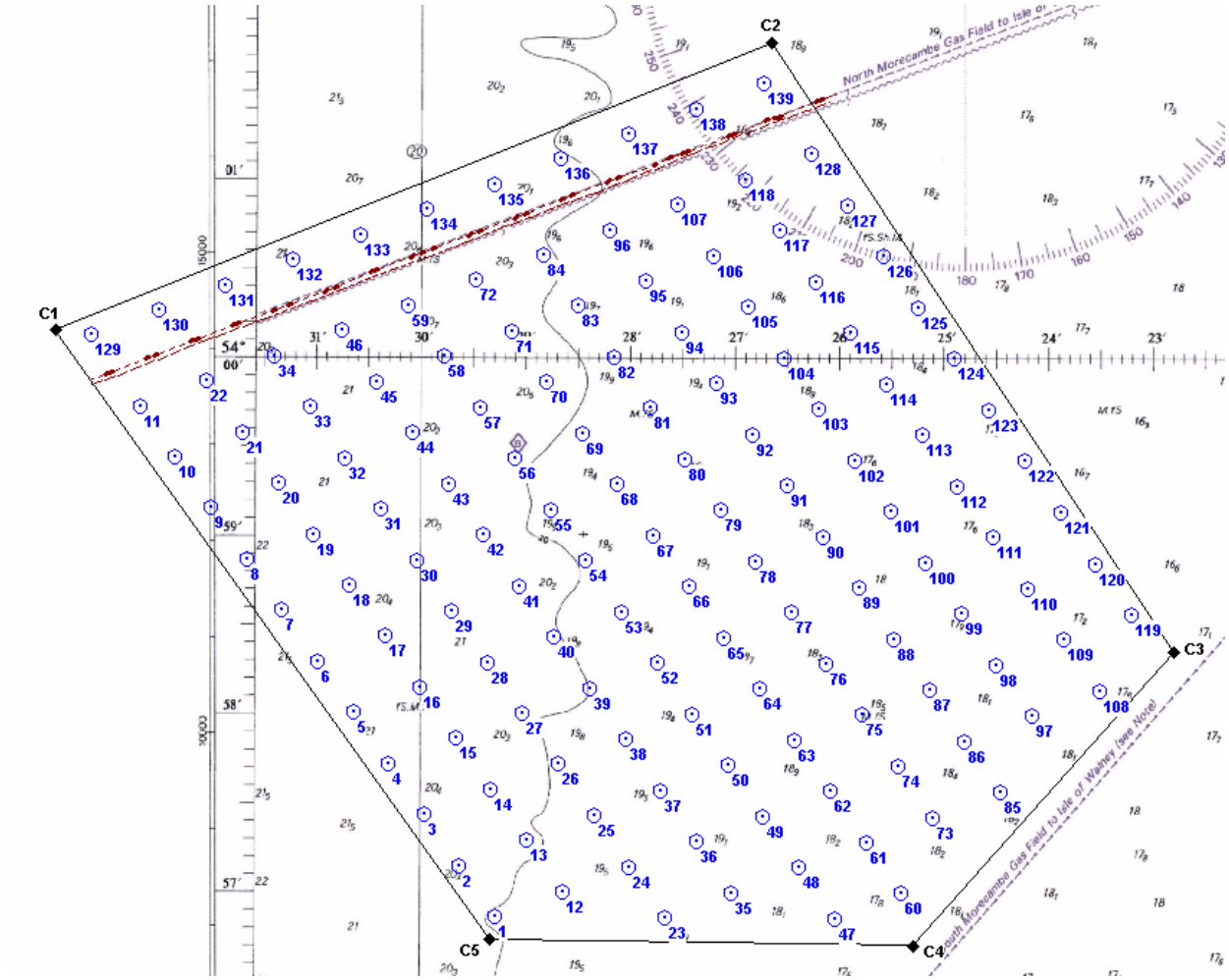
Within the wind farm area a number of considerations must be given to the placement of the turbines. The following restrictions have been considered:

- Minimum 100 m clearance from center of each wind turbine to boundary of wind farm.
- Minimum 232 m distance from oil/gas pipelines and electrical cables measured from center of turbines
- Wrecks and other seabed obstructions
- Alignment of turbines in straight lines. This applies especially along the long eastern boundary where numerous vessels pass within short distance.

In the following examples of turbine configurations are given for:

- 139 pcs. of 3.6 MW turbines
- 111 pcs. of 4.5 MW turbines
- 83 pcs. of 6.0 MW turbines

3.1.1 139 nos. 3.6 MW turbines



Spacing between turbines (centre-centre): N-S: 649 m , E-W: 748m

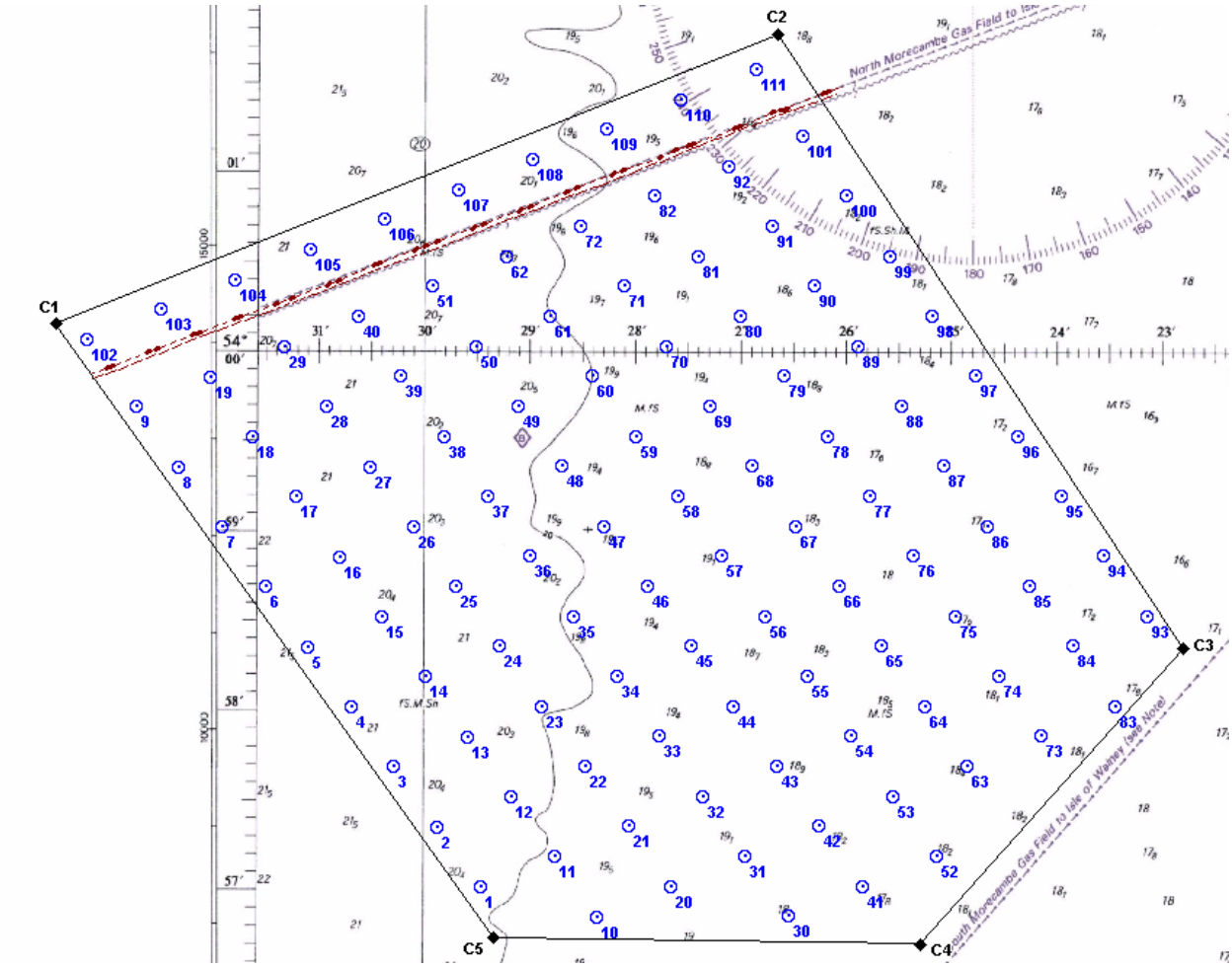
Turbine co-ordinates, UTM 30N, WGS84.

Turbine	Easting	Northing
1	467958	5977786
2	467589	5978321
3	467220	5978856
4	466851	5979391
5	466482	5979926
6	466112	5980461
7	465743	5980996
8	465374	5981531
9	465005	5982066
10	464636	5982601
11	464267	5983136
12	468662	5978044
13	468293	5978579
14	467924	5979114
15	467555	5979649
16	467186	5980184
17	466817	5980719
18	466447	5981254
19	466078	5981789
20	465709	5982324
21	465340	5982859
22	464971	5983394
23	469735	5977767
24	469366	5978302
25	468997	5978838
26	468628	5979373
27	468259	5979908
28	467890	5980443
29	467521	5980978
30	467152	5981513
31	466782	5982048
32	466413	5982583
33	466044	5983118
34	465675	5983653
35	470439	5978026
36	470070	5978561
37	469701	5979096
38	469332	5979631
39	468963	5980166
40	468594	5980701
41	468225	5981236
42	467856	5981771
43	467486	5982306
44	467117	5982841
45	466748	5983376
46	466379	5983911
47	471513	5977749

Turbine	Easting	Northing
48	471144	5978284
49	470774	5978819
50	470405	5979354
51	470036	5979889
52	469667	5980424
53	469298	5980959
54	468929	5981494
55	468560	5982029
56	468191	5982564
57	467821	5983099
58	467452	5983634
59	467083	5984169
60	472217	5978008
61	471848	5978543
62	471479	5979078
63	471109	5979613
64	470740	5980148
65	470371	5980683
66	470002	5981218
67	469633	5981753
68	469264	5982288
69	468895	5982823
70	468525	5983358
71	468156	5983893
72	467787	5984428
73	472552	5978801
74	472183	5979336
75	471813	5979871
76	471444	5980406
77	471075	5980941
78	470706	5981476
79	470337	5982011
80	469968	5982546
81	469599	5983081
82	469230	5983616
83	468860	5984151
84	468491	5984686
85	473256	5979059
86	472887	5979594
87	472518	5980129
88	472148	5980664
89	471779	5981199
90	471410	5981734
91	471041	5982269
92	470672	5982804
93	470303	5983340
94	469934	5983875

Turbine	Easting	Northing
95	469565	5984410
96	469195	5984945
97	473591	5979853
98	473222	5980388
99	472852	5980923
100	472483	5981458
101	472114	5981993
102	471745	5982528
103	471376	5983063
104	471007	5983598
105	470638	5984133
106	470269	5984668
107	469899	5985203
108	474295	5980111
109	473926	5980646
110	473557	5981181
111	473187	5981716
112	472818	5982251
113	472449	5982786
114	472080	5983321
115	471711	5983856
116	471342	5984391
117	470973	5984926
118	470604	5985461
119	474630	5980905
120	474261	5981440
121	473892	5981975
122	473522	5982510
123	473153	5983045
124	472784	5983580
125	472415	5984115
126	472046	5984650
127	471677	5985185
128	471308	5985720
129	463761	5983876
130	464465	5984134
131	465169	5984393
132	465873	5984651
133	466577	5984909
134	467281	5985168
135	467985	5985426
136	468689	5985685
137	469393	5985943
138	470098	5986201
139	470802	5986460

3.1.2 111 nos 4.5 MW turbines



Spacing between turbines (centre-centre): N-S: 764 m , E-W: 827m

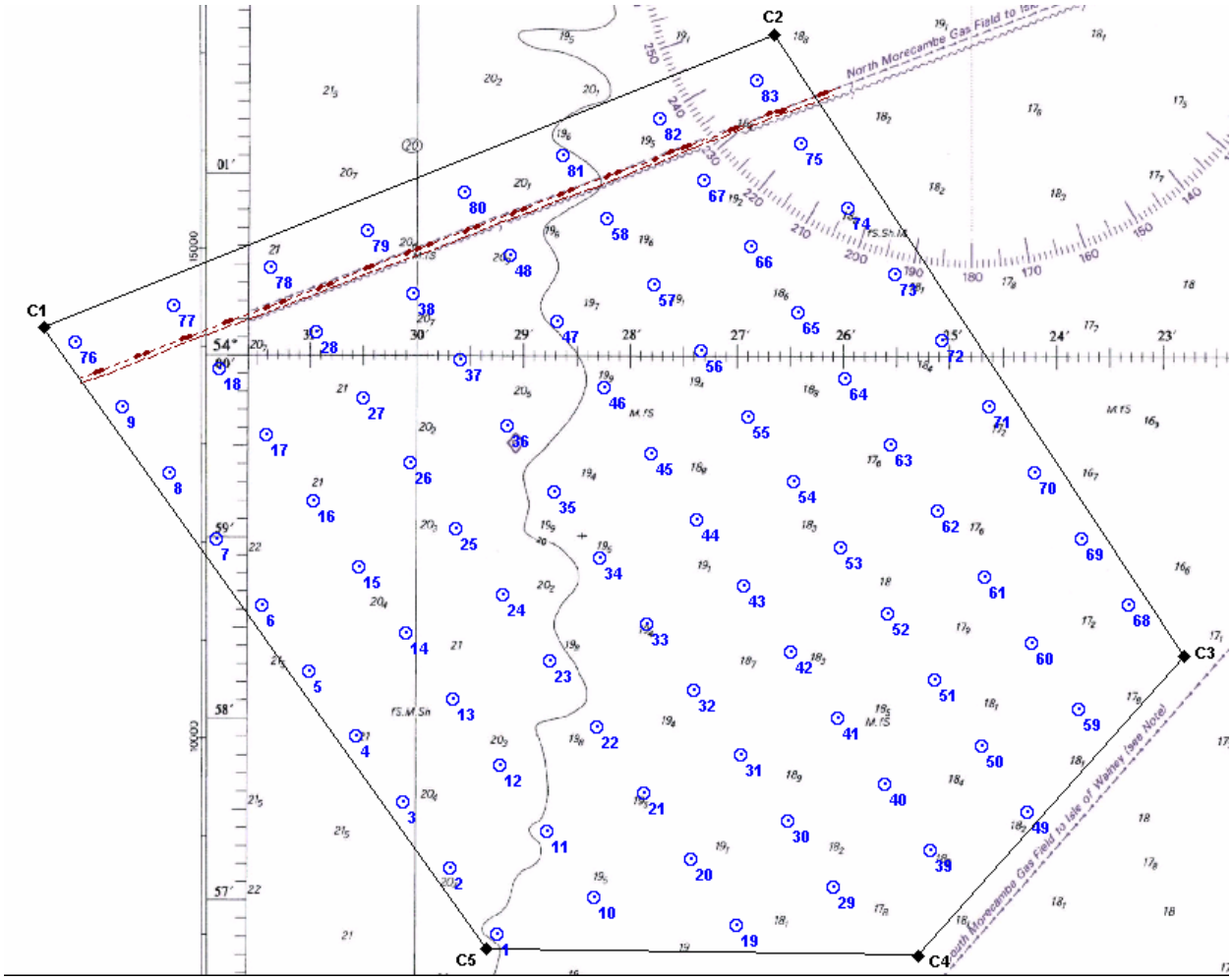
Turbine co-ordinates, UTM 30N, WGS84.

Turbine	Easting	Northing
1	467773	5978078
2	467329	5978701
3	466885	5979324
4	466441	5979947
5	465997	5980570
6	465553	5981193
7	465109	5981816
8	464665	5982439
9	464221	5983062
10	468987	5977763
11	468543	5978386
12	468099	5979009
13	467655	5979632
14	467211	5980255
15	466768	5980878
16	466324	5981501
17	465880	5982124
18	465436	5982747
19	464992	5983370
20	469758	5978071
21	469314	5978694
22	468870	5979317
23	468426	5979940
24	467982	5980563
25	467538	5981186
26	467094	5981809
27	466650	5982432
28	466206	5983055
29	465763	5983678
30	470973	5977756
31	470529	5978379
32	470085	5979002
33	469641	5979625
34	469197	5980248
35	468753	5980871
36	468309	5981494
37	467865	5982117

Turbine	Easting	Northing
38	467421	5982740
39	466977	5983363
40	466533	5983986
41	471743	5978064
42	471299	5978687
43	470855	5979310
44	470412	5979933
45	469968	5980556
46	469524	5981179
47	469080	5981802
48	468636	5982425
49	468192	5983048
50	467748	5983671
51	467304	5984294
52	472514	5978372
53	472070	5978995
54	471626	5979618
55	471182	5980241
56	470738	5980864
57	470294	5981487
58	469850	5982110
59	469407	5982733
60	468963	5983356
61	468519	5983979
62	468075	5984602
63	472841	5979303
64	472397	5979926
65	471953	5980549
66	471509	5981172
67	471065	5981795
68	470621	5982418
69	470177	5983041
70	469733	5983664
71	469289	5984287
72	468845	5984910
73	473612	5979611
74	473168	5980234

Turbine	Easting	Northing
75	472724	5980857
76	472280	5981480
77	471836	5982103
78	471392	5982726
79	470948	5983349
80	470504	5983972
81	470060	5984595
82	469616	5985218
83	474382	5979919
84	473938	5980542
85	473494	5981165
86	473051	5981788
87	472607	5982411
88	472163	5983034
89	471719	5983657
90	471275	5984280
91	470831	5984903
92	470387	5985526
93	474709	5980850
94	474265	5981473
95	473821	5982096
96	473377	5982719
97	472933	5983342
98	472489	5983965
99	472046	5984588
100	471602	5985211
101	471158	5985834
102	463719	5983766
103	464491	5984072
104	465263	5984378
105	466035	5984684
106	466807	5984990
107	467579	5985296
108	468351	5985602
109	469123	5985908
110	469895	5986214
111	470667	5986520

3.1.3 83 nos. 6.0 MW turbines



Spacing between turbines (centre-centre): N-S: 827 m , E-W: 1064m

Turbine co-ordinates, UTM 30N, WGS84.

Turbine	Easting	Northing
1	468014	5977698
2	467536	5978375
3	467058	5979052
4	466581	5979729
5	466103	5980406
6	465625	5981083
7	465148	5981760
8	464670	5982437
9	464192	5983114
10	469011	5978078
11	468533	5978755
12	468055	5979432
13	467577	5980109
14	467100	5980786
15	466622	5981464
16	466144	5982141
17	465667	5982818
18	465189	5983495
19	470485	5977782
20	470007	5978459
21	469530	5979136
22	469052	5979813
23	468574	5980490
24	468097	5981167
25	467619	5981844
26	467141	5982521
27	466664	5983198
28	466186	5983875

Turbine	Easting	Northing
29	471482	5978162
30	471004	5978839
31	470527	5979516
32	470049	5980193
33	469571	5980870
34	469094	5981547
35	468616	5982225
36	468138	5982902
37	467661	5983579
38	467183	5984256
39	472479	5978543
40	472001	5979220
41	471524	5979897
42	471046	5980574
43	470568	5981251
44	470091	5981928
45	469613	5982605
46	469135	5983282
47	468658	5983959
48	468180	5984636
49	473476	5978923
50	472998	5979600
51	472520	5980277
52	472043	5980954
53	471565	5981631
54	471087	5982309
55	470610	5982986
56	470132	5983663

Turbine	Easting	Northing
57	469654	5984340
58	469177	5985017
59	473995	5979981
60	473517	5980658
61	473040	5981335
62	472562	5982012
63	472084	5982689
64	471607	5983366
65	471129	5984043
66	470651	5984720
67	470174	5985397
68	474514	5981038
69	474037	5981715
70	473559	5982393
71	473081	5983070
72	472604	5983747
73	472126	5984424
74	471648	5985101
75	471171	5985778
76	463722	5983777
77	464723	5984154
78	465722	5984531
79	466722	5984908
80	467723	5985284
81	468723	5985661
82	469722	5986038
83	470722	5986414

Appendix 2 – Antenna Location Check Sheets

Pager Power Limited
Microwave Link Antenna Location Check

Customer	**Scottish Power**
Customer Reference	**West of Duddon Sands**
Pager Power Reference	**5198**

RCA Link Reference	**14173**
Link Operator	**HRL/Centrica**
Link Frequency Low (MHz)	**7500 (For Calculation Purposes)**
Link Frequency High (MHz)	**7500 (For Calculation Purposes)**
Service	**Offshore**
Survey Date	**20 Sept 05 (onshore)**
Surveyor	**Michael Watson**

	A End	**B End**
Location Name	North Morecambe Gas Field (DPPA) - Upper	HRL/Centrica north Terminal Barrow
RCA Specified NGR	290400E 452900N (535736N 034014W)	322900E 467300N (540530N 031040W)
Measured NGR	**290383E 452815N**	**322726E 467510N**
Measurement Accuracy	10m	10m
Specific Antenna Identified	Yes	Yes
Measurement Method	Fugro / Centrica	GPS1 on path + 1:10,000OS + 25cm aerial photo
Crosscheck Method	Initial Coords and Mainland Theodolite	GPS2 and map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Garmin	Garmin
GPS Model	Geko 201	GPS 12
GPS Serial Number	*90421141*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	This relates to the upper microwave antenna at DPPA Offshore Antennae measurements supplied by Fugro Onshore antennae heights approx. 38m and 44m measured using Clinometer

Pager Power Limited
Microwave Link Antenna Location Check

Customer	**Scottish Power**
Customer Reference	**West of Duddon Sands**
Pager Power Reference	**5198**

RCA Link Reference	**14173**
Link Operator	**HRL/Centrica**
Link Frequency Low (MHz)	**7500 (For Calculation Purposes)**
Link Frequency High (MHz)	**7500 (For Calculation Purposes)**
Service	**Offshore**
Survey Date	**20 Sept 05 (onshore)**
Surveyor	**Michael Watson**

	A End	**B End**
Location Name	North Morecambe Gas Field (DPPA) - Lower	HRL/Centrica north Terminal Barrow
RCA Specified NGR	290400E 452900N (535736N 034014W)	322900E 467300N (540530N 031040W)
Measured NGR	**290365E 452829N**	**322726E 467510N**
Measurement Accuracy	10m	10m
Specific Antenna Identified	Yes	Yes
Measurement Method	Fugro / Centrica	GPS1 on path + 1:10,000OS + 25cm aerial photo
Crosscheck Method	Initial Coords and Mainland Theodolite	GPS2 and map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Garmin	Garmin
GPS Model	Geko 201	GPS 12
GPS Serial Number	*90421141*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	This relates to the lower microwave antenna at DPPA Offshore Antennae measurements supplied by Fugro Onshore antennae heights approx. 38m and 44m measured using Clinometer

Pager Power Limited
Microwave Link Antenna Location Check

Customer	**Scottish Power**
Customer Reference	**West of Duddon Sands**
Pager Power Reference	**5198**

RCA Link Reference	**26376**
Link Operator	**HRL/Centrica**
Link Frequency Low (MHz)	**7500 (For Calculation Purposes)**
Link Frequency High (MHz)	**7500 (For Calculation Purposes)**
Service	**Offshore**
Survey Date	**20 Sept 05 (onshore)**
Surveyor	**Michael Watson**

	A End	**B End**
Location Name	Accomodation Platform AP1	BT Dalton Radio Station - Lower
RCA Specified NGR	296000E 440100N (535046N 033451W)	322500E 475700N (541005N 031105W)
Measured NGR	**295922E 440016N**	**322444E 475646N**
Measurement Accuracy	10m	10m
Specific Antenna Identified	Yes	Yes
Measurement Method	Fugro / Centrica	GPS1 on path and Interpolation
Crosscheck Method	Initial Coords and Mainland Theodolite	GPS2 and 1:10,000 map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Garmin	Garmin
GPS Model	Geko 201	GPS 12
GPS Serial Number	*90421141*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	This measurement relates to the lower dish at the onshore end Offshore Antennae measurements supplied by Fugro Lower Antenna approx 7.5m agl

Pager Power Limited
Microwave Link Antenna Location Check

Customer	**Scottish Power**
Customer Reference	**West of Duddon Sands**
Pager Power Reference	**5198**

RCA Link Reference	**26376**
Link Operator	**HRL/Centrica**
Link Frequency Low (MHz)	**7500 (For Calculation Purposes)**
Link Frequency High (MHz)	**7500 (For Calculation Purposes)**
Service	**Offshore**
Survey Date	**20 Sept 05 (onshore)**
Surveyor	**Michael Watson**

	A End	**B End**
Location Name	Accomodation Platform AP1	BT Dalton Radio Station - Upper
RCA Specified NGR	296000E 440100N (535046N 033451W)	322500E 475700N (541005N 031105W)
Measured NGR	**295922E 440016N**	**322441E 475645N**
Measurement Accuracy	10m	10m
Specific Antenna Identified	Yes	Yes
Measurement Method	Fugro / Centrica	GPS1 on path and Interpolation
Crosscheck Method	Initial Coords and Mainland Theodolite	GPS2 and 1:10,000 map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Garmin	Garmin
GPS Model	Geko 201	GPS 12
GPS Serial Number	*90421141*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	This measurement relates to the upper dish at the onshore end Offshore Antennae measurements supplied by Fugro Upper Antenna approx. 16.5m agl

Appendix 3 – Exclusion Zone Charts

Charts are shown for each of the three layouts.

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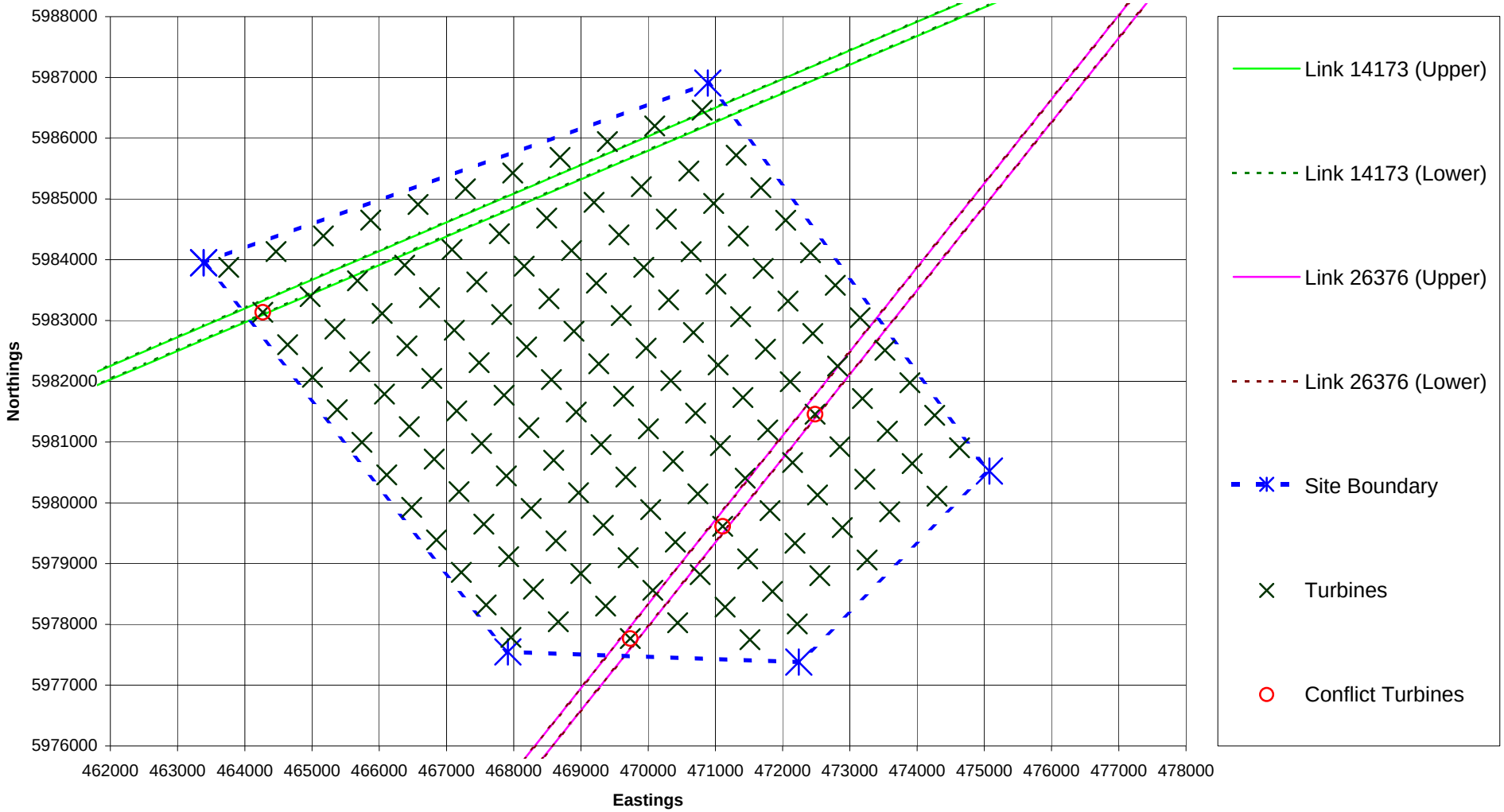
Proposed Wind Farm West of Duddon Sands - Exclusion Chart - Microwave Communications Links
139 x 3.6 MW Layout



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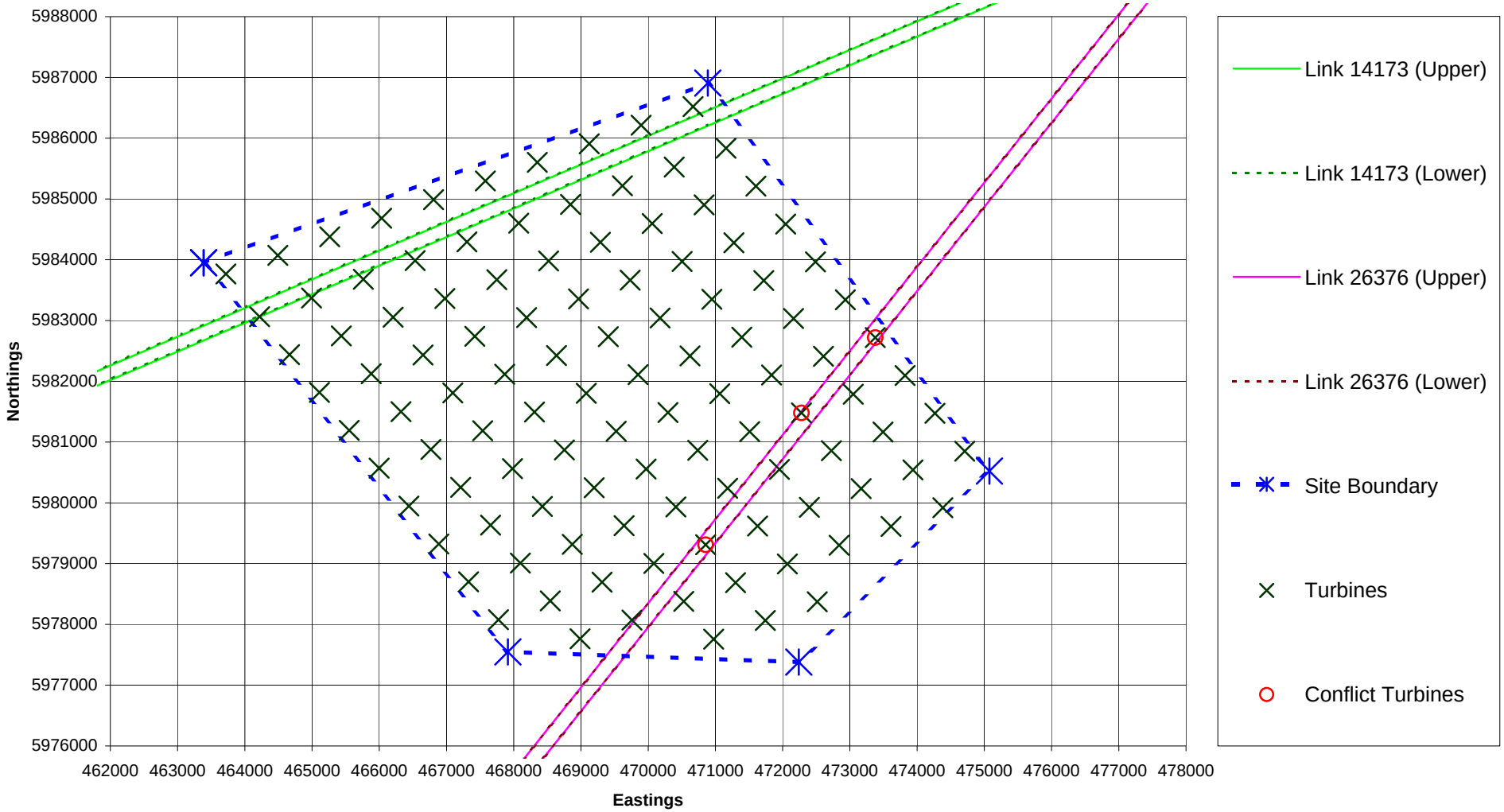
Proposed Wind Farm West of Duddon Sands - Exclusion Chart - Microwave Communications Links
111 x 4.5 MW Layout



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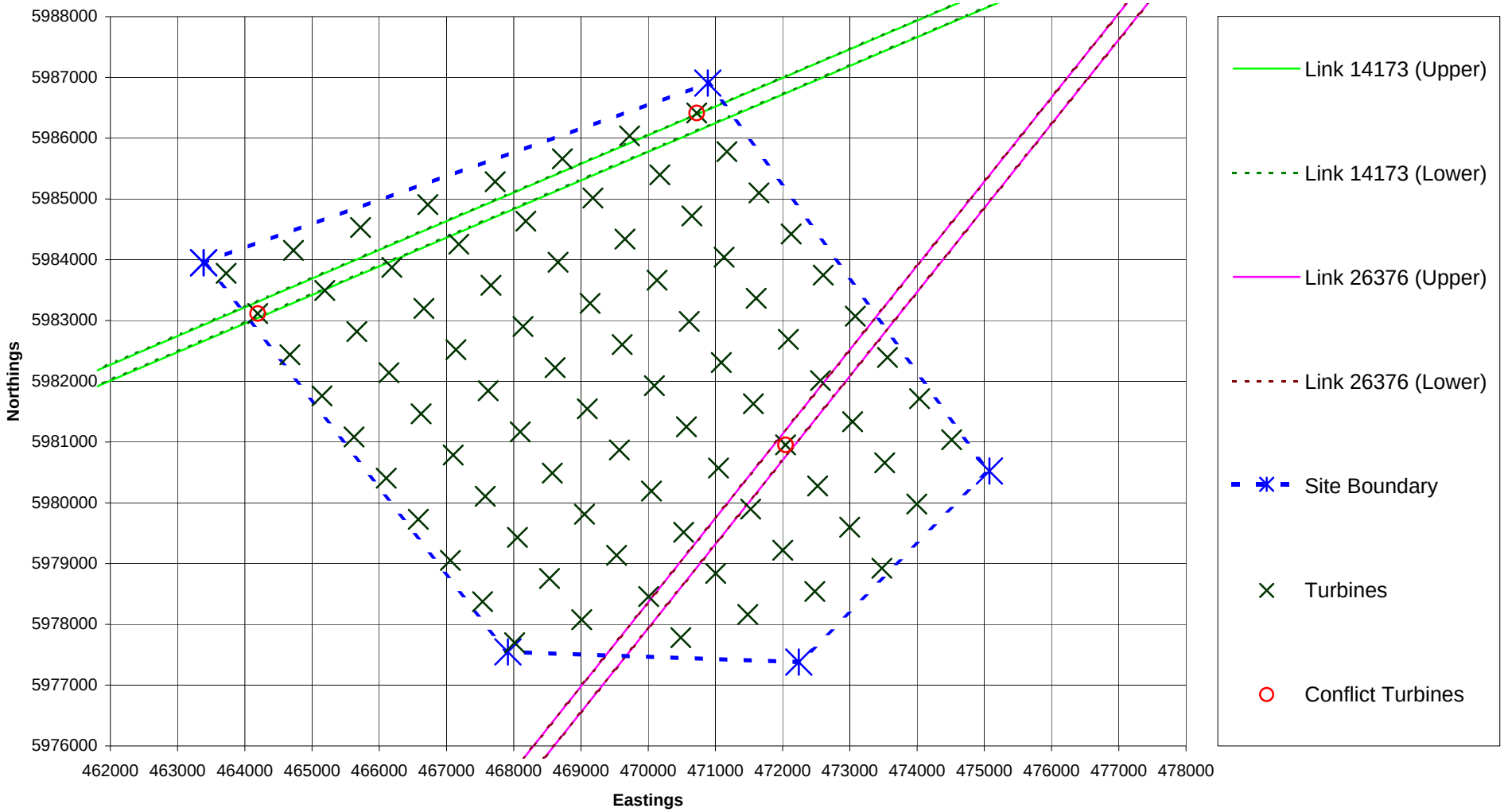
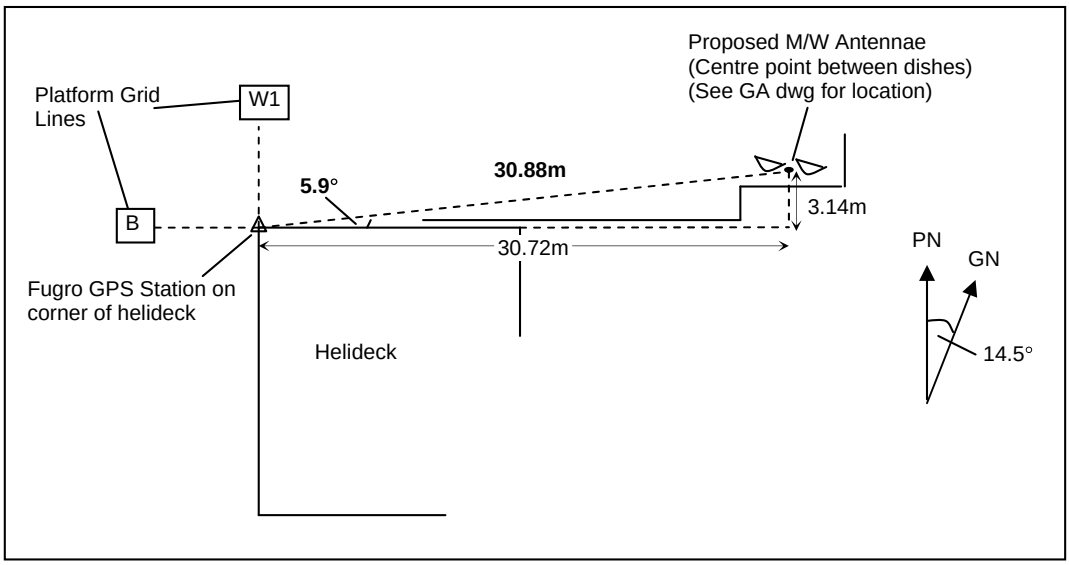
Proposed Wind Farm West of Duddon Sands - Exclusion Chart - Microwave Communications Links
83 x 6.0 MW Layout



Appendix 4 – Fugro Offshore Aerial position information

Calculation of Proposed Microwave Antennae Co-ords on AP1 from Fugro GPs station

1. Location of GPS station and proposed microwave antennae (Not to scale)
   See scaled GA drawing provided by HRL for dimensions



2. Computed Grid Bearing and Distance from GPS Stn to Antenna Centre:

   30.88m @ 69.6° (G)

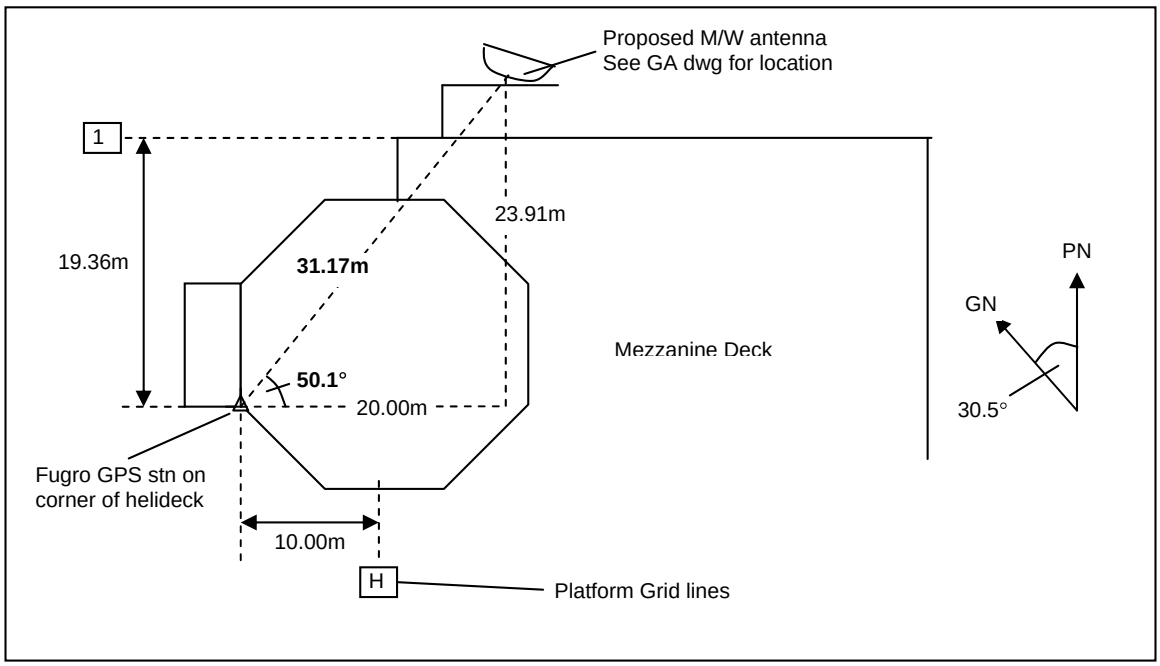
3. Co-ordinates:

	WGS84	UTM (International / 3°W)	Height (AMSL)
AP1 GPS Station	53° 50’ 44.995”N	461 683.57mE	
(from Fugro report)	03° 35’ 02.143”W	5 966 746.24mN	54.8m
M/W Antenna	**53° 50’ 45.351”N**	**461 712.5mE**	*****
(Centre point)	**03° 35’ 00.564”W**	**5 966 757.0mN**	

* Exact height location of antennae not known. This can be deduced from engineering drawings assuming the MSL height of GPS station at helideck level at 54.8m

Calculation of Proposed Lower Microwave Antennae Co-ords on DPPA from Fugro GPs station

1. Location of GPS station and proposed lower microwave antenna (Not to scale)
   See scaled GA drawing provided by HRL for dimensions



2. Computed Grid Bearing and Distance from GPS Stn to Antenna Centre:

   31.17m @ 70.4° (G)

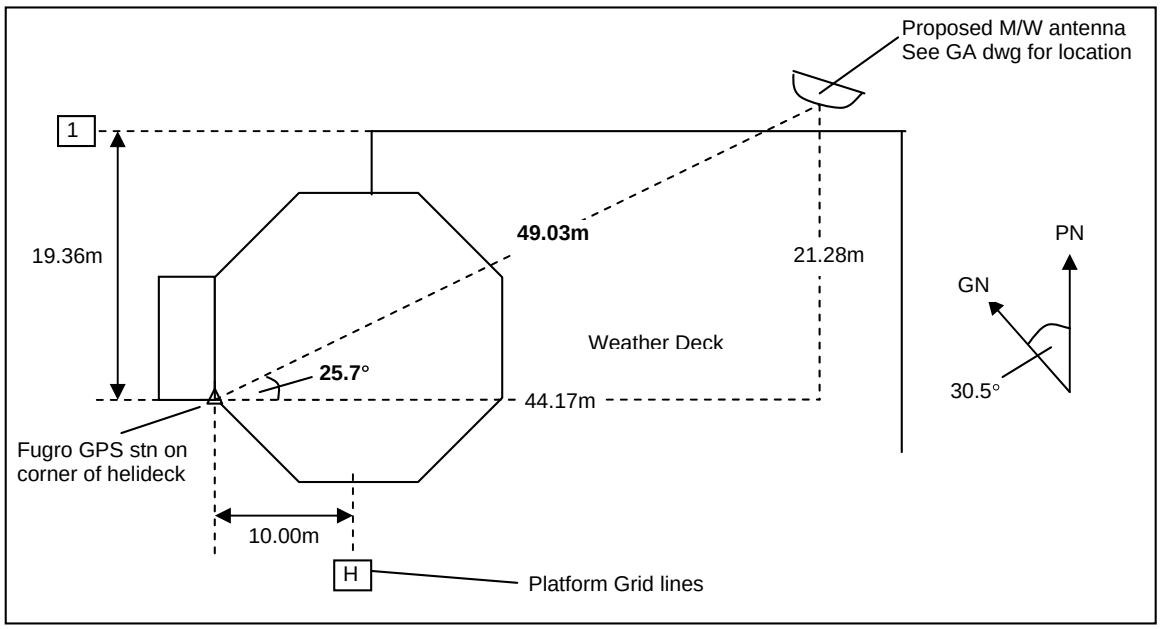
3. Co-ordinates:

	WGS84	UTM (International / 3°W)	Height (AMSL)
DPPA GPS Station	53° 57’ 35.300”N	455 946.77mE	
(from Fugro report)	03° 40’ 22.640”W	5 979 478.48mN	41.4m
M/W Antenna	**53° 57’ 35.646”N**	**455 976.1mE**	*****
(Lower)	**03° 40’ 21.030”W**	**5 979 488.9mN**	

* Exact height location of antenna not known. This can be deduced from engineering elevation drawings assuming the MSL height of GPS station at helideck level at 41.4m

Calculation of Proposed Upper Microwave Antennae Co-ords on DPPA from Fugro GPs station

1. Location of GPS station and proposed upper microwave antenna (Not to scale)
   See scaled GA drawing provided by HRL for dimensions



2. Computed Grid Bearing and Distance from GPS Stn to Antenna Centre:

   49.03m @ 94.8° (G)

3. Co-ordinates:

	WGS84	UTM (International / 3°W)	Height (AMSL)
DPPA GPS Station	53° 57' 35.300"N	455 946.77mE	
(from Fugro report)	03° 40' 22.640"W	5 979 478.48mN	41.40m
M/W Antenna	**53° 57' 35.183"N**	**445 995.6mE**	*****
(Upper)	**03° 40' 19.959"W**	**5 979 474.4mN**	

* Exact height location of antenna not known. This can be deduced from engineering drawings assuming the MSL height of GPS station at helideck level at 41.4m

Appendix 5 – Clearance Calculations

Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 14173	
Easting	455893	488022
Northing	5979260	5994409

Turbine	T11 3.6
Turbine Easting	464267
Turbine Northing	5983136
Turbine Rotor Diameter	110

Calculation Reference	5198/1

Turbine Distance from Link Path (m)	65.5
Turbine Tip Distance to Link Path (m)	10.5
Turbine Distance from A End (km)	9.2
Turbine Distance from Z End (km)	26.3
Link Length (km)	35.5

Easting Difference A - Z End (m)	-32129
Northing Difference A - Z End (m)	-15149
Point Separation A-Z (m)	35521.3294
Easting Difference A - Turbine (m)	-8374
Northing Difference A - Turbine (m)	-3876
Point Separation A - Turbine (m)	9227.526863
Easting Difference Z - Turbine (m)	23755
Northing Difference Z - Turbine (m)	11273
Point Separation Z - Turbine (m)	26294.11634
Rotor Radius (m)	55
Link Gradient	0.471505493
Inverse Gradient	-2.120866064
Cab	5764303.946
Cpq	6967784.125
Xqinit	464239.0769
Xq	464239.0769
Yq	5983195.221
Easting Difference Turbine - Line (m)	27.92308155
Northing Difference Turbine - Line (m)	-59.22111605
Point Separation Turbine - Line (m)	65.47395719

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487622
Northing	5966542	6002538

Turbine	T23 3.6
Turbine Easting	469735
Turbine Northing	5977767
Turbine Rotor Diameter	110

Calculation Reference	5198/2

Turbine Distance from Link Path (m)	10.3
Turbine Tip Distance to Link Path (m)	-44.7
Turbine Distance from A End (km)	13.9
Turbine Distance from Z End (km)	30.6
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26011
Northing Difference A - Z End (m)	-35996
Point Separation A-Z (m)	44410.40573
Easting Difference A - Turbine (m)	-8124
Northing Difference A - Turbine (m)	-11225
Point Separation A - Turbine (m)	13856.4065
Easting Difference Z - Turbine (m)	17887
Northing Difference Z - Turbine (m)	24771
Point Separation Z - Turbine (m)	30554.00481
Rotor Radius (m)	55
Link Gradient	1.383876052
Inverse Gradient	-0.722608068
Cab	5327729.592
Cpq	6317201.301
Xqinit	469726.6405
Xq	469726.6405
Yq	5977773.041
Easting Difference Turbine - Line (m)	8.359450636
Northing Difference Turbine - Line (m)	-6.040606471
Point Separation Turbine - Line (m)	10.31355135

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487622
Northing	5966542	6002538

Turbine	T63 3.6
Turbine Easting	471109
Turbine Northing	5979613
Turbine Rotor Diameter	110

Calculation Reference	5198/3

Turbine Distance from Link Path (m)	42.8
Turbine Tip Distance to Link Path (m)	-12.2
Turbine Distance from A End (km)	16.2
Turbine Distance from Z End (km)	28.3
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26011
Northing Difference A - Z End (m)	-35996
Point Separation A-Z (m)	44410.40573
Easting Difference A - Turbine (m)	-9498
Northing Difference A - Turbine (m)	-13071
Point Separation A - Turbine (m)	16157.4455
Easting Difference Z - Turbine (m)	16513
Northing Difference Z - Turbine (m)	22925
Point Separation Z - Turbine (m)	28253.04929
Rotor Radius (m)	55
Link Gradient	1.383876052
Inverse Gradient	-0.722608068
Cab	5327729.592
Cpq	6320040.164
Xqinit	471074.3191
Xq	471074.3191
Yq	5979638.061
Easting Difference Turbine - Line (m)	34.68089096
Northing Difference Turbine - Line (m)	-25.0606916
Point Separation Turbine - Line (m)	42.7878775

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487622
Northing	5966542	6002538

Turbine	T100 3.6
Turbine Easting	472483
Turbine Northing	5981458
Turbine Rotor Diameter	110

Calculation Reference	5198/4

Turbine Distance from Link Path (m)	75.8
Turbine Tip Distance to Link Path (m)	20.8
Turbine Distance from A End (km)	18.5
Turbine Distance from Z End (km)	26.0
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26011
Northing Difference A - Z End (m)	-35996
Point Separation A-Z (m)	44410.40573
Easting Difference A - Turbine (m)	-10872
Northing Difference A - Turbine (m)	-14916
Point Separation A - Turbine (m)	18457.72034
Easting Difference Z - Turbine (m)	15139
Northing Difference Z - Turbine (m)	21080
Point Separation Z - Turbine (m)	25952.95207
Rotor Radius (m)	55
Link Gradient	1.383876052
Inverse Gradient	-0.722608068
Cab	5327729.592
Cpq	6322878.028
Xqinit	472421.5229
Xq	472421.5229
Yq	5981502.424
Easting Difference Turbine - Line (m)	61.47705596
Northing Difference Turbine - Line (m)	-44.42381661
Point Separation Turbine - Line (m)	75.84789971

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 14173	
Easting	455893	488022
Northing	5979260	5994409

Turbine	T9 4.5
Turbine Easting	464221
Turbine Northing	5983062
Turbine Rotor Diameter	125

Calculation Reference	5198/5

Turbine Distance from Link Path (m)	112.8
Turbine Tip Distance to Link Path (m)	50.3
Turbine Distance from A End (km)	9.2
Turbine Distance from Z End (km)	26.4
Link Length (km)	35.5

Easting Difference A - Z End (m)	-32129
Northing Difference A - Z End (m)	-15149
Point Separation A-Z (m)	35521.3294
Easting Difference A - Turbine (m)	-8328
Northing Difference A - Turbine (m)	-3802
Point Separation A - Turbine (m)	9154.82321
Easting Difference Z - Turbine (m)	23801
Northing Difference Z - Turbine (m)	11347
Point Separation Z - Turbine (m)	26367.44223
Rotor Radius (m)	62.5
Link Gradient	0.471505493
Inverse Gradient	-2.120866064
Cab	5764303.946
Cpq	6967612.565
Xqinit	464172.8982
Xq	464172.8982
Yq	5983164.017
Easting Difference Turbine - Line (m)	48.10180445
Northing Difference Turbine - Line (m)	-102.0174847
Point Separation Turbine - Line (m)	112.7889656

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aviation studies

Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487625
Northing	5966542	6002539

Turbine	T43 4.5
Turbine Easting	470855
Turbine Northing	5979310
Turbine Rotor Diameter	125

Calculation Reference	5198/6

Turbine Distance from Link Path (m)	13.7
Turbine Tip Distance to Link Path (m)	-48.8
Turbine Distance from A End (km)	15.8
Turbine Distance from Z End (km)	28.6
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26014
Northing Difference A - Z End (m)	-35997
Point Separation A-Z (m)	44412.97339
Easting Difference A - Turbine (m)	-9244
Northing Difference A - Turbine (m)	-12768
Point Separation A - Turbine (m)	15763.03778
Easting Difference Z - Turbine (m)	16770
Northing Difference Z - Turbine (m)	23229
Point Separation Z - Turbine (m)	28649.94487
Rotor Radius (m)	62.5
Link Gradient	1.383754901
Inverse Gradient	-0.722671334
Cab	5327785.516
Cpq	6319583.411
Xqinit	470843.8767
Xq	470843.8767
Yq	5979318.038
Easting Difference Turbine - Line (m)	11.12325054
Northing Difference Turbine - Line (m)	-8.038454304
Point Separation Turbine - Line (m)	13.72382783

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487622
Northing	5966542	6002538

Turbine	T76 4.5
Turbine Easting	472280
Turbine Northing	5981480
Turbine Rotor Diameter	125

Calculation Reference	5198/7

Turbine Distance from Link Path (m)	101.6
Turbine Tip Distance to Link Path (m)	39.1
Turbine Distance from A End (km)	18.4
Turbine Distance from Z End (km)	26.1
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26011
Northing Difference A - Z End (m)	-35996
Point Separation A-Z (m)	44410.40573
Easting Difference A - Turbine (m)	-10669
Northing Difference A - Turbine (m)	-14938
Point Separation A - Turbine (m)	18356.7809
Easting Difference Z - Turbine (m)	15342
Northing Difference Z - Turbine (m)	21058
Point Separation Z - Turbine (m)	26054.10386
Rotor Radius (m)	62.5
Link Gradient	1.383876052
Inverse Gradient	-0.722608068
Cab	5327729.592
Cpq	6322753.338
Xqinit	472362.3298
Xq	472362.3298
Yq	5981420.508
Easting Difference Turbine - Line (m)	-82.32979061
Northing Difference Turbine - Line (m)	59.4921709
Point Separation Turbine - Line (m)	101.5751585

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487625
Northing	5966542	6002539

Turbine	T96 4.5
Turbine Easting	473377
Turbine Northing	5982719
Turbine Rotor Diameter	125

Calculation Reference	5198/8

Turbine Distance from Link Path (m)	61.1
Turbine Tip Distance to Link Path (m)	-1.4
Turbine Distance from A End (km)	20.0
Turbine Distance from Z End (km)	24.4
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26014
Northing Difference A - Z End (m)	-35997
Point Separation A-Z (m)	44412.97339
Easting Difference A - Turbine (m)	-11766
Northing Difference A - Turbine (m)	-16177
Point Separation A - Turbine (m)	20003.35184
Easting Difference Z - Turbine (m)	14248
Northing Difference Z - Turbine (m)	19820
Point Separation Z - Turbine (m)	24409.79115
Rotor Radius (m)	62.5
Link Gradient	1.383754901
Inverse Gradient	-0.722671334
Cab	5327785.516
Cpq	6324814.988
Xqinit	473327.5038
Xq	473327.5038
Yq	5982754.77
Easting Difference Turbine - Line (m)	49.49623484
Northing Difference Turbine - Line (m)	-35.76951005
Point Separation Turbine - Line (m)	61.06828238

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487625
Northing	5966542	6002539

Turbine	T96 4.5
Turbine Easting	473377
Turbine Northing	5982719
Turbine Rotor Diameter	125

Calculation Reference	5198/8

Turbine Distance from Link Path (m)	61.1
Turbine Tip Distance to Link Path (m)	-1.4
Turbine Distance from A End (km)	20.0
Turbine Distance from Z End (km)	24.4
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26014
Northing Difference A - Z End (m)	-35997
Point Separation A-Z (m)	44412.97339
Easting Difference A - Turbine (m)	-11766
Northing Difference A - Turbine (m)	-16177
Point Separation A - Turbine (m)	20003.35184
Easting Difference Z - Turbine (m)	14248
Northing Difference Z - Turbine (m)	19820
Point Separation Z - Turbine (m)	24409.79115
Rotor Radius (m)	62.5
Link Gradient	1.383754901
Inverse Gradient	-0.722671334
Cab	5327785.516
Cpq	6324814.988
Xqinit	473327.5038
Xq	473327.5038
Yq	5982754.77
Easting Difference Turbine - Line (m)	49.49623484
Northing Difference Turbine - Line (m)	-35.76951005
Point Separation Turbine - Line (m)	61.06828238

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 14173	
Easting	455893	488022
Northing	5979260	5994409

Turbine	T18 6.0
Turbine Easting	465189
Turbine Northing	5983495
Turbine Rotor Diameter	145

Calculation Reference	5198/10

Turbine Distance from Link Path (m)	134.0
Turbine Tip Distance to Link Path (m)	61.5
Turbine Distance from A End (km)	10.2
Turbine Distance from Z End (km)	25.3
Link Length (km)	35.5

Easting Difference A - Z End (m)	-32129
Northing Difference A - Z End (m)	-15149
Point Separation A-Z (m)	35521.3294
Easting Difference A - Turbine (m)	-9296
Northing Difference A - Turbine (m)	-4235
Point Separation A - Turbine (m)	10215.22594
Easting Difference Z - Turbine (m)	22833
Northing Difference Z - Turbine (m)	10914
Point Separation Z - Turbine (m)	25307.33658
Rotor Radius (m)	72.5
Link Gradient	0.471505493
Inverse Gradient	-2.120866064
Cab	5764303.946
Cpq	6970098.563
Xqinit	465131.865
Xq	465131.865
Yq	5983616.176
Easting Difference Turbine - Line (m)	57.13496855
Northing Difference Turbine - Line (m)	-121.1756158
Point Separation Turbine - Line (m)	133.9699015

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 14173	
Easting	455875	488022
Northing	5979274	5994409

Turbine	T83 6.0
Turbine Easting	465189
Turbine Northing	5983495
Turbine Rotor Diameter	145

Calculation Reference	5198/11

Turbine Distance from Link Path (m)	148.5
Turbine Tip Distance to Link Path (m)	76.0
Turbine Distance from A End (km)	10.2
Turbine Distance from Z End (km)	25.3
Link Length (km)	35.5

Easting Difference A - Z End (m)	-32147
Northing Difference A - Z End (m)	-15135
Point Separation A-Z (m)	35531.64553
Easting Difference A - Turbine (m)	-9314
Northing Difference A - Turbine (m)	-4221
Point Separation A - Turbine (m)	10225.82207
Easting Difference Z - Turbine (m)	22833
Northing Difference Z - Turbine (m)	10914
Point Separation Z - Turbine (m)	25307.33658
Rotor Radius (m)	72.5
Link Gradient	0.470805985
Inverse Gradient	-2.124017179
Cab	5764645.322
Cpq	6971564.427
Xqinit	465125.7637
Xq	465125.7637
Yq	5983629.315
Easting Difference Turbine - Line (m)	63.23627238
Northing Difference Turbine - Line (m)	-134.3149288
Point Separation Turbine - Line (m)	148.4564793

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Pager Power Limited Clearance Calculation

	A End	Z End
Link Description	Centrica 26376	
Easting	461611	487625
Northing	5966542	6002539

Turbine	T52 6.0
Turbine Easting	472043
Turbine Northing	5980954
Turbine Rotor Diameter	145

Calculation Reference	5198/12

Turbine Distance from Link Path (m)	13.7
Turbine Tip Distance to Link Path (m)	-58.8
Turbine Distance from A End (km)	17.8
Turbine Distance from Z End (km)	26.6
Link Length (km)	44.4

Easting Difference A - Z End (m)	-26014
Northing Difference A - Z End (m)	-35997
Point Separation A-Z (m)	44412.97339
Easting Difference A - Turbine (m)	-10432
Northing Difference A - Turbine (m)	-14412
Point Separation A - Turbine (m)	17791.35655
Easting Difference Z - Turbine (m)	15582
Northing Difference Z - Turbine (m)	21585
Point Separation Z - Turbine (m)	26621.62559
Rotor Radius (m)	72.5
Link Gradient	1.383754901
Inverse Gradient	-0.722671334
Cab	5327785.516
Cpq	6322085.944
Xqinit	472031.9238
Xq	472031.9238
Yq	5980962.004
Easting Difference Turbine - Line (m)	11.0761673
Northing Difference Turbine - Line (m)	-8.004428598
Point Separation Turbine - Line (m)	13.66573669

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Appendix 6 – Exclusion Radius Graph

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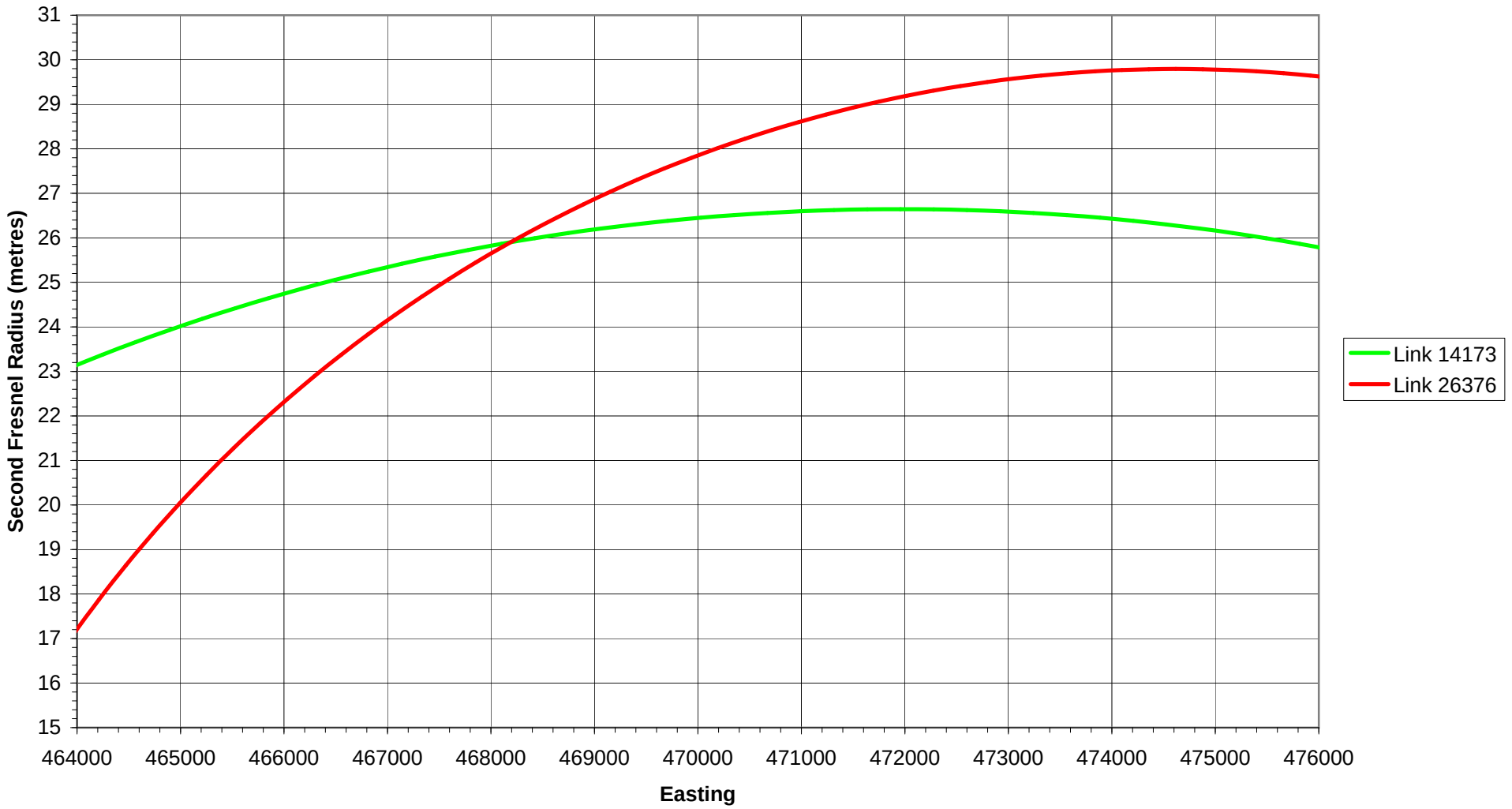
Proposed Wind Farm West of Duddon Sands - Microwave Communications Links
Exclusion Radius

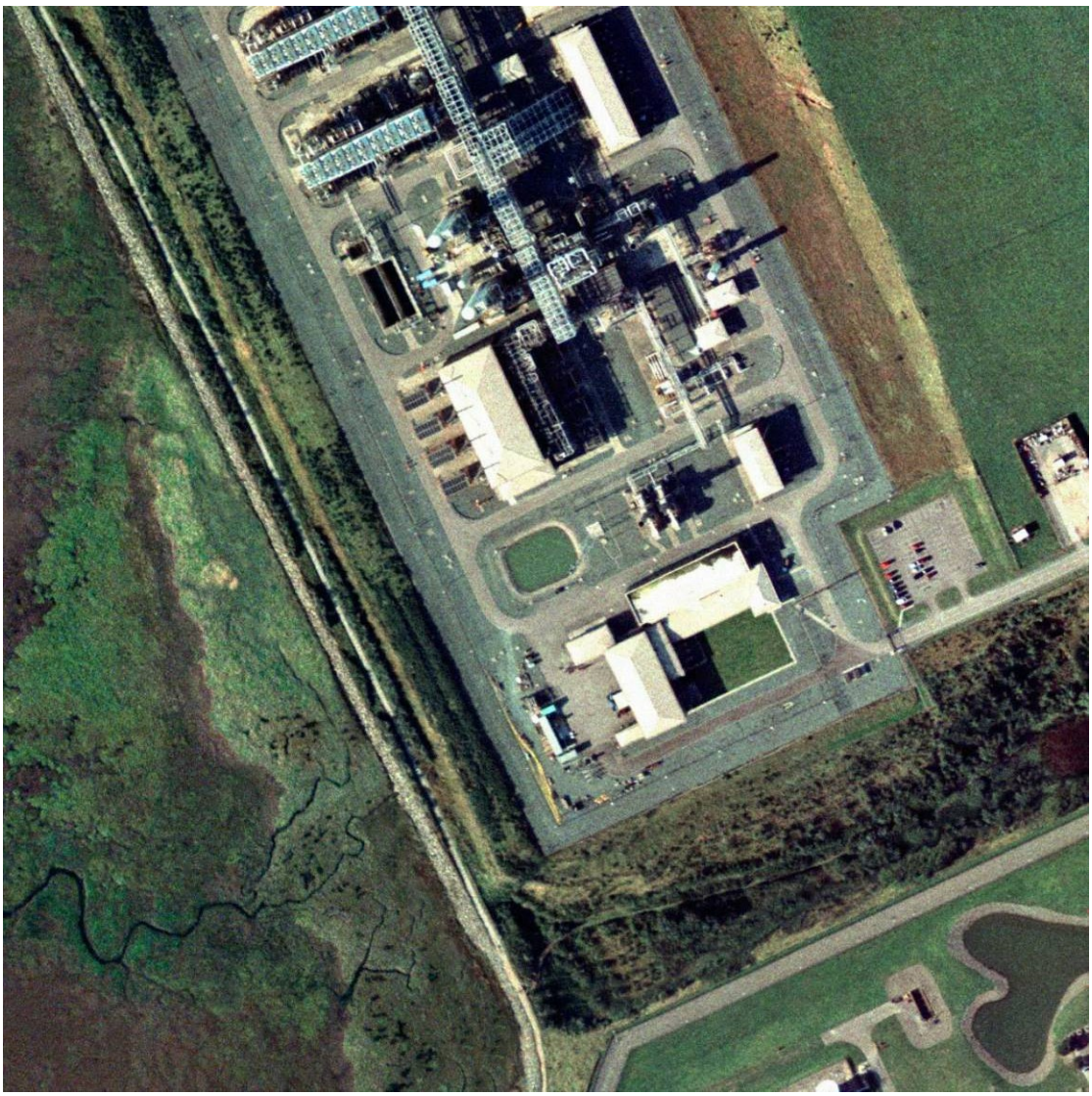


Appendix 7 – Photographs of Onshore Installations

Photograph 1 – Barrow communications mast

Photograph 2 – Barrow Antennae

Photograph 3 – Aerial Photograph of Barrow Mast



Photograph 4 – Aerial Photograph of Barrow Gas Terminal

Photograph 6 – Dalton Radio Mast