PROPOSED NAVITUS BAY WIND PARK

PRELIMINARY ENVIRONMENTAL INFORMATION 3

CHAPTER 7
OFFSHORE AIR QUALITY

SEPTEMBER 2013

NAVITUSBAY

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TABLE OF CONTENTS

7.1. Introduction 1
7.2. Legislation, Policy and Guidance 1
7.3. Assessment Methodology 3
7.4. Baseline Environment 11
7.5. Impact Assessment 21
7.6. Potential Mitigation 26
References 28
Glossary 29
Abbreviations 29

LIST OF TABLES

Table 7.1 Air quality standards 1
Table 7.2 MARPOL convention – nox limit values 2
Table 7.3 MARPOL sulphur limits 2
Table 7.4 Summary of NPS guidance regarding air quality 4
Table 7.5 Definition of impact magnitude for changes in pollutant concentrations 6
Table 7.6 Impact descriptors for annual mean concentrations 6
Table 7.7 EPUK factors to judge significance 7
Table 7.8 Statistics for meteorological data 7
Table 7.9 Details of assessed receptors 11
Table 7.10 Local pollution monitoring 14
Table 7.11 Average background annual mean air pollution concentrations along the coastline and contribution from shipping/off-road sources 16
Table 7.12 Average background annual mean air pollution concentrations at receptors 16
Table 7.13 Estimated number of vessel movements 21
Table 7.14 Emission factors at sea and on station 22
Table 7.15 Construction activities and associated vessel input data 23
Table 7.16 Modelled pollutant concentrations (in $\mu g/m^3$) 23
Table 7.17 Total annual mean no_2 and pm_{10} concentrations 24
Table 7.18 Significance of impacts 24
Table 7.19 Maximum modelled concentrations for sensitivity testing route 26

LIST OF FIGURES

Figure 7.1 Offshore Development Boundary 5
Figure 7.2 Wind rose of meteorological data at St Catherine's, 2011 8
Figure 7.3 Histogram of temperature for St Catherine's, 2011 8
Figure 7.4 Location of Modelled Point A and Western/Eastern Routes of Export Cable Corridor 10
Figure 7.5 Location of Assessed Receptors 13
Figure 7.6 Location of Local Monitoring Sites 15
Figure 7.7 Background NOx Concentrations (2012) 17
Figure 7.8 Background NO_2 Concentrations (2012) 18
Figure 7.9 Background PM_{10} Concentrations (2012) 19
Figure 7.10 Background SO_2 Concentrations (2001) 20
Figure 7.11 Location of Estimated Route Through the Solent For Sensitivity Testing 27

7. OFFSHORE AIR QUALITY

7.1. Introduction

7.1 This chapter assesses the potential impacts on air quality arising from the construction, operation and maintenance ('O&M') and decommissioning of the offshore elements of the Navitus Bay Wind Park ('the Project').

7.2 For the purpose of this assessment, the Offshore Development Area comprises the following project elements: the Turbine Area and an Offshore Export Cable Corridor. For details of the Project description used within this assessment refer to Chapter 2, Navitus Bay Wind Park Project.

7.3 Potential local air quality impacts could arise for human receptors from the Project, as a result of emissions to the atmosphere from shipping associated with activities undertaken during all phases of the Project. Ship engines are large compared with onshore vehicles and their fuel quality is less well regulated (compared with petrol and diesel for motor vehicles).

7.4 The main pollutants associated with the use of marine engines are nitrogen oxides ('NOx'), sulphur dioxide ('SO_2') and particulate matter ('PM'). This chapter examines the relevant guidance and legislation, the sources of these atmospheric emissions, their quantification and an assessment of their impacts.

7.2. Legislation, Policy and Guidance

7.5 This section outlines the legislation, policy and guidance that is relevant to the assessment of potential impacts on air quality associated with the construction, O&M and decommissioning phases of the Project. In addition, other national, regional and local policies are considered within this assessment where they are judged to be relevant and important to the Project. Other policies are considered within this assessment and these are grouped into those regarding air quality and those relating to fuel quality and emissions standards. Most of these are national policies that aim to achieve international targets, so they are presented by subject rather than geographic status.

7.2.1. Air Quality Standards

7.6 Ambient air quality limit values and objectives for various pollutants have been set at european and national levels. These standards are mainly applied to onshore situations but can be applied up to three miles offshore, as the Environment Agency ('EA') is the regulator for air quality to this distance. There are two sets of standards: *limit values* that are set at European level and are air quality standards that should be achieved by their target date (EU Directive 2008/50/EC), and *objectives* that are target values that local authorities in the UK should work towards achieving (Air Quality Standards Regulations 2010, SI 2010/1001).

7.7 In most cases the limit values and objectives are numerically the same but have different target dates. Air quality objectives usually have an earlier target date for achievement as they were partly intended to be a mechanism to improve air quality before the limit values were applicable. In the context of this assessment, the most relevant pollutants are those produced from combustion of fossil fuels, namely, NOx[1], PM[2] and SO_2. The relevant air quality standards are shown in Table 7.1.

Table 7.1 Air quality standards

Pollutant	Averaging period	Limit value / objective	Date for compliance	Basis
Nitrogen Dioxide (NO_2)	1 hour mean	200 µg/m^3, not to be exceeded more than 18 times a year (99.8th percentile)	31/12/05 01/01/10	UK EU
	Annual mean	40 µg/m^3	31/12/05 01/01/10	UK EU

[1] The limit values for ambient air quality have been set based on recommendations by the World Health Organisation after conducting epidemiological studies to assess the impact of various pollutants to human health. Therefore, a limit value has been set for nitrogen dioxide (NO_2) instead of NOx in relation to impacts on human health.
[2] Air quality standards have been set for specific sizes of particulate matter, namely less than 10 µm (PM_{10}) and less than 2.5 µm ($PM_{2.5}$).

Table 7.1 Air quality standards				
Fine Particulate Matter (PM_{10})	Daily mean	50 µg/m^3, not to be exceeded more than 35 times a year (90.4th percentile)	01/01/05	UK / EU
	Annual mean	40 µg/m^3	01/01/05	UK / EU
Very Fine Particulate Matter ($PM_{2.5}$)	Annual mean	25 µg/m^3	01/01/15	UK / EU
Sulphur Dioxide (SO_2)	1 hour mean	350 µg/m^3, not to be exceeded more than 24 times a year	01/01/05	UK / EU
	Daily mean	125 µg/m^3, not to be exceeded more than 3 times a year	01/01/05	UK / EU

7.2.2. Fuel quality and emission standards

MARPOL

7.8 The MARPOL Convention is the key international convention covering the prevention of pollution from ships (International Maritime Organisation, 2011). It is a combination of two treaties adopted in 1973 and 1978 and updated by various amendments since. This sets limits on emissions of sulphur oxides ('SOx') and NOx from ships' exhausts. The limits for NOx are shown in Table 7.2.

Table 7.2 MARPOL convention – nox limit values				
Tier	Ship construction date on or after	Total weighted cycle emission limit (g/kWh) n = engine's rated speed (rpm)		
		n < 130	n = 130–1999	n ≥ 2000
I	01/01/00	17.0	$45.n^{-0.2}$ e.g. 720 rpm – 12.1	9.8
II	01/01/11	14.4	$44.n^{-0.23}$ e.g. 720 rpm – 9.7	7.7
III	0101/01/16*	3.4	$9.n^{-0.2}$ e.g. 720 rpm – 2.4	2.0

* Subject to a technical review to be concluded in 2013 this date could be delayed, regulation 13.10

7.9 The Tier III controls apply only to the specified ships while operating in Emission Control Areas ('ECA') established to limit NOx emissions; outside such areas the Tier II controls apply. In accordance with regulation 13.5.2, certain small ships would not be required to install Tier III engines.

7.10 For SOx the limits are set in terms of the sulphur content of fuels as shown in Table 7.3.

Table 7.3 MARPOL sulphur limits	
Outside an ECA established to limit SOx and PM emissions	Inside an ECA established to limit SOx and PM emissions
4.50% m/m[(a)] prior to 01/01/12	1.50% m/m prior to 01/07/10
3.50% m/m on and after 01/01/12	1.00% m/m on and after 01/07/10
0.50% m/m on and after 01/01/20[(b)]	0.10% m/m on and after 01/01/15

(a) % m/m stands for % by mass

(b) Depending on the outcome of a review, to be concluded in 2018, as to the availability of the required fuel oil, this date could be deferred to 1 January 2025.

7.11 The ECAs currently established are:

- Baltic Sea area – as defined in Annex I of MARPOL (SOx only);
- North Sea area (including the English Channel) – as defined in Annex V of MARPOL (SOx only);
- North American area (entered into effect 1 August 2012) – as defined in Appendix VII of Annex VI of MARPOL (SOx, NOx and PM);

- United States Caribbean Sea area (expected to enter into effect 1 January 2014) – as defined in Appendix VII of Annex VI of MARPOL (SOx, NOx and PM).

7.12 Most ships operating outside and inside these ECAs will use different fuel oils in order to comply with the respective limits. In such cases, prior to entry into the ECA, the ship must have fully changed over to using the ECA compliant fuel oil, regulation 14.6, and to have implemented written procedures as to how this is to be undertaken. Similarly, changeover from using the ECA compliant fuel oil is not to commence until after exiting the ECA.

European Directive

7.13 The European Union has introduced the Sulphur Content of Marine Fuels (SCMF) Directive (2005/33/EC) which came into force in July 2005. The main obligations of the SCMF Directive are:

- A 1.5% sulphur limit for fuels used by all ships in the SOx ECAs of the Baltic Sea and the North Sea and English Channel;
- A 1.5% sulphur limit for fuels used by passenger ships on regular services between EU ports.

7.14 Alternatively, Member States can allow the use of emission abatement techniques, such as desulphurisation, as an alternative to low sulphur fuels. However, they must meet the same levels of emissions reductions that would have been achieved by the use of the lower sulphur fuels required by the Directive.

UK Regulations

7.15 The UK is a party to the MARPOL Convention and the limits are implemented at a national level by the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008. The Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2010 are an amendment to the 2008 Regulations and implement the marine fuel requirements of the SCMF Directive.

7.2.3. National Planning Policy

7.16 The Overarching National Policy Statement ('NPS') for Energy ('EN-1') (Department of Energy and Climate Change (DECC), 2011a) and the NPS for Renewable Energy Infrastructure ('EN-3') (DECC, 2011b) provide the primary policy framework within which the Project will be assessed.

7.17 EN-1 published by DECC sets out planning policy and guidance for new energy infrastructure. The detailed comments relating to air quality are presented in Table 7.4.

7.2.4. Guidance

7.18 The Environmental Protection UK ('EPUK') guidance note 'Development Control: Planning for Air Quality' (EPUK, 2010) responds to the need for closer integration between air quality and development control. It provides a framework for air quality considerations within local development control processes, promoting a consistent approach to the treatment of air quality issues within development control decisions. The guidance includes a method for assessing the significance of the impacts of development proposals in terms of air quality, and how to make recommendations relevant to the development control process in light of this assessment.

7.3. Assessment Methodology

7.3.1. Study area

7.19 The study area comprises the Turbine Area and the Export Cable Corridor (together referred to as the Offshore Development Area). The air quality assessment covers the offshore area around the Offshore Development Area and the surrounding coastline as shown in Figure 7.1.

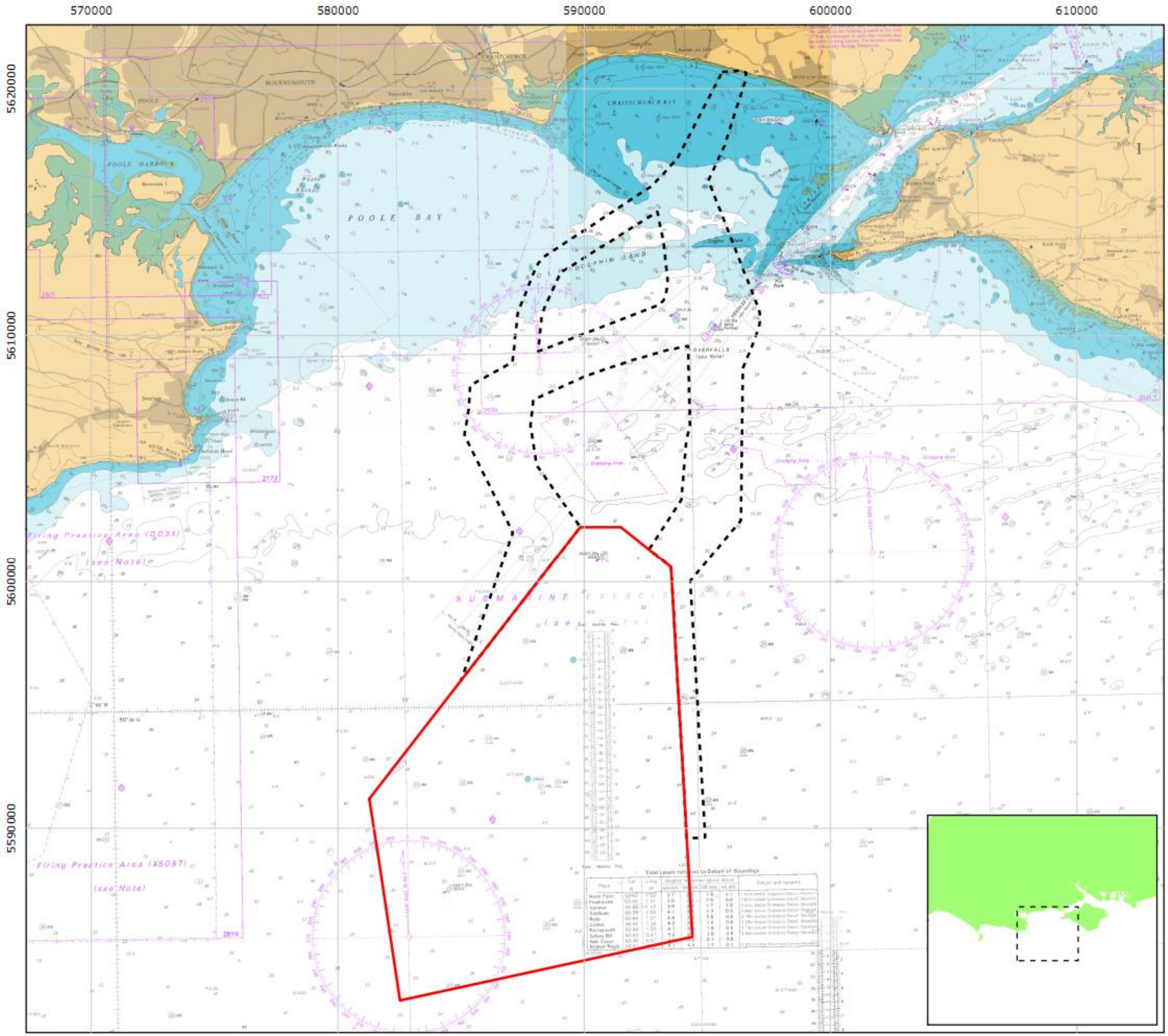
7.20 Since the construction port will not be confirmed until after a development consent order has been secured, a worst case route for vessels was defined via the Solent. This route was chosen as it passes closest to onshore receptors.

7.3.2. Consultation

7.21 There was no feedback in the Scoping Opinion regarding offshore air quality. In addition, there were no comments made through subsequent consultation.

Table 7.4 Summary of NPS guidance regarding air quality

NPS Provision	Consideration within PEI
NPS EN-1	
Paragraph 5.2.1: "Air emissions include particulate matter (for example dust) up to a diameter of ten microns (PM_{10}) as well as gases such as sulphur dioxide, carbon monoxide and nitrogen oxides ('NOx'). Levels for pollutants in ambient air are set out in the Air Quality Strategy which in turn embodies EU legal requirements. The Secretary of State for the Environment Food and Rural Affairs is required to make available up to date information on air quality to any relevant interested party (Air Quality Standards Regulations 2010, No.2010/1001)."	Predictions for PM_{10}, NOx and SO_2 are given within the Impact Assessment section. Carbon monoxide is not considered.
Paragraph 5.2.2: "CO_2 emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided."	CO_2 emissions are not generated by the Project. CO_2 is emitted from associated shipping, but this is regulated through procedures established by the International Maritime Organisation (IMO) and therefore is not considered within the assessment.
Paragraph 5.2.3: "A particular effect of air emissions from some energy infrastructure may be eutrophication, which is the excessive enrichment of nutrients in the environment."	Eutrophication is not relevant to this Project, as the activities do not change nutrient levels, and therefore is not included within the assessment.
Paragraph 5.2.7: "The ES should describe: ➢ Any significant air emissions, their mitigation and any residual effects distinguishing between the project stages and taking account of any significant emissions from any road traffic generated by the project; ➢ The predicted absolute emission levels of the proposed project, after mitigation methods have been applied; ➢ Existing air quality levels and the relative change in air quality from existing levels; and ➢ Any potential eutrophication impacts."	The emissions associated with shipping during construction, and, to a lesser extent, operation are given within with Impact Assessment section. No mitigation is proposed so emission levels remain. The existing air quality levels are discussed in within the Baseline Environment section. Eutrophication is not discussed as the activities do not change nutrient levels and therefore is not included within this assessment.
NPS EN-3	
This does not specifically mention air quality with regard to offshore wind farms, although it does mention that the Environment Agency (EA) regulates emissions to land, air and water out to a distance of 3 NM.	



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Offshore Development Boundary

Legend

- Turbine Area
- Offshore Export Cable Corridor

Please note only one of the export cable corridors will be taken forward

Fig. No.: Figure 7.1		**Date:** 12/11/2012
Author: MJW	**Checked:** NDU	**Approved:** SMF
Scale@A3: 1:160,000		**Revision No.:** 02
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS SeaZone
Datum: WGS 1984	**Ref. No.:** 0210130201214/02	

0 2 4 NM

0 5 10 km

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7.3.3. The scope of assessment

7.22 The overall approach to the air quality assessment comprises:

- A review of the existing air quality at the coastline around the Project to establish the baseline;
- An assessment of the potential changes in air quality arising from construction, operation and decommissioning of the Project;
- An assessment of the significance of impacts using the EPUK significance criteria, taking into consideration embedded mitigation measures and good practice techniques; and
- Formulation of mitigation measures, where appropriate, to ensure any adverse impacts on air quality are avoided, or, where avoidance is not possible, minimised.

Issues scoped out

7.23 Impacts on air quality for offshore human receptors are not considered, as the potential exposure to pollutants from shipping for people spending time offshore would be infrequent and short term, and are well below the exposure times set by the air quality standards.

7.3.4. Impact assessment methodology

7.24 The assessment of impacts associated with the offshore elements of the Project on air quality are all related to the vessels used. The parameters for which air quality is assessed are provided within the Impact Assessment of this chapter.

7.25 The sigificance of impacts for air quality receptors is assessed according to the EPUK guidance (EPUK, 2010). The methodology combines the magnitude of the impact (represented as a change in pollutant concentrations) along with the absolute concentration relative to the national objective (sensitivity), as given in Table 7.1, to derive an impact descriptor at each receptor. The matrix for the impact magnitude and descriptors adjusted from the EPUK guidance are shown in Tables 7.5 and 7.6. These categories are slightly different to those within the Project's EIA methodology (Chapter 3) but are appropriate for air quality assessment as given within the guidance (EPUK, 2010).

Table 7.5 Definition of impact magnitude for changes in pollutant concentrations

Magnitude of change	Change
High	Increase / decrease > 10%
Medium	Increase / decrease 5 – 10%
Low	Increase / decrease 1 – 5%
Imperceptible	Increase / decrease < 1%

Adjusted from EPUK (2010: 18)

Table 7.6 Impact descriptors for annual mean concentrations

Change in concentration (magnitude)	Total concentrations with scheme (sensitivity)			
	Above limit value	Just below limit value (within 10%)	Below limit value (within 10–25%)	Well below limit value (more than 25%)
	High	Medium	Low	Imperceptible
Increase / Decrease with Scheme				
High	Major	Major OR moderate	Moderate OR minor	Negligible
Medium	Major OR moderate	Moderate	Minor	Negligible
Low	Moderate OR minor	Minor	Minor	Negligible
Imperceptible	Negligible	Negligible	Negligible	Negligible

Adjusted from EPUK (2010: 18)

7.26 Where appropriate, professional judgement has been used within the assessment to determine the appropriate levels of significance. This ensures the assessment reflects the study area and project details and is not too prescriptive.

7.27 The EPUK guidance also provides a set of factors (Table 7.7) that determines the significance of a proposal in terms of air quality. These factors were considered to determine the overall significance of the offshore elements of the project.

Table 7.7 EPUK factors to judge significance

- Number of people affected by *minor*, *moderate* or *major* air quality impacts and a judgement on the overall balance.
- Where new exposure is being introduced into an existing area of poor air quality, then the number of people exposed to levels above the objective or limit value will be relevant.
- The magnitudes of the changes and the descriptions of the impacts at the receptors.
- Whether or not an exceedancee of an objective or limit value is predicted to arise in the study area where none existed before, or an exceedance area is substantially increased.
- Whether or not the study area exceeds an objective or limit value, and this exceedance is removed or the exceedance area reduced.
- Uncertainty, including the extent to which worst case assumptions have been made.
- The extent to which an objective or limit value is exceeded.

SOURCE: EPUK (2010: 21)

7.3.5. Modelling methodology

7.28 The impact of offshore activities at specified points (receptors) along the coast has been assessed using atmospheric dispersion modelling techniques (ADMS v5.0[3]). This model is widely used in the UK for dispersion modelling of industrial and other emission sources.

7.29 Indicative data relating to vessel movements and the time required for each construction activity has been used to generate an emissions inventory for the Project. The emissions inventory has calculated the emissions of NOx, SO_2 and PM_{10} following the guidance in the Defra UK Ship Emissions Inventory (Entec, 2010). This uses estimated vessel movements, and an indicative time of operation provided by NBDL and is provided within the Impact Assessment section of this chapter.

7.30 Hourly sequential meteorological data for 2011 were used to run the model from St Catherine's station in the Isle of Wight, located approximately 30 km east of the Turbine Area. Table 7.8 shows a statistical analysis of the temperature, wind speed/direction and relative humidity variable and Figure 7.2 illustrates the wind rose showing the prevailing winds. Figure 7.3 also shows the histogram of the temperature with percentage frequency for the year. The prevailing winds are westerly with a median speed of 5.7 m/s.

Table 7.8 Statistics for meteorological data

Value	Temperature (°C)	Wind speed (m/s)	Wind direction (degrees)	Relative humidity (%)
Minimum	-1.3	0	–	36
Maximum	26.2	21.1	–	100
Median	12.6	5.7	240	83
Mode	16.7	4.6	260	100

[3] Developed by Cambridge Environmental Research Consultants (CERC) (http://www.cerc.co.uk)

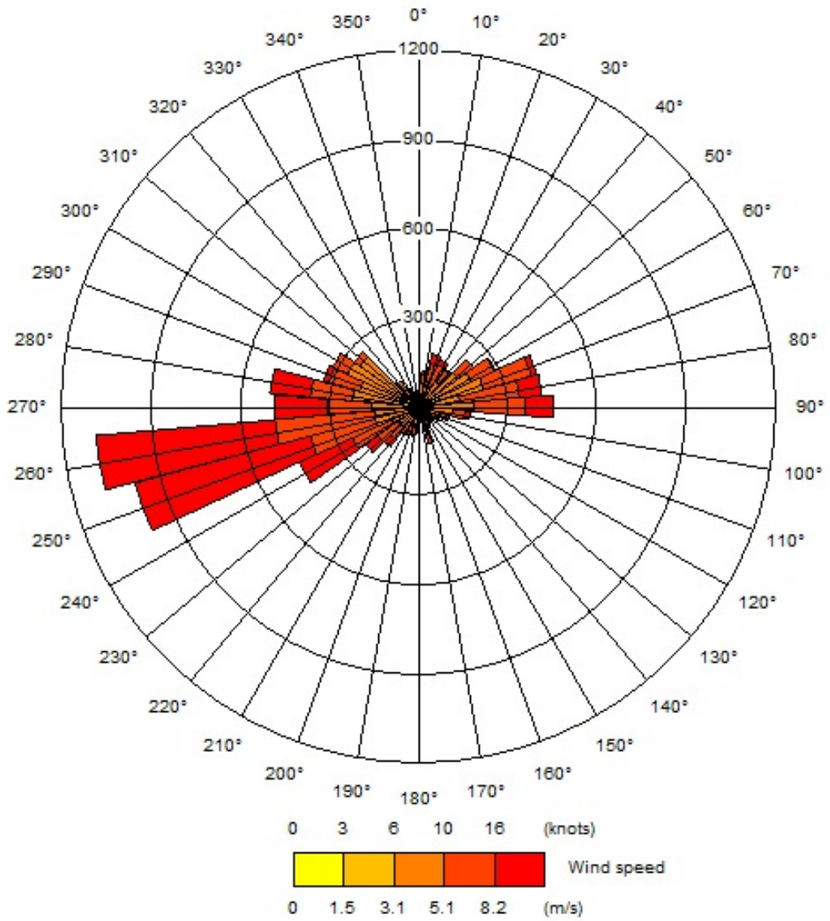


Figure 7.2 Wind rose of meteorological data at St Catherine's, 2011

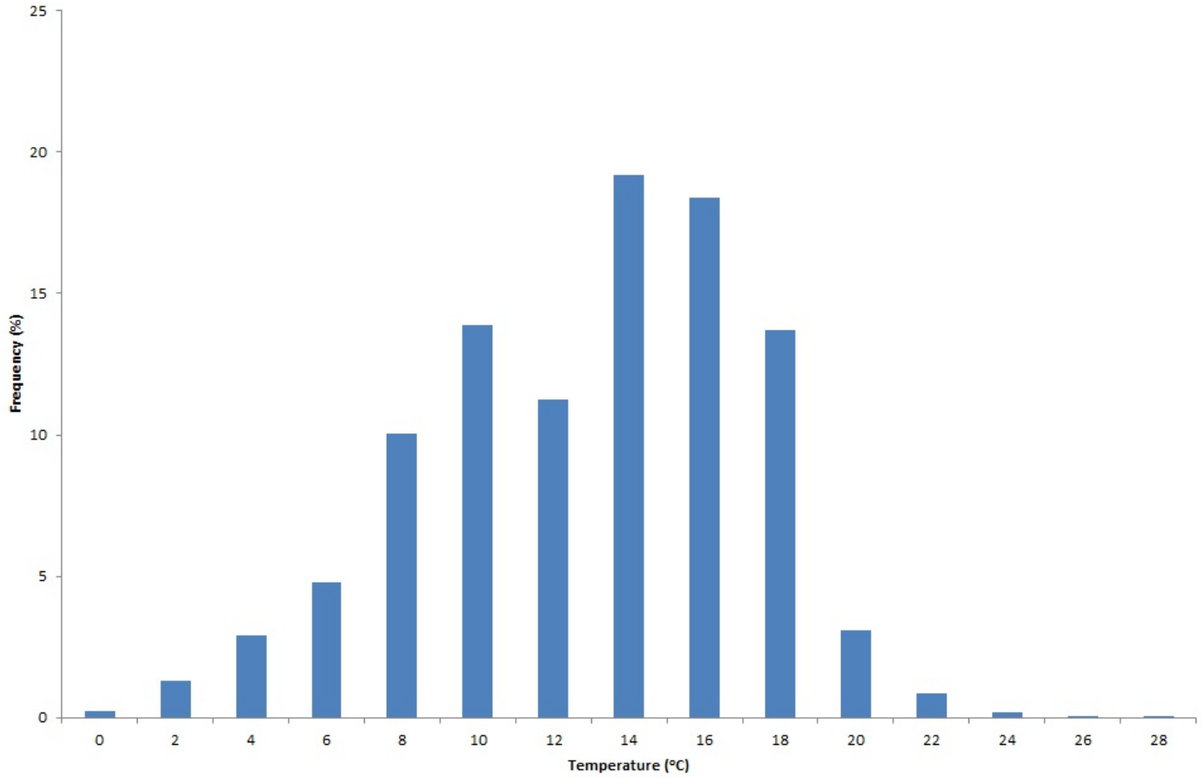


Figure 7.3 Histogram of temperature for St Catherine's, 2011

7.31 The model predicts NOx concentrations, but the objectives are set for NO_2. As such, a conversion is carried out following the Environment Agency's methodology (Environment Agency, 2012) which states that 70% of annual mean and 35% of hourly mean NOx concentrations convert to NO_2 as a worst case scenario.

7.3.6. Limitations and embedded mitigation

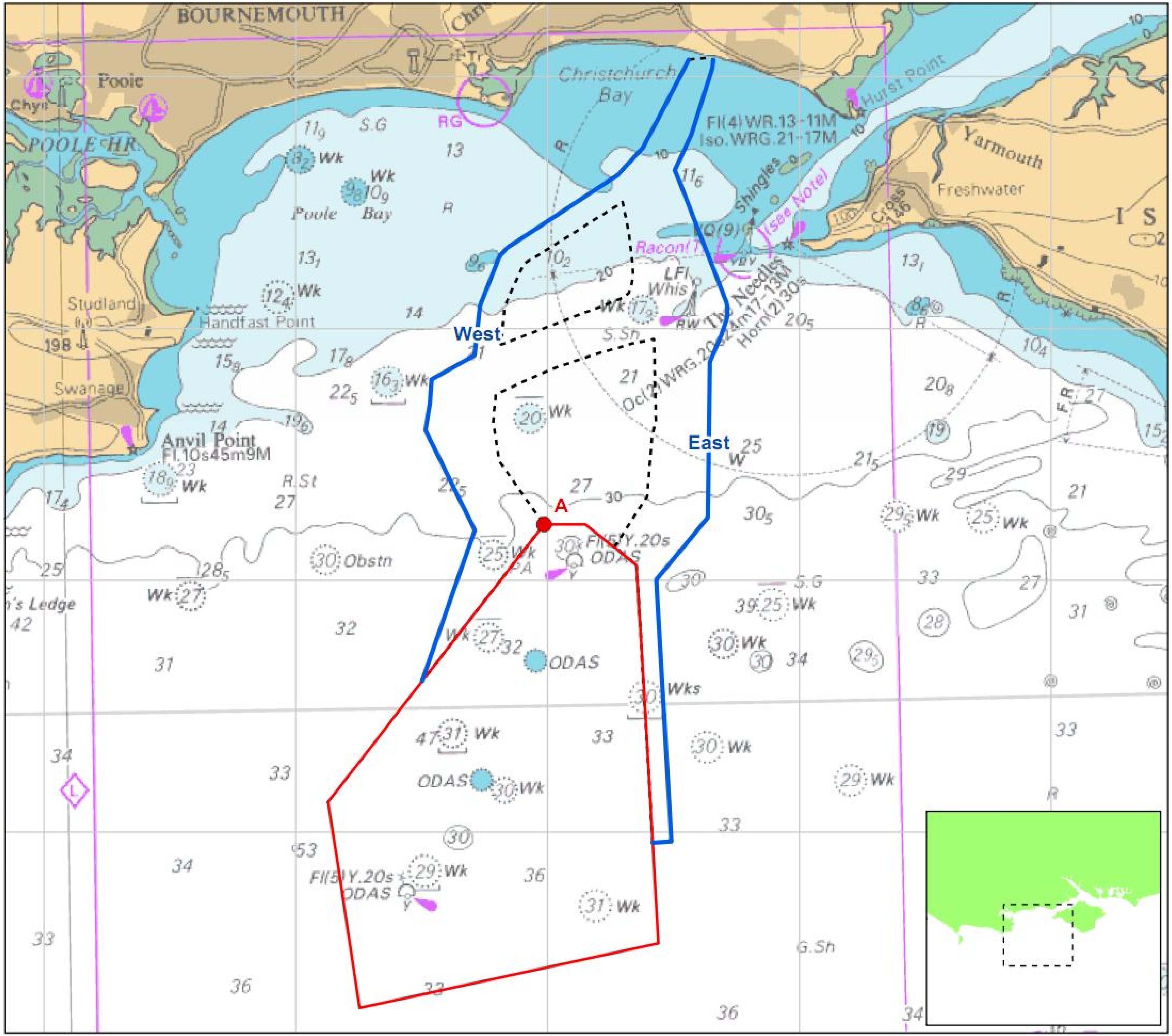
Limitations

7.32 As the exact routes for vessels are not defined at this stage, assumptions have been made. Emissions associated with the construction activities within the Turbine Area have been assumed to occur at the point of the

boundary closest to the shore (Point A Figure 7.4). Emissions associated with the Export Cable Corridor have been assumed to occur at a path closest to the shore following the western or eastern edge of the corridor. As such, two separate options have been modelled for the Export Cable Corridor and the worst case has been used in the analysis of results.

Embedded mitigation

7.33 Vessels will need to comply with national and international emissions standards. As stated previously, the English Channel has been declared a SOx ECA, which means that all ships within these waters are required to use low sulphur fuel. There is no relevant site-specific embedded mitigation for the air quality assessment.



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Location of Modelled Point A and Western/Eastern Routes of Export Cable Corridor

Legend

- Turbine Area
- Offshore Export Cable Corridor
- Modelled Site - Point A
- Modelled Export Cable Corridor

Fig. No.: Figure 7.4	**Date:** 11/08/2013
Author: MK	**Checked:** MB
Approved: MB	
Scale@A3: 1:160,000	**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N	**Data Sources:** OS, SeaZone
Datum: WGS 1984	**Ref. No.:** /Arup

0 2 4 NM

0 5 10 km

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7.4. Baseline Environment

7.34 The following section details the baseline data gathering methodology for the assessment, the data sources used and provides a summary of the air quality baseline for the Project.

7.4.2. Baseline data gathering methodology

7.35 A desk based study was undertaken compiling the local air quality information, monitoring data and background concentrations from the above data sources to establish the current air quality conditions at the coastline. As there is no guidance for offshore air quality assessments, this study follows standard practice for onshore assessments.

Data sources

7.36 This section provides information on the organisations from which relevant contextual information was requested. Information has been requested from a range of organisations and has been used to inform the baseline and the assessment.

7.37 Data sources that were used in this assessment include:

- Air Quality Review and Assessment reports from local authorities along the coastline to provide information on local air quality conditions.
- The UK Air Information Resource website (Defra 2012b) and
- The Department for Energy, Food and Rural Affairs (Defra) "UK Ships Emissions Inventory" report (Entec, 2010).

7.4.3. Receptors

7.38 Existing and background pollutant levels have been determined at onshore locations likely to be affected by shipping. The receptors have been selected as worst case according to their proximity to the Offshore Development Area, i.e. locations that are closest to the Turbine Area, Export Cable Corridor and associated shipping routes. The receptors themselves are considered to be people who would experience the change in air quality; however, the sensitivity by which the air quality is assessed relates to the thresholds listed in Table 7.1. Offshore locations have not been considered in the assessment as the potential exposure to pollutants from shipping for people spending time offshore would be infrequent and short term, and are well below the exposure times set by the air quality standards. Details of the receptors considered are given in Table 7.9 and their location shown in Figure 7.5.

Table 7.9 Details of assessed receptors

Receptor ID	OS X	OS Y	Distance to Export Cable Corridor	Distance to Turbine Area
R01	404136	078653	10.3 km	14.5 km
R02	405812	089016	12.4 km	20 km
R03	417840	090184	4.3 km	16.2 km
R04	424473	092724	651 m	19.1 km
R05	428323	091509	2.4 km	19.1 km
R06	429237	084897	3.4 km	13.9 km

7.4.4. Local air quality monitoring

7.39 The Environment Act 1995 requires local authorities to review and assess air quality with respect to the objectives for seven pollutants specified in the Government's National Air Quality Strategy ('NAQS)' (Defra, 2007). Local Authorities are required to carry out an Updating and Screening Assessment ('USA') of their area every three years. If the USA identifies potential areas likely to exceed air quality objectives, then a detailed assessment of those areas is required. Where it is predicted that the objectives would not be met, local authorities must declare the area as an Air Quality Management Area ('AQMA'). In addition, local authorities are required to produce an Air Quality Action Plan ('AQAP') which includes measures to improve air quality within the AQMA.

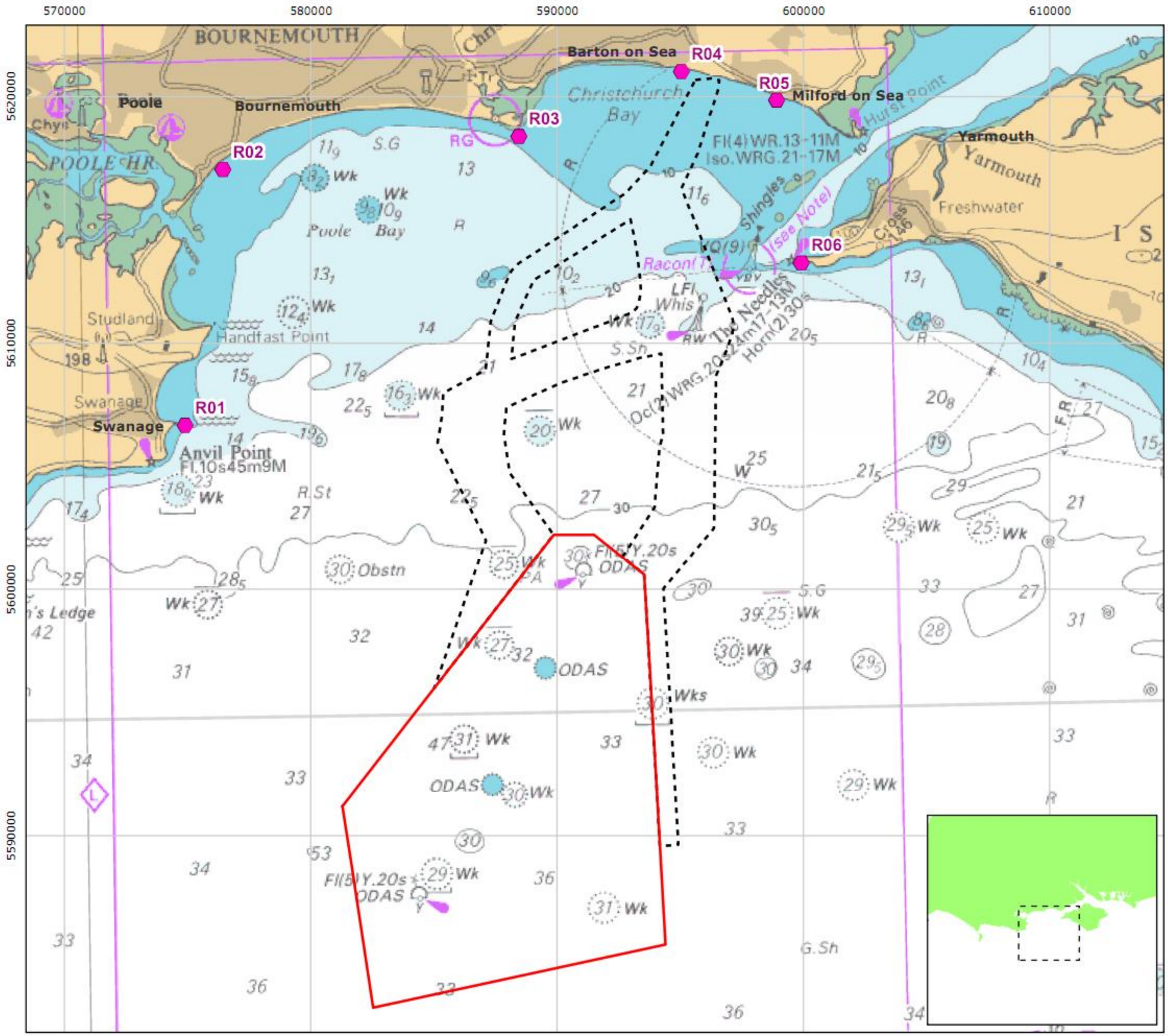
7.4.5. Monitoring

7.40 Monitoring data have been acquired from the following local authorities along the coastline:

- Purbeck District Council;
- Poole Borough Council;

- Bournemouth Borough Council;
- Christchurch Borough Council;
- New Forest District Council; and
- Isle of Wight Council.

7.41 No AQMAs have been declared near the coastline by any of these local authorities. The local monitoring at background and industrial locations was used to supplement the background data, in order to establish the baseline air quality conditions along the coast. Details of these sites are given in Table 7.10 and their location shown in Figure 7.6. There were no representative monitoring sites on the Isle of Wight.



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Location of Assessed Receptors

Legend

- Turbine Area
- Offshore Export Cable Corridor
- Receptors

Fig. No.: Figure 7.5		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:160,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone
Datum: WGS 1984	**Ref. No.:** /Arup	

0 2 4 NM

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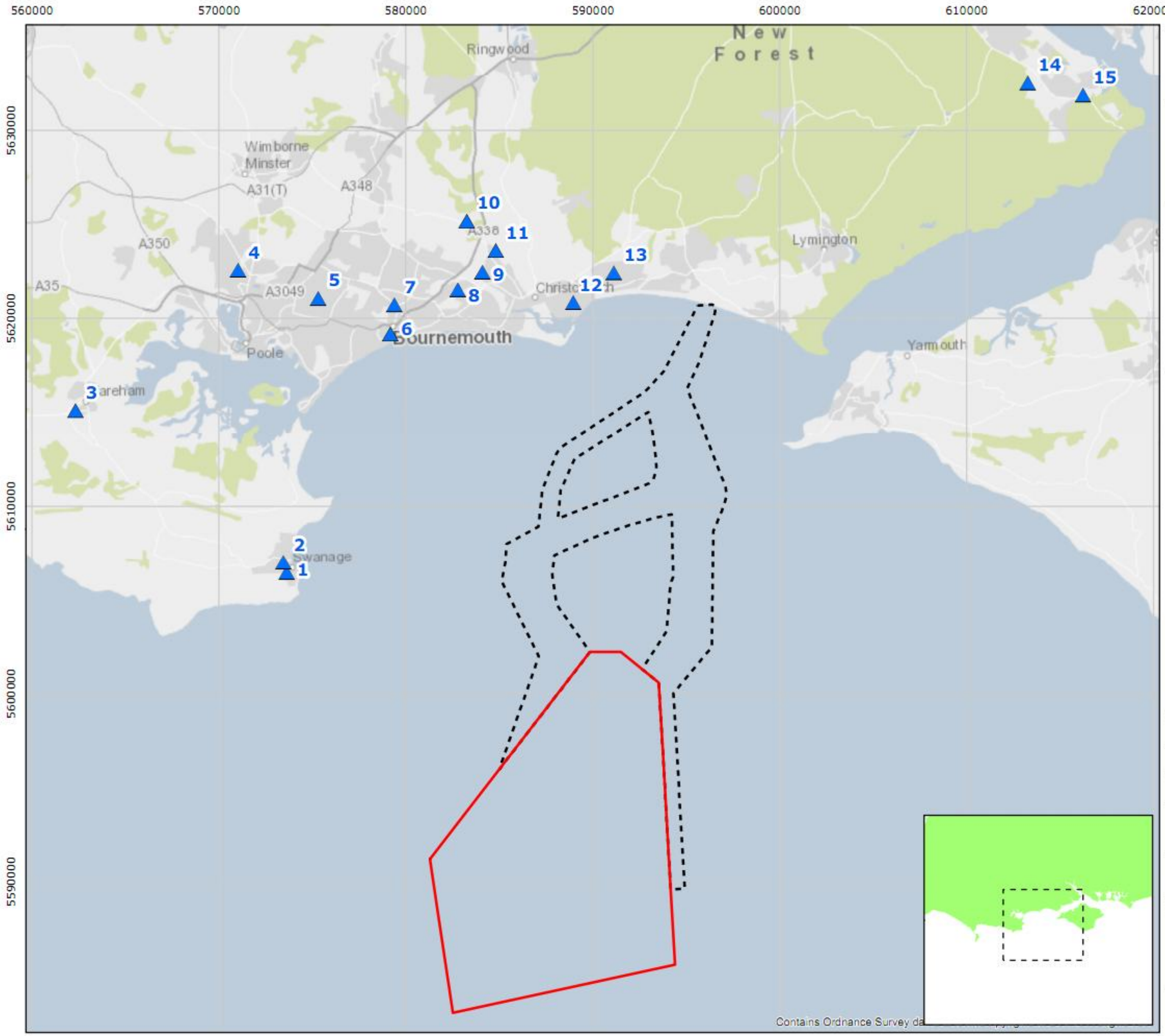
Table 7.10 Local pollution monitoring

ID	Name	Local Authority	OS Coordinates	Type	2008	2009	2010	2011
NOx concentrations (µg/m^3)								
8	Bournemouth CM	Bournemouth	412321, 093345	UB	21.9	23.2	23.8	19.7
NO_2 concentrations (µg/m^3)								
1	Swanage Queens Road	Purbeck	402970, 078410	UB	13.1	11.4	9.1	*n/a*
2	Swanage Gilbert Road	Purbeck	402790, 078950	UB	16.0	16.1	13.3	*n/a*
3	Wareham B3070	Purbeck	391790, 087190	UB	16.3	15.9	14.5	*n/a*
5	Fortescue Road	Poole	404841, 092986	UB	17.0	15.9	18.5	24.3
6	Lower Gardens	Bournemouth	408689, 091935	UB	18.7	17.4	20.2	*n/a*
7	Cemetery	Bournemouth	408922, 092579	UB	21.5	23.3	24.6	*n/a*
8	Bournemouth CM	Bournemouth	412321, 093345	UB	15.2	16.5	17.8	*n/a*
	Diffusion tubes co-location				14.7	13.4	16.2	*n/a*
9	49 River Way	Christchurch	413658, 094261	BG	7.7	11.6	10.4	8.9
10	Hurn Sporting Club	Christchurch	412852, 096996	BG	6.9	9.2	10.2	9.4
11	Woodland Walk, St Catherine's Hill	Christchurch	414384, 095405	BG	7.6	8.3	8.1	7.2
12	Mortimer Close	Christchurch	418488, 092581	BG	6.7	8.1	10.1	6.9
13	21 Braemar Drive	Christchurch	420680, 094132	BG	5.6	8.8	8.7	6.8
14	Teachers Way, Holbury	New Forest	442947, 103931	I	16.0	12.7	15.3	*n/a*
15	Jubilee Hall, The Square, Fawley	New Forest	445881, 103247	I	20.5	16.7	18.1	*n/a*
PM_{10} concentrations (µg/m^3)								
14	Holbury CM	New Forest	442948, 103932	I	19.0	16.0	18.0	*n/a*
SO_2 concentrations (µg/m^3)								
4	Kitchener Crescent	Poole	400587, 094546	UB	9.8	8.6	6.6	*n/a*
9	49 River Way	Christchurch	413658, 094261	BG	*n/a*	1.2	1.2	0.9
10	Hurn Sporting Club	Christchurch	412852, 096996	BG	*n/a*	1.6	4.6	0.8
11	Woodland Walk, St Catherine's Hill	Christchurch	414384, 095405	BG	*n/a*	1.2	1.2	1.2
12	Mortimer Close	Christchurch	418488, 092581	BG	*n/a*	1.3	0.9	1.4
13	21 Braemar Drive	Christchurch	420680, 094132	BG	*n/a*	1.4	0.9	1.5

CM: Continuous Monitor BG: background, I: industrial, UB: urban background, n/a: Data not available



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Location of Local Monitoring Sites

Legend

- Turbine Area
- Offshore Export Cable Corridor
- Local Monitoring

Fig. No.: Figure 7.6		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:210,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS
Datum: WGS 1984	**Ref. No.:** /Arup	

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7.4.6. Background pollutant concentrations

Defra has produced estimated background air pollution data for each 1x1 km Ordnance Survey ('OS)' grid square for each local authority area (Defra, 2012a). Background maps are available for 2010 and projected through to 2030. Estimated pollutant concentrations along the coastline (3 miles inwards) have been obtained for 2012 and the average concentrations are presented in Table 7.11. Background concentrations at the receptors are also presented in Table 7.12. Background SO2 concentrations are only available for 2001, but are not expected to change much over the years (Defra, 2012c). Background concentrations for all pollutants are estimated to be well below their respective air quality limit values, which also agrees with the local monitoring data. The 2012 NOx, NO2, PM10 and SO2 background concentrations are shown in Figures 7.7, 7.8, 7.9 and 7.10 respectively.

Table 7.11 Average background annual mean air pollution concentrations along the coastline and contribution from shipping/off-road sources

Pollutant	Year	Annual mean concentration (µg/m^3)	Shipping and off-road sources (µg/m^3)	Contribution from shipping and off-road
NOx	2012	13.1	0.054	0.41%
NO_2	2012	9.9	–	–
PM_{10}	2012	12.5	0.015	0.12%
SO_2	2001	2.1	–	–

SOURCE: Defra (2012)

Table 7.12 Average background annual mean air pollution concentrations at receptors

Receptor	NOx (µg/m^3)	NO_2 (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)
R01	12.8	10.0	12.7	2.5
R02	17.8	13.2	12.9	2.2
R03	12.2	9.4	12.0	2.1
R04	12.6	9.7	12.2	2.5
R05	12.6	9.6	12.1	2.5
R06	9.0	7.1	11.4	2.7

SOURCE: Defra (2012)

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Background NOx Concentrations (2012)

Legend

- Turbine Area
- Offshore Export Cable Corridor

2012 Background NOx Concentrations

- < 10 µg/m3
- 10 - 20 µg/m3
- 20 - 30 µg/m3
- 30 - 40 µg/m3
- 40 - 50 µg/m3
- 50 - 60 µg/m3
- 60 - 70 µg/m3
- 70 - 80 µg/m3
- 80 - 90 µg/m3
- > 90 µg/m3

Fig. No.: Figure 7.7		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:160,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone Defra
Datum: WGS 1984	**Ref. No.:** /Arup	

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Background NO_2 Concentrations (2012)

Legend

- Turbine Area
- Offshore Export Cable Corridor

2012 Background NO2 Concentrations

- < 10 µg/m3
- 10 - 20 µg/m3
- 20 - 30 µg/m3
- 30 - 36 µg/m3
- 36 - 40 µg/m3
- > 40 µg/m3

Fig. No.: Figure 7.8		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:160,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone Defra
Datum: WGS 1984	**Ref. No.:** /Arup	

0 2 4 NM

0 5 10 km

N

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Background PM10 Concentrations (2012)

Legend

- Turbine Area
- Offshore Export Cable Corridor

2012 Background PM10 Concentrations

- < 10 µg/m3
- 10 - 15 µg/m3
- 15 - 20 µg/m3
- 20 - 30 µg/m3
- 30 - 40 µg/m3
- 40 - 50 µg/m3
- > 50 µg/m3

Fig. No.: Figure 7.9		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:160,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone Defra
Datum: WGS 1984	**Ref. No.:** /Arup	

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0 5 10 km

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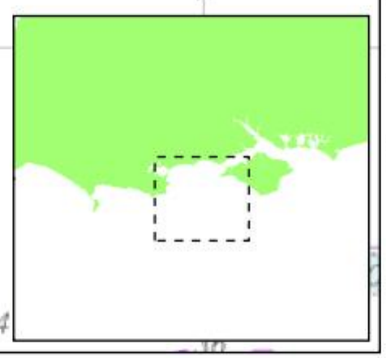
BOURNEMOUTH Poole Christchurch Bay Mudeford Hurst Point Yarmouth Freshwater I S

POOLE HR Poole Bay Brownsea I. Studland Sandbanks Ferry Landfast Point Swanage Bay Anvil Point Fl.10s45m9M R St Ledge

Fl(4)WR.13-11M Iso.WRG.21-17M Shingles (see Note) Racon(T) VBY LFl Whis RW The Needles Horn(2)30s Oc(2)WRG.20-12-4m17-13M S.Sh

ODAS Fl(5)Y.20s ODAS Obstn Wks S.G G.Sh



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Background SO_2 Concentrations (2001)

Legend

- Turbine Area
- Offshore Export Cable Corridor

2001 Background SO2 Concentrations

- < 3 µg/m3
- 3 - 5 µg/m3
- 5 - 10 µg/m3
- 10 - 15 µg/m3
- 15 - 20 µg/m3
- 20 - 25 µg/m3
- > 25 µg/m3

Fig. No.: Figure 7.10		**Date:** 11/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:160,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone Defra
Datum: WGS 1984	**Ref. No.:** /Arup	

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7.5. Impact Assessment

7.5.1. Realistic worst case scenario

7.42 Impacts associated with the offshore elements of the Project on air quality are all related to the maximum number of vessels used.

7.43 Chapter 2 (Navitus Bay Wind Park Project) provides details of the Project, including estimated vessel movements and an indicative time of operation associated with each construction activity, which have been used to develop an inventory of the shipping emissions associated with the Project. The total vessel numbers and movements represent a worst case scenario in accordance with the Rochdale Envelope approach, which considers the envelope of maximum values.

7.44 Table 7.13 shows the number of vessel movements during operation are much lower than during construction. This is based on five service vessels undertaking routine maintenance four times per year per turbine, plus an unknown number of unscheduled visits. At this stage, the activities during decommissioning are not known, but it is assumed that a comparable number of vessels would be needed to remove each structure as to install it. Overall vessel movements would be lower than during construction as the subsea cables would remain *in situ*.

7.45 As most vessels are used during construction, this has been assessed as the worst case and the total construction phase has been assumed to be three years, as this assesses the most vessels present in the shortest period, and thus the greatest concentration of emissions at any one time. Construction operations have been assumed to be in constant operation throughout the year (seven days a week, 24 hours a day) and vessels have been assumed to follow defined navigation routes.

Table 7.13 Estimated number of vessel movements

Activity	Total Number of Vessels	Total Number of Movements*
Construction		
Foundation installation	3 (heavy)	400 (heavy)
Wind turbine installation	3 (heavy)	200 (heavy)
Substation nstallation	2 (heavy)	18 (heavy)
Inter-array cable laying	2 (heavy)	100 (heavy)
Export cable laying	1 (heavy)	18 (heavy)
Meteorological mast installation	2 (heavy)	5 (heavy)
Scour protection	1 (heavy)	400 (heavy)
Towing and anchoring	–	300 (light)
Crew transfer	–	2,500 (light)
Commissioning	–	2,500 (light)
Guarding	–	1,000 (light)
TOTAL for the whole construction period – depending on the pace of the construction programme which may vary from 3 years to 4.5 years.	*14 (heavy vessels)*	*1,141 (heavy vessels)* *6,300 (light vessels)* *- estimated over the total construction period*
Operation and maintenance		
Workboat movements for planned and unplanned maintenance	5 (service vessels)	1000 (light vessels) per year

* Each vessel movement represents a two-way journey from the port to the Project and return.

7.5.2. Impact assessment - construction

Results of assessment

7.46 Indicative data relating to vessel movements (refer to Table 7.13) and the time required for each construction activity has been used to generate an emissions inventory, as discussed within the Scope of the Assessment

section of this chapter. Indicative vessel types have been acquired from various sources (see Entec, 2010) and worst case scenarios (maximum values) for engine types and size have been used to calculate the engine power ('kW') and the subsequent emissions (g/hr). Emission factors (g/kWh) for NOx, SO_2 and PM_{10} have been taken from the UK Ship Emissions Inventory (Entec, 2010) split into *at sea* emissions, when the ships are travelling and *on station* emissions when the ships are stationary or manoeuvring.

7.47 The emission factors were then used in conjunction with the engine power data to derive emission rates for each vessel per construction activity, taking into account the assumptions set out above.

7.48 Table 7.14 shows the emission factors for each engine type that were used to calculate the total emissions, while Table 7. shows the data input for the calculation of the emissions inventory for each construction activity.

Table 7.14 Emission factors at sea and on station

Engine Type	At sea emissions (g/kWh)			On station emissions (g/kWh)		
	NOx	SO_2	PM	NOx	SO_2	PM
SSD	17.0	10.5	1.7	13.6	11.6	2.4
MSD	13.1	11.5	0.8	10.5	12.7	2.4

SOURCE: Entec (2010: 63-64)

Table 7.15 Construction activities and associated vessel input data							
Activity	Ship	Size (tonnes)	Engine type[a]	Example ship[b]	Total movements[c]	Average speed (km/hr)	Engine power (kW)
Foundation installation	Heavy lift / jack up barge	17,600	SSD	*MPI Adventure*	400	23	6,396
Wind Turbine installation	Semi-submersible	29,000	SSD	*Mighty Servant*	200	22	9,088
Substation installation	Semi-Submersible	29,000	SSD	*Mighty Servant*	18	22	9,088
Inter-array cable laying	Cable laying ship	13,201	SSD	*Global Sentinel*	100	19	5,225
Export cable laying	Cable laying ship	13,201	SSD	*Global Sentinel*	18	19	5,225
Met mast installation	Jack up barge	17,600	SSD	*Mighty Servant*	5	22	6,396
Scour protection	Rock dumping vessel	7,737	MSD	*William de Vlamingh*	400	24	3,588
Towing and anchoring	Tug	6,273	MSD	*Loke Viking*	300	19	14,000
Crew transfer	Work boat	62	MSD	*Carboclyde*	2,500	19	720
Commissioning	Work boat	62	MSD	*Carboclyde*	2,500	19	720
Guarding	Work boat	62	MSD	*Carboclyde*	1,000	19	720

(a) SSD: slow speed diesel, MSD: medium speed diesel

(b) These ships have been used as examples and they represent a realistic worst-case scenario for this assessment. The ships to be used for the project have yet to be determined.

(c) Each vessel movement represents a two-way journey from the port to the Project and return.

7.49 The dispersion of the NOx, SO_2 and PM10 emissions has been modelled using ADMS v5.0 for all shipping associated with the construction activities, and results have been obtained as total annual mean, peak hourly mean and peak daily mean concentrations at the selected receptors. The worst case modelled concentrations are shown in Table 7.16. For receptors R01 – R04 the worst case concentrations were achieved with modelling the western edge of the Export Cable Corridor, while for receptors R05 – R06 with the eastern edge.

Table 7.16 Modelled pollutant concentrations (in µg/m^3)						
Receptor ID	NOx	NOx hourly	PM_{10}	PM_{10} daily	SO_2 hourly	SO_2 daily
*Limit Value**	*40*	*200*	*40*	*50*	*350*	*125*
R01	0.4	32.1	0.1	0.2	25.2	5.6
R02	0.1	10.3	0.02	0.03	7.9	2.2
R03	0.3	33.4	0.04	0.1	20.0	5.6
R04	0.3	27.2	0.04	0.1	20.4	3.8
R05	0.3	24.8	0.04	0.1	19.5	3.0
R06	0.5	33.9	0.1	0.2	23.1	4.5
* As per Table 7.1						

7.50 The annual mean concentrations were then derived by combining the modelled results with the background concentrations at the location of each receptor. Table 7.17 shows the predicted annual mean NO_2 and PM_{10} concentrations for comparison with the national objectives. SO_2 is not included within the annual concentrations as this is only modelled for short-term exposure, and annual values would be very low so no limit values have been set. It can be observed that concentrations are well below the annual mean objective of 40 µg/m^3 for both pollutants at all receptors. The short-term concentrations are also well below the respective objectives for all pollutants (NO_2, PM_{10} and SO_2).

Table 7.17 Total annual mean no_2 and pm_{10} concentrations

Receptor ID	NO_2 (µg/m^3)	PM_{10} (µg/m^3)
R01	10.3	12.7
R02	13.3	12.9
R03	9.6	12.0
R04	9.9	12.2
R05	9.9	12.2
R06	7.4	11.5

Impact significance - construction

7.51 In order to calculate the impact significance, the magnitude of change was first estimated and then the concentration at each receptor assessed, relative to the national objectives. The overall significance was then derived for each receptor using the impact descriptors for annual mean concentrations (Table 7.17). Table 7.18 shows the assessment of the impact significance for all pollutants at each receptor.

Table 7.18 Significance of impacts

Pollutant	Absolute change (µg/m^3)	Magnitude of change	Limit value /objective* (µg/m^3)	Comparison with objective value (Sensitivity)	Impact Significance
Receptor R01					
NO_2 annual	0.3	Imperceptible	40	Imperceptible	Negligible
NO_2 hourly	11.2	Medium	200	Imperceptible	Negligible
PM_{10} annual	0.1	Imperceptible	40	Imperceptible	Negligible
PM_{10} daily	0.2	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	25.2	Medium	350	Imperceptible	Negligible
SO_2 daily	5.6	Low	125	Imperceptible	Negligible
Receptor R02					
NO_2 annual	0.1	Imperceptible	40	Imperceptible	Negligible
NO_2 hourly	3.6	Low	200	Imperceptible	Negligible
PM_{10} annual	0.02	Imperceptible	40	Imperceptible	Negligible
PM_{10} daily	0.03	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	7.9	Low	350	Imperceptible	Negligible
SO_2 daily	2.2	Low	125	Imperceptible	Negligible
Receptor R03					
NO_2 annual	0.2	Imperceptible	40	Imperceptible	Negligible
NO_2 hourly	11.7	Medium	200	Imperceptible	Negligible
PM_{10}	0.04	Imperceptible	40	Imperceptible	Negligible

Table 7.18 Significance of impacts					
annual					
PM_{10} daily	0.1	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	20.0	Medium	350	Imperceptible	Negligible
SO_2 daily	5.6	Low	125	Imperceptible	Negligible
Receptor R04					
NO_2 annual	0.2	Imperceptible	40	Imperceptible	Negligible
NO_2 hourly	9.5	Low	200	Imperceptible	Negligible
PM_{10} annual	0.04	Imperceptible	40	Imperceptible	Negligible
PM_{10} daily	0.1	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	20.4	Medium	350	Imperceptible	Negligible
SO_2 daily	3.8	Low	125	Imperceptible	Negligible
Receptor R05					
NO_2 annual	0.2	Imperceptible	40	Imperceptible	Negligible
NO_2 hourly	8.7	Low	200	Imperceptible	Negligible
PM_{10} annual	0.04	Imperceptible	40	Imperceptible	Negligible
PM_{10} daily	0.1	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	19.5	Medium	350	Imperceptible	Negligible
SO_2 daily	3.0	Low	125	Imperceptible	Negligible
Receptor R06					
NO_2 annual	0.3	Imperceptible	40	Imperceptible	Negligible
NO_2	11.9	Medium	200	Imperceptible	Negligible

Table 7.18 Significance of impacts					
hourly					
PM_{10} annual	0.1	Imperceptible	40	Imperceptible	Negligible
PM_{10} daily	0.2	Imperceptible	50	Imperceptible	Negligible
SO_2 hourly	23.1	Medium	350	Imperceptible	Negligible
SO_2 daily	4.5	Low	125	Imperceptible	Negligible

7.52 Overall, the impact significance is **negligible** for all pollutants at all receptors. Considering the significance of the air quality impacts, according to the impact descriptors for annual mean concentrations, the following points are noted:

- The overall magnitude of impact is negligible for all pollutants (NO_2, PM_{10} and SO_2);
- It is unlikely that any person would be affected by increases in pollutant concentrations;
- No new public exposure is being introduced in the wider area by the offshore elements of the Project;
- Total pollutant concentrations would remain well below the national objectives for NO_2, PM_{10} and SO_2 at all receptors; and
- The offshore elements of the Project would not impact on any AQMAs.

7.53 Based on the above, the significance of the effects on air quality is judged to be **Not Significant** for the development of the offshore elements of the Project.

Sensitivity testing

7.54 The above assessment has only considered the impacts due to the construction activities taking place across the Offshore Development Area, without considering the emissions from the route the vessels would take from the port to this area. Since a construction port has not been confirmed at this stage, a sensitivity test was undertaken using an estimated route via the Solent (Figure 7.11). This was considered the worst case as it is closer

to the receptors than alternative routes. The same methodology of assessment was followed and all vessels were assumed to pass through the Solent, thus were modelled with *at sea* emissions.

7.55 It was observed that concentrations would be well below the respective national objectives for all pollutants. The maximum modelled concentrations are presented in 7.19. Overall, no significant impact to local air quality is anticipated from vessels using this route.

Table 7.19 Maximum modelled concentrations for sensitivity testing route

Pollutant	Maximum Concentrations (µg/m^3)			Objectives (µg/m$^{3)}$		
	Annual Mean	Hourly	Daily	Annual mean	Hourly	Daily
NOx	1.2	21.6	*NA*	*NA*	*NA*	*NA*
NO_2	0.8	15.1	*NA*	40	200	*NA*
PM_{10}	0.1	*NA*	0.2	40	*NA*	50*
SO_2	*NA*	16.6	4.5	*NA*	350*	125*

NA: Not applicable

** See Table 7.1 for additional factors*

Impact Assessment - operation and maintenance

7.56 It is not anticipated that any noticeable increase in air pollution would arise from the operational activities of the offshore elements of the Project. Regular maintenance would be required during its lifetime (estimated 1,000 shipping movements per year), but these emissions are expected to have a *negligible* impact to the area due to the type of vessel used and the relatively low number of trips relative to existing shipping levels. As vessel types are larger, with a greater number of vessel movements during construction and predicted impacts are assessed as **negligible**, a detailed assessment for the O&M of the offshore elements of the Project is therefore not required. It is therefore assumed that operation and maintenance impacts are **Not Significant**.

Decommissioning

7.57 The activities associated with decommissioning are similar to the construction activities but in reverse order, through removal of all structures above the seabed. It is anticipated the same type of vessels with the same number of movements would be needed to remove structures as to install them, but the cables would be left *in situ* and therefore overall vessel numbers would be reduced.

7.58 As such, it is assumed that the impact on local air quality from decommissioning would be similar or of a reduced magnitude as the construction activities, thus producing a **negligible** impact. It is therefore assumed that decommissioning impacts would be **Not Significant**. However, a full Decommissioning Plan will be agreed with the relevant government department prior to the commencement of decommissioning activities.

7.6. Potential Mitigation

7.59 As previously stated, the English Channel is an SOx ECA, which means that all ships within these waters are required to use low sulphur fuel. However, given that only negligible air quality impacts are predicted due to the shipping emissions associated with the construction, operation and decommissioning phases, no air quality specific mitigation measures are proposed.

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Wimborne Minster
A31(T)
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A338
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Christchurch
Lymington
Bournemouth
Poole
Wareham
Yarmouth
Swanage
West
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A

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Location of Estimated Route through the Solent for Sensitivity Testing

Legend

- Turbine Area
- Offshore Export Cable Corridor
- Solent Route
- Modelled Export Cable Corridor
- Modelled Site - Point A

Fig. No.: Figure 7.11		**Date:** 14/08/2013
Author: MK	**Checked:** MB	**Approved:** MB
Scale@A3: 1:200,000		**Revision No.:** 03
Coordinate System: WGS 1984 UTM Zone 30N		**Data Sources:** OS, SeaZone The Crown Estate
Datum: WGS 1984	**Ref. No.:** /Arup	

0 2.5 5 NM

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Legislation

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Glossary

TERM	DEFINITION
Median	The value that lies in the middle of a sample distribution dividing the total frequency in half; i.e. half the numbers are greater than the median value and half are smaller.
Mode	The value that occurs with the greatest frequency in a sample.
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen (NO and NO2)
PM_{10}	Airborne Particulate Matter passing a sampling inlet with a 50% efficiency cut-off at 10 µm aerodynamic diameter and which transmits particles of below this size
$PM_{2.5}$	Airborne Particulate Matter passing a sampling inlet with a 50% efficiency cut-off at 2.5 µm aerodynamic diameter and which transmits particles of below this size
SO_2	Sulphur Dioxide
SOx	Sulphur Oxides

Abbreviations

TERM	DEFINITION
ADMS	Atmospheric Dispersion Modelling System
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
DECC	Department of Energy & Climate Change
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
ECA	Emission Control Area
EPUK	Environmental Protection UK
ES	Environmental Statement
IMO	International Maritime Organisation
MARPOL	International Convention for the Prevention of Pollution from Ships
MMO	Marine Management Organisation
NAQS	National Air Quality Strategy
NPS	National Policy Statement
O&M	Operation and Maintenance
OS	Ordnance Survey
RoTAP	Review of Transboundary Air Pollution
SCMF	Sulphur Content of Marine Fuels
USA	Updating and Screening Assessment