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8.1 PHYSICAL ENVIRONMENT

8.1.1 Coastal Geomorphology

Construction Impacts

Coastal geomorphology (coastal landform) is determined by the interaction between sediment budget and hydrodynamic coastal processes (waves, currents etc). The sediment budget is the amount of mobile sediment in the water column available for distribution. Under normal conditions, this sediment originates from the re-suspension of seabed material and erosion of coastal cliffs, rocks and beaches. New developments or structures below mean high water springs (MHWS) have the potential to release sediment through artificial alterations to hydrodynamic processes, which in turn has the potential to change the amount of sediment available for redistribution. New developments also affect the erodability of substrate, so even without changes in hydrodynamics, erosion can occur where it didn't before.

The method by which the cable or cables are installed at the landfall will determine the potential for impacts to coastal geomorphology during construction.

As the cable is to be installed by open cut trenching , there is a minor potential for changes in sediment dynamics. It is proposed that a back-hoe will excavate a trench at least 2 m deep, from mean low water spring (MLWS) to the sea defences, starting at low tide. As soon as the trench is complete, the cable will be installed and the trench backfilled immediately to minimise the length of time that excavated beach material is exposed. Excavation, burial and reinstatement will take place over one or two tidal cycles. If four 33 kV cables are required, two separate trenches will be needed. As the majority of trench installation will be possible at low tide, this will reduce the potential for re-suspension. It is not thus anticipated that there will be any significant changes to coastal sediment dynamics and coastal geomorphology.

The presence of plant on the beach may lead to some localised compaction of sand, potentially affecting the erodability of the beach. Compaction impacts will be managed through good plant use according to best practice management.

No significant impacts are anticipated to coastal geomorphology during construction.

Long Term Impacts

Studies undertaken by HR Wallingford (2002) indicate that the presence of the proposed wind farm will result in a potential reduction by up to 1% of the incident wave energy at the coast (in the vicinity of the proposed cable landfall) in Colwyn Bay. It should be noted that this value represents a maximum and that more typical values are in the order of 0.2% decrease in the incidence of wave energy at the coast. This represents a small change, predicted to be within the natural variability of wave incidence in the near-shore wave climate. These minor changes in wave energy are not expected to result in any significant changes to accretion or erosion patterns at the shoreline. Similarly, the zone within which the currents may be altered as a result of the presence of the monopiles is limited to within the proposed lease area (HR 2002), hence no impacts are predicted at the shoreline along the north Wales coast.

Existing levels of littoral drift have been assessed and no significant alterations are anticipated as a result of the presence of the offshore structures (HR 2002).

Long term impacts to coastal geomorphology are not anticipated to be significant.

Cumulative Impacts

The potential for cumulative impacts is associated with the interaction between existing projects which are located at the landfall and proposed ones (including Rhyl Flats wind farm proposals).

There are a number of existing cable and pipeline landfall locations situated along the North Wales coast as follows:

- Penryn Bay sewage outfall;
- three disused cables on the eastern side of Rhos Point ;
- Kinmel Bay sewage outfall; and
- Douglas field gas pipeline landfall at Point of Ayr.

The above installations are not known to have caused any historical impacts to coastal geomorphology.

Other wind farm proposals in the vicinity of Rhyl Flats wind farm (which include cable connections to shore) also have the potential for cumulative impacts.

The above projects either have not or are not anticipated to cause significant impacts to coastal geomorphology. When considering the minor additional impacts caused by the Rhyl Flats landfall, the cumulative impacts are not anticipated to be significant.

Mitigation

In order to minimise the potential for impacts from changes to coastal geomorphology (due to interactions between sediment budget and coastal processes), mitigation during construction will include the following.

- Trenching (open cut method only) will take place at low tide from Mean Low Water Spring (MLWS) to the sea defences, thus minimising the potential for material to be re-suspended.

- The trench (open cut method only) will immediately be backfilled once the cable has been installed, thus minimising the exposure of excavated material to coastal processes.

- Following backfilling (open cut method only) the beach will be regraded and reprofiled to its former state, in order to minimise changes to beach sediment dynamics.

- Compaction impacts will be managed through good plant use according to best practice management.

Summary

Short term localised changes in sediment dynamics are likely to be associated with sediment release the open cut trench during construction. Provided that the above mitigation is incorporated, these impacts are not considered to be significant.

Since no significant alteration to littoral drift is anticipated as a result of the presence of the wind farm, long term impacts to coastal geomorphology are not anticipated to be significant along the North Wales coastline.

8.1.2 Flood Defence

Construction Impacts

There are a number of actions which could influence the probability of flooding at the cable landfall as follows:

- siting of landfall;
- construction method; and
- timing of construction.

The cable landfall (*Figure 3.4*) is located within the Abergele, Pensarn, Towyn and Kinmel Bay flood risk area [1] (Binnie, Black and Veatch 2002). The cable landfall benefits from a natural storm beach in front of an unimproved defence, comprising mainly of a masonry wall approximately 1m high. There is a gap in the wall which has been filled by stop boards at the proposed crossing point.

(1) as defined by the Environment Agency

Due to the lack of space, the preferred construction option is open cut trenching and backfilling. It is proposed that the cables could be laid through an existing gap in the sea defences currently closed with stop boards. Following installation, the gap would be filled with concrete and the defence reinstated. The overall condition of the sea defences will be improved as a result of the replacement of the stop boards with something more substantial.

In order to protect the cable and minimise risk of disturbance, the cable will be buried at a depth of at least 2m.

As the open cut method proposed will result in the temporary removal of the timber stop boards, this will result in the formation of a temporary flow path through the defence. As it is proposed that this work will be undertaken at low tide during the spring tidal range.The potential for flooding impacts are considered to be low.

Long Term Impacts

The completed cable landfall will not alter the overall performance of the flood defences at or adjacent to the proposed cable landfall locations, therefore no long term impacts are anticipated. Proposals are not expected to compromise coastal defence strategies in the future.

There will always remain risk of flooding from overtopping of the defences at the cable landfall location. The post construction risk will not, however, be any greater than the existing risk. The replacement of the duck boards with concrete will, in fact, reduce the long term flood risks.

Cumulative Impacts

Given the limited potential for interactions with other schemes, the scope for cumulative impacts is small. In combination with recent improvements to some of the sea defences in the area, the upgrading of sea defences associated with the cable landfall are likely to result in an overall positive cumulative impact.

Mitigation

In order to minimise the potential for impacts to flood defence, mitigation measures will include the following:

- Any construction work involving the flood defence crossing will be undertaken at low tide.

- The stop boards currently comprising the cable landfall will be replaced with concrete, thus improving the condition of the existing sea defences.

- An emergency response plan (dealing with accidental breaching) will be incorporated into the contractors invitation to tender. The contractor will be responsible for providing appropriate mitigation measures in the event of a breach during construction.

- COWL will continue to liase with the Environment Agency and Local Authority during detailed design to ensure that the final sea defence design and construction methods are acceptable.

Summary

Provided the above mitigation measures are included, impacts to flood risk impacts are not predicted to be significant.

8.1.3 Physical Impacts to the Seabed

Construction Impacts

Physical impacts to the seabed during construction may arise as a result of the following activities:

- drilling and grouting (option) - monopiles, meteorological masts and offshore substation (option);

- piling (option) - monopiles, meteorological masts and offshore substation (option);

- ploughing (option) - subsea cables;

- trenching (option) - subsea cables; and

- burial of infield cables.

Drilling is likely to be the technically preferred option for installation of the monopiles, meteorological towers, and offshore substation (option). If this is the case, each structure will be inserted into the drilled hole and grouted into the seabed. The installation method will ultimately depend on the results of detailed geotechnical investigations currently in progress, however the possibility of driven piling should not be excluded.

The diameter of the above structures is expected to be as follows:

- 30 turbine monopiles between 3.5 to 4.5m in diameter;
- two meteorological masts between 2 and 3m in diameter; and
- offshore substation (option) between 3.5 and 4.5m in diameter.

Taking into consideration that cement (10 m^3 approx) will be pumped into the annulus of each hole and that an additional $5m^3$ of cement is likely to form a collar around each structure on the seabed, this will effectively increase the diameter of each footprint to the order of 5m. The total seabed footprint occupied is expected to be approximately $20m^2$ per structure. The permanent habitat loss associated with all 33 structures is therefore predicted to be in the order to 630m^2. If the offshore substation proposal is not technically preferred, and is subsequently located onshore, the habitat loss is anticipated to be in the order of 610m^2.

The spud can [1] footprint (resulting from the presence of the jack-up rig during construction) may result in the temporary disturbance of up to 378m^2 of seabed per hole drilled (12,474m^2 in total) assuming the use of the largest of the vessels available. As the drilling rig has not yet been chosen, this area represents a worst case scenario, hence the area of disturbance is likely to be less than this.

Drilling will result in the need to dispose of a maximum of 500m^3 of arisings from each hole drilled. The arisings will be discharged *in situ* at the seabed.

The results of borehole surveys undertaken within the proposed lease area indicates that the sediment typical profile comprises the following (Fugro 2002):

- sand and gravel (surficial sediments);
- sandy gravely clay (up to about 20 m depth); and
- till (a combination of mudstone and siltstone) (down to 30 m depth).

The geotechnical data indicate that the large bulk of the arisings is likely to comprise a clay conglomerate, which is relatively strong and likely to be dissipated only over a long time period due to wave and tidal action. Immediately post-drilling, the arisings will form a mound which will be relatively steep (given the strength of the clay material) so that parts of the drilled material will occupy a large proportion of the water column. Wave action will tend to reduce the height of each mound, and the fine material eroded will be removed from the area by the tidal currents.

For the monopiles in deep water (up to 17-18m LAT bed level), the arisings will initially reach a height of 7m, and cover an area of 70m^2. In the shallower areas (of order 5m LAT) wave action will spread the arising out further, with perhaps an accumulation of order 1m height covering 500m^2. Based on this analysis, and considering the range of depths of the proposed monopiles, the arisings of all 33 structures are likely to cover an area initially of up to 10,700m^2.

Where driven piling remains a technical option, disturbance to the seabed will be confined to the area immediately adjacent to the monopile causing only localised sediment disturbance. The overall area of permanent seabed loss will, however, remain the same.

The subsea cables to shore will be installed either by jet trenching or by ploughing to a depth of up to 3m. It is anticipated that the trench will be

(1) The foot of the jack-up rig is called a spud can.

between 0.25 and 0.3m in width, however trenching methods will result in disturbance to a slightly larger area. This area will ultimately depend on the trenching method used. Until the results of the geotechnical studies are available, trenching methods being considered include jetting and ploughing. For the purpose of this assessment, both methods have been assessed.

Jetting involves the use of a jet sled which is pulled over the cable route by a barge. The sled carries a vertical 'claw' which consists of two tubes equipped with jets, one on each side of the cable route. Water is pumped from the barge down hoses to the jets which are aimed at the cable route on the seabed. The pressure of the water erodes the seabed and forms a slurry of water and sediment. A jet eductor system ejects the slurry to one side. The cable is then laid in the trench, following which backfilling occurs.

If the ploughing technique is used, the plough is supported on the seabed by skids or wheels, with shares on either side of the cable which is laid on the seabed. It is pulled over the cable by an anchored barge. When the plough is pulled forward, by a cable fixed to the front end of the beam, the shares rotate and close under the cable, and a V-shaped trench, in which the cable falls. The sediment falls back in place immediately after the cable has passed through the shares, thus minimising disturbance to sediment during backfilling.

Substrate loss and disturbance associated with the physical presence of the cable are anticipated to be 1,090m long by 3m depth by 0.3m width, 981m^3 habitat loss.

It should also be taken into account that the jetting method does not involve instantaneous mechanical backfill, therefore a small area of seabed adjacent to the trench will also be disturbed, which cannot be readily quantified. There will also be a disturbance impacts from the settling of the slurry adjacent to the cable trench which will cause minor localised impacts.

The infield cables will be buried by jetting or ploughing methods. Impacts are anticipated to be restricted to disturbance in the immediate vicinity of the infield cables, much of which falls within the disturbance footprint of the monopiles. As a result, impacts will be localised and are not considered to be significant.

Although there is clearly a degree physical impact to the seabed during installation of the monopiles and subsea cables, the area of impact is relatively localised in the context of the proposed lease area. Turbidity plumes caused through the disturbance of sediment are anticipated to be within the natural variability in the system. Impacts are therefore not anticipated to be significant. The potential for impacts to benthic flora and fauna through smothering is discussed in *Section 8.3.1.*

Operational Impacts

Both the presence of the offshore structures and changes to the available sediment budget have the potential to cause physical impacts.

Desk based studies indicate that the potential scour depth in fine to medium sands is highly likely to be less than 0.5m as a result of wave and current interaction (HR Wallingford 2002). On the basis that a 40 degree angle of repose is not implausible for this sediment, a maximum upper limit of 2.1m can be adopted (HR 2002). Given the large spacing between the turbines, no scour interaction is anticipated.

The arisings will be placed at the predicted location of the scour hole, where the relative shelter from the tidal currents will reduce the dispersion, and the material could also help prevent scour.

A post-construction monitoring programme will identify the rate at which scour takes place. Additional scour protection measures will be implemented at such a time that suitable information to inform design becomes available. Potential options for mitigation measures may include:

- rock rip rap to resist design conditions;
- mattresses (concrete, grout filled);
- sandbags (grout filled bags); and
- use of fronds to promote sedimentation (these can be used in conjunction with mattresses).

There are a number of factors to consider when installing scour protection measures of which the primary one is the level of protection to be afforded under the design wave and current conditions. The rip rap, mattresses and bag options can be designed to withstand various storm conditions. Whichever method is used the protection layer must extend between 2.5 to 5m from the turbine to provide adequate protection against scour. For rip rap, mattresses and bags a suitable filter layer (usually quarry run stone and/or geotextile layer) must be placed between the protection layer and the seabed material to prevent settlement. As some scour will take place soon (within a few tides) after installation of the turbine the scour mitigation measures will need to take account of this and it may be possible to utilise the scour hole that develops during installation within the scour mitigation design. The thickness of the scour protection material will not be excessive as it would provide additional blockage to the flow and shift the scour development to the edge of the protection layer.

Given that the subsea cables will be buried, no long term impacts are anticipated to the physical environment from the presence of the cables on the seabed. The significance to benthic flora and fauna is discussed further in *Section 8.3.1.*

The implementation of the post construction monitoring programme will ensure the appropriate design and timing of scour protection measures, minimising long term physical impacts to the seabed. Long term physical impacts are not expected to be significant.

Cumulative Impacts

The characteristic sediment types in Liverpool Bay and the North Wales coast are fine to medium sands, although localised patches of gravel and sandy gravel occur. There are numerous inshore sand banks in the wider area.

The proposed wind farm is associated with medium and fine sands. The level of predicted sediment disturbance is not expected to cause any significant impacts to the seabed resource as a whole.

Despite the number of other developments within the wider area (including old spoil dumping grounds, dredging and oil and gas interests), given the relative uniformity of seabed types the potential for cumulative impacts is considered to be small and is therefore not significant.

Mitigation

A post-construction monitoring programme will identify the rate at which scour takes place. Appropriate scour protection measures will be recommended at such a time that suitable information to inform design becomes available.

Summary

Under a worst case scenario an area of up to 630m^2 of seabed may be lost due to the presence of the offshore structure footprints. Substrate loss associated with the installation of the cable is predicted to be between 981m^3 and 1,044m^3 depending on the cable route option chosen. Natural reworking is anticipated to restore the substrate of the cable routes.

The chosen installation method for the monopiles, meteorological masts and offshore substation will determine the additional disturbance to the seabed during construction. Considering the worst case scenario (drilling of 33 holes), the spud cans could temporarily occupy 12,474m^2, whilst it is anticipated that the arisings could potentially occupy a further 10,700m^2. The clayey nature of the arisings suggests that much of the accumulation will remain for a long period of time and not result in significant scour.

A small area of seabed will be disturbed immediately adjacent to the area of seabed lost due to the presence of the cable. This will result in minor localised increases in turbidity during construction, however once the trench is backfilled, it is anticipated that the sediment dynamics will not be altered. The impacts are considered to be minor.

Given the high energy nature of the environment and the resultant naturally dynamic seabed, the overall physical impacts of the project are not considered to be significant. This is because the predicted changes are not anticipated to be outside their natural range.

8.2 *ENVIRONMENTAL QUALITY*

8.2.1 *Water Quality*

Construction Impacts

The principal sources of impacts to water quality during construction are as follows:

- aqueous discharges from piling/drilling rigs and construction/support vessels;
- leachate from marine cement;
- chemical constituents of the epoxy based antifouling paint;
- increases in suspended solids (has the potential to effect bacteriological decay, thus affecting water quality).

Untreated drainage will be limited to rainwater, seaspray runoff, etc and will have no effects on the water quality of the receiving waters.

The drilling/piling rig and support vessels will produce standard wastes and discharges typical of any vessel at sea including sewage and drainage water.

Sewage will be treated to ensure that biological oxygen demand does not exceed the standards set out in MARPOL 73/78, the UK Merchant Shipping (Prevention of Pollution) Regulations 1983 and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations (1988). Treated sewage can only be discharged at a distance of more than 6.4km (4 miles) from the nearest land. Untreated sewage can be discharged more than 19.2km (12 miles) from the nearest land. In both cases sewage must be discharged from a vessel travelling at a minimum of 4 knots in order to disperse the discharge. Although sewage may contain chlorine (if UV disinfection or biological methods are not used) the anticipated dilution effect will ensure that there will be only minor localised impacts to water quality.

Rig drainage could potentially introduce contaminants to the marine environment, with consequential impacts to marine water quality. An oily drainage system will treat contaminated waters to 15ppm oil in water content prior to discharge. The support vessels will treat and dispose of drainage in accordance with MARPOL 73/78 and UK Merchant Shipping Regulations.

Rig wash, cement and epoxy paint (used for antifouling) will all include some chemical constituents. In order to manage the use of chemicals, thus minimising the potential for impacts to water quality (and flora and fauna), it is recommended that a similar approach be adopted to that used by the offshore hydrocarbon exploration and production operators (Metoc 2000).

The UK Offshore Chemicals Regulations 2001 implement the Harmonised Mandatory Control System (HMCS)[1] which supersedes the voluntary UK Revised Offshore Chemical Notification System (OCNS) which has operated in accordance with the requirements of the Harmonised Offshore Chemical Notification Format (HOCNF) since 1996. Both schemes provide a code of practice regarding offshore chemical use to Hydrocarbon Exploration and Production (E & P) initiatives. Under this system, chemicals are classified into groups depending on their biodegradation and bioavailability characteristics together with their toxicity to a range of taxanomic groups. On this basis, operators will be able to select the least harmful chemicals.

Typically, rig wash chemicals will contain degreasing and detergent products. The requirement for rig washing is currently unknown, however the contractor will ensure that the chemical constituents in rig wash are environmentally acceptable under the Harmonised Mandatory Control System.

If the monopiles are drilled and grouted, there is the potential for impacts to water quality through the release of chemicals used in the cement. The exact details of the chemical constituents are not available, however the contractor will ensure that the chemical constituents are environmentally acceptable under the Harmonised Mandatory Control System.

Similarly, the contractor will ensure that the chemical constituents of antifouling epoxy paints are environmentally acceptable under the Harmonised Mandatory Control System as described above.

Given the high level of mixing (resulting from the hydrodynamics in the vicinity of the proposed wind farm), the anticipated nature and quantities of chemicals that will be discharged to sea during construction, impacts to water quality are not anticipated to be significant.

Offshore construction activity (such as monopile installation and jetting/ploughing) has the potential to cause temporary localised increases to suspended solids in the water column. As a result, this could affect the rate of natural bacterial decay, thus potentially effecting water quality.

(1)for the Use and Reduction of Discharge of Offshore Chemicals (in accordance with PARCOM Decision 96/3).

Near-shore construction activity (proposed between June and September) has the potential to cause impacts to water quality through increases in suspended solids which may effect the rate of bacterial decay. It should be taken into consideration that beaches in Colwyn Bay are used for bathing during the summer months. The water quality is also monitored regularly by the Environment Agency. The cable landfall is anticipated to be sufficiently far away from the main bathing areas not to cause any significant impacts. In order to minimize the risks of impacts to water quality and to bathers, a 'curtain' will be installed to prevent the spread of suspended sediment into bathing areas during construction. Monitoring of sediment levels within bathing areas will also be undertaken. If sediment levels rise above critical levels, works will be halted until the levels return to within their natural variability. Mitigation will be discussed in advance with the Environment Agency.

Operational Impacts

The potential for long term impacts to water quality are limited to the following:

- aqueous discharges from operational support vessels;
- aqueous discharges from offshore substation (option);
- near or far-field changes to turbidity as a result in alterations to sediment dynamics; and
- release of contaminants associated with the Penrhyn and Kinmel Bay sewage outfalls as a result in far-field changes to sediment dynamics.

Operational support vessels and the offshore substation (optional) will produce standard wastes and discharges typical of any vessel at sea. These impacts have been described in the previous section.

Sediment transport modelling indicates an overall reduction in the suspended sediment as a result of an overall reduction in current speeds due to the presence of the wind farm (HR 2002). In parallel, minor increases in suspended solids are restricted to the immediate vicinity of the subsea structures as a consequence of the small increase in current speed in this area (HR 2002). Impacts are therefore anticipated to be minor and localised.

Modelling indicates that the far-field impacts to hydrodynamics will be limited (HR 2002). No changes in current profiles will be observed beyond the limit of the proposed lease area. A maximum of a 1% reduction in wave energy will be observed at the coastline. More typically, wave energy is predicted to decrease by less than 0.2% at the coast which represents a small change when compared with the natural variability in the near-shore wave climate (HR 2002). No significant changes to sediment dynamics are anticipated at the shoreline or to the sediments associated with the Penrhyn or

Kinmel Bay sewage outfalls. As a result, no changes are anticipated to water quality through the release of potentially contaminated sediment from these locations.

Cumulative Impacts

Scheme specific impacts are predicted to be minor both during construction and operation. The potential for impacts to water quality from other coastal and offshore projects in the vicinity, including the proposed adjacent wind farm projects, will be similar, therefore small in nature. As the potential for impacts from the Rhyl Flats project and the other projects in the vicinity are small, cumulative impacts are not considered to be significant.

Mitigation

The offshore contractor will ensure that all discharges from the rigs and ships will be in accordance with MARPOL 73/78, the UK Merchant Shipping (Prevention of Pollution) Regulations 1983 and the Merchant Shipping (Prevention of Pollution by Garbage) Regulations (1988) and that the chemical constituents of rig wash, cement and epoxy paints are environmentally acceptable under the Harmonised Mandatory Control System as described above. In order to control the overall quantities of all chemicals used, the type and quantity used will be monitored.

Good working practice throughout the construction period will prevent and contain any accidental spills and avoid the dropping of solid objects overboard.

A 'curtain' will be installed to prevent the spread of suspended sediment into bathing areas during construction. Monitoring of sediment levels within bathing areas will also be undertaken. If sediment levels rise above critical levels, works will be halted until the levels return to within their natural variability. Mitigation will be discussed in advance with the Environment Agency

Summary

Potential impacts are amenable to mitigation. Good practices during construction and operations will minimise impacts to water quality. No significant impacts are anticipated.

8.2.2 Sediment Quality

Construction Impacts

This section discusses the potential for impacts to seabed sediment quality as a result of construction activities associated with the installation of the offshore structures.

If the monopiles are drilled and grouted into the seabed, there is the potential for impacts to sediment quality from leaching of chemical constituents of the grout into the seabed. The chemical constituents will be confirmed during detailed design. The contractor will be responsible for ensuring that the chemical constituents are environmentally acceptable under the Harmonised Mandatory Control System as described in the *Section 8.2.1*.

Operational Impacts

The following factors have the potential for long term disturbance to sediments and therefore to sediment quality:

- near-field scour caused by changes in current or wave dynamics; and
- far-field impacts through changes in wave and current dynamics.

Sediment quality within the proposed lease area is good (Titan, 2002). Any near-field scour is therefore not anticipated to result in the disturbance of any contaminated sediments which may potentially contaminate other sediments. Impacts to sediment quality are considered negligible.

Cumulative Impacts

Current changes will not be detected outside the wind farm footprint and changes in wave energy at the coast are not predicted to be significant. As a result, scheme specific impacts are predicted to be minor both during construction and operation. The potential for impacts to sediment quality from other coastal and offshore projects in the vicinity will be similar in nature and therefore minor. As the potential for impacts to sediment quality are generally considered minor for Rhyl Flats and other proposals, the potential for cumulative impacts is not anticipated to be significant.

Mitigation

The contractor will be responsible for ensuring that the chemical constituents of any grouting cement used are environmentally acceptable under the Harmonised Mandatory Control System. In addition, quantities of all chemicals used will be monitored.

Post construction monitoring will be carried out to monitor scour. When sufficient information has been collected regarding the actual scour, appropriate mitigation will be implemented in order to minimise scour, thus minimising the potential for contaminant release from disturbed sediments.

Summary

As a result of the mitigation measures which will be applied, impacts to sediment quality are not predicted to be significant.

8.2.3 *Air Quality*

Construction Impacts

Vessel movements during construction will result in emissions of greenhouse gases. The following vessels will be used during the 20-week construction period:

- main construction vessel;
- accommodation vessel;
- jack-up for tailing crane;
- transport barges for turbines and foundations;
- service vessel;
- cable vessel; and
- infield cable vessel.

It is estimated that these will produce the following emissions during the 20 week construction period:

- approximately 28 tonnes CO_2;
- approximately 730kg NO_x;
- approximately 50kg SO_2 (this is highly dependent on the sulphur content of the fuel); and
- approximately 9kg PM_{10}.

UK annual emissions of CO_2 are estimated to be 547 million tonnes (1999 data, (DEFRA, 2001) (1) therefore the anticipated CO_2 emissions are not considered significant in a national context.

The anticipated emissions are predicted to cause only short term localised impacts to air quality and are not considered to be significant.

There will be no impacts from construction dust, due to small amounts of dust generating activities and a lack of local dust sensitive receptors.

Operational Impacts

No gaseous emissions or particulate emissions will be associated with the operation of the wind farm with the exception of minor emissions of NO_x, PM_{10} and CO_2 from the service vessels.

The generation of energy from wind is a major contribution towards the reduction of the effects of greenhouse gases and subsequently climate change.

(1) Digest of Environmental Statistics, Source NETCEN

This is achieved through substituting energy which would have been produced from the burning of fossil fuels with 'green' energy.

Table 8.1 presents a comparison of the CO_2 emissions produced for the proposed wind farm using different types of fuel.

These numbers should only be taken as indicative, since generation efficiencies across different plants can result in a significant variation in unit-based emission factors.

Table 8.1 Comparison of CO_2 Emissions for Power Generation

Fuel	CO_2 Emissions kg /MWh [a]	Annual CO_2 Emissions / ktonnes	
		75 MW Installed Capacity	150 MW Installed Capacity
Wind	0	0	0
Natural Gas	452	104	208
Oil	583	134	268
Coal	920	212	423

(a) Source: IEA/OECD *CO_2 Emissions from Fuel Combustion,* 1999
(b) The rated capacity of the wind farm is estimated at 35% therefore the expected output of the wind farm will range from 26 MW to 52 MW for 75 MW and 150 MW installed capacity, respectively.

This project helps to contribute towards the UK Governments Climate Change targets of:

- a 12.5% reduction in emissions of greenhouse gases by 2008 –2012, as agreed in Kyoto Protocol; and

- a 20% reduction in CO_2 below the 1990 levels by 2010.

Cumulative Impacts

The potential for cumulative impacts as a result of the emissions generated during construction in combination with the construction phases of other developments in the vicinity is low and is not considered to be significant.

Mitigation

The contractor will use vessels which are well maintained and use high economy fuels (low sulphur fuels if possible).

Summary

During construction, construction vessels will result in emissions of greenhouse gases. The impacts will be short term and localised and are not anticipated to be significant.

The operating wind farm represents a significant benefit in terms of greenhouse gasses released to the atmosphere by producing energy from wind power rather than by burning fossil fuels. The overall long term impacts are considered to be positive.

8.2.4 Subsea Noise

Introduction

The generic and potential impacts of subsea noise are discussed in this section. Details of impacts to fish are given in *Section 8.4.2* and details of impacts to marine mammal are discussed in *Section 8.5.2*.

Generic Impacts of Noise on Marine Biota

The potential effects of noise on marine organisms can be categorised as follows:

- potential for changes in behaviour (including avoidance and attraction);
- potential for interference with acoustic communication; and
- potential for physical damage (including damage to hearing apparatus).

Mobile fauna may exhibit behavioural changes, however these are often hard to detect. Behavioural changes will typically involve a cessation of normal activities and the commencement of avoidance or 'startle' behaviour as a result of the detection of sound from marine construction activity. Continued detection of noise activity by organisms often results in habituation to the sound, followed by a re-commencement of normal behaviour.

Interference with sounds produced by animals for communication purposes is also difficult to assess, but is likely to result in the temporary cessation of sound production, or a muffling of sounds.

Physical damage can arise from the differential rate of transmission of sound pressure waves through tissues of varying densities. The effect is particularly marked at interfaces between tissues and gas-filled cavities, for example the swim-bladders of fishes or the lungs of mammals. The sound-receiving apparatus of most organisms is generally comprised of sensory hair cells, which are extremely sensitive to vibrations. Over-stimulation of these can potentially lead to permanent damage.

For an organism to respond to introduced sound sources such as drilling or operational noise, the sound has to exceed that of the ambient noise, which has either non-biological or biological origins. McCauley (1994) noted that non-biological underwater noise has three sources, namely wind (including waves and the surf zone), rain and anthropogenic causes. Wind noise increases with increasing wind speed and most of the noise is generated by bubble oscillations within waves (Richardson et al 1995). Rain produces broad-frequency spectra sounds, increasing with the intensity of the downpour.

The most pervasive anthropogenic noise sources are those produced by ships. Shipping sounds cover a wide range of spectra, and include extremely loud noises when the source is in close proximity. *Table 8.2* summarises the non-biological sources of marine noise and provides some anticipated ranges in relation to the Rhyl Flats wind farm project.

Table 8.2 ***Comparison of Underwater Noise Types (Source Richardson et al 1995)***

Source	**Frequency and Strength**
Wind	1Hz - 25kHz; 95dB at 100-200Hz (Force 12)
Rain	Broad spectrum; 80dB (heavy rain)
Ships	1Hz - 1kHz; 0 - 200dB (depending on range)
Invertebrates	2-10kHz; <140dB-m
Fish	100Hz - 5kHz; <140dB-m
deep seismic exploration	10 –120Hz; <250dB
drilling (from semi-submersible)	29-70Hz; 125dB
drilling (from drill ships)	10-10,000Hz; 191dB
windfarm operational noise*	115-120 db re 1µPa-1m

*source Vella *et al*(2001)

Underwater biological noises are produced by a wide variety of marine organisms, particularly during reproduction, displays of territoriality and echo-location. Sounds produced by fish have a frequency range from 100Hz to about 5kHz. Marine mammals demonstrate the greatest range of frequencies during sound production, ranging from 12Hz in large baleen whales such as blue whale *Balaenoptera musculus* to 160kHz in harbour porpoises *Phocoena phocoena* (Richardson et al 1995).

There appear to be no studies on the reactions of fish to drilling, however there are several studies on fish reaction to seismic activity which can be used to give an indication of the anticipated impacts. The noise from drilling is within the same frequency as the noise from the seismic activity, however generally quieter (125dB) than the noise from seismic activity. The noise generated by seismic activity is intermittent whilst the noise from drilling is more continuous.

Behavioural changes became noticeable at about 180dB re 1µPa-m, and increased with increasing sound intensity. Studies have also demonstrated the ability of fish to acclimate to airgun noise with time (Chapman and Hawkins, 1969). Enger (1981) and Cox *et al* (1987) showed that, with prolonged and continuous exposure to high intensities of sound, the hearing apparatus of fish could be damaged. The intensities experienced during drilling activity are much lower than these frequencies.

Potential Impacts during Construction

During piling, noise will be radiated from the pile through two transmission paths as follows:

- directly from the pile wall into the water; and
- through the end of the pile which is located in the seabed, through the seabed and then back into the water.

The most efficient transmission path will occur from the pile steel wall into the water directly.

The potential for disturbance to marine mammals and fish has been assessed on the basis of noise predictions undertaken by QinetiQ. The assessment has considered the following:

- potential audibility of the piling operations;
- the potential for temporary threshold shifts (TTS) of fish and marine mammal hearing; and
- permanent threshold shifts (PTS) of fish and marine mammal hearing.

To determine the potential range over which such effects may occur, predictions have been performed of piling noise at distances from the pile of 5 m and 20 km.

Offshore construction activity associated with Rhyl Flats wind farm will involve;

- pile driving activity (optional) during monopile installation;
- drilling activity (optional) during monopile installation;
- jetting (optional) or ploughing (optional) during the installation of the subsea cable; and
- construction vessel movement.

The monopiles will be installed either by pile driving, drilling and grouting or a combination of both. Installation of the subsea cable will be either by jetting or trenching.

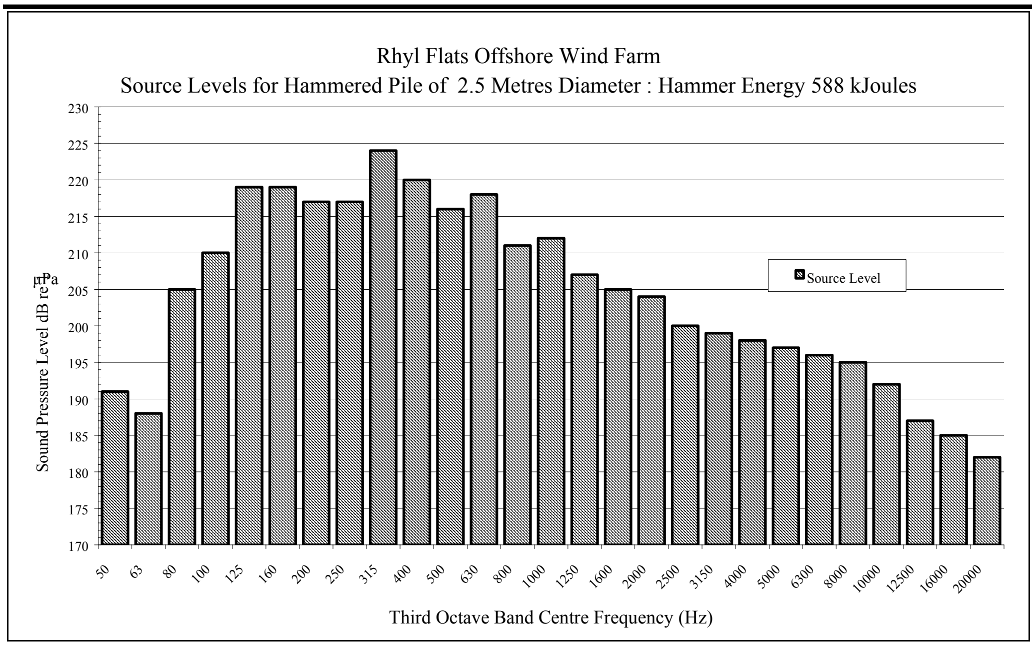
Richardson *et al*. (1995) states that impulsive hammering sounds may be as high as 131 – 135dB re 1 µPa at a range of 1km from the pile (pile size unknown) and that the transient signals have the strongest components at frequencies of 30 – 40Hz and approximately 100Hz. Work undertaken as part of the San Francisco – Oakland Bay Bridge East Span Seismic Safety Project (ESSSP) Pile Installation Demonstration Project (PIDP) indicated that piling noise levels (2.4 m diameter piles) are considerably higher than the levels quoted by Richardson *et al*.

The ESSSP pile lengths were considerably longer (120m) than those proposed for Rhyl Flats wind farm (30-40m) therefore, the level of energy required to insert the piles for Rhyl Flats is predicted to be less than that required for the PIDP Pile Insertion. PIDP noise measurements indicated noise levels between 185 – 196 dB rms. re 1 µPa at 1 and 6m depth respectively (measured at a distance of 103m from the pile). This provides a source level of between 225 and 236 dB re 1 µPa at 1m from the pile. The hammer energy that produced this level of noise was 918kJ, equivalent to approximately 39 tonnes falling 3 m. At Rhyl Flats, a 30 tonne hammer dropped from a distance of 2m (producing energy of 588 kJ) will be used to install the monopiles for the two meteorological masts. The hammer for driven turbine monopiles may be larger but the equipment specification has yet to be determined. Therefore the assessment of construction impacts of the driven pile solution has been based on the meteorological mast installation specification. It should be noted that a doubling of the pile hammer energy will result in only a 3 dB increase in radiated noise levels.

On the basis of simple energy difference between the energy levels for the ESSSP and Rhyl Flats piles, it has been estimated that the source levels of piling noise for Rhyl Flats will be between 223 and 234dB re 1 µPa at 1 m.

Third octave band spectra for PIDP indicated that piling noise peaked between 125 and 500 Hz and then reduced in level by between 3 and 4 dB per octave above 500 Hz. When assessing the potential for disturbance due to hammered piles, the spectrum shape shown in *Figure 8.1* has been adopted.

Figure 8.1 ***Source Noise Levels for Hammered Pile of 2.5 m Diameter***



Potential Impacts during Operation

Operational noise sources are related to the transmission of noise from the tower support structure into the marine environment, airborne noise incident upon the water surface and associated service boat movements for turbine maintenance.

There are currently very few data on underwater noise emissions from wind turbines. Available data include noise measurements taken for tripod pile turbines. This type of turbine has very different radiation characteristics to the monopile structure which is proposed for the Rhyl Flats wind farm.

Using the currently available data collected by the Hayes McKenzie Partnership, the potential sound power level likely to be radiated from the monopile wall has been determined. The source sound pressure level in water has also been determined and has then been used to assess the potential effects of turbine operations to the fish and marine mammals.

Table 8.3 Source Levels for Turbine Operational Calculations

Frequency (Hz)	30	50	70	90	160	250	400
Intensity dB re 1 picowatt	40.0	34.4	42.5	45.5	41.3	43.0	47.6
In Water dB re 1 μ Pa @ 1 m	90.9	85.3	93.4	96.4	92.2	93.9	98.5
Frequency (Hz)	600	800	1000	1200	1400	1600	
Intensity dB re 1 picowatt	38.3	35.9	28.0	23.3	22.7	22.1	
In Water dB re 1 μ Pa @ 1 m	89.2	86.8	78.9	74.2	73.6	73.0	

The anticipated spectrum shape is smooth, however the actual noise levels predicted to be radiated from the monopiles will be dependent upon the type of gear box installed and the speed of the wind turbine. This is because most noise transmitted down the tower into the monopile will be sourced from the gear box and generator. As the proposed wind turbines will be variable speed in operation, the driving frequencies associated with the gear box gear meshing frequencies will vary from turbine to turbine. It is not possible, without knowing exactly which turbine and gear box are to be used and the operational characteristic of the turbine, to indicate a true picture of the noise environment within the sea. A worst-case assessment has therefore been undertaken using a broad band spectrum. The effect of discrete frequencies being radiated into the sea is likely to reduce any potential masking that might occur due to turbine operation.

Predictions of the transmission losses and incident sound pressure levels for a water depth of 10 m have been undertaken by QinetiQ in order to determine the levels of underwater noise radiated by the wind turbine pile structure. When considering these predictions, it should be borne in mind that they represent a worst-case. It has been assumed that the seabed is flat and smooth. The geophysical survey undertaken as part of the site evaluation indicates that the sea bed in the site area is covered with sand ripples to the depth of 1.5 to 3 m. In reality, the ripples will result in the reflection of acoustic energy back towards the source such that attenuation rates will be greater than has been calculated for a smooth sea bed.

The predictions indicate that at frequencies above 300 Hz, little attenuation is predicted to turbine noise due to beaming of the sound through the water (QinetiQ).

8.3 BENTHOS

8.3.1 *Sublittoral Impacts*

Construction Impacts

The wind farm proposals have the potential to affect flora and fauna either through direct habitat loss (discussed in *Section 8.1.3*) or through temporary disturbance during construction.

Construction activities have the potential to cause impacts to benthic habitats and fauna as follows:

- direct habitat loss (footprint of offshore structures);
- habitat disturbance (as a result in subsea equipment installation); and
- toxic effects to benthic communities (from chemical additives in cement, drilling water).

The monopiles, meteorological towers and substation (optional) will result in an area of habitat loss approximately 650m^2 (worst case). The total area within the boundary of the proposed wind farm is approximately 12.43km^2. In addition, a volume of approximately 1,044m^3 (worst case) seabed habitat will be lost due to cable installation, although the seabed strip will recover in the longer term, once the cable has been installed.

The presence of the drill rig will cause temporary disturbance to the seabed in the order of 378 m^2 per hole (12,474 m^2 in total) whilst it is anticipated that the arisings (from each drill hole) could potentially disturb a further 10,700 m^2 seabed habitat.

All subsea construction activities have the potential to result in re-suspension of sediment into the water column, potentially leading to smothering impacts to benthic flora and fauna. Smothering impacts will be the most significant for the larger, less mobile organisms such as crab, lobster, shrimp, sea urchin, etc. Smothering may also cause impacts to fish (discussed in *Section 8.4*). Impacts will be localised and are not considered significant in the context of the wider area, particularly as the community types within the proposed lease area are broadly consistent with that of the wider area.

The benthic infaunal communities identified at Rhyl Flats and further inshore (Titan 2002) are also broadly typical of fauna found in mobile sands and characterise the 'shallow sand faunal communities' biotope, which is fairly common in the wider area and in the UK. Given that most of these species are adapted to living in a highly mobile environment, natural recovery and recolonisation is likely to occur rapidly. Impacts to benthic communities are not anticipated to be significant.

If piling occurs at any of the proposed monopile locations instead of drilling, the direct impacts to the seabed and associated communities will be reduced in scale due to less direct disturbance to the seabed.

Ploughing is likely to result in slightly less sediment disturbance than jet trenching. As a result, the potential for disturbance to flora and fauna adjacent to the final cable route option is likely to be smaller for ploughing than jet trenching as this relies on pressure hosing of the seabed. In both cases, however, the impacts are considered to be relatively minor in the context of the wider area and colonisation is predicted to occur rapidly.

The release of organic polymers and heavy metals associated with grouting/cementing material could be toxic to marine organisms whilst wet, potentially contaminating sediment, inhibiting recolonisation after construction. Cement will only come into contact with the area immediately surrounding each subsea structure, therefore impacts to marine fauna will be moderate and localised. Given the limited extent of these effects, impacts to marine fauna are not anticipated to be significant.

Operational Impacts

Long term impacts to benthic flora and fauna may be caused by:

- direct permanent habitat loss; and
- introduction of new habitats (monopiles, stones/gravel mattress/artificial fronds installed as part of scour protection measures).

Under a worst case scenario, an area of up to 630m^2 of benthic habitat may be permanently displaced by the offshore structures (not including the cables). Although other areas may be disturbed during jet trenching/ploughing and drilling (described in the previous section), the effects are considered localised and are anticipated to be short-lived. When the area of direct habitat loss is considered in the context of relative importance of the habitat type compared with the habitat distribution in the wider area, the impacts from direct habitat loss are not considered to be significant.

Sediment transport modelling indicates that there will be an overall reduction in the suspended sediment, as a result of an overall reduction in current speeds (HR 2002). Localised increases to suspended solids are restricted to the immediate vicinity of the subsea structures as a consequence of small increases in current speed in this area (HR 2002). These changes to sediment dynamics are not predicted to cause any significant changes to benthic habitats and benthic faunal structure.

As the potential for far-field changes to far-field sediment dynamics are negligible, no knock-on impacts are predicted to benthic flora and fauna in the wider area. As a result, no significant alterations in suspended sediment will occur and the resulting impacts to flora and fauna are not, therefore, considered to be significant.

The wind farm proposals will result in an area of permanent habitat loss *ie* where the monopiles have been installed. In addition, there is the potential for coarse material (rock, stones, gravel/fronds) to be installed around the base of the monopiles to provide scour protection. The design details of such protection will be defined from post-construction monitoring. If such material is installed, this has the potential to locally alter the habitat type, potentially resulting in colonisation by different benthic communities. The scour protection design together with the hydrographic parameters are important factors determining the extent and rate of biofouling, as well as the development of hard-bottom organisms. It is highly likely that each monopile foundation will essentially create a reef community offering shelter and food for fish (Danish Institute for Fisheries Research 2000). The implications for fish are described further in *Section 8.4*.

Cumulative Impacts

Given the fact that any impacts are minor and localised, the scope for cumulative impacts is low and therefore not considered significant.

Mitigation

A post-construction monitoring programme will identify the rate at which scour takes place. Appropriate scour protection measures will be recommended at such a time that suitable information to inform design becomes available. This approach will ensure that impacts to benthic habitats and fauna are minimised.

Post construction benthic sampling will be undertaken in order to assess the recovery of the benthos within the proposed wind farm area. Surveying will be undertaken annually until the benthos has made a full recovery or until the condition of the benthos is the same as it was the previous year, indicating that the benthos has recovered as much as it is going to. Sites inside and outside the wind farm area will be chosen (from the sites used for the Titan 2001 benthic survey) and surveying will be undertaken during Autumn/Winter. The exact scope of the post construction surveys wioll be discussed with CCW and CEFAS.

Summary

Construction activities and equipment installation will result in some localised smothering of benthic communities. Impacts will be focused on the larger less mobile organisms such as crab and sea urchin. Considering the distribution of these species in the wider area, impacts are considered to be minor. Physical disturbance to sediments will also cause disturbance to benthic communities. However, given the already highly mobile environment and the resilience of the species associated with the mobile sands, recolonisation of disturbed sediments is anticipated to be rapid. Overall impacts to benthic communities during construction are not considered to be significant.

In the longer term, the presence of any scour protection measures has the potential to provide a habitat for other benthic communities associated with hard bottom habitats. This is likely to improve the area in terms of biodiversity and the combination of shelter and food will be beneficial for fish species.

8.3.2 Intertidal Impacts

Construction Impacts

The longshore and cross shore littoral drift is not anticipated to be significantly altered by the presence of the proposed wind farm (HR 2002).

As the cable is to be installed by open cut trenching, the potential for disturbance to the beach and beach profile exists. It is proposed that a back-hoe would excavate a trench at least 2m deep, from mean low water spring (MLWS) to the sea defences, starting at low tide. If four 33kV cables are required, two separate trenches will be needed. As soon as the trench is compete, the cable will be installed and the trench backfilled immediately to minimise the length of time that excavated beach material is exposed. Excavation, burial and reinstatement will take place over one or two tidal cycles. Trenching across the foreshore will temporarily impact the beach during construction. Although the exact area that will be disturbed under this option is not known, the impacts are not anticipated to be significant due to the following factors:

- there are no sensitive/rare communities;
- the aerial extent to the impact is small; and
- the impact is temporary.

Following backfilling and regrading, it is anticipated that the natural beach fauna will rapidly recolonise the disturbed zone from adjacent areas.

Thrust bore installation of the cables under the rail tracks to the south are not ecologically significant.

Operational impacts

The wind farm is predicted to result in a maximum overall reduction of 1% in wave energy reaching the shore. No changes in currents are predicted outside the proposed lease area (HR Wallingford 2002). The proposed wind farm is not anticipated to result in any significant changes to littoral drift at the cable landfall as a result of the presence of the wind farm (HR Wallingford 2002). As a result, no impacts to ecology are anticipated during operation.

Cumulative Impacts

The landfall associated with the Rhyl Flats wind farm is not expected to result in any significant impacts to intertidal flora and fauna. As the impacts on flora and fauna as a result of landfall disturbance are relatively generic, it is likely that the impacts from other proposed schemes in the area (including Burbo Bank and West Hoyle proposed wind farms), are likely to be similar in nature, *ie* minor, although the communities disturbed may be slightly different. As a result, the potential for cumulative impacts is low and not considered significant.

Mitigation

In order to minimise the potential for impacts to flora and fauna from the release of sediments during construction of the cable landfall, mitigation during construction will include the following.

- Trenching will take place at low tide between the Mean Low Water Spring (MLWS) level and the sea defences, thus minimising the potential for material to be re-suspended causing smothering impacts to intertidal organisms.

- The trench will immediately be backfilled once the cable has been installed, thus minimising the exposure of excavated material to coastal processes reducing the potential for smothering impacts.

Summary

The construction proposals for the cable landfall (open cut trench) have the potential to cause impacts to intertidal flora and fauna. Although the exact area of habitat disturbance is unknown, the impacts are anticipated to be minor due to the fact that the disturbance is temporary and there are no important flora and fauna present in the vicinity of this landfall option.

No long term impacts to intertidal flora and fauna are anticipated.

8.4 FISH

8.4.1 Physical Impacts

Construction Impacts

There are a number of construction activities which have the potential to cause impacts to fish as follows:

- physical impacts from presence of structures and construction vessels;

- smothering impacts from minor increases in localised sediment as a result of disturbance to the seabed; and

- noise impacts from drilling/piling and vessel movements.

The potential for impacts to fish from the physical presence of subsea structures and vessels is low due the fact that fish are highly mobile and are able to avoid such structures. The mechanism by which fish change their behaviour is associated with noise disturbance, and the impacts of underwater noise are discussed in further detail in *Section 8.4.2*

The disturbance of sediments during construction will result in minor localised increases in suspended sediment in the water column. Potential impacts to fish include the following:

- visual predators such as mackerel (*Scomber scombrus*) may be affected by reduced visibility, resulting in reduced feeding efficiency;

- burrowers and sand-dwelling non-migratory species such as sandeels (*Ammodytes* and *Hyperoplus* spp) may be affected by habitat loss as well as suffering direct mortality; and

- the eggs of demersal fish spawners such as sandeels and herring (*Clupea harengus*) are sensitive to smothering by fine particles.

The significance of impacts during construction depends on the use of the area by fish and the importance of the area to fish for different activities. The most significant impacts to fish are likely to occur to fish using the area as a nursery area or for spawning. Sprat, sole, plaice and whiting are known to spawn in the vicinity of Constable Bank (Coull et al 1998). The inshore waters of Liverpool Bay in general (including Constable Bank area) are known to be important for spawning by herring, whiting and plaice (Coull et al 1998). Sole also frequent the inshore waters of Colwyn Bay but are not believed to use Constable Bank itself as a nursery area.

Offshore construction activity will take place between May and July coinciding with the spawning periods for sprat, sole and whiting. The presence of physical structures (including vessels) during construction and changes to suspended sediment are anticipated to result in only minor impacts to fish because:

- construction impacts are be temporary in nature; and

- fish demonstrate avoidance behaviour thus in most cases are able to avoid impacts.

Subsea noise impacts caused by vessel movements and construction activities are discussed in *Section 8.4.2.*

Operational Impacts

The proposed wind farm has the potential to result in the enhancement of habitats for fish as follows:

- the scour protection measures may result in the creation of artificial reef habitat; and
- the exclusion zones will result in the creation of a safe haven for fish from being fished.

In the first instance, arisings from the drill hole will be deposited in the predicted location of the scour hole. Due to the anticipated clay nature of the arisings it is predicted that much of this material will remain *in situ*. Pre and post construction monitoring will enable the exact nature of any additional scour protection methods to be identified. Scour protection may include the installation of rocks/gravel mattresses/artificial fronds around the base of each monopile. These new substrates, may, if properly designed, provide a habitat for a variety of marine flora and fauna, providing food and refuge to a number of fish species and generally contributing to the biodiversity of the region (Danish Institute of Fisheries research 2000).

The restrictions on fishing within the wind farm will result in the area being used as a safe haven by fish. In the longer term, this is likely to increase the productivity of the wider area resulting in benefits for local fishermen.

Cumulative Impacts

The potential for cumulative impacts during construction is negligible.

In the longer term, the construction of more than one wind farm in the wider area may be beneficial for fish and the fisheries resource provided it is managed properly.

Mitigation

Although the primary function of scour protection is to reduce scour, design of such measures will be undertaken with ecological factors in mind in order to maximise the potential for increasing biodiversity.

Summary

Physical impacts to fish during construction are limited to the physical presence of subsea features and construction vessels and the potential for smothering effects. These impacts are not considered to be significant due to fact that the impacts are temporary and because fish demonstrate avoidance behaviour thus avoiding the impacts.

In the longer term, it is likely that the combination of restricted fishing and improved habitat biodiversity will have beneficial effects for fish populations.

8.4.2 Subsea Noise Impacts

Introduction

The generic impacts and potential impacts of subsea noise are set out in *Section 8.2.4* above.

Criteria for Assessment

Studies of fish audibility thresholds indicate that the presence of a gas bladder or octic gas bladder can greatly increase the sensitivity of fish to detect noise at selected frequencies. Such fish are, for the purpose of this report, classified as hearing sensitive fish. Fish without a gas bladder can have an audibility threshold which is as much as 20 to 30 dB higher than hearing sensitive fish.

When assessing the potential effects of noise upon the hearing of fish, levels of between 75 and 85dB above the hearing threshold will result in a TTS(1). Work reported by Scholik and Yan(2) indicates that exposure to sound that is 75 dB above the threshold of audibility for an hour can give rise to a TTS within hearing sensitive fish.

With this in mind, and using the precautionary principle, the TTS criterion level for a number of fish, based upon the energy to cause TTS for one hour's exposure to a noise, may be determined. This equates to an 8 hour noise exposure period TTS threshold that is 66 dB above the audibility threshold of hearing sensitive fish.

Scholik and Yan also determined that a 24 hour exposure to a level 75dB above the threshold of audibility would result in PTS. Based upon this observation, it has been estimated that there is the potential for PTS to occur to hearing sensitive fish for levels which are 80 dB above the hearing threshold when exposed for an 8 hour period. This level is close to the health, safety and environment Noise Exposure Action Levels to protect humans against hearing damage. Richardson (1995) indicates that this is not surprising given that there are basic similarities between audiological response and inner-ear transduction mechanisms between the various species.

Construction Impacts

- *Piling*

The potential for disturbance to fish from piling has been assessed on the basis of noise predictions undertaken by QinetiQ. The scope for this work is described in *Section 6*.

Figure 8.2 and *Figure 8.3* indicate the levels at which TTS and PTS would occur if fish remained within the 'separation distances' for a period of 8 hours. The

(1) The Environmental Impact of Underwater Sound: Proc. IoA Vol 23 Part 4 (2001) Page 1 - 12
(2) The effects of underwater noise on auditory sensitivity of fish: Proc. IoA Vol 23 Part 4 (2001) Page 27 - 36

separation distance is the distance between the source, *ie* the pile, and the receptor, in this case, the fish. It is likely that the level of noise from piling operations when close to the pile will result in a startle response which will result in the fish moving away from the noise source, thereby reducing the potential for TTS and PTS.

Figure 8.4 indicates that piling noise will be audible up to 20 km and beyond. The sound pressure levels detailed within these figures are the L_{max} using a 0.1 second averaging time.

Figure 8.2 details the potential for TTS from piling operations. The sound pressure levels within these figures has been determined from the L_{max} levels assuming a duty time of 5%, *ie* for only 5% of the time will there be noise from the pile. This equates to a reduction in level of 13dB to determine the L_{eq} (energy equivalent) of the piling noise. These figures indicate that hearing sensitive fish may be subject to TTS within 1000 m of the piling activity. The spectral peak occurs between 100 – 630 Hz which is the sensitive range for fish, most Marine Mammals hearing works best between 1 kHz and above upto 100 kHz except Baleen Whale which is assumed, based upon its call frequencies, to have a sensitive range in the low Hz region. TTS is unlikely to occur beyond 1000 m. For a fish to acquire the required dose level, however, it must remain within 1000 m of piling activity throughout for the pile installation period (which may take 8 hours, but is expect to only occur for 4 – 5 hours).

Figure 8.3 detail the potential for PTS from piling operations. The predicted levels indicate that hearing sensitive fish within 200 m of a piling activity may risk PTS if exposed to 8 hours of noise.

*Table 8.1*details distances at which TTS or PTS will occur for example exposure times.

Table 8.4 Predicted Separation Distances and Exposure Times to Piling Noise for TTS and PTS to Occur

	Hearing Sensitive Fish	
Exposure Period (Seconds)	**Separation Distance for TTS (Metres)**	**Separation Distance for PTS (Metres)**
28800.00	1000.0	200.0
14400.00	707.9	141.6
7200.00	501.2	100.2
3600.00	354.8	71.0
1800.00	251.2	50.2
900.00	177.8	35.6
450.00	125.9	25.2
225.00	89.1	17.8
112.50	63.1	12.6
56.25	44.7	8.9
28.13	31.6	6.3
14.06	22.4	4.5
7.03	15.8	3.2

	Hearing Sensitive Fish	
Exposure Period (Seconds)	**Separation Distance for TTS (Metres)**	**Separation Distance for PTS (Metres)**
3.52	11.2	2.2
1.76	7.9	1.6
0.88	5.6	1.1

Figure 8.2 and *Figure 8.3* indicate that incident noise levels increase as the distance of the fish from the pile decreases. The potential for TTS and PTS is related to the energy dose value. As the fish approaches the pile, the received energy from each hammer strike will increase. As an indication:

- the levels incident upon a fish 5 m from piling activity are 48 dB higher than at the distance where the TTS threshold occurs, i.e. 1000 metres for an 8 hour exposure; and

- 33 dB higher for the PTS threshold , *ie* a separation distance of 200 m.

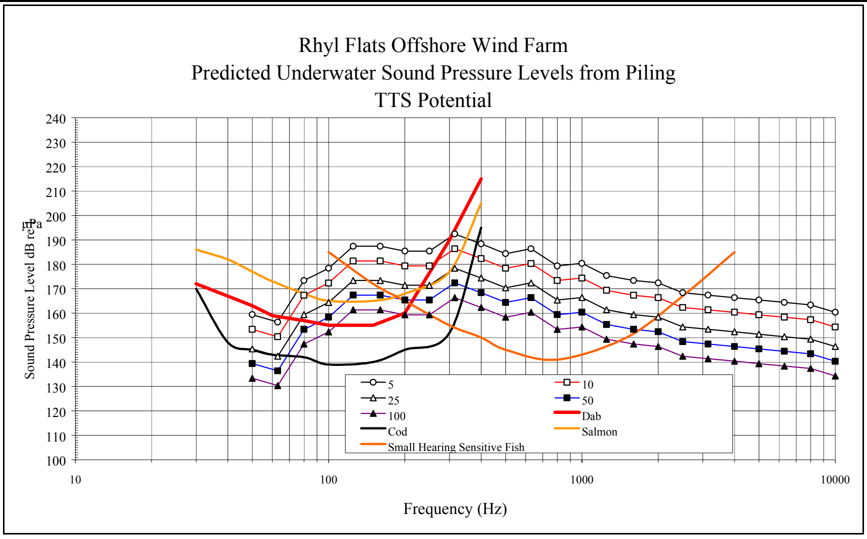
Based upon an 'exchange rate (1)' of 3 dB, this implies that a fish within 10 m of the piling activity will experience TTS within around 03.52 seconds. PTS may be experienced if the fish remains in the vicinity of the piling activity for up to 56 seconds.

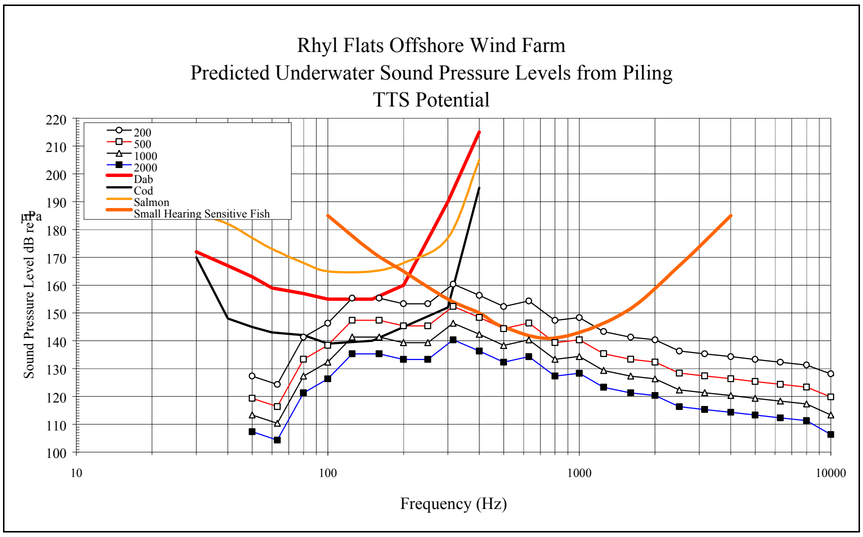
The noise predictions indicate that there is a risk that hearing sensitive fish (which represent a worst case scenario) will suffer TTS and PTS during piling activity. Noise sensitive fish including cod (*Gadus morhua*), whiting (*Merlangius merlangus)*, herring (*Clupea harengus*) and haddock (*Malanogrammus aeglefinus*) are known to be present within the proposed wind farm area and therefore have the potential to be affected. In reality, fish that are present within 5m of the monopile when piling is started are likely to be affected. It is expected that fish will avoid the area (*ie* will not swim within 5 m of the monopile) once piling has started and are therefore unlikely to experience sound levels that cause TTS or PTS.

A number of fish spawn within the proposed wind farm area including whiting (February to May) plaice (December to March), and herring (August to September). The proposed wind farm area is also used as a nursery ground by whiting, plaice, sole and sprat. The majority of the piling will be carried out in July and August and as such is unlikely to coincide with any of the peak spawning seasons. There is the potential for juveniles to be using the area as a nursery area during the proposed piling period. Impacts to juvenile fish will, however be localised and restricted only to individuals which are located within 5m of the monopiles when piling begins. Impacts are therefore predicted to be low and are not considered significant.

(1) [1] The Exchange Rate is defined within ANSI S1.25 as " the change in sound level corresponding to a doubling or halving of the duration of a sound level while a constant percentage of criterion exposure is maintained." It is assumed that marine fauna will expereicne an exposure factor = 1 and therfore an Exchange Rate of 3 dB.

Figure 8.2 Predicted Underwater Sound Pressure Levels from Piling, TTS Potential





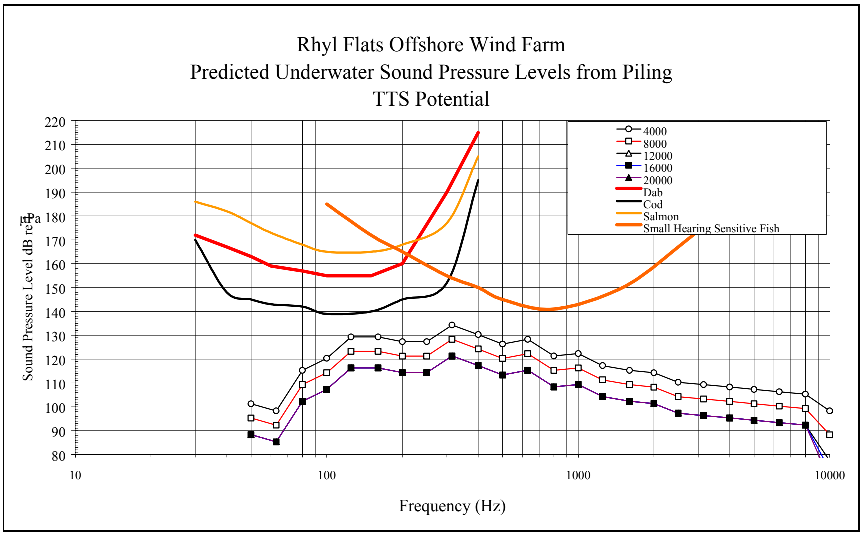
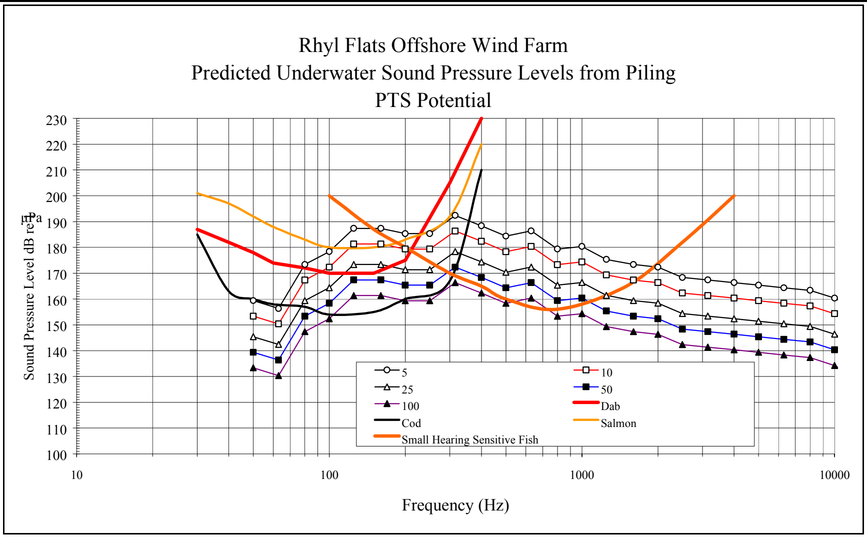
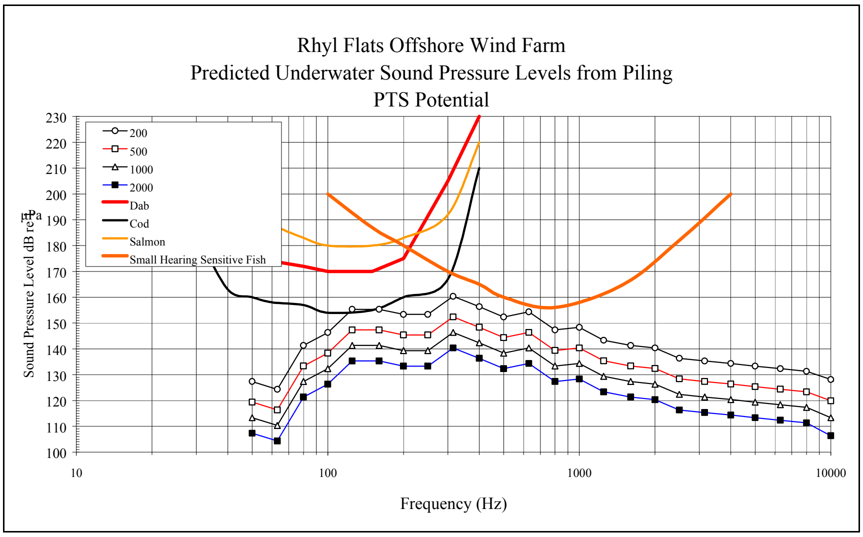


Figure 8.3 Predicted Underwater Sound Pressure Levels from Piling, PTS Potential





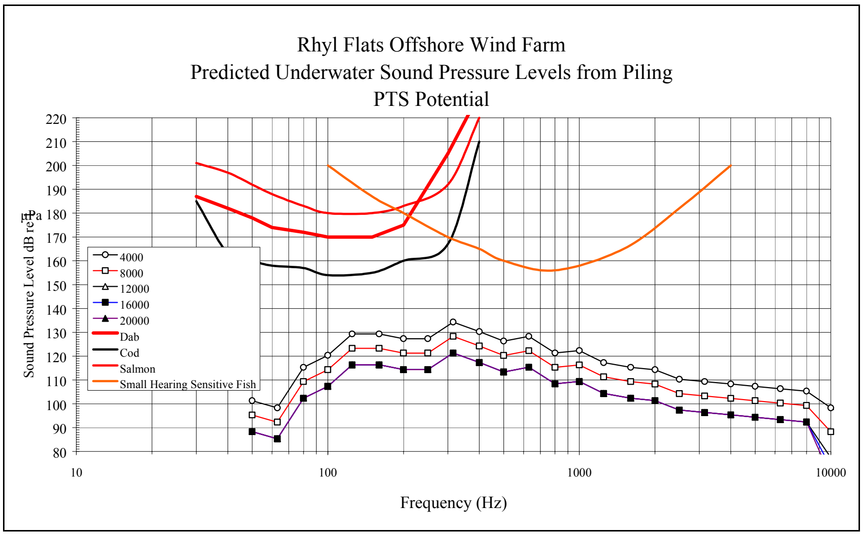
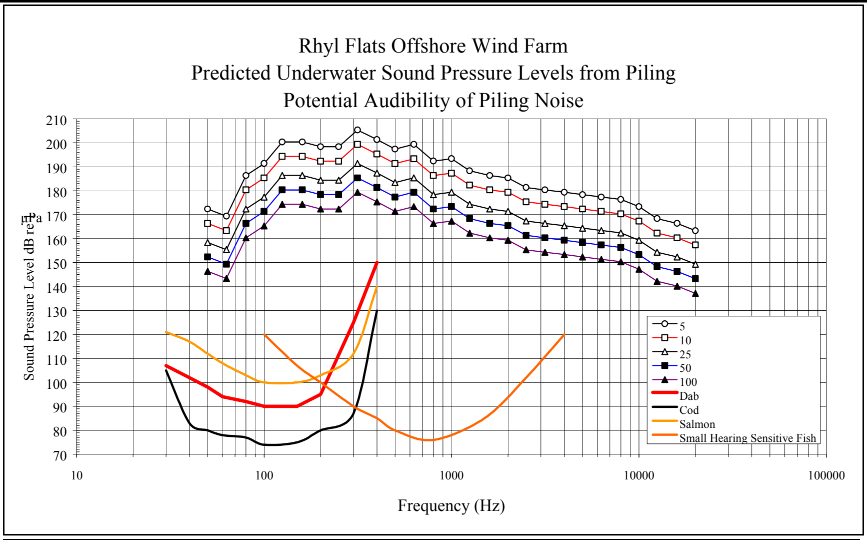
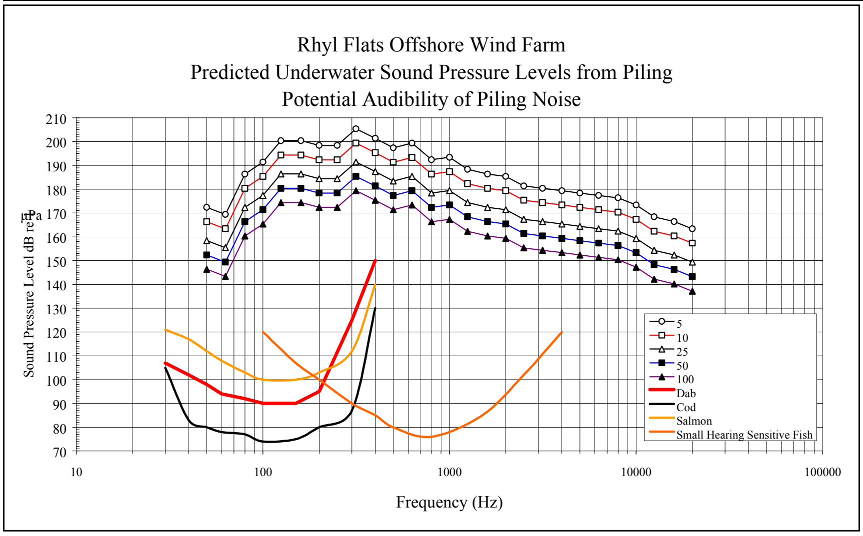
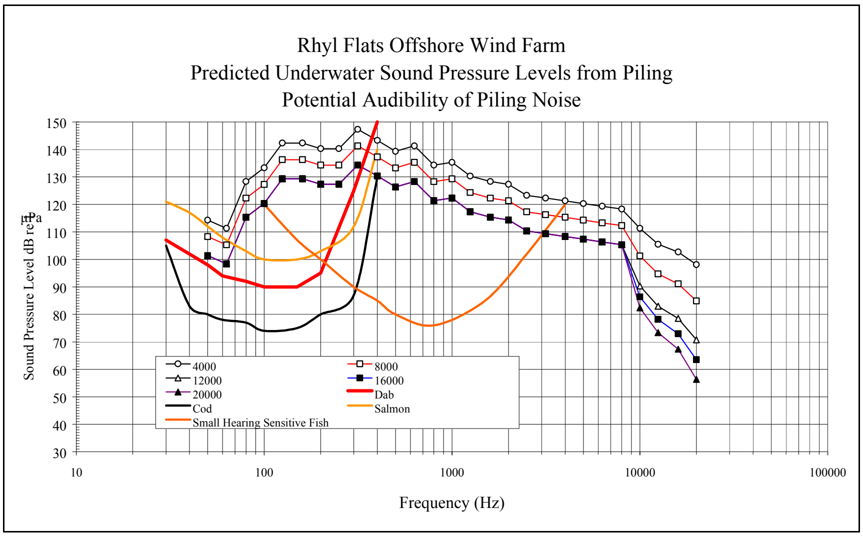


Figure 8.4 Predicted Underwater Sound Pressure Levels from Piling, Potential Audibility of Piling Noise







- *Drilling*

An alternative method of monopile installation that may be employed at Rhyl Flats is drilling and grouting. There are few data concerning drilled pile noise levels in water. Noise levels of 191 dB re 1µPa at 1m have been recorded for noise emissions from drilling from ships (Richardson 1995). This is a level which is between 22 and 23 dB below the piling source levels cited above. If the preferred pile installation method is drilling, underwater noise from this activity will still be audible for fish at distances of 20 km. TTS and PTS will occur within 50m and 5m for hearing sensitive fish respectively (for an 8 hour exposure). It is anticipated that any fish present within a 50m radius of the monopile will demonstrate avoidance behaviour as soon as drilling starts and will not remain within 50m of the source for 8 hours. Consequently, only small numbers of fish are likely to suffer from TTS and an even fewer from PTS. Similarly, once drilling has started, fish are unlikely to swim into the area and are therefore unlikely to be affected. Noise impacts to fish from drilling are predicted to be minor and therefore not significant.

- *Cable Laying / Trenching*

No specific noise data are available for cable laying or trenching. This type of noise is likely to be similar, however to the noise generated by dredging activity. Richardson *et al* reported that levels of 185 dB re 1µPa at 1m have been measured for dredging activity (Richardson et al. 1995). Noise of this level is predicted to be audible up to 20km from the source for some hearing sensitive fish. TTS and PTS separation distance will be similar to those for pile driving. As fish are likely to demonstrate avoidance behaviour on contact with TTS and PTS noise levels, they are likely to swim away from the noise, thus avoiding impacts from noise. Impacts from vessel movements are therefore considered to be insignificant.

- *Vessel Movements*

Noise produced by boat movements in the vicinity of the site will be transitory and unlikely to exceed levels of between 170 and 180 dB re 1µPa at 1 m. As a result, boat activity will be audible to some hearing sensitive fish up to distances of between 10 and 20 km from the source. It is unlikely that these noise levels will cause TTS or PTS to hearing sensitive fish due to their movement around the site. Impacts from vessel movements are therefore considered to be insignificant.

Operational Impacts

Figure 8.5 details predicted levels of wind turbine operational noise at selected locations from the wind farm. The locations at which the predictions have been made are shown in *Figure 8.6*.

These figures indicate that in up to 1.5 m depth water, predicted noise levels will be lower than those found at deeper depths. Wind turbine noise is predicted to be audible to hearing sensitive fish and exceed the threshold of audibility by between 20 and 30 dB at most. It is likely that hearing insensitive fish will not be aware of the turbines operations until they are very close *ie* within 5 m of the monopile.

Figure 8.5 Predicted Levels of Wind Turbine Operational Noise at Selected Locations from the Wind Farm

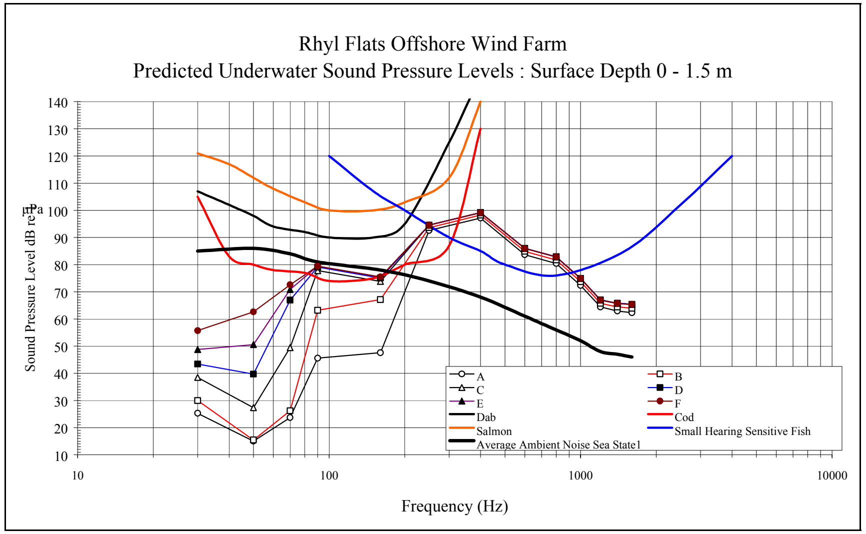


Figure UW Op Impact / 1

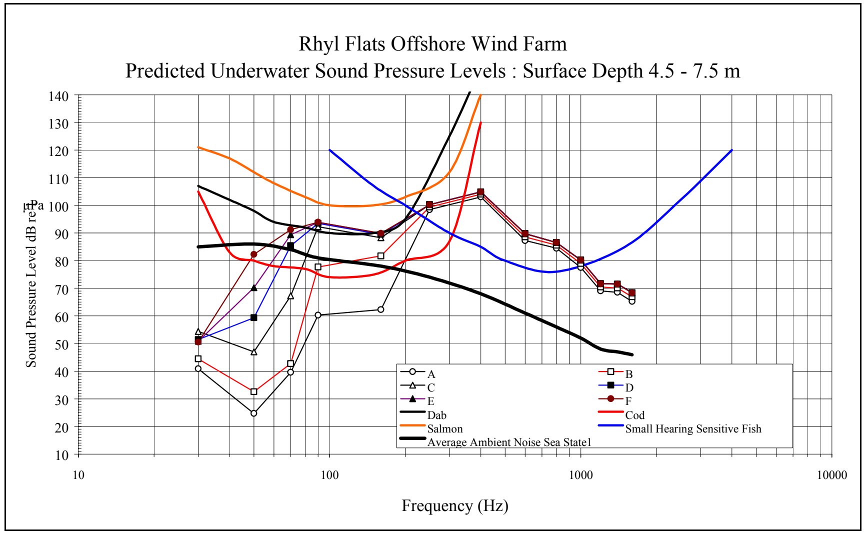
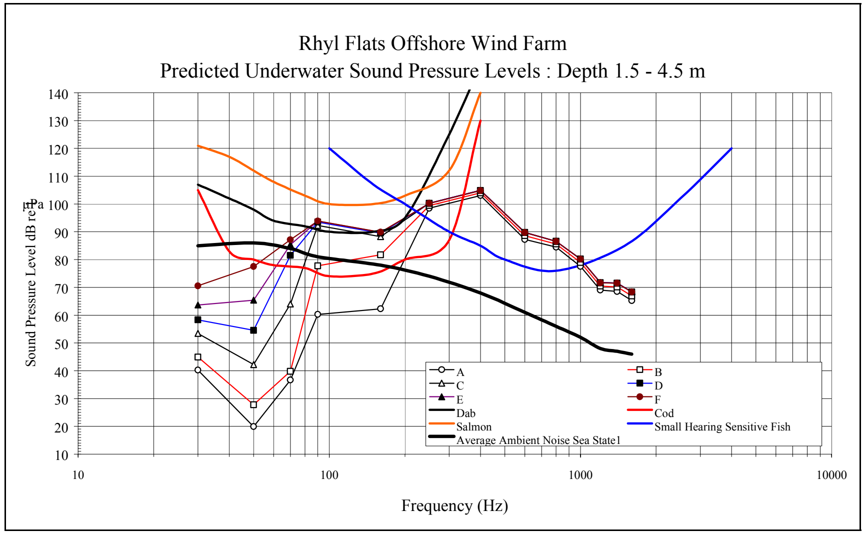


Figure UW Op Impact / 3



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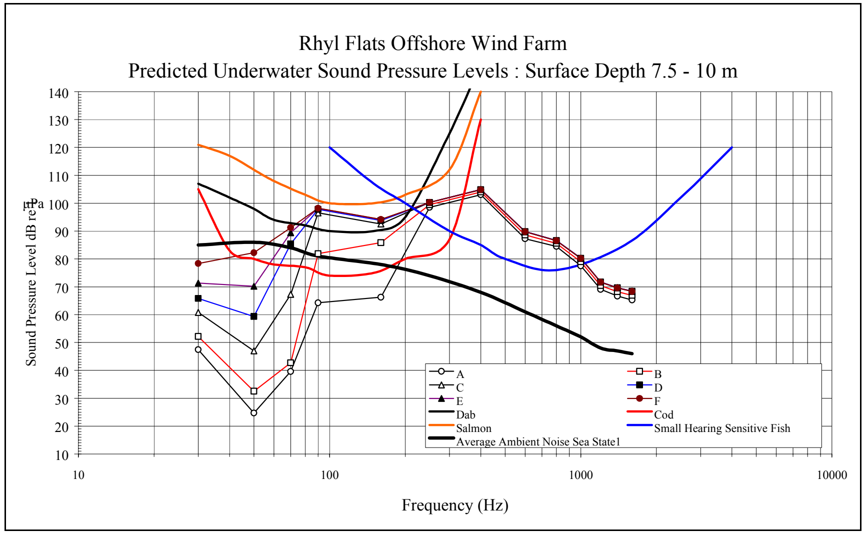

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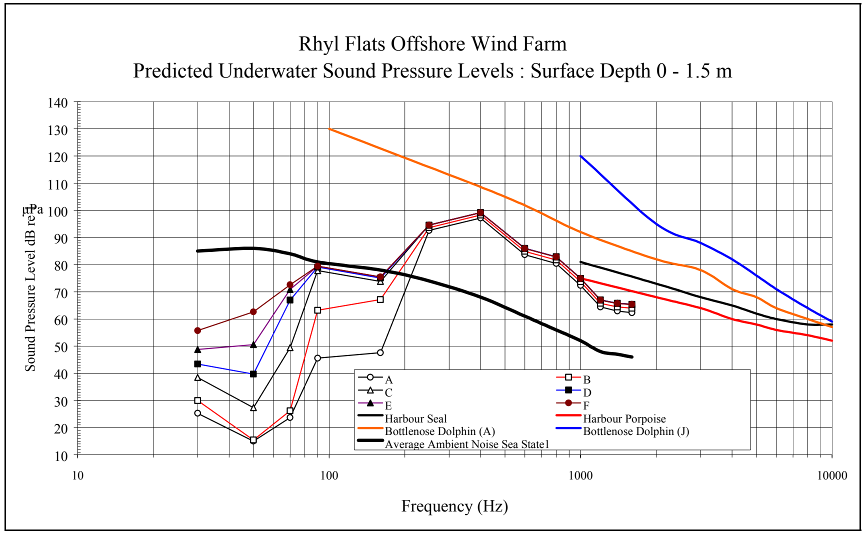
Figure 8.5 Predicted Levels of Wind Turbine Operational Noise at Selected Locations from the Wind Farm



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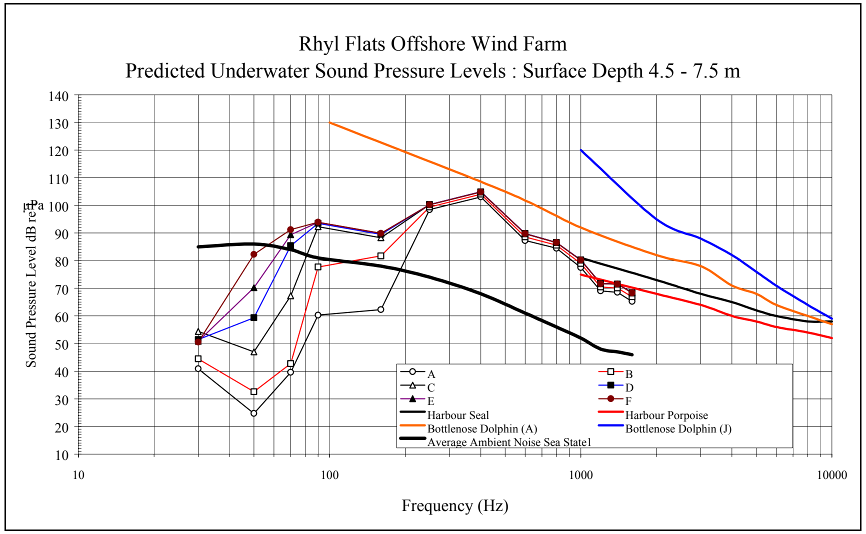

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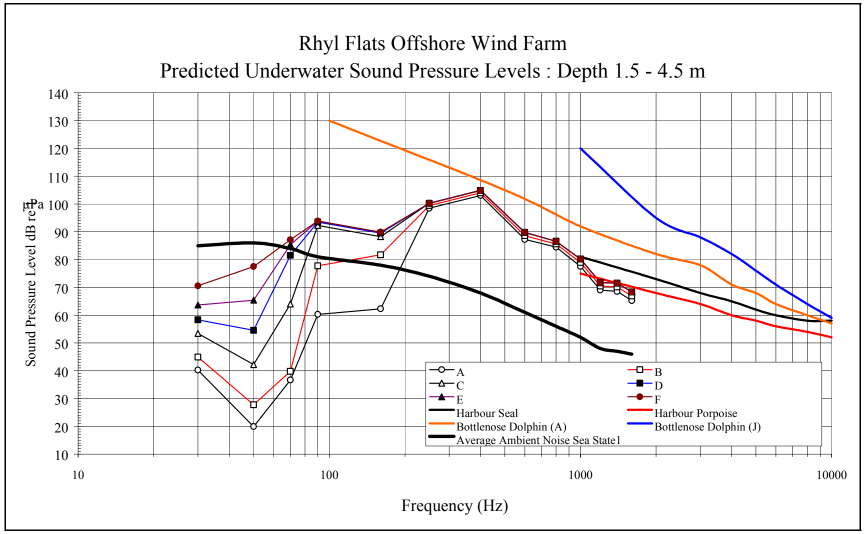


Figure UW Op Impact / 6

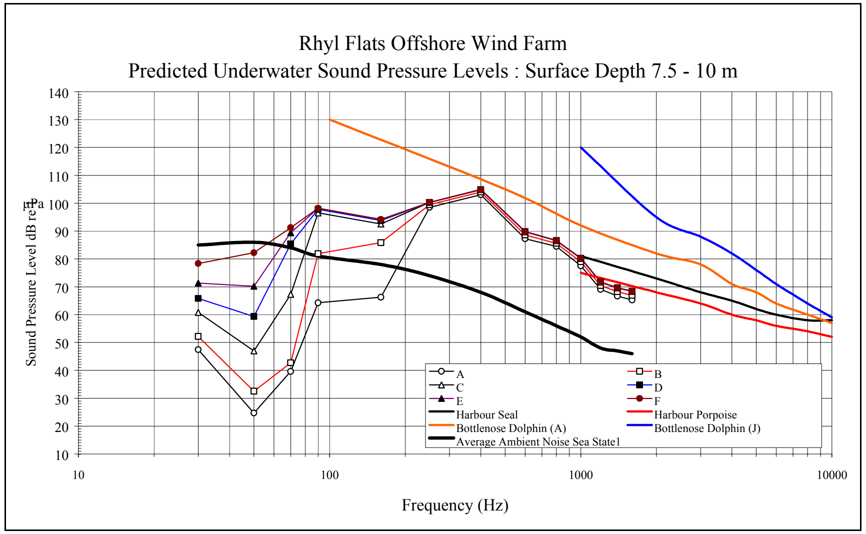
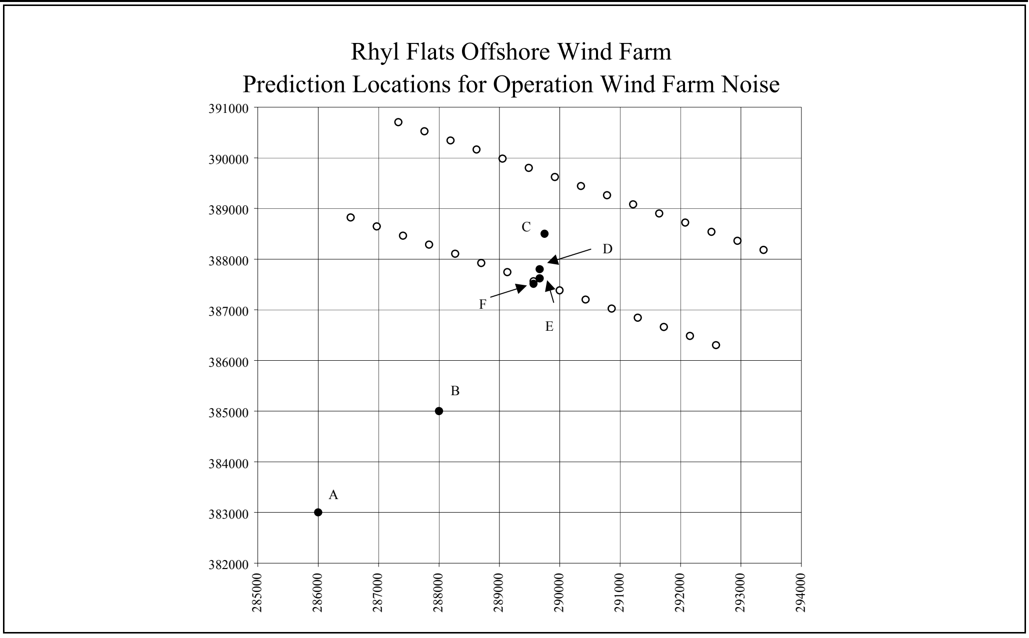


Figure UW Op Impact / 8

Figure 8.6 Locations for Operational Noise Predictions



Cumulative Impacts

Cumulative noise levels due to construction activites will only occur if other offshore wind farms are developed within 40 km of Rhyl Flats and at the same time. The separation of the proposed North Hoyle wind farm from Rhyl Flats will result in the potential for audible construction noise to be detected beyond 20 km. However, the separation of the two sites will not result in any predicted increase in the potential zones where TTS and PTS may occur.

Mitigation

There are a number of methods by which the impacts of noise from piling activity can be minimised as utilising attenuation techniques to reduce sound propagation from the pile, *ie* bubble curtains. Bubble curtain systems have been employed as part of the remedial measures for the PIDP and in field measurements indicate level reductions of 4 – 12 dB. However, most of the attained attenuation occurs at high frequencies. Therefore, the beneficial gains from the application of such a system are greater for marine mammals than for fish, which are more sensitive to noise below 1.5 kHz.

Summary

Construction and operational noise levels from the proposed development have been predicted. During piling of the monopiles no significant impacts are expected even on spawning fish except where individuals are within a few metres of the piling activity.

Operation of the wind farm will be audible to hearing sensitive fish but will not give rise to significant noise impacts.

8.4.3 *Electromagnetic Impacts*

Construction Impacts

Elasmobranch fish species or cartilaginous fish (sharks, skates and rays) exploit the electric fields generated by animals in saltwater to detect their prey. As the construction phase will not result in any alteration to the electromagnetic fields within or adjacent to the proposed wind farm, no impacts are anticipated to elasmobranch fish.

Operational Impacts

Once the wind farm becomes operational, up to four 33kV (130mm diameter) submarine cables will be installed from a gathering point on the wind farm site to the cable landfall (< 10 m depth). The cables will be up to 200mm diameter and buried to a depth of up to 3m. If the offshore substation option is chosen, a single armoured 132 kV cable will be chosen. This will measure up to 200mm diameter and be buried at a depth of up to 3m.

Elasmobranch species known to be present within the study area include several species of shark including angel shark *Squatina squatina* and dogfish *Scyliorhinus canicula*, skate *Raja batis* and several species of ray (thornback ray *Raja clavata*, spotted ray *Raja montagui*, cuckoo ray *Raja naevus* and sting ray *Dasyatis pastinaca*).

The common skate is recently said to be extinct in Welsh waters due to overfishing (Gill and Taylor 2001) and is now confined to coastal waters off Scotland and Ireland. It is a UK Biodiversity Action Plan species and the IUCN status is Endangered on a global scale (but Critically Endangered for inshore populations). The thornback ray is common in inshore sandy and gravel habitats in British waters most of the year, however it is seriously declining in Welsh waters due to overfishing, especially in the case of juveniles (Gill and Taylor 2001). The cuckoo ray can be found on all types of substrata in British waters, however it prefers the North Sea to the Irish Sea. The spotted ray is more common to waters off the south coast but is occasionally found in Welsh waters. The sting ray is common off the south coast in summer favouring mud or sandy bottom habitats including sheltered estuaries. Of these species, only sting ray and angel shark are common in shallow waters (< 10m depth). The other species are generally found in deeper water (up to 60 m depth).

Studies in association with the Horns Rev wind farm in Denmark indicate that the 33kV cables have 400A flowing through them whilst in comparison, 150kV cables have 600A flowing through them (Danish Institute for Fisheries Research 2001). Studies demonstrated that the 33kV cable has an electrical field intensity of 1000μV m^{-1} less than 1m from the cable (assuming a seabed resistance of 0.7ohms), falling sharply to under 100μV m^{-1} at a distance of approximately 12m from the cable. The effects appear to be negligible at 100m distance from the cable. In comparison, the 150kV cable has an electrical field intensity of 1000μV m^{-1} immediately adjacent to the cable (assuming a seabed resistance of 0.7ohms), maintaining a plateau of 1000 μV m^{-1} up to approximately 4 metres from the cable. Again the effects appear to be negligible well within 100m distance from the cable (Gill and Taylor 2001).

Research into the effects to elasmobranches is limited. However, a recent study has demonstrated that dogfish avoid electric fields at 1000μV cm^{-1} (the maximum predicted to be emitted from a 3-core subsea 150kV, 600A cable). The avoidance response of the dogfish of 1000μV cm^{-1} was highly variable amongst individuals. The same species were attracted to 8μA (representing an electric field of 0.1μV cm^{-1} at 10cm from the source, which is consistent with the predicted bioelectric field from prey species (Gill and Taylor 2001).

The available evidence suggests that fish will demonstrate avoidance behaviour only to strong magnetic fields within close proximity to the subsea cable (up to 4m from the cable) whereas they will be attracted to weaker electromagnetic fields further away from the cable. The extent to which elasmobranches will be attracted or repelled in reality will be species dependant and will be determined by the electromagnetic field resulting from the cables chosen. Overall impacts are predicted to be localised and restricted to only 2 species of elasmobranch, angel shark and sting ray. Impacts are therefore not anticipated to be significant.

Cable insulation and the burial of the sub-sea cable will help minimise impacts to elasmobranch fish.

Cumulative Impacts

As the cables will not be operational during construction, there is nor scope for cumulative impacts. As the electrical field intensity from 150kV cable has been shown to be negligible beyond 100m from the cable, the potential for cumulative impacts is low and is not considered significant.

Mitigation

COWL have incorporated the following measures into the subsea cable design which will help to minimise the impacts to elasmobranchs from alterations in electromagnetic fields:

- the cable will be buried at a minimum depth of 1m;

- the cable will include the following layers for insulation;

    - ethylene Propylene Rubber (EPR) or Cross-linked Polyethlyene (XPLE) insulator;
    - metallic electromagnetic screen (aluminium, lead or copper);
    - double armouring (steel braid); and
    - polypropylene outer coating.

Summary

There is currently no evidence to suggest that in practice, marine power cables, which have been used for many years, have caused any significant impacts to fish.

It is recognised, however, that recent studies indicate that there is the potential for impacts to elasmobranch fish.

The maximum capacity cables intended for the Rhyl Flats wind farm are 132kV cables if the offshore substation is chosen, otherwise the cables will be 33kV cables. It is predicted that fish will demonstrate avoidance behaviour only to strong magnetic fields within close proximity to the subsea cable (up to 4m from the cable) whereas they will be attracted to weaker electromagnetic fields further away from the cable. Whether elasmobranches will be attracted or repelled in reality will be species dependant and will be determined by the electromagnetic field resulting from the cables chosen. Overall impacts are predicted to be localised and restricted to only 2 species of elasmobranch, angel shark and sting ray. Impacts are therefore not anticipated to be significant. Cable insulation and the burial of the sub-sea cable will help minimise impacts to elasmobranch fish.

8.5 *MARINE MAMMALS*

8.5.1 *Physical Impacts*

Construction Impacts

The potential for physical impacts to marine mammals from the presence of construction vessels is low due to the fact that construction activity is temporary and marine mammals are mobile animals which can display avoidance behaviour. The mechanism by which marine mammals change their behaviour is associated with noise disturbance and is discussed in further detail in *Section 8.5.2*.

Operational Impacts

Operational impacts to marine mammals are considered to be low due to the fact that the wind farm occupies such a small area relative to foraging areas and because marine mammals are mobile and can physically avoid wind farm structures as necessary.

Cumulative Impacts

Given the low potential for impacts to marine mammals from the physical presence of structures and construction vessels, the potential for cumulative impacts is low.

Mitigation

COWL will implement the following mitigation measures to ensure that there are no significant impacts to marine mammals as a result of the proposed wind farm construction activities.

- Opportunistic observations of marine mammals and recording of their behaviour response to the presence of the construction vessels will be made. This information will help understand the behaviour of marine mammals in the vicinity of construction activity.

- All construction vessels will take great care when close to marine mammals. With the possible exception of an emergency situation, at no time will vessels approach marine mammals at high speed or make rapid changes in course in their vicinity.

Summary

Provided the above mitigation measures are included, impacts to marine mammals from subsea structures and construction vessels are not considered to be significant.

8.5.2 Subsea Noise Impacts

Introduction

The generic impacts and potential impacts of subsea noise are set out in *Section 8.2.4* above.

Criteria

Unlike fish hearing which is mainly centred between 100 and 2kHz for the most sensitive region of hearing, marine mammals are sensitive to a far greater range of frequencies. The range for greatest sensitivity is between 8kHz and 80kHz, depending upon the species. Marine Mammal hearing is also more sensitive than fish hearing, *ie* lower levels of noise may be detected. This is in part due to the fact that ambient noise levels between 8kHz and 80kHz are significantly lower than those found between 100 and 2kHz (the hearing frequency range of most fish). In the 8kHz to 80kHz range, the threshold of audibility for marine mammals is determined by the ambient noise levels in the sea.

Construction Impacts

- *Piling*

The potential for disturbance to marine mammals from piling has been assessed on the basis of noise predictions undertaken by QinetiQ. The scope for this work is described in *Section 6*.

Figure 8.7 indicates that piling noise will be audible to marine mammals at ranges beyond 20km to the pile.

Figure 8.8 indicates that there is the potential for Temporary Threshold Shift (TTS) at ranges up to 500m from the piling activity. However, as indicated above, a marine mammal located within 5m of the pile may be subjected to TTS within 28 seconds (where noise levels are 30 dB above the 8 hour Harbour porpoise TTS Criterion Curve). *Figure 8.9* indicates that there is the potential for Permanent Threshold Shift (PTS) at ranges of 25 – 50 m from piling activity for an 8 hour exposure. Within 5m of the piling activity, PTS may occur within 15 minutes.

Exposure times calculated for marine mammal TTS and PTS are below those predicted for hearing sensitive fish. This is due to several factors as follows:

- More acoustic energy is concentrated in the lower frequencies.

- Hearing sensitive fish have lower audibility thresholds than marine mammals at these frequencies.

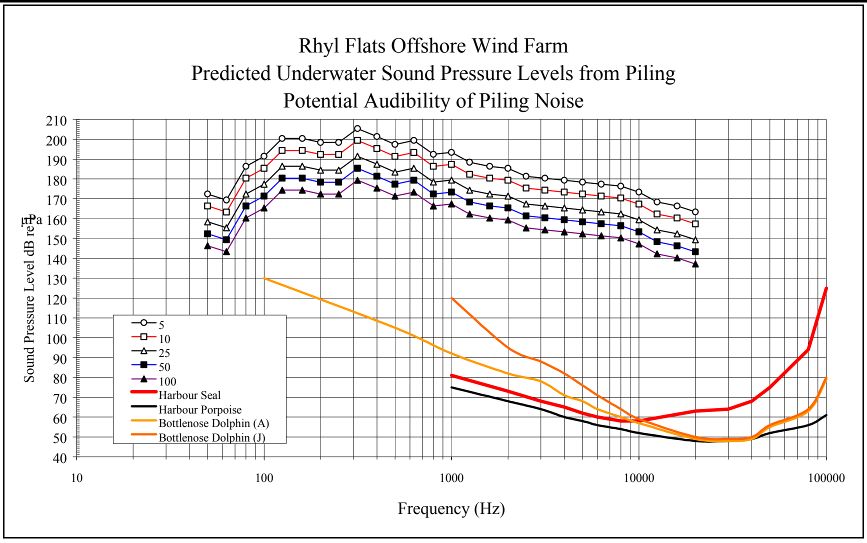
- Hearing sensitive fish have been demonstrated to be subject to TTS for lower levels of noise exposure than marine mammals. A Harbour Seal (*Phoca vitulina*) has been shown to experience a TTS of 6 dB and 12 dB for a sensation level of 95 dB experienced for 25 and 50 minutes respectively [(1)]. This indicates the potential for TTS for a sensation level of 79 dB for an 8 hour exposure, i.e. a level 79 dB above the threshold of audibility. This may be compared with a hearing sensitive fish where a sensation level of 66 dB has been shown to cause TTS. Bottlenose Dolphins (*Tursiops truncatus*) have been shown to experience TTS for sensation levels of 78 – 85 dB for an 8 hour exposure period [(2)].

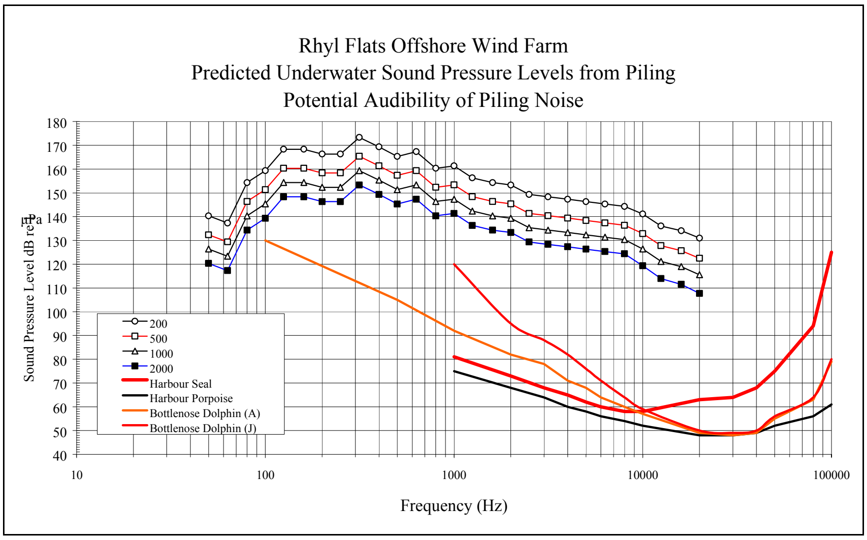
Several species of marine mammal are known to be present in the eastern Irish Sea including harbour porpoise (*Phocoena phocoena)*, bottlenose dolphin (*Tursiops truncatus*) and common dolphin (*Delphinus delphis*). Both the harbour porpoise and bottlenose dolphin have been sighted off Ormes Head (to the south-west of the proposed wind farm) during the summer months. These species will rarely be present in the proposed wind farm area and are therefore unlikely to be affected by piling noise, particularly at the close range required for TTS or PTS to occur. To ensure that impacts are kept to a minimum, piling will not be undertaken if marine mammals are sighted in the vicinity of the proposed wind farm.

[1] Kastak, D. Schusterman, R.J., Southall, B.L., and Reichmuth, C.J. (1999). Underwater temporary threshold shift in three species of pinniped. J. Acoust. Soc. Amer. 106, 1142 - 1148

[2] Behavioral Responses and Temporary Shift in Masked Hearing Threshold of Bottlenose Dolphins, *Tursiops truncatus,* to 1-second Tones of 141 to 201 dB re 1 µPa . Technical Report 1751 July 1997 S. Ridgeway, D Carder, R Smith, T Kamolnick, C Schlundt and W Elsberry Naval Command, Control and Ocean Surveillance Centre (NCCOSC), RDT&E Division, San Deigo, California

Figure 8.7 Predicted Underwater Sound Presure Levels from Piling, Potential Audibility of Piling Noise





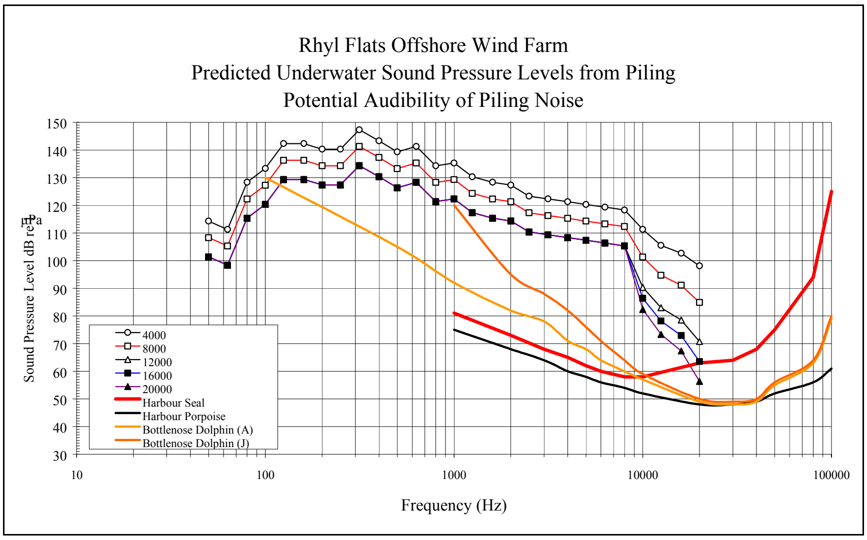
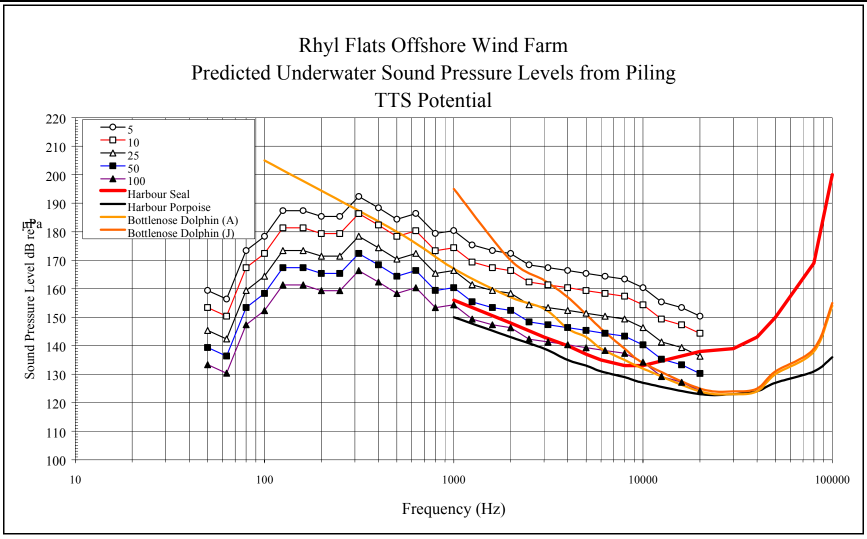
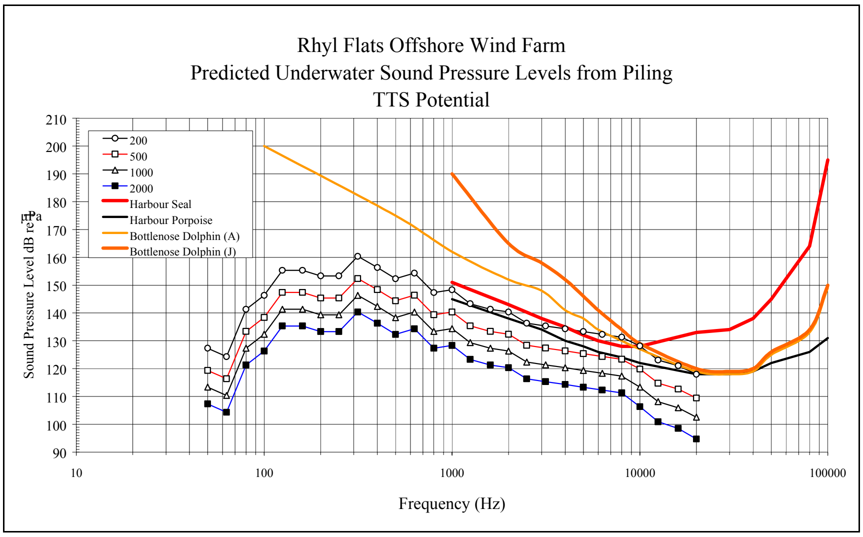


Figure 8.8 Predicted Underwater Sound Presure Levels from Piling, TTS Potential





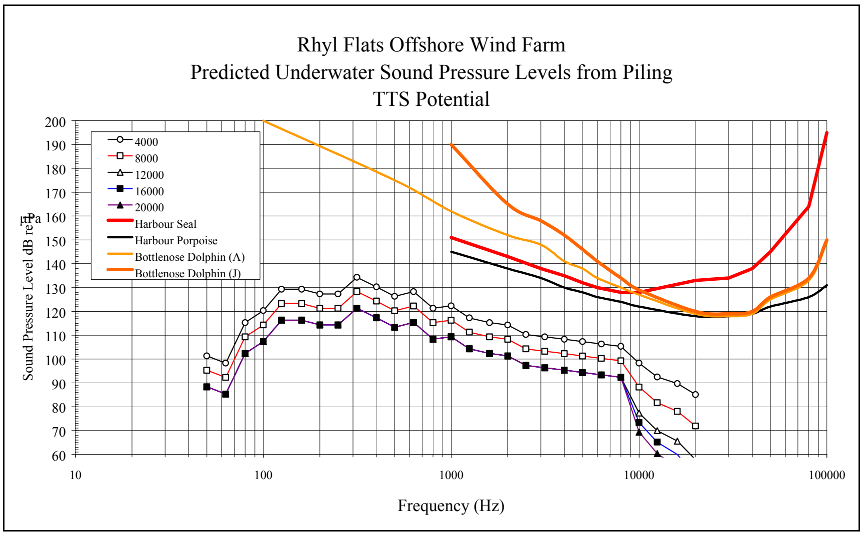
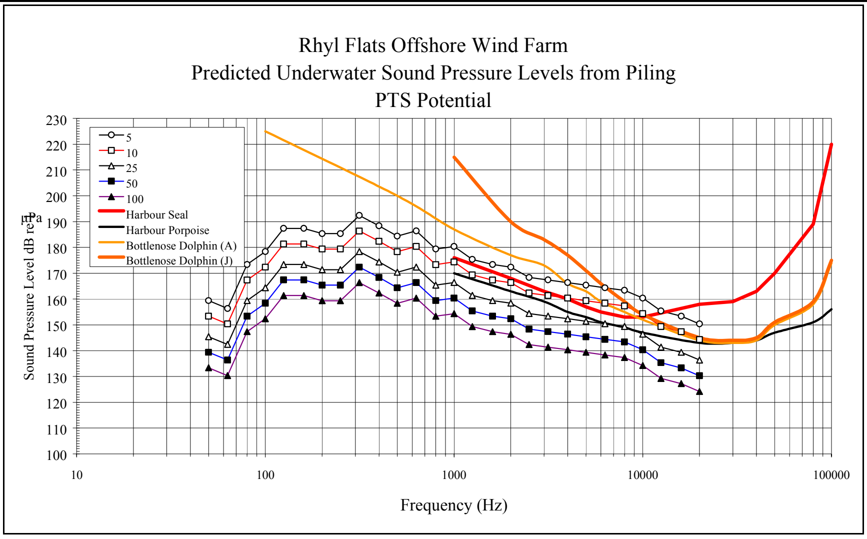
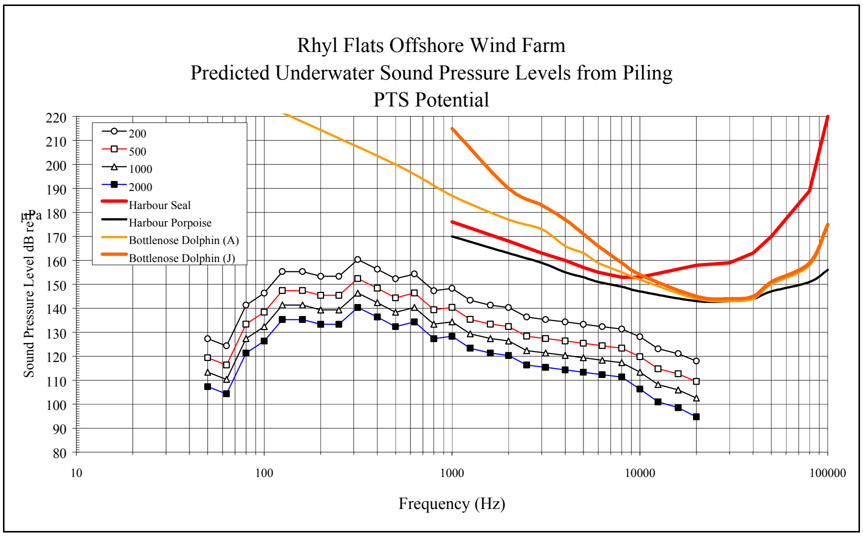
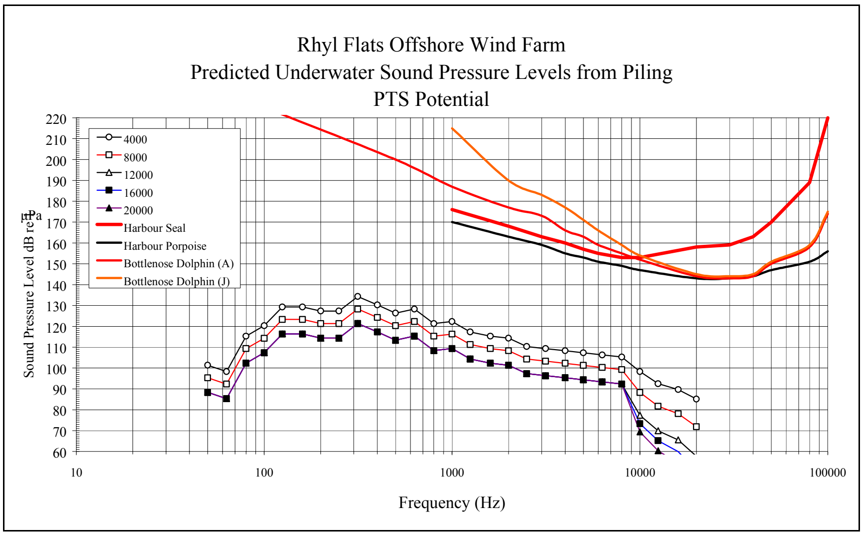


Figure 8.9 Predicted Underwater Sound Presure Levels from Piling, PTS Potential







- *Drilling*

An alternative method of monopile installation that may be employed at Rhyl Flats is drilling and grouting. There are few data concerning pile drilling noise levels in water. Noise levels of 191dB re 1µPa at 1m have been recorded for noise emissions from drilling from ships (Richardson 1995). This is a level which is between 22 and 23dB below the piling source levels cited above. If the preferred pile installation method is drilling, underwater noise from this activity will still be audible to marine mammals at distances of 20km, but TTS may occur within 25m for individuals subjected to an exposure period of 8 hours. It is predicted that PTS will not occur for marine mammals from pile drilling. As marine mammals are rare within proposed wind farm area, it is unlikely that any individuals will remain within 25m drilling activity for long enough to suffer TTS. Noise impacts to marine mammals from drilling are predicted to be minor and therefore not significant.

- *Cable Laying / Trenching*

No specific noise data are available for this activity. However, it is unlikely to be significantly greater than the noise associated with dredging. Richardson *et al* report that levels of 185 dB re 1µPa at 1m have been measured for such sources. Therefore, this noise is likely to be audible up to 20km away by marine mammals. The TTS and PTS separation distance will be similar to those for drilled piles. Noise impacts to marine mammals from drilling are predicted to be minor and therefore not significant.

- *Vessel Movement*

Noise produced by boat movements in the vicinity of the site will be transitory and unlike to exceed levels of 170 – 180 dB re 1µPa at 1m. In this event, they will be audible to some marine mammals up to distances of between 10 – 20km from the source. It is unlikely that the anticipated noise generated by vessel movement will cause TTS or PTS to marine mammals due to vessel movement. Noise impacts to marine mammals from vessel movements are predicted to be minor and therefore not significant.

Operational Impacts

Figure 8.5 details predicted levels of wind turbine operational noise at selected locations from the wind farm. The locations at which the predictions have been made are shown in *Figure 8.6*.

The predictions indicate that in a water depth of 1.5m, noise levels will be lower than those found at deeper depths. The operational noise is predicted to be just audible by some marine mammals including harbour porpoise and harbour seal. Operational noise is unlikely to be audible to bottlenose dolphins. As effects on marine mammals are predicted to be small and the occurrence of marine mammals within the wind farm area is limited, operational impacts are considered low and therefore insignificant.

Cumulative Impacts

The proposed offshore wind farm at North Hoyle is to use similar sized turbines and foundation type, *ie* monopile. In these circumstances, it is expected that a similar level of noise from the wind turbines may be experienced from the operation of North Hoyle.

In these circumstances, it is predicted that a location equi-distant between the two sites may be subject to operational turbine noise which could be audible to some hearing sensitive fish. Marine mammals may just detect the presence of the operational wind farms at this location.

Mitigation

There are a number of methods by which the potential for impacts to marine mammals from noise generated by piling can be minimised by utilising attenuation techniques to reduce sound propagation from the pile, *ie* bubble curtains. Bubble curtain systems have been employed as part of the remedial measures for the PIDP and in field measurements indicate level reductions of 4 – 12 dB. However, most of the attained attenuation occurs at high frequencies. Therefore, the beneficial gains from the application of such a system are greater for marine mammals than for fish, which are more sensitive to noise below 1.5 kHz.

Piling will not be undertaken if marine mammals are sighted in the area.

Summary

Piling is likely to give rise to the highest underwater noise impact during construction. Noise impacts are likely to be significantly more widespread during pile driving than during cable laying or vessel movement. If drilled piling is used, the impacts are also likely to be lower than during hammered pile driving. Noise from these activities is likely to be audible to marine mammals over a wide area (10 to 20 km from the proposed site).

However, even during pile driving marine mammals are only likely to suffer TTS if they if they spend 8 hours at a distance of 500 m from the proposed piling activity. Permanent effects on hearing are only likely at around 25 to 50 m from the piling activity.

Operational noise is expected to be just audible to some marine mammals (harbour porpoise and harbour seal). These mammals are rare in the proposed wind farm area. Therefore operational impacts are not expected to be significant.

8.6 ORNITHOLOGY

8.6.1 Potential Impacts

Impacts on birds that may result from the proposals include:

- permanent loss of foraging habitat;
- disturbance to, or displacement/exclusion of, a species from foraging habitat due to construction activities, during decommissioning activities, by the operating turbines and during any maintenance activities;
- risk of bird collisions with operating turbines;
- attraction of birds to lighting on the turbines;
- the creation of a barrier by the rows of turbines;
- creation of new marine habitat around the turbine bases which may create new foraging habitat;
- use of the turbines (and the offshore sub-station if it is required, see *Chapter 3*) as loafing, roosting, or nesting sites by birds.

The likely impacts of the proposals are set out following sections, which take account of mitigation measures (see *Section 8.6.6*) that have been incorporated into the scheme design.

This assessment has made a number of judgements about distribution of bird species in the study area based on available information and research. Further surveys are continuing in the study area (see *Section 6.5* and *Section 8.6.7*). The results of these surveys will be used to further refine the mitigation measures, as appropriate, to avoid significant impacts (*see Section 8.6.6*).

8.6.2 Impacts on Designated Sites

Data analysed as part of this assessment (*see Section 6.6.1*) indicate that no significant impacts are predicted on existing sites that are designated for their nature conservation value. None will be directly affected as all lie at some distance from the wind farm project area (see *Figure 7.9*), and no significant impacts are considered likely from the proposals to the bird species and populations that form part of the qualifying interests of the designations.

8.6.3 *Construction Impacts*

Permanent Habitat Loss

If all habitats were permanently lost from within the wind farm project area (*ie* the wind farm site and the sub-sea cable route) due to construction activities and the arisings from the drilling, approximately 20 km^2 would be affected (see *Section 8.3*). This comprises approximately 1% of the total study area of 1680 km^2. Very much less will be permanently lost for the footprint of the turbines, the meteorological towers and the sub-station, amounting to approximately 650 m^2. Areas affected by the sub-sea cables are likely to recover relatively rapidly (see *Section 8.3*). The effects of this loss on marine habitat and benthos are not considered significant (see *Sections 8.3.1*).

Common scoter is the main benthic feeding bird species that is likely to be directly affected by this loss of habitat. However, significant impacts on common scoter from direct loss of benthic habitat are not predicted as:

- only small areas of habitat supporting benthic species will be lost (see above);
- there is a relative paucity of bivalves recorded in grab samples taken from the wind farm site (likely to be an important factor in their avoidance of the wind farm site recorded by the 2001/2002 winter aerial surveys) (1) ; and
- low numbers of common scoter are considered likely to be present during the months when the main construction activity will take place on the wind farm site (April to August, although some work will be required in September).

The majority of the birds which are likely to be present in the study area during the months when construction is taking place, are fish eaters from the nearby breeding seabird colonies (*eg* cormorant, gulls and terns). Species such as red-throated diver and great crested grebe, again both fish eaters, are not expected to be present in any numbers during the summer months as they typically occur as winter visitors (or on passage) to offshore waters (see local bird reports), although peak numbers of red-throated diver are understood to occur in the study area in March (*pers comm* John Clark, 2002).

Analyses of the foraging preferences of these species indicate that most of the breeding seabird species in the colonies along the North Wales coast are unlikely to make significant use of the wind farm site for foraging due to its distance offshore and the typical foraging depths of these species (see *Table 7.10*). On the basis of this data only cormorant from the colony at Little Ormes Head is considered likely to make moderate to high use of the wind farm site, however, the findings of the aerial surveys in 2001/2002 did not suggest that this area was favoured by cormorant/shag (see *Section 7.7*). The effects of the construction works on fish populations that use the area are not considered

(1) Benthic communities are known to undergo annual fluctuations and further sampling will be undertaken to monitor any fluctuations in bivalve communities in the years up to construction as these may effect common scoter distribution.

significant, as fish are likely to avoid the works areas (see *Section 8.4.1*). It is likely, therefore, that fish eating predators including seabirds such as red-throated diver will follow their prey and forage in areas away from the construction site, and thus will not be significantly affected by the construction works.

Disturbance

The delivery of construction materials to the land based staging port, subsequent delivery to, and work on, the wind farm site, will require the use of boats and involve a human presence in the area over a period of approximately 7 months (March - September). However, COWL do not expect to undertake any construction offshore before April. In transporting materials to and from the site, boats would use existing and well established shipping routes from local ports (*eg* Liverpool, Mostyn or Holyhead). The main effect would be disturbance that caused birds to maintain a standoff distance from the construction works, effectively excluding them from foraging areas on and around the wind farm site.

Common scoter is a species that is known to take flight readily, and is more sensitive to human disturbance than many of the other species recorded in the study area (see *Section 7.7*). It is likely that some common scoter will be present in the study area during the months when construction work is taking place. Initial reports from the ongoing aerial surveys of 2001/2002 indicate that concentrations of common scoter remain in the study area at least until in March 2002 (*pers comm* Peter Cranswick, 2002). Whilst the construction programme commences in March all the construction work in this month is expected to be on land in the staging port at Mostyn Dock. It is possible also that common scoter may be present in the study area during the moulting period (July – September / October) (see *Section 7.7*), when construction work is still ongoing. In the period April to June it is likely that common scoter will be present in much lower numbers in the study area compared with the passage and winter months (see *Section 7.7*).

Section 7.7 has highlighted typical factors that appear to be important in the selection of foraging sites by common scoter during the early and middle winter (appropriate bivalve food resource, sandy sediments, low tidal currents and water depths and low levels of disturbance) and shown that they are not met on the wind farm site, or in the surrounding waters up to approximately 2km. This correlates well with the low use of these areas by common scoter.

Significant disturbance effects on important numbers of common scoter are considered unlikely based on a view that in future years:

- common scoter continue to favour similar parts of the study area to those recorded by the 2001/2002 aerial surveys;

- that much lower numbers of common scoter are present in April and over the summer months;

- that levels of construction shipping movements are low (1);

- that the construction vessels use appropriate existing shipping lanes to reach the wind farm site.

It is possible that common scoter may move into slightly deeper waters as the winter progresses (as has been recorded in some Danish waters, see *Section 7.7*) and hence closer to the construction vessels working along the southern turbine row, however, common scoter are expected to be present in much lower numbers in April and over the summer, in which case significant impacts are considered unlikely.

Similarly if these factors referred to above for foraging site selection are also important in selecting moulting sites off the North Wales coast, then the wind farm site (and surrounding waters up to 2km from the wind farm site) may not be a favoured moulting site for common scoter, and hence significant effects from construction work between July and September are unlikely.

The laying of the sub-sea cable(s) may have direct effects on common scoter as it crosses part of the study area that is known to support concentrations of wintering common scoter. If wintering sites are also ones favoured at other times of the year including the moulting period, then it is possible that summering and moulting scoter could be affected by the construction works. The moulting period in particular is a time when common scoter is more sensitive to disturbance as it is flightless (see *Section 7.7*). WeBs data indicate much larger numbers of common scoter during the period when cable laying is proposed (*see Annex G*).

The proposed laying of the sub-sea cable will require only one or two vessels and could be completed within a few days. This will help to reduce the duration of any disturbance. In the event that the area through which the route passes is found to support moulting scoter prior to construction commencing, COWL will review the timing of this work to identify the most appropriate period to undertake the work.

The effects of the wind farm works on fish and hence on fish eating bird species has been considered above. Most of the fish eating bird species in particular are expected to be foraging at some distance from the wind farm site and following their prey and no significant disturbance effects are considered likely on these species during construction.

(1)Construction Shipping Traffic (estimates only): Main Construction Vessel (2 journeys out in May back in September), Accommodation Vessel (2 journeys out in May back in September), Jack-up for tailing crane (2 journeys out in May back in September), Transport barges for turbines and foundations (60 journeys evenly spread between May and September),Service vessel (280 journeys, evenly spread between May to September), Cable vessel (2 journeys out in June back in August), Infield cable vessel (30 journeys evenly spread between June and August).

In addition some seabird species especially fulmar and gulls are known to be attracted to, and follow boats.

8.6.4 *Operational Impacts*

Habitat Avoidance / Disturbance

Once operational it is likely that some birds will be excluded from foraging within the wind farm site given the proximity of the turbine rows (2km apart), although birds may still fly between the rows. This area represents only a small part of the study area (<1%) and given the low level of use of the wind farm site by birds recorded in the winter months, and on the basis that this remains valid for other times of the year and in future years (see *Section 7.7* and *8.6.3*), the impacts on birds are unlikely to be significant.

There is little documented evidence the likely effects of the operating turbines on birds in the waters surrounding the wind farm. Research at Tunø Knob in Denmark has shown only minor effects from the turbines, with more significant impacts resulting from a disappearance of the food resource, which was unrelated to the construction of the wind farm (see *Section 7.7*). This work was undertaken on eider, which is considered less sensitive to disturbance than common scoter and on a wind farm site that comprised fewer turbines than at Rhyl Flats (Guillemette *et al*, 1997, 1998 and 1999).

The effects from on-shore wind farms have been more widely researched than those offshore. Some exclusion from habitat around operating turbines has been reported from all studies undertaken, due to avoidance of the area closest to wind turbines, however, there seems to be many species-specific differences with some wildfowl foraging to within 25 metres of operating farms whilst foraging birds including those on passage have shown avoidance distances up to 800 metres (Percival, 2001).

Species such as common scoter are known to be more sensitive to human disturbance and in particular are known to be sensitive to disturbance including boats, however, the effects on them from stationary objects with moving parts, such as wind farms are uncertain.

None of the data from the 2001/2002 winter aerial surveys to date suggest that the wind farm site is of any special importance to seabirds, rather the birds showed either no preference for it over other parts of the study area, or apparently avoided it. In particular the data show that cormorant/shag and common scoter actively avoided the wind farm site and an area of up to 2km surrounding it (see *Section 7.7*). There is no evidence to date of effects on birds at over 2km from a wind farm hence significant impacts from the wind farm are considered unlikely. As noted in *Section 7.7* above it is possible that common scoter may move into deeper water as the winter progresses. This would increase the risk of effects on common scoter from that described above.

Displacement effects on fish eating species such as red-throated diver and cormorant are not considered significant, as there is no evidence of any significant effects on their fish food resource from the operating turbines.

Current disturbance sources in the area will remain and there will be occasional maintenance visits. The Mostyn – Dublin fast ferry service will be re-routed slightly, into deeper water to the north of the wind farm site, and hence it will run further away from the areas known to be favoured by common scoter. The effects of any required maintenance works are considered likely to be similar but a much lower level, to those described during construction.

Collision Risk

The proposed Rhyl Flats offshore wind farm may impact on the area's bird populations by causing additional mortality through bird collisions with the wind turbines. No detailed studies on collision rates of birds with offshore wind turbines have been carried out, so it is not possible to draw on specific offshore experience to determine the likely effects of the Rhyl Flats development.

Studies of collision risks at onshore windfarms do provide some relevant information and there have been several studies at coastal wind farms where bird species similar to those in the Rhyl Flats study area occurred. The work carried out to date suggests that for a significant impact to occur, large numbers of turbines would need to be located within an area used by a major population concentration of a species which is known to be sensitive to collision and at risk from the additional mortality which would result [(1)]. A very high number of birds would need to be passing regularly through a wind farm area at a suitable height for significant mortality to occur. Available data suggest this is unlikely at the Rhyl Flats site.

At Kreekrak in the Netherlands, on a site immediately adjacent to the Oosterschelde SPA, only 1.9-4.6 collisions per turbine per year were recorded of a local population of waterfowl that was estimated to be 2-6,000 (Musters *et al,* 1995 and 1996). Similarly in the Northumberland SPA, at Blyth Harbour wind farm, where 4,500 waterfowl regularly occur (Still *et al,* 1995) an average of 1.3 collisions per turbine per year was recorded, apparently declining in some species as birds habituated to the presence of the turbines (Painter *et al,* 1999).

Given the absence of field data on collisions, the risk of collisions has been estimated and assessed using a standardised modelling approach developed by the British Wind Energy Association with SNH (Percival *et al*. 1999, Band 2000). Further details on the model are provided in *Annex G*.

(1) For example species with a high adult survival rate and low breeding rate as they would be less able to replace any losses.

The collision risk assessment was carried out for two key species common scoter and red-throated diver. Both species have been recorded on, and flying across the wind farm area (see *Section 7.7* and *Annex G*). Consideration was given also to the risk of collisions:

- as a result of waterfowl movements between the internationally important estuarine sites along the North Wales coast; and
- of other species found using the site during the baseline studies (including land based migrants over-flying the wind farm site).

The numbers of collisions predicted for the key species and the percentage increase in annual mortality as a result were in general very low. For all the species except red-throated diver, the increased mortality even in a worst case scenario, is less than 1% on the baseline mortality rate. Whilst the predicted number of collisions of red-throated diver is still low (only 1.4 birds per year), the population within the study area is comparatively low also (see *Section 7.7*). As red-throated diver is generally quite long-lived (1), this was equivalent to a 7% increase in the annual mortality rate (see *Table 8.1*), although this is considered unlikely (see below).

Table 8.1 ***Worst Case Collision Risk Predictions (2) for Key Bird Species at the Rhyl Flats Wind Farm***

Species	**Predicted Annual Collisions with Wind Farm (worst case)**	**Annual Mortality Rate**	**Collision Mortality as % of Overall Annual Mortality**
Common scoter	8.2	23%	0.4%
Red-throated diver	1.4	10%	7%
Oystercatcher (Lavan Sands)	2.0	7%	0.6%
Oystercatcher (Dee Estuary)	11.0	7%	0.6%
Knot (Dee Estuary)	7.3	22%	0.2%
Curlew (Dee Estuary)	2.3	26%	0.2%
Curlew (Lavan Sands)	0.7	26%	0.2%
Dunlin (Dee Estuary)	12.3	25%	0.2%

Given the low collision mortality predictions for species other than red-throated diver it was not considered that any species require further assessment. Red-throated diver can be used as a worst case model. If all the red-throated divers flew at rotor height, then a significant impact on the local population may occur, however, this is considered to be a very unlikely scenario as:

- no diver collisions have been reported from any operating wind farm to date;

(1) Annual survival rate of approximately 90%.

(2) Assuming all birds recorded within a 4km radius of the site fly through it at rotor height.

- this species flies relatively low over the water – confirmed by observations from the boat surveys undertaken in January 2002, as all the birds observed were flying at a height of 10 metres, or less, above sea level which is well below the rotor height of at least 20 metres above sea level; and

- the collision risk assessment is based on a worst case avoidance rate and whilst no information is available for wintering divers, breeding divers have been reported in close proximity to wind turbines on Orkney, with regular feeding flights past the turbines without any collisions (Meek *et al*. 1995).

Hence the actual collision rate is expected to be substantially less than the 1.4 birds per year predicted in the model.

The significance of the overall collision risks that would be likely to result from the proposed Rhyl Flats wind farm have been assessed using an approach currently being developed by the BWEA and SNH. None of these would be deemed to be significant (see *Table 8.2)*. Further details on the criteria used to assess magnitude, sensitivity and significance are contained in *Annex G.*

Table 8.2 Summary of Collision Risks from the Rhyl Flats Offshore Wind Farm.

Species	**Magnitude of Effect**	**Sensitivity of Local Population**	**Significance**	**Significant Impact?**
Common scoter	Negligible	High	Very low	No
Red-throated diver	Low	High	Low	No
Migrant waterfowl	Negligible	Very high	Low	No
Other seabirds	Negligible	Medium	Very low	No
Migrant landbirds	Negligible	Low	Very low	No

Barrier Effect

It has been suggested by studies in Denmark that wind farms may act as a barrier to bird flight lines, with birds preferring to fly around wind farms rather than between turbines, where they are closely spaced, for example 200m (Tulp *et al* 1999). [(1)]. COWL has sought to use a greater separation distance (335 metre gap between the rotor blades [(2)]) to reduce the risk of such effects.

Lighting

There is extensive literature documenting the effects on birds of lighting on tall structures, particularly on songbirds that migrate during the night. Many birds are attracted to the lights and can collide with them (*Op cit* Percivcal, 2001). Whilst it is known that such effects may be influenced further during periods of poor visibility, the factors that cause birds to fly into lit structures are in general less well understood.

(1)Study at Tuno Knob in Denmark, eider ducks avoided flying between turbines at 200m separation
(2) Assuming the turbines are located approximately 440 metres apart and the blades are approximately 52.5 metres long.

Current guidelines for marking of offshore wind farms do recommend the use of flashing yellow marker lights on some of the turbines below the lowest point of the arc of the rotor blade (see *Section 3.2.6*). In addition the met mast is likely to have a flashing white light that will be visible for approximately 10 miles. Research into the effect of different light colours and flash speeds is ongoing, but the findings of research particularly in the USA suggests that strobe or flashing lighting is preferred to continuous lighting, that white light is better than red and that low intensity lighting should be used where possible (Ogden, 1996; Evans & Manville, 2000; Kerlinger, 2000; Percival, 2001). Also some research has indicated less effect where the time between light flashes is longest. The current design proposals for the wind farm will, therefore, be using lighting that should reduce the risk of impacts to birds and yet still meet the necessary navigation and safety requirements.

A review of meteorological data from Anglesey for the period 1982 – 1997 indicate that the combination of poor visibility (less than 7.5 km) and strong winds (Force 6 and above) occurs on average for only 3% of the year and hence the likelihood of risk to birds is low.

Perching Posts

The provision of platforms in marine waters that are currently devoid of them will undoubtedly attract sitting and perching gulls and possibly cormorants to the wind farm and in particular the sub-station facility. The turbines may be of benefit to the birds as perching posts.

Creation of New Habitats

It is likely that the operational wind farm will enhance the use of the area by fish in two ways. It will create new habitats for fish by creating artificial reefs as a result of scour protection measures, and also creation a safe haven for fish, due to a fishing exclusion zone (see *Section 8.4.1*). This may increase the productivity of the wider area and the food resource for fish eating birds that use the study area.

8.6.5 Cumulative Impacts

The Rhyl Flats wind farm proposal is one of three along the North Wales coast, in the study area, with a submission already made at North Hoyle and a further one expected at Burbo Bank. Insufficient is known about the current proposals at Burbo Bank to allow any meaningful assessment to be made about its likely impacts, or the cumulative impacts that may result. These will be issues that are likely to be assessed in the submissions accompanying the applications for these developments.

Hence the following sections consider the likely cumulative impacts that may arise from the Rhyl Flats and North Hoyle proposals. The North Hoyle site is located approximately 10 km to the north east.

The permanent loss of habitat from the two proposals is likely to comprise only a small part of the Rhyl Flats project study area. At North Hoyle approximately 0.02 km^2 of benthic habitat will be lost for the turbines and some 650 m^2 at Rhyl Flats.

The assessment of impacts at North Hoyle focused on a similar range of bird species to those being considered as part of the assessment of the Rhyl Flats proposals. Given the very low number of common scoter recorded on the North Hoyle site, and the recorded and predicted low use of the Rhyl Flats site by common scoter, the cumulative effects of habitat loss on this species are not significant. The North Hoyle ES does predict the risk of significant effects on red-throated diver, primarily due to the concentrations on the Rhyl Flats site. The aerial survey data for 2001/2002 does not indicate the Rhyl Flats wind farm site to be of any particular importance to red-throated diver. Significant impacts on the other important bird species such as cormorant, terns, great crested grebe, red-breasted merganser and auks (all fish eating species) are not predicted from the assessments of either the Rhyl Flats or North Hoyle proposals. It is likely that they will forage away from the construction works and hence the likely effects on fish-eating species are not considered significant. Once operational it is likely that both wind farms will provide opportunities for new habitat to colonise. The Rhyl Flats Wind Farm may also provide safe havens for fish as a result of reduced fishing effort within the wind farm area.

Some disturbance effects resulting in exclusions of birds during construction and once the wind farms are operational are likely, however, neither of the assessments of the effects on birds from the proposals at the two sites predicts any significant impacts. Boats and human presence in the offshore waters has been identified as a key source of disturbance to the bird species in the study area, particularly common scoter, and red-throated diver, both present in important numbers. Given that construction work at the Rhyl Flats site will take place at a time of the year when bird usage of the wind farm site is expected to be low and that only low impacts to bird species are predicted from the operating North Hoyle site, then cumulative impacts are considered unlikely.

It is not envisaged that significant impacts to birds will result once both sites are operational, based on the findings reported in the North Hoyle ES and the impacts that are considered likely from the Rhyl Flats proposals on the basis of available information.

The cumulative collision risk from the two wind farm sites is not significant. Only a low number of bird movements were recorded through the North Hoyle site and modelling predictions for the Rhyl Flats site concluded that no significant impacts were likely.

It is possible that at both Rhyl Flats and North Hoyle the close proximity of the turbines to one another could provide a barrier to bird flight lines across the wind farm sites in certain directions. Research in Denmark has recorded effects at sites where the separation of the turbines has been only 200 metres. To reduce the risk of such impacts COWL have sought to use minimum separation distances well in excess of this figure (*ie* 335 metres at Rhyl Flats). The two wind farm sites are approximately 10km apart and no barrier to movements of birds between the sites is considered likely.

Both wind farm sites will be lit at night to meet with the necessary navigation and safety requirements. The lighting that will be used is of a type (*ie* flashing white light) that recent research has indicated is likely to have a lower risk of causing impacts to at least some than other types. In addition the meteorological data suggest that the combination of high winds and low visibility occurs relatively infrequently (3% of the time). The key bird species of importance in the Rhyl Flats project study area are ones that are not known to migrate at night offshore. Hence the risk of lighting and bad weather causing significant collision impacts is considered to be low.

Overall the development of both wind farm sites is not considered likely to have significant cumulative impacts to bird species and populations in the study area.

8.6.6 Mitigation Measures

The following mitigation measures have been agreed with COWL:

- further aerial and boat based bird surveys and annual benthic sampling, will be undertaken as necessary up to the onset of construction, during construction, operation and during the decommissioning phases to provide further information about the use of the study area by bird species such as common scoter and red-throated diver. This information will be used to refine the proposals wherever possible (*eg* timing of activities; routing of shipping traffic).

- the findings of ongoing CCW aerial surveys will be used to help refine the timing of the laying of the sub-sea cable from the wind farm site to the landfall. This will be undertaken at a time that keeps the risk of impacts to sensitive bird species to a minimum;

- routes used by construction boat traffic will follow existing shipping routes to reduce the risk of additional disturbance;

- the construction programme will minimise work offshore in March to reduce the risk of impacts to concentrations of common scoter that are known to be present in the study area;

- a separation distance of over 300 metres has been allowed between the wind turbines to reduce the risk of a barrier effect to the movement of birds in the north south direction, whilst a 2 km separation has been allowed in the east west direction to held reduce the risk of impacts to birds flying parallel to the coast;

- habitat loss will be reduced to a necessary minimum to avoid loss of benthic communities and habitat for fish species;

- best site management practices will be implemented to reduce the risk of impacts to surrounding habitat and species.

8.6.7 *Monitoring*

COWL is committed to ongoing programme of bird monitoring through funding to studies that are undertaken by CCW and perhaps other organisations, and more specific monitoring of construction and de-commissioning of the Rhyl Flats site undertaken directly by COWL. The aims of this monitoring are to:

- monitor any changes in the baseline conditions between submission of the application for consent and the onset of construction and, through the construction, operation and decommissioning phases of the project; and

- provide feedback into the effectiveness of agreed mitigation and provide information that will be of use in assessing future offshore wind farm proposals.

A formal monitoring programme will be prepared following discussion with CCW and other key consultees following submission of the application and its review by CCW and other organisations such as RSPB.

The monitoring techniques which will be considered for inclusion of the programme will include aerial and boat based surveys, the trialing of radar technology and additional benthic sampling. COWL will continue to fund aerial surveys as part of the CCW surveys over coming months and undertake further boat based surveys to assess movements of common scoter.

8.6.8 *Summary*

- No direct or indirect impacts to designated sites as a result of the proposals are predicted.

- Habitat loss will be kept to the minimum necessary for the works which will reduce the effects on benthic feeding bird species.

- Common scoter (which occur in nationally important numbers in the study area) is the main benthic feeding bird species which could be affected by habitat loss but significant impacts are not predicted because benthic habitat loss will be small; there is a paucity of their preferred food source in the location of the proposals and numbers are low in the months when most construction activity is likely to take place (April to August).

- The majority of birds present in the area during the likely construction period are fish eating species. Important fish eating species such as red-throated diver and great crested grebe are winter or passage visitor and unlikely to be present in great numbers in the summer months.

- With the exception of cormorant (a fish eating species) few species are considered likely to forage in the area of the proposals because of its distance from the shore and the depth of water.

- Fish are likely to leave the area during construction because of disturbance and any fish eating predators are likely to follow their prey out of the area.

- There may be some general disturbance effects during construction when birds normally using the area will maintain a stand off distance from the works.

- Common scoter is susceptible to disturbance but for the reasons given above it is considered unlikely (based on current knowledge) that large numbers of birds will be present in the area during the summer months or during the moulting period.

- Moulting common scoter could be affected by laying of the sub-sea cable. The work period will be short and if possible will be programmed to avoid causing significant effects if these are indicated to be likely.

- Surveys to date have not indicated that the wind farm site is of any special importance to seabirds and significant impacts to use of the site during operation of the wind farm are considered unlikely.

- Bird collision with the wind turbines may cause mortality.

- Collision risk modelling indicates that the risk is greatest to red- throated diver but that no significant impacts to numbers of the species in the area are likely.

- A 335m gap between rotor blades will reduce the risk of a barrier effect from the turbines to bird flight lines.

- Proposed lighting for the site has been designed to reduce the risk of attracting birds into the turbines.

- Some species may use the site infrastructure as perching posts.

- Underwater structures are likely to create artificial reefs and potential new habitats for fish which in combination with the exclusion of fishing may increase the fish resource for fish eating bird species in the area.

- Cumulative impacts from construction and operation of the North Hoyle Site (some 10km away from the Rhyl site) are considered not to be significant based on current data.

- The findings of ongoing research studies will be used to refine the scheme mitigation detail as necessary. COWL is committed to a programme of further monitoring.

8.7 SOCIO-CULTURAL IMPACTS

8.7.1 Fisheries

Construction Impacts

An extensive assessment of the level of fishing activity in the proposed lease area has been carried out as part of the EIA. Data from several different sources have been analysed, which show the following:

- DEFRA overflight data which take account of vessels over 10m in length indicate that the majority of fishing activity takes place between April and June. Fishing activity is reduced during the winter months between November and February although December is a peak beam trawling period.

- DEFRA overflight data indicate that beam trawling is the predominant fishing activity undertaken throughout the majority of the year, but most intensively between March and May and November and December.

- DEFRA overflight data indicate that most of the fishing activity occurs to the north and north-west of the proposed lease area and Constable Bank.

- DEFRA effort data was collected and compared with overflight data which suggests a decline in beam trawling effort since 1998.

- Consultation with fisheries umbrella organisations (*Annex C, Volume V*) and subsequently with vessel operators (generally less than 10m) active in the vicinity has identified two vessel operators that contribute a significant proportion of total fishing effort in the vicinity of the proposed lease area. A third vessel spends a proportion of its time fishing commercially and spends the rest of the time sea angling within the vicinity of the proposed lease area.

- It has also been identified through consultation that there are up to ten angling operators which regularly use the proposed lease area.

- All of the vessel operators identified are known to operate both in the proposed lease area and adjacent areas. The presence of the exclusion zones has the potential to cause displacement of fishing activity.

The degree to which the vessel operators will be impacted will depend on the type of fishing activity employed in the area and the proportion of working time spent in the area. Although both static and mobile gear types are deployed in the area, the static gear can technically be remobilised in adjacent areas in the longer term.

The exclusion area implemented during the construction phase is likely to result in an alteration of fishing vessel movements adjacent to the proposed lease area.

Fishing activity is a dynamic one, responding from one year to the next to various external changes. The assessment of impact significance is based on past trends which may change. To ensure that future changes in fishing activity do not lead to conflict with the proposed wind farm, and that fishing interests at the time of construction are properly dealt with, COWL will:

- continue consultations and inform fishing interests in advance of the timing and nature of construction activity; and

- subject to the requirements of affected fishing groups, continue liaison with fishing groups.

These measures will ensure that any future uncertainty is managed and that the overall impacts will be moderate.

Operational Impacts

Impacts from the operation phase will be similar to those identified for the construction phase as a result of the permanent presence of the exclusion zones. During wind farm operation, partial exclusion zones will be in operation which will allow vessels into the wind farm, although not within 50 m of each turbine. Although this rule will permit static fishing vessels within the wind farm area, mobile gear fishing vessels will not be permitted within 50 m from the perimeter turbines, hence causing impacts to mobile gear fishermen. These impacts will include direct loss of traditional fishing ground although this fishing ground is not considered unique in the context of the North Wales coast. There are three mobile gear fishermen and the possibility that non-local vessel operators could also be affected (although consultation with fisheries umbrella groups anticipates that this number is small). Although impacts to mobile gear fishing have the potential to be considerable, appropriate mitigation measures such as on-going liaison with the fishermen involved will ensure that the impacts are minimised. Approximately 10 local sea anglers operate within the proposed wind farm area, however these will not be significantly affected by the exclusion zone proposals as they will still be permitted to fish within the wind farm area. Overall, the impacts to the fishing community are anticipated to be moderate but are not considered significant.

On addition, there is the potential for behavioural changes to elasmobranch fish from alterations in the electromagnetic field in the vicinity of the submarine cable (*Section 8.4.3*).

Elasmobranch species known to be present within the study area include several species of shark including monkfish *Squatina squatina* and dogfish *Scyliorhinus canicula*, skate *Raja batis* and, several species of ray (thornback ray *Raja clavata*, spotted ray *Raja montagui*, cuckoo ray *Raja naevus* and sting ray *Dasyatis pastinaca*). Skates and rays represented 13% of the total catch (weight) and 22% of the overall value of commercial fish caught between 1996 and 2000 (DEFRA 2001). The potential for impacts to skates and rays is discussed in detail in *Section 8.4.3.* Impacts to the fishing industry are anticipated to be localalised and therefore not considered to be significant.

In the first instance, arisings from the drill hole will be deposited in the predicted location of the scour hole. Due to the anticipated clay nature of the arisings it is predicted that much of this material will remain *in situ*. Post construction monitoring will enable to the exact nature of any additional scour protection methods to be identified. Scour protection may include the installation of rocks/gravel mattresses/artificial fronds around the base of each monopile. These new substrates, may, if properly designed, provide a habitat for a variety of marine flora and fauna, providing food and refuge to a number of fish species (*ie* rays, potentially allowing numbers to recover following periods of intense fishing activity) and generally contributing to the biodiversity of the region (Danish Institute of Fisheries research 2000).

The restrictions on fishing within the wind farm will result in the area being used as a safe haven by fish. This is anticipated to be beneficial to fisheries in the wider area over time.

Cumulative Impacts

In the longer term, the construction of more than one wind farm in the wider area may be beneficial for fish and the fisheries resource provided it is managed properly.

Mitigation

To ensure that future changes in fishing activity do not lead to conflict with the proposed wind farm, and that fishing interests at the time of construction and in the long term are properly dealt with, COWL will:

- continue consultation and inform fishing interests in advance of the timing and nature of construction activity; and

- subject to the requirements of affected fishing groups, continue liaison with fishing groups.

Summary

Three local fishing operators and approximately 10 local sea angling operators are likely to be affected by the wind farm proposals. In addition, there is a possibility that non-local vessel operators could be affected. However, consultations with fisheries umbrella organisations and local fishermen suggest that numbers of non-local vessel operators will be small. The effects will include direct loss of traditional fishing ground for mobile gear fishing vessels.

The anticipated impacts from the presence of the electromagnetic cable are unknown, although preliminary investigations indicate that there is likely to be some behavioural effect.

The potential for negative impacts as a result of the direct loss of fishing area may potentially be offset through increases in fish stocks as a result in the presence of the exclusion zones in the long term. Overall impacts to fishing interests are anticipated to be moderate but are not considered significant.

8.7.2 Marine Archaeology

Construction Impacts

Marine construction activities which have the potential to cause impacts to marine archaeological heritage include:

- foundations for turbines, masts and offshore substation;
- scour protection;
- internal electrical infrastructure;
- connection to shore;
- shore landing point;
- anchoring *etc*. by construction vessels; and
- decommissioning.

The foundations for turbines, meteorological masts and offshore substation are expected to be tubular monopiles fabricated from steel, 30 m in length and between 3.5 and 4.5m in diameter. Drilling and grouting is likely to be the technically preferred option for installation of the subsea upright structures although driven piling cannot be eliminated.

The arisings generated from drilling will be placed at the predicted location of the scour hole, where the relative shelter from the tidal currents will reduce the dispersion, and the material could also help prevent scour. A pre and post-construction monitoring programme will identify the rate at which scour takes place. Additional scour protection measures will be carried out at such a time that suitable information to inform design becomes available. Potential options for mitigation measures may include the installation of rock/gravel mattresses/artificial fronds.

The internal electrical infrastructure will comprise cables running along each line of turbines, with cables between the two lines at the centre and ends. The cables will be buried in subsea trenches to a depth that provides protection against marine activities and scour.

The connection to shore will depend on the substation option adopted. If an offshore substation is used, then the connection to shore will comprise a single cable buried in a subsea trench to a depth that provides protection against marine activities and scour. If an onshore substation is used, then up to four cables will be buried each in its own subsea trench to a suitable depth. The cables/trenches will be separated by at least 30 m along their lengths.

The cable landfall will installed by open cut trenching.

Numerous vessels will be used in constructing the wind farm, including vessels that anchor conventionally and jack-up vessels. Anchors, their cables and jack-up spuds (feet) will impact the seabed, sometimes to a depth of several meters and over an extended area.

It is likely that the former landsurfaces indicated by peat horizons on the foreshore and in boreholes are reasonably extensive and may underlie the development area, the subsea cable routes, and the areas where the subsea cables come ashore. As well as providing direct, datable palaeo-environmental evidence of the development of the landscape in the Holocene, discoveries of artefacts on the foreshore suggest that more artefacts (and potentially sites), may be found in association with the landsurfaces. Additional work (discussed in the mitigation section) will therefore be carried out in order to establish whether this potential coincides with the footprint of the scheme.

Any prehistoric deposits, landsurfaces and artefacts that are present within the footprint of scheme elements at depths reached by construction will be impacted directly by excavation (*eg* dredging of subsea cable trenches, open trenching across the beach) and monopile installation, and indirectly by erosion triggered by construction activities. Construction will disturb and/or remove both the deposits and any associated artefacts, exposing them to physical, biological and chemical decay.

The nearest site designated under the *Protection of Wrecks Act 1973* is the *Resurgam* that lies 3.6 km to the north-east of the proposed development area. The national importance of the *Resurgam* is demonstrated by its designation. Any damage to the site and the seabed in its vicinity would be a significant adverse effect, as well as a criminal offence. However, it is not anticipated that the proposed development will impact this site.

The wreck of *SS Penrhos* lies within the development area. In the absence of mitigation it is possible that this wreck might be damaged by construction, both directly (by adjacent works) or indirectly (from construction vessel anchors, for example). Damage might include:

- direct damage to the wreck structure and contents;
- disturbance to relationships between structures, artefacts and their surroundings;
- destabilisation prompting renewed corrosion, decay *etc*; and
- erosion leading to damage, disturbance and instability in the medium to long term.

A further 11 sidescan contacts were identified in the development area, the majority of which may be boulders (Fugro UDO 2001), though one such anomaly (3008) is described as boat shaped. In the event that an anomaly proves to be wreck and construction activities take place within its vicinity, then damage might encompass direct damage, disturbance, destabilisation and/or erosion.

Two wrecks, the *Four Brothers* (2004) and the Avro Anson (2005), lie to the immediate south-east of the proposed wind farm. However, neither site has been shown to comprise structural material in recent years. The *Guardian Angel* (2002) is 800 m east of the proposed connection to shore. If there is wreckage at these three sites, then it is possible that it will be damaged indirectly by construction vessel anchors.

The importance of the known wrecks other than *Resurgam* is not apparent from any designation, and on present knowledge they are unlikely to be considered of special importance. However, the loss of life on the *SS Penrhos* warrants due care, as does the protected status of the Avro Anson.

Any prehistoric material beneath the seabed or foreshore is likely to be of regional if not national importance, on account of the contribution that its investigation would make to understanding the early human history of North Wales and other parts of the UK. Limited damage to deposits that can be shown to be extensive can be acceptable, particularly if the damage is offset by palaeo-environmental analysis and dating. However, extensive damage to deposits, and even limited damage to direct evidence of human inhabitation (*eg* artefact scatters, structures, features), would be a significant adverse effect.

The other reported wrecks within the marine study areas are unlikely to be impacted by the proposed development.

The proposed development has the potential to impact hitherto unknown wrecks and sites within the Survey Area as well as discrete items of ship-borne debris. Damage might encompass direct damage, disturbance, destabilisation and/or erosion. It should be noted that repeated discoveries of apparently discrete items from a specific area might indicate the presence of a coherent shipwreck.

The importance of any hitherto unknown wrecks cannot be established without some form of assessment and evaluation upon discovery. However, given the long history of maritime activity in the region, it is conceivable that the remains of vessels of regional, national and even international importance might be discovered. Damage to wrecks of demonstrated importance would be a significant adverse effect.

The wind farm will be decommissioned by removing the turbine towers and meteorological masts and either lifting the foundations or cutting them below seabed level. Cables will be capped and ballasted to the seabed or removed. The additional disturbance to the seabed, and any archaeological material therein, will be relatively minor. However, the anchors, cables and jack-up spuds of vessels used in decommissioning may impact archaeological material, as during construction.

Implementation of the mitigation proposals (see below) will avoid or reduce the potential for significant adverse effects identified above.

Operational Impacts

There is no scope for impacts during operation of the proposed wind farm.

Cumulative Impacts

In the event that several offshore wind farms are built in the region, then it is conceivable that the construction of Rhyl Flats wind farm may have an additional cumulative effect on marine archaeology. The significance of any such cumulative effect is difficult to assess in the absence of an over-arching conservation framework for the archaeology of Liverpool Bay. Nonetheless, archaeological information arising from the Rhyl Flats wind farm will feed back into local and national monuments records and inform subsequent curatorial decisions. Consequently, the development is likely to have a beneficial cumulative effect on marine archaeology.

Mitigation

In order to minimise the potential for impacts to archaeological features, COWL will ensure that the following mitigation measures are implemented.

- Any further geophysical survey will be reviewed by a suitably experienced archaeologist.

- The specification and implementation of marine geotechnical surveys (boreholes) will be subject to archaeological advice. Where Holocene material is apparent, provision will be made for recovery of continuous undisturbed samples.

- A Written Scheme of Investigation (WSI) will be developed for the construction phase in consultation with Cadw and Clwyd Powys Archaeological Trust.

- Preparation of the WSI will be informed by archaeological coring across the foreshore. Where Holocene material is apparent, provision will be made for complete recovery of cores. If suitable horizons are identified, provision will be made for palaeo-environmental assessment and radiocarbon dating of sub-samples.

- The position and extent of the designated area around the *Resurgam* will be marked as an exclusion zone on scheme masterplans, including contract documents.

- An exclusion zone will be defined around the *SS Penrhos*, which will be marked on scheme masterplans, including contract documents.

- Existing data relating to the 11 sidescan anomalies will be reviewed in consultation with Cadw. If warranted, exclusion zones will be defined around anomalies that are suspected as being of archaeological importance. In the event that an exclusion zone would impinge on construction and an archaeological origin to the anomaly is still suspected, then further archaeological investigation (*eg* diving inspection) will be undertaken to resolve the situation.

- Further exclusion zones will be defined around any other features shown to be of archaeological importance prior to or in the course of construction.

- A protocol will be prepared setting out procedures for dealing with any features that appear to be of archaeological importance which are discovered in the course of construction. The protocol will make provision for the institution of temporary exclusion zones around areas of possible archaeological interest, for prompt archaeological advice and, if necessary, for archaeological inspection of important features prior to further construction in the vicinity. The protocol will also provide for the reporting of archaeological discoveries to Cadw, the National Monuments Record of Wales, and Clwyd Powys Archaeological Trust. The protocol will comply with the *Merchant Shipping Act 1995*, including notification of the Receiver of Wreck, and accord with the JNAPC Code of Practice for Seabed Developers. The protocol will be appended to the WSI for the construction phase referred to above.

Summary

The assessment has addressed possible impacts on deposits of prehistoric age that may underlie the seabed and foreshore. Mitigation measures will be adopted and include provision for assessment and dating of samples from suitable marine and/or foreshore cores.

The assessment has addressed possible impacts on known and unknown wreck. The *Resurgam*, which is designated under the *Protection of Wrecks Act 1973*, is unlikely to be impacted because it is distant from the development area. The *SS Penrhos* lies within the development area. Although not of great historical importance, the wreck was a result of military action and involved loss of life. The wreck will be protected by an exclusion zone. Provision has been made to establish exclusion zones around anomalies suspected of being of archaeological origin. A protocol will be prepared setting out procedures for dealing with any features that appear to be of archaeological importance which are discovered in the course of construction.

Implementation of the mitigation proposals will avoid or reduce the significant adverse effects identified above to a sustainable level. Furthermore, the additional information about human inhabitation and maritime activity in the area is likely to add to understanding, appreciation and future conservation of the historic environment of North Wales. Consequently, the residual effect of the proposed development on the archaeological heritage is likely to be positive.

8.7.3 Airborne Noise

Construction Impacts

Noise associated with the construction of the proposed wind farm will occur from a number of sources. In general, noise associated with heavy lifting gear, *ie* cranes and barges to lift towers/turbine nacelles into place will result in no audible noise along the seashore. Transportation of equipment and loading of barges is expected to occur at locations remote from the site. However, the installation of piles to support the turbine tower/nacelle structure could result in the potential for audible noise along the seashore for specific weather conditions.

It is proposed that the turbine support structure will be placed upon monopiles which will either be driven or drilled into the seabed. Drilling of the monopile would minimise the noise emissions from this construction operation, however, it may be appropriate to drive the pile into the seabed. If this is the case, then there is the potential for impulsive piling noise to occur.

Based upon estimated pile sizes for the project and published and measured noise data for such operations, it is predicted that piling noise may just be audible if performed during the night-time period, during low tide and with a positive wind vector from the site towards the receiver position. At the shoreline, it is predicted that piling noise will fall into the range of 26 – 38dB L_{Amax} for these specific weather conditions. This represents a low noise level. For example, the sleep disturbance criterion within a bedroom is 45dB L_{Amax}. Piling noise is predicted to be between 7 – 19dB below this threshold of disturbance level outside a building. Allowing for the attenuation due to a typical building structure, these levels will be further reduced by 5 – 10dB, *ie* internal noise levels of 16 – 33dB L_{Amax}. Daytime noise levels due to piling will be below the prevailing background noise levels found at any of the measurement locations. It is expected that, during the daytime, piling noise will rarely, if ever, be audible.

No significant impacts are anticipated during construction and therefore mitigation measures are not required.

Operational Impacts - Prediction of Wind Turbine Noise Levels

The method of noise prediction used for the prediction of incident wind turbine noise at locations along the coast is dependent on a number of factors as follows:

Source Sound Power Level - The sound power level (SWL) of a noise source is normally expressed in dB re: 1pW[1]. The SWL used for prediction has been based upon an estimated noise level for a generic 3.2 MW wind turbine. The SWL used for prediction has been based upon measurements of 2 MW turbine, which have then been increased to allow for the increased rotor size. The SWL used is the maximum allowable SWL, inclusive of measurement uncertainty, of any turbine to be installed at site. An absolute maximum allowable SWL of 110dB(A) for a wind condition of 8m s^{-1} at 10m height, *ie* 108dB(A) ± 2 dB. The proposed wind turbines for installation are all variable speed in operation, *ie* the rate of rotation of the rotor is related to the strength of the wind. Based upon data supplied by manufacturers of 1.5 – 2MW wind turbines, it has been found that the rate of change in noise level with wind speed ranges between 1 – 3dB(A) /m/s. For the purpose of our noise predictions, we have assumed a rate of change based upon a Vestas V-80 wind turbine.

Effective sound power level from a wind turbine varies according to direction. The SWL as measured downwind of the turbine has been used for our calculations since this represents the worst case propagation direction for wind turbine noise. *Table 8.5* details the SWL used for the calculation of incident noise levels at neighbouring properties. The turbine locations are those set out in *Section 3*.

Table 8.5 ***Sound Power Levels Used for Noise Predictions***

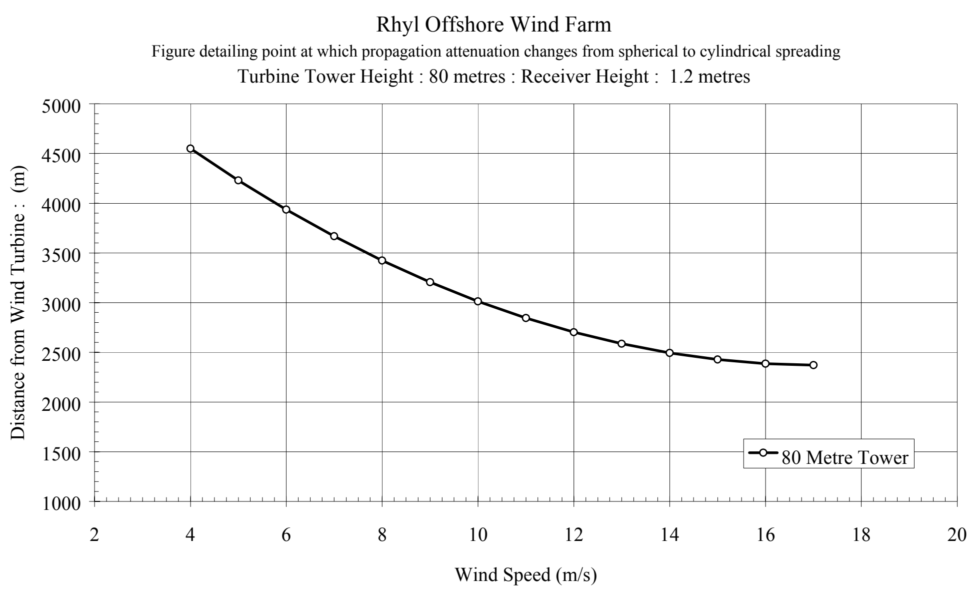
		Octave Band Centre Frequency (Hz)								
Wind Speed at 10 m height	**A-weighted**	**31**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
3.5	101.6	72.1	80.6	87.7	94.2	97.4	95.4	92.3	86.4	77.3
4.0	102.1	72.6	81.1	88.2	94.7	97.9	95.9	92.8	86.9	77.8
5.0	105.7	76.2	84.7	91.8	98.3	101.5	99.5	96.4	90.5	81.4
6.0	108.4	78.9	87.4	94.5	101.0	104.2	102.2	99.1	93.2	84.1
7.0	109.3	79.8	88.3	95.4	101.9	105.1	103.1	100.0	94.1	85.0
8.0	109.5	80.0	88.5	95.6	102.1	105.3	103.3	100.2	94.3	85.2
9.0	110.2	80.7	89.2	96.3	102.8	106.0	104.0	100.9	95.0	85.9
10.0	111.3	81.7	90.2	97.3	103.8	107.0	105.0	101.9	96.0	86.9
11.0	112.1	82.6	91.1	98.2	104.7	107.9	105.9	102.8	96.9	87.8
12.0	112.8	83.2	91.7	98.8	105.3	108.5	106.5	103.4	97.5	88.4

(1) [1] pW = Picowatt = 10^{-12} watts = reference level for sound power level determination

Tonal Noise Correction - It has been assumed that no clearly audible tones will be radiated by the installed wind turbines. It is proposed that any warranty with a turbine supplier will include a warranty against the emission of tonal noise. No allowances have been made for any penalties due to tonal noise within the noise predictions.

Geometric Spreading - If the noise source can be considered as a single point in free space, the sound energy can be considered to spread out equally in all directions resulting in a reduction of noise level of 6dB per doubling of distance. It has been assumed that the sound energy spreads spherically from the point source and that the water surface is hard and reflective. This equates to assuming hemispherical radiation from the point source. Current literature[1] indicates that the propagation of noise from a single turbine may be considered as a point source but that at distances of greater than around 1 - 3km, depending on the wind speed and the relative height of the source and receiver, the attenuation with distance may be less. An attenuation rate of 6dB per doubling of distance up to change over distance [(2)] from each turbine and 3dB per doubling of distance thereafter has been assumed. *Figure 8.10* below details the change over distance for various wind speeds.

Figure 8.10 ***Distance at which Propagation Attenuation Changes from Spherical to Cylindrical Spreading***



Atmospheric Absorption - Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the pressure, temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with little

1 The Prediction of Propagation of Noise from Wind Turbines with regard to Community Disturbance : ETSU WN 5066 Published 1990.

(2) The change over distance is distance at which atenuation changes from 6 dB per doubling of distance to 3 dB per doubling of distance.

attenuation at low frequency. The reduction is proportional to the distance between receiver and source. Well-established tables exist which provide these attenuation factors at different temperature, pressure and humidity. A temperature of 7°C and a relative humidity of 80% has been assumed. The attenuation rate/metre used for the predictions are given in *Table 8.6*.

Table 8.6 Atmospheric Absorption Coefficients used for Predictions

Atmospheric Attenuation	Octave Band Centre Frequency (Hz)								
	31	63	125	250	500	1k	2k	4k	8k
dB / metre	0.0001	0.0004	0.0005	0.0010	0.0021	0.0042	0.0099	0.0247	0.0638

Ground Effect - Ground effects are caused by the interference of a reflected sound wave from the water surface with the direct sound wave from the source. This may result in destructive or constructive interference at the receiver position. However, the existing published data is based on relatively still conditions at the test sites, with no temperature variations vertically or horizontally along the propagation path. The conditions likely to be experienced here would result in the phase relationships which exist between the direct and reflected waves being muddled through the effects of wind and temperature and are likely to result in the averaging out of the effect. Investigations comparing predicted and actual measured levels, undertaken for the International Energy Agency for their recommended practices for wind turbine testing and evaluation, indicate the inclusion of these ground effects normally results in greater errors in the predicted levels. There have, therefore, not been included in the assessment calculations.

Refraction by Meteorological Gradients - The way in which a sound wave travels through the atmosphere to a receiving position is dependent upon the way temperature and wind velocity change with height above ground level. As temperature and wind velocity, and thus sound velocity, change with height above ground level, so a sound velocity profile is created bending the sound waves towards or away from the ground depending on exact conditions. Decreasing temperature with height results in the sound being bent away from the water surface and increasing temperature with height results in sound waves being bent towards the water surface. Similarly, the propagation of sound up-wind results in the bending of the sound waves away from the water surface and down-wind the sound waves are bent back towards the water surface.

Temperature inversion effects are fairly unpredictable and, although they have been noted to increase noise levels over the expected calculated levels quite significantly under certain very infrequent conditions, they have not been included the assessment in as wind effects are much more dominant around wind farm sites. With regard to wind velocity profiles, current research indicates that positions upwind of the wind turbines are likely to have lower incident sound pressure levels than predicted for distances greater than 5.25 times the nacelle height with little or no effect to the predicted levels at downwind positions.

The potential for temperature inversion is greater at sea when warm fronts approach the UK during the winter and spring periods when the sea is cool. In these circumstances, temperature inversion may occur but it may be accompanied by fog conditions. In these circumstances, increased atmospheric absorption may be experienced due to the suspension of water droplets in the air as fog.

Turbine Wind Speed - Noise predictions have been performed assuming that all the wind turbines will experience the same hub height wind speed throughout the site. The assumption that all the wind turbines are operating at the same wind speed will lead to some errors. However, this error is likely to be low.

Assessment of Wind Turbine Noise Levels during Operation

Predictions of wind turbine noise at 10 locations along the coast are given within *Annex I*. An assessment of the potential noise impact has been given for both the `quiet daytime' and `night-time' periods. For all locations for which an assessment has been performed, wind turbine noise is predicted to be between 7 and 25 dB below the prevailing background noise levels. This is a positive indication that wind turbine noise will not give rise to complaints at properties facing the development. The predicted noise levels meet the requirements of the DTI NWG Recommendations for wind turbine noise.

The maximum predicted noise level at a wind speed of 12m s^{-1} is a level of 32.1dB L_{Aeq}, 30.1dB L_{A90} at the Old Life Boat House at Llanddulas. The prevailing background noise level at this location is around 40dB L_{A90} for this wind condition.

Sleep Disturbance during Operation

Predicted internal noise levels with windows open indicate that turbine noise will be below 22dB L_{Aeq} at all dwellings with a view of the wind farm. The wind turbines will have no effect upon the sleep of occupants of houses with views of the proposal.

Audibility of Wind Farm during Operation

The background noise measurements indicate that the lowest noise levels measured at any of the three measurement locations occurred when the following conditions were met:

- it was low tide;
- traffic flows were low along the A55 or any other neighbouring roads; and
- human activity was a minimum.

In these circumstances, background noise levels as low as 24 – 27dB L_{A90} have been recorded. Therefore, it is possible that wind turbine noise might be audible when the wind is from a northerly direction when the above conditions are met, *ie* the tide is out, it is 0230 hrs and there is little human activity. In these relatively unusual circumstances, it is possible that noise from the wind farm may be just detected. This is not considered to be a significant impact.

Cumulative Impacts

An offshore wind farm is proposed at Hoyle Bank located 12km to the east of the Rhyl Flats wind farm site. This wind farm is located sufficiently far from both the Rhyl Flats site and the nearest coastline to have no discernible cumulative impact at locations onshore. Predicted noise level increases due to the combined effects of the wind farms are of the order of less than 0.2dB L_{A90}.

Theoretical increases of the order of 1 – 2dB L_{A90} are predicted at sea surface locations between the two wind farms. However, for such level increases to occur would require that the receptor was downwind of both sites simultaneously, clearly a situation that will not occur in practice.

Summary of Noise Impact due to Wind Farm Operation

An assessment of the potential noise impact of the wind farm has been performed. This has taken account of existing guidance with respect to wind turbine noise which is contained within ETSU-R-97, the DTI NWG Recommendations.

Background noise level measurements have been performed at three locations along the coast which were identified through preliminary noise predictions as likely to be subject to the greatest noise levels from the proposed wind turbines.

Analysis of the measured noise data indicates that the noise environment between Rhos-on-Sea and Rhyl is dominated by traffic noise from the A55.

Predictions of wind turbine noise at 10 locations along the coast indicate that wind turbine noise will be between 7 and 25dB below the prevailing background noise levels. This is a positive indication that complaints are unlikely due to turbine operation.

Predicted internal noise levels indicate that sleep disturbance due to turbine operation will not occur.

Overall the impacts are not anticipated to be significant.

8.7.4 Tourism and Amenity

Construction Impacts

Water-based recreational activities are largely limited to yachting and power boating (pleasure boating) and diving. Some recreational day angling is carried out within the proposed lease area. The impacts to day anglers have been discussed in *Section 8.7.1*.

A detailed technical note concerned with pleasure boat activity has identified that there are no pleasure boat routes through the proposed wind farm (Anatec 2001). In addition, the wider area is not of significant importance for pleasure boating activity in the context of the UK where the south coast represents the preferred geographical location for such activities. There is a potential for impacts to recreational users during construction from:

- restricted access to the proposed wind farm area as a result of the exclusion zones; and

- the presence of construction vessels in the vicinity of the proposed wind farm.

There will inevitably be some disruption to recreational activity due to the presence of the exclusion zone around each individual turbine and construction vessels during the construction period. The construction period falls over the spring and summer months, with peak activity occurring between April and August. The exclusion zones will be physically be marked with buoys and the scheme details will be provided to the UK Admiralty in order for them to make the appropriate chart updates. Regular broadcasts will be made on the appropriate channels to inform vessels in the area of the presence of the wind farm construction activity. Impacts are anticipated to be minor provided appropriate mitigation measures are taken.

Diving is popular off the coast of Anglesey between April and November, although is not believed to take place within the proposed wind farm area. There is the potential for impacts to visibility from changes in suspended solids during construction. As diving is not believed to take place within the proposed wind farm area and any increases in suspended solids are anticipated to be short-lived and within the natural variation at this location, no significant impacts are anticipated.

Operational Impacts

- Potential operational impacts will be associated with an alteration in shipping and commercial fishing movements in the vicinity of the proposed wind farm.

Although the exclusion zones have the potential to cause some disruption at first, it is likely to become a navigation feature of the area in the long term. Consultation with local yachting groups has indicated that the presence of the proposed wind farm would only present a potential hazard to vessels during periods of strong north-westerly winds, at which times the route is less likely to be used.

The physical presence of the wind farm is not predicted to cause significant impacts to access to dive sites during operation.

The potential for impacts to pleasure boating from longer term alterations in shipping and commercial fishing routes is discussed further in *Section 8.7.5*, and is not considered to be significant.

Consultation with the National Assembly for Wales has suggested that the wind farm may provide a reason for some people to indulge in day boating in the area, potentially increasing the demand for day pleasure boating and providing a boost for the local economy.

Cumulative Impacts

Cumulative impacts to tourism and amenity are anticipated to be negligible.

Mitigation

Mitigation measures will include the following:

- COWL will contact the UK Hydrographic office in advance of the construction period to ensure that details are included in weekly notices to mariners and via NAVTEXT broadcasts.

- Prior to arrival on site, the offshore construction manager will review the precise risks and agree the detailed contingency plans, roles and responsibilities in managing hazards.

- The drilling/piling rigs will be registered as a navigational hazard to shipping with the HM Coastguard and Hydrographic Office. While on station, the rigs will use navigational lights and warning devices (obstruction lights and foghorn) to advise its shipping presence.

- A guard vessel will be present to assist the standby vessel. Its prime purpose will be to perform 'chase boat' duties as instructed by the standby vessel.

Summary

The overall impacts to recreational sea users are not predicted to be significant.

8.7.5 Shipping and Navigation

Construction Impacts

Construction work at the site is anticipated to be carried out between April and September 2004. During this phase of the work there will be an increased level of activity in terms of vessels, mobile cranes, dredgers, service boats, tugs and the three jack-up type barges which will be operating in the area. As with any other offshore construction facility, this introduces additional risks in terms of ship-to-ship encounters or grounding risk as a result of a vessel having to take avoiding action. There also exists the potential for delays to the Mostyn/Dublin ferry schedule and other commercial vessels in the area during this phase of work. Hence, there is a potential for navigation impacts.

In order to manage the risks, a workshop will be carried out as part of the project planning process. The objective of this workshop will be to identify all of the different activities which will be taking place and identify any potential hazards as well as appropriate mitigation measures and operating procedures. In addition the workshops can be used to further develop operational mitigation. The suggested composition for the workshop is as follows:

- COWL Project Team;
- Contractor Representatives (barges, cable-laying, etc.);
- Harbour Master from relevant Port Authority; and
- P&O Fleet Manager and Ferry Captain.

This process will also help build mutual understanding of the activities and operating constraints of the different parties involved.

If the construction phase of the nearby NWP North Hoyle wind farm overlaps with the COWL wind farm construction, it is proposed that the relevant parties involved in this development are invited to the workshop to ensure any cumulative impacts are identified and appropriate measures taken.

By adopting this workshop approach to the identification of control measures, it is expected that the risks during the construction phase will be minimal, and that the impacts on shipping and navigation will not be significant.

Operational Impacts

The potential for long term impacts to shipping and navigation are confined to the following:

- alterations to existing shipping routes;

- increased risks of collision with other vessels; and

- the potential for collision with the offshore structures.

In order to assess the above, a navigation risk assessment has been carried out (Anatec 2002). The assessment has identified that there are 16 routes passing within a 16km radius of the proposed wind farm. Three of these routes pass directly through the proposed wind farm boundary as follows;

- Mostyn to Dublin;
- SkerriesTSS to Mostyn; and
- Liverpool to Llanddulas.

The Mostyn to Dublin P & O ferry service operates four passages per day through the proposed wind farm area, and will be affected by the proposals. Consultation with the ferry operator has identified that this route will be displaced approximately 1.6km to the north of its current route.

The Skerries TSS to Mostyn route passes through the north-west corner of the proposed wind farm area and is trafficked by approximately 70 vessels a year. This route is likely to move to north, passing north of the north cardinal buoy marking the north-west extremity of the proposed wind farm area.

The Liverpool to Llanddulas route passes through the wind farm in a north-east south-west direction. The operator of the 'regular runner' on this route has been consulted and it is likely that this route will be displaced to a new position approximately 0.8km to the west and north of the site perimeter.

There will also be minor alterations to the Mostyn-Skerries TSS, Dundalk-Mostyn and Solway Firth-Llandulas routes.

None of the anticipated alterations to shipping routes are considered to cause significant effects to shipping and navigation through physical displacement.

In order to assess the potential for collision impacts, Anatec have included preliminary risk modelling in their studies (Anatec 2002). The following scenarios were included:

- powered passing ship collision with wind farm;
- drifting passing ship collision with wind farm;
- anchor dragging/drifting ship collision with wind farm; and
- ship/ship collision.

Risk modelling using the current and revised routeing patterns has predicted the increase in shipping risks in the area. This is a combination of new risks directly introduced by siting the wind farm at Rhyl Flats (*ie* collisions with the wind farm structures) as well as changes to existing shipping risk levels indirectly resulting from displacement of shipping routes. The model takes account of the slightly higher probability of poor visibility in Liverpool Bay. The additional risks are comparable to several oil and gas installations in Liverpool Bay and off the south coast where shipping activity is comparable to Rhyl Flats. Given the above, the risks are not considered unreasonable. The mitigation measures will ensure that the impacts are as low as reasonably practicable (ALARP). A stakeholder workshop will be used to further develop mitigation measures and to promote an understanding of the potential for impacts.

Cumulative Impacts

A review of the ship routeing in the wider area has identified that the only route that will change as a result of the presence of the North Hoyle wind farm in addition to the Rhyl Flats wind farm is the Liverpool to Mostyn route (trafficked by approximately 116 vessels per annum). The main vessel using this route is the coastal tanker that fuels the ferries (Anatec 2002).

The proximity of the two wind farms may affect the sea room available to vessels making an approach to Mostyn. Through consultation with P&O, this effect was not regarded as significant given that there will be approximately 10km between the two wind farms as well as the fact that there are limited ship-to-ship encounters in the area (Anatec 2002). The current anchoring area is approximately equidistant between the Rhyl Flats site and the NWP site. It is noted that anchored vessels already give consideration to the presence of the gas pipeline to the north-east of the North Rhyl buoy, therefore a wind farm farther east of this is unlikely to have a major effect (Anatec 2002).

Mitigation

The following mitigation measures will be carried out in order to minimise impacts to shipping and navigation:

- As a first measure, COWL has already contacted the regular runners and obtained feedback during the consultation process.

- A workshop will be held with stakeholders, which may include the North Hoyle developers in order to discuss construction phasing and mitigation measures.

- Both during construction and operation, buoys will be used to mark the limits of the navigation restrictions. The buoys will be lit according to the relevant UK Admiralty procedures.

- The movement of the rig and construction vessels to and from the wind farm site will be carefully planned with regard to the existing routing pattern in the area to minimise the effects to passing vessels. Details of rig movements will be circulated to mariners so they can plan their routes accordingly.

- COWL will contact the Hydrographic Office in advance of rig deployment to ensure that details of the construction operations are included in weekly notices to mariners and via NAVTEXT broadcasts.

- Prior to mobilisation of the rig and construction vessels to site, the offshore construction manager will review the precise risks and agree the detailed contingency plans, roles and responsibilities in managing the hazards.

- The wind farm and any exclusion zones will be registered as a navigational hazard to shipping with the HM coastguard and the Hydrographic Office. The turbines at the field extremities will be marked with appropriate navigational lights.

- The potential exists for transmitting the climatic and sea state data obtained from the meteorological masts to the Mostyn-Dublin ferry. This may help ensure vessels meet their schedules, saving time and fuel and minimising waiting times in the proximity to the wind farm.

- Shipping activity will be periodically monitored through on-going liaison with shipping operators following the establishment of the wind farm. This will help to analyse vessel behaviour and ensure that the measures in place to minimise risks to shipping are sufficient.

Summary

The mitigation measures proposed will ensure the impacts are as low as reasonably practicable (ALARP).

8.7.6 Traffic and Transport

Construction Impacts

The construction of the offshore wind farm will give rise to the following sources of traffic:

- importation of plant and other construction equipment;

- private cars and vans used by construction personnel;

- foods vehicles engaged in supplying construction materials or items of equipment; and

- visitors to the proposed development site.

Any materials, plant and equipment which does not arrive at the docks by sea will be transported by HGV to Mostyn Docks via the A548 and Mostyn Docks approach road. This will be by way of conventional road haulage vehicles or specialist low loaders.

The construction activities will involve:

- the laying of cabling from the wind farm to the grid connection point onshore;

- the installation of the wind turbine monopile foundations on Rhyl Flats; and

- the installation of the wind turbine towers, nacelles and blades.

The cabling will be laid by ship or barge between the project site on Rhyl Flats and the North Wales coastline near Rhyl. The transport and traffic effects of the onshore element of the project are discussed separately, in *Section 12, Volume III*.

The installation of the turbine monopile foundations would be undertaken by sea-borne equipment but the construction personnel, some 30 – 40 persons, would be based locally and travel to and from the docks by road. It is assumed that a proportion of the construction personnel will travel to the site by minibus, the remainder travelling by private car – there will be an estimated 18 personnel vehicles per day, resulting in a daily two-way flow of 36. It is expected that the construction work would take approximately three months to complete. Construction materials for the project would generally be delivered by sea with the exception of gravel required to protect the turbine foundations from erosion (scour), which is discussed below. The monopiles will also be delivered to the site by sea.

If scour protection is required, it is estimated that some 10,000 cubic metres of scour protection aggregate would be required during the foundation installation period of approximately three months. The importation of this aggregate potentially gives rise to the greatest element of construction traffic, estimated at a total of 600 to 800 heavy goods movements, dependant upon the size of vehicle used to transport the aggregate. Assuming a regular delivery of material to the docks this would lead to a daily average of between 18 to 26 additional movements into and out of the site each day, or two to three additional movements per hour.

The final stage of the construction programme would be the erection of the wind turbines themselves and again this would be undertaken by sea. All major offshore components will be delivered directly from the manufacturer to the quayside at Mostyn Docks. The construction workforce would again travel to and from the docks by car and would comprise 30 – 40 personnel. It is anticipated that this part of the construction programme would take approximately 2 months to complete.

Consumables will need to be delivered during the installation of the foundations and of the turbines. The consumables may include such items as fuel and lubricants, specialist paints, concrete grout, fresh water and food, and hardware. It is anticipated that this would give rise to no more than three additional heavy goods movements per day.

A summary of generated traffic flows is given in *Table 8.7*.

Table 8.7 ***Summary of Generated Traffic Flows***

Construction Phase	Activity	Generated Traffic Flows (Vehicles / Day)	Type of Vehicle
Installation of foundations	Personnel movements	36	Car / Minibus
	Delivery of aggregates (1)	18 to 26	HGV
	Delivery of consumables	3	HGV
	Total:	57 to 65	
Installation of wind turbines	Personnel movements	36	Car / Minibus
	Delivery of consumables	3	HGV
	Total:	39	

Note (1) This will only apply if scour protection is required.

The traffic impact of the additional HGVs will be extremely limited as the majority of development traffic will be additional shipping movements for delivery of the turbine parts and monopile foundations. Given the existing traffic flows to and from the port on a daily basis, as outlined above, it is not expected that the traffic increase will be significant, as demonstrated in *Table* 8.8.

Table 8.8 ***Estimated Increase in Traffic Flow***

Road	Baseline Daily Traffic Flow (Vehicles / Day)	Estimated Construction Traffic Flow (Vehicles / Day)	Percentage Increase (%)
Dock Road	775	Installation of Foundations: 65	8
		Installation of Turbines: 39	5
A548	7277	Installation of Foundations: 65	1
		Installation of Turbines: 39	0.5

The number of construction staff on site will be some 30 - 40 and so there will not be any significant movement of vehicles at the beginning and end of the day. The number of service vehicles will be very low. During the day the additional traffic on the dock access road will amount to an occasional HGV movement. This is relatively insignificant in the context of some 270 to 290 heavy goods movements per day, and will imperceptibly raise the typical hourly traffic movements.

Traffic flows along the dock service road are low compared to the traffic on the A548, typically ranging from 9 to 40 vehicles each way per hour during a 12 hour period of 07.00 to 19.00 hours. The dock access road has a practical capacity of approximately 1400 to 1600 vehicles per hour by direction (TA79-99 Traffic Capacity of Urban Roads), although in practice the capacity will be governed by the traffic signals at the junction with the A548.

The effect of the additional traffic on the A548 will be insignificant as the additional traffic is much less than the normal daily variation, assumed at typically 12% per day. The junction onto the A548 is to the highest practical standard for the type of service road.

Table 8.8 above indicates that traffic-related environmental impacts, including noise, are unlikely to occur.

There are no footpaths or bridleways affected by this proposal. Pedestrians walking along the service road will be affected by the additional traffic but there is a purpose built footpath to minimise any adverse effect.

Operational Impacts

Beyond the construction phase of the project, and following commissioning of the wind farm, the traffic generation will be minimal. Site engineers will be based locally in the North Wales area and may be required to make occasional visits to the site to undertake routine maintenance.

Decommissioning

At the end of the life of the wind farm the site will need to be decommissioned and it is anticipated that the level of traffic generation will be similar to that for the construction period. Component parts of the wind turbines may need to be disposed of by road from the port but these are likely to involve few heavy goods movements, and these will create a negligible increase in the daily general port traffic.

The access to the docks will be from the existing service road from the A548. This roadway is suitable for this purpose, and conflicts with existing vehicles are not anticipated.

Mitigation Measures

The construction will only last for six months and the following "best practice" mitigation measures will be implemented:

- suitable measures will be taken during the construction period to prevent the deposit of mud and dirt on the public highway and to prevent the propagation of dust from the site;

- the distribution of HGVs bringing construction materials, or other equipment, to the site will be organised to avoid vehicles travelling in convoy;

- adequate storage facilities will be provided within the docks to ensure that vehicles do not wait, or park, on the public highway;

- any specialist abnormal loads will be programmed to avoid periods of peak traffic flows on local roads; and

- any specialist abnormal loads will be brought to the site by the approved primary road network in the area and with consultation via the Local Highways Authority and Police.

Given that the foregoing measures are implemented it is considered that this would be sufficient to mitigate any adverse effect.

Summary

The scale of the construction and the time period over which it will occur is very limited. In addition the dock site lies within 1.5km of a primary highway, and access to that highway is by an existing high standard junction.

Traffic flows along the dock service road are very low and the addition of the occasional HGV movement per day will have no significant effect on existing conditions.

The HGVs travelling to and from the site will not create any noticeable effect on the local amenity as the site is so close to a high standard road they will not have to pass any dwelling or other sensitive development.

Traffic and transport impacts during operation or decommissioning of the project are not anticipated.

8.7.7 Other Marine Commercial Interests

Construction Impacts

Other commercial interests within the vicinity of the proposed wind farm include oil, gas, dredging and wind farm interests.

No impacts to existing offshore physical structures (oil and gas) and dredging resources are anticipated. Disturbance from the physical presence of the construction activity and exclusion zone are not considered to be significant.

Operational Impacts

The potential for impacts to other marine users is limited to the loss of the area as a future resource from other marine commercial users. These impacts are not considered to be significant.

Cumulative Impacts

No cumulative impacts are anticipated in relation to other commercial marine interests.

Mitigation

Mitigation measures identified in relation to shipping and navigation aspects will ensure minimal impacts to other commercial marine users.

Summary

Provided appropriate mitigation measures are carried out, no significant impacts are anticipated to other commercial marine users.

8.7.8 *The Local Economy*

Construction Impacts

The COWL consortium has a policy to, whenever possible, procure the services and skills of local organisations and contractors, in addition to recruiting personnel from within the locality. While it is not possible currently to quantify this local benefit, experience onshore indicates that up to 30% of the total value of a wind farm project may be available for tender to firms in the project locality.

COWL anticipates that up to 60 jobs will be generated during the construction of the wind farm. In addition to these core staff, there may be the provision for an additional 10 jobs for local crew.

Operational Impacts

As there is a requirement for on-going maintenance once the wind farm has become operational, it is likely that between 5 and 10 long term jobs are generated.

Consultation with the National Assembly for Wales has suggested that the wind farm may provide a reason for some people to indulge in day boating in the area, potentially increasing the demand for day pleasure boating and providing a boost for the local economy.

Cumulative Impacts

Although construction and operation of the wind farm will result in the generation of some jobs, impacts to the local economy are not anticipated to be significant. As a result, the scope for cumulative impacts is low.

Mitigation

Consultation has already been undertaken with the local councils and the National Assembly for Wales and communication will continue in order to exploit any opportunities which may help enhance the employment opportunities and the local economy.

Summary

Although there is some scope for the generation of a small number of jobs during construction and operation of the proposed wind farm, the overall impacts are not considered to be significant.

8.8 *SEASCAPE, LANDSCAPE AND VISUAL AMENITY*

8.8.1 *Introduction*

The marine and coastal environment has traditionally been utilised by man for resource exploitation, such as fishing, mineral extraction, oil and gas extraction and shipping. Some of the attractive features around our coastlines, such as fishing villages and harbours, are the result of man's long relationship with the sea.

It is only in the last 100 years or so, mainly since Victorian and Edwardian times, that the coastal and inshore waters have also been used for recreational purposes, with visitors and residents attracted in part by the way that these current and past industrial uses have shaped the character of the coastline and hinterland. Such recreational uses of the coastal and inshore waters have, in turn, also resulted in changes to the character of the seascape.

Therefore, man-made developments and activities are not necessarily alien in the seascape environment. For example, in the Colwyn Bay seascape area, there are already offshore installations in view, busy shipping and ferry routes and coastal quarrying, alongside the recreational uses and structures, such as the Sky Tower, all of which are part of its existing character.

However, the horizontal nature of the seascape means that any tall vertical moving structures erected in the sea within territorial waters will be visible, at times, from the surrounding sea, the coastline and elevated vantage points on the land. This can result in potentially significant changes to the character of the seascape and adjacent landscapes, and in potentially significant changes to views of and from the sea.

In assessing the potential for significant changes to the baseline in the following assessment, a scenario of excellent visibility (>30km) has been assumed, *ie* a clear sunny day when haze is not reducing visibility. This assumes, therefore, that the wind turbines will be visible and takes account of the fact that it is in such weather conditions that the majority of people are attracted out onto the promenades, down to the beach or onto cycle routes and footpaths for the purpose of enjoying their surroundings. In reality, the very changeable weather around the UK coastline means that excellent visibility occurs for only a small percentage of the time and tall marine structures will come in and out of view, often several times a day, when viewed from the seas, the coast and elevated inland locations.

The following sections make an objective assessment of the changes to seascape, landscape and visual amenity, which will occur in both the construction and operational phases of the project. However, it is important to recognise that even significant changes at individual locations are not necessarily unacceptably adverse. The Conclusions section (8.8.7) draws together all the changes identified and provides an overall assessment of acceptability.

8.8.2 *Potential Effects and Mitigation*

Rhyl Flats Offshore Wind Farm

An analysis of the three stages of the proposed development has been undertaken to identify the aspects of the development with the potential to cause an effect on seascape, landscape and visual amenity, the mitigation measures that will avoid, reduce or compensate for these effects, and the residual effects, which are the subject of the following assessment. This analysis is presented in detail in *Annex K* and summarised below.

Construction Phase

The main construction operations with the potential to cause an effect on seascape, landscape and/or visual amenity are listed below:

- Road haulage, shipping and port activities – for delivery and assembly of components.
- Construction of foundations, erection of towers and installation of turbines.
- Construction of substation (if the offshore option is chosen).
- Erection of second meteorological mast.
- Cable laying within the wind farm and from the wind farm to the shore.
- Commissioning.

Each of these activities will occur over a relatively short timescale (1 – 4 months within the seven month construction programme), and their effects on seascape, landscape and visual amenity will be temporary, reversible and intermittent. As a result it has not been considered necessary to incorporate any particular mitigation measures into the construction phase to reduce its effects on seascape, landscape and visual amenity.

Those construction activities involving small boats and activity on the sea (erection of meteorological mast, cable laying and commissioning) are considered to have a potentially positive effect on seascape, landscape and visual amenity, as small scale boats and activity on the sea are considered to add interest to the seascape. Those involving large jack up barges and cranes (construction of foundations, erection of towers, installation of turbines, and construction of substation) are considered to have a potentially negative effect on seascape, landscape and visual amenity, due to the contrast between the vertical nature of the supporting structures and the essentially horizontal nature of the seascape.

Operational Phase

The main aspects of the operational phase with the potential to cause an effect on seascape, landscape and/or visual amenity are listed below.

- The 30 wind turbines, 152.5m to tip - their presence, arrangement, size, design, colours and movement.
- Two meteorological masts – their positions, size, design and colours.
- Additional (and necessary) navigational aids – foundation colour, new navigational buoy, and lights on the turbines.
- Planned and emergency maintenance activities.

The arrangement of the wind turbines has been carefully considered and several different arrangements examined (*eg* two curved rows, several straight rows, turbines of different heights and spacing). As a result, it is considered that a simple, regular arrangement of two straight lines, using wind turbines of the same size, design, colour and slow rotor speed, would best suit the relatively large scale, open, and simple nature of the sea with its relatively muted colours and the regular, steady movement of the waves. The slender towers and dull light grey colour of the wind turbines will minimise their visibility against both the sea and the sky, and research has shown that the public prefer solid towers to lattice construction in wind turbines (Stevenson and Griffiths 1995). The bright yellow finish of the foundations below the platform is required for navigational safety and will make the base of the towers more visible than the dull grey towers and rotors above.

The offshore substation will be located alongside the inner row of turbines and so will be seen as part of the development, and will be less noticeable from the shore (compared to a position between the turbines and the shore). The meteorological masts will also be located alongside the rows of wind turbines so will also be seen as part of the development.

Despite these mitigation measures, the presence of the wind turbines, substation and meteorological masts are considered to have a potential residual effect on seascape, landscape and visual amenity, due to the contrast between the vertical nature of these structures and the essentially horizontal nature of the seascape.

The additional navigation aids and the planned maintenance activities are considered to have a potentially positive effect on seascape, landscape and visual amenity, as they will add interest to the seascape. Internal lifting gear has been incorporated into the turbine towers to avoid the need for external lifting equipment during routine maintenance.

Any emergency maintenance activities that require the use of large jack up barges and cranes are considered to have a potentially negative effect.

However, all the components have been carefully selected and designed to minimise the likelihood of major failure and so such activities will be rare over the 20-year operating life of the wind farm.

Decommissioning Phase

The main decommissioning operations with the potential to cause an effect on seascape, landscape and/or visual amenity are listed below.

- Removal/severing of foundations, removal of towers and turbine components.
- Removal of substation (if the offshore option is chosen).
- Removal of both meteorological masts.
- Removal of sub-sea cabling, if this is required under the decommissioning plan.
- Road haulage, shipping and port activities – for removal and disassembly of components, and disposal of components and waste materials.

All these activities will occur over a relatively short timescale (4 months), and their effects on seascape, landscape and visual amenity will be temporary, reversible and intermittent. As a result it has not been considered necessary to incorporate any particular mitigation measures into the decommissioning phase to reduce its effects on seascape, landscape and visual amenity.

As during the construction phase, any decommissioning activities that involve small boats and activity on the sea will have a potentially positive effect on seascape, landscape and visual amenity, whereas those involving large jack up barges and cranes (removal of foundations, towers, turbine components and the substation) will have a potentially negative effect on seascape, landscape and visual amenity.

North Hoyle Offshore Wind Farm

According to the Environmental Scoping Study (NWP 2001), the North Hoyle Offshore Wind Farm will be constructed in 2003, one year in advance of the Rhyl Flats development, and will have a 6-month construction programme.

Once completed, the development will consist of:

- 30 wind turbines of 2MWe capacity, with a hub height of approximately 80m above MSL and a rotor diameter of 100m (so tip height will be approximately 130m above MSL), with associated access facilities, navigation lighting and marking;
- an anemometry mast with a height of 70m above MSL; and

- buried sub-sea cables linking the wind farm to the shore, and then underground cabling to the Manweb sub-station at Rhyl, plus an extension to this sub-station.

As shown on the cumulative Zone of Visual Influence plot (*Volume IV*), it is understood that the 30 wind turbines will be arranged in five parallel rows spaced 750m apart, each row with six turbines spaced 300m apart. The alignment of the rows will be north-northwest/south-southeast, almost perpendicular to the coastline at Prestatyn.

If both the North Hoyle and Rhyl Flats wind farms receive the necessary consents, the two construction phases will be in consecutive summers, the 20 year operational phases will overlap by 19 years and the two decommissioning phases will be in consecutive summers. As a result of these timescales and the distance between the two developments (approximately 11 km), there is the potential for cumulative effects on seascape, landscape and visual amenity, and these effects are considered in *Section 8.8.6*.

8.8.3 Construction Effects

The following assessment of effects on the seascape, landscape and visual amenity of the study area draws on the seascape character assessment (see *Section 7.9* and *Annex K3*), the landscape character assessment (*Annex K4*), the schedule of potential effects and mitigation for the construction phase (*Section 8.1.2* and *Annex K5*) and the viewpoint analysis (*Annex K*7 and *S8*). The assessment of construction effects is summarised in *Tables 8.7* and *8.8*.

Construction Effects on Seascape Character

The Red Wharf Bay, Conwy Bay, Dee Estuary and Liverpool Bay Seascape Units will be remote from all the construction activities at the offshore site. The Red Wharf Bay, Conwy Bay and Liverpool Bay Seascape Units are also remote from the potential port of Mostyn, staging point and assembly facility on shore, and the road haulage routes and shipping routes are unlikely to pass through these seascape units. The Dee Estuary Seascape Unit contains the existing port of Mostyn, which may be used during the construction stage and, if so, will contain the staging point and assembly facility on shore. Also, parts of the shipping routes and road haulage routes will pass through this seascape unit. However, the port activities, staging point and assembly facility on shore will be part of the ongoing industrial use of this location, the road haulage routes will be along the existing A-road network, will be intermittent and of short duration and the ships on the shipping routes to the port are already a characteristic of this seascape. Therefore, the construction phase will not have any significant effects on the character of the Red Wharf Bay, Conwy Bay, Dee Estuary and Liverpool Bay Seascape Units.

The Llandudno Bay Seascape Unit shoreline will be over 30km from the port of Mostyn and the port, the staging point and assembly facility on shore will be screened from view by intervening land. The road haulage and shipping routes will not pass through this seascape unit. From elevated locations, such as the Great Orme, the movement of boats between the assembly facility and the offshore wind farm site will be visible but will very intermittent and very short-term so are unlikely to have a significant effect on seascape character.

The Llandudno Bay Seascape Unit shoreline will be 8 – 12km from the construction activities at the offshore wind farm site. In coastal views from around sea level, such as on the beach and promenade at Llandudno (Viewpoint 20), the sea level activities will be over the horizon, but taller structures and activities, such as the lifting cranes and the erection of the turbine towers, will be visible beyond the horizon and against the sky.

A key characteristic of this relatively small regional seascape unit is its close relationship with the sea, with sea views from much of the coastal zone and hinterland. There will be views of various offshore construction activities from different parts of this seascape unit throughout the 7-month construction phase and this will have a significant short-term effect on the character of this seascape unit.

The Colwyn Bay Seascape Unit will contain all the construction activities at the port of Mostyn, staging point and assembly facility on shore. Also, parts of the shipping routes and road haulage routes will pass through this seascape unit. The port activities, staging point and assembly facility on shore will be part of the ongoing industrial use of this location road, the haulage routes will be along the existing A-road network, will be intermittent and of short duration and the ships on the shipping routes to the port are already a characteristic of this seascape unit. Therefore, these construction activities will not have a significant effect on seascape character.

However, the Colwyn Bay Seascape Unit will also contain the offshore construction site, which will be a new feature in this seascape unit. The construction phase will introduce a concentration of activity and structures in the middle distance and in the Bay itself. As the offshore site is progressively developed, it will occupy a relatively large proportion of the panorama in views from this seascape unit, particularly from the coastline along the western half of the Bay (generally over 30°) as the rows are parallel to the shoreline (Viewpoints 11, 12, 14, 21 and 22); less from the coastline along the eastern half (less than 15°) as the rows are more perpendicular to this shoreline (Viewpoints 15, 16, 17 and 23).

Views of the sea currently contain the distant oil and gas platforms, passing ships and small boat activity. However, these are generally in the far distance. Although views of the sea are fragmented, they are still one of the key characteristics of the coastal zone and of the more elevated parts of the hinterland. There will be views of the entire offshore construction site and its activities from these parts of this seascape unit throughout the 7-month construction phase and, as a result, the construction phase will have a significant short-term effect on the character of the Colwyn Bay Seascape Unit.

Construction Effects on Landscape Types

As the result of the seascape assessment and the zone of visual influence (ZVI) for the final turbine layout, the landscape assessment (*Annex K4*) has concentrated on the landscapes within the Llandudno Bay and Colwyn Bay seascape units. These landscape units make up the coastal and hinterland zones of the two seascape units. As a result, they are remote from the offshore construction site and, all except the Coastal and Estuarine Flats, are also remote from the onshore port, staging and assembly activities. However, as explained in the methodology (*Annex K2*), development activities can have a significant effect on the character of a landscape unit that is remote from the development where views are a key characteristic of that landscape unit and the proposed development will result in significant changes to those views.

Sea views are a key characteristic of the Coastal Slopes, Limestone Farmlands, the northern edge of the Trelawnyd Plateau, the north facing Hill Slopes and the Moorland Ridge landscape types. However, whilst the construction site activities and structures will be visible from various locations in theses landscape type, they will be in the distance, will cause only short-term changes to views and will not become a defining characteristic of these landscape types. Therefore, the construction phase will not have a significant effect on the character of these landscape types.

Construction Effects on Landscape Designations

The following assessment has examined whether the proposed construction phase will have a significant effect on the purposes/objectives of the national statutory and non-statutory designations in the study area.

- *Snowdonia National Park*

All aspects of the construction phase will be remote from Snowdonia National Park so the development will not have any effects on the first purpose of the Park *"to preserve and enhance the natural beauty … of the Park"*.
With regard to the second purpose, *"the promotion of opportunities for the understanding and enjoyment of the special qualities of the Park by the public",* it has been argued at development control public inquiries that developments that significantly change views ***of*** a National Park or views ***from*** a National Park could significantly effect on this second purpose, that is, that changes in views of and from a National Park could affect the understanding and enjoyment of the special qualities of the Park by the public.

In the case of Snowdonia National Park and the proposed construction phase, the only location where the offshore construction site will come within views ***of*** Snowdonia Park will be for viewers at sea, such as on the proposed re-aligned Mostyn – Dublin ferry route and other commercial shipping routes further offshore. In such views of the Park, the site will in the foreground for only a short time as the ferry or ship passed by, and the Park will be a distant backdrop behind the Great and Little Ormes. Much more spectacular views of the coastal hills and high peaks of Snowdonia are obtained by from further westwards, as the ferry passes the entrance to Conwy Bay. As a result, there will not be a significant effect on views of the Park.

In views ***from*** the Park, the offshore construction site will be visible from the coastal hills, such as Conwy Mountain (Viewpoint 1) and from high peaks much further into the Park. However, in all these views, the site will be 15km+ from the viewer, will occupy a small proportion of the overall panoramic view of the sea, will be seen over a deep foreground of intervening land and will be seen almost entirely against a background of sea. As a result, there will not be a significant effect on views from the Park.

As there will not be a significant effect on views of or from the Park, the construction phase will not have a significant effect on the understanding and enjoyment of the special qualities of the Park by the public. Therefore, the construction phase will not have a significant effect on the purposes of Snowdonia National Park.

- *Isle of Anglesey AONB*

All aspects of the construction phase will be remote from the Isle of Anglesey Area of Outstanding Natural Beauty (AONB) and will not affect its natural beauty, so the construction phase will not have any effects on the purpose of the AONB.

- *Clwydian Hills AONB*

All aspects of the construction phase will be remote from the Clwydian Hills AONB and will not affect its natural beauty, so the construction phase will not have any effects on the purpose of the AONB.

- *Great Ormes Head Heritage Coast*

As a non-statutory designation outside any national statutory designations, the Heritage Coast designation provides a lower level of protection in landscape terms than National Parks and AONBs. The objectives of the designation are also more wide ranging. For example, as well as, *"to conserve, protect and enhance the natural beauty of the coasts"* and *"to facilitate and enhance their enjoyment, understanding and appreciation by the public"*, the objectives include *"improving and extending opportunities for recreational, educational, sporting and tourist activities"* and *"promoting sustainable forms of development"* (PPG20).

As the construction phase will be at a distance from the Heritage Coast, it will not affect the natural beauty of the coastline.

Elevated, long distance views are a key characteristic of this landscape and part of peoples' enjoyment of visiting the Great Orme. They are also an integral part of the recreational and tourist activities provided on the Great Orme.

The most spectacular of these views are those over Conwy Bay to Snowdonia, and in these views the site will not be visible.

There are also panoramic views along the Colwyn Bay coastline and northwards to the open sea, in which the site will be 10km+ from the viewer, will occupy a small proportion of the overall panoramic view and will be seen almost entirely against a background of the sea. As a result, there will not be a significant change in the view for viewers on the Great Orme during the construction phase.

Therefore, the construction phase will not have a significant effect on the objectives of the Heritage Coast designation.

Construction Effects on Visual Amenity

The following assessment has examined whether the proposed construction phase will bring about significant changes in the view for fixed viewpoint, linear route and marine-based receptors in the study area. Significant changes in a view do not necessarily bring about unacceptably adverse effects on visual amenity, and this is discussed in more detail in the *Section 8.8.7*.

- *Fixed Viewpoint Receptors*

Settlements	The settlements of Moelfre and Benllech on the Isle of Anglesey are at least 34km from the offshore site. Sea level activities will be screened by the curvature of the earth and the taller structures will be very small and distant. Therefore, the construction phase will not result in significant changes in the views for residents and visitors to these settlements. From the settlement of Beaumaris on the Isle of Anglesey, the Great Orme, Little Orme and the land between these two hills screen views of the sea in Colwyn Bay. As a result, sea level activities at the offshore construction site will be screened and only some of the taller structures will be visible over the intervening lower land between the Ormes. Therefore, the construction phase will not result in significant changes in the views for residents and visitors to Beaumaris. Llandudno is approximately 10km from the offshore construction site. It occupies the lower land between the Ormes with some properties built on the lower slopes of the Great Orme. The buildings along the seafront are tall (3 or 4 storey) Victorian hotels and houses, which largely obscure views of the sea from the rest of the town behind. Residents and visitors in properties along the seafront and on the lower slopes of the Great Orme currently have views of Llandudno Bay framed by the cliffs of the Great and Little Ormes and an essentially empty sea, with the regular passing ferry or ship in the distance. The construction phase will introduce activities and structures into the middle distance and across 27° (over a quarter of this view). As a result, the construction phase will result in significant short-term changes in the views for residents and visitors in these seafront and hillside properties, but not for residents and visitors in properties elsewhere in the town. The seaside towns of Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas are all situated on the sea-facing slopes of the Coastal Slopes and Limestone Farmlands landscape types, and will all be 8 - 13km from the offshore construction site. The construction phase will introduce activities and

structures into the middle distance and across more than 35° of the seascape in views from many properties in these towns. Sea level activity will be screened by the curvature of the earth in views from the beaches that front these towns, but from the towns themselves, which rise above the coastline, both the sea level activities and the taller structures will be visible. As a result, the construction phase will result in significant short-term changes in the views for residents and visitors in many of the properties in these towns.

Abergele, Pensarn and Belgrano, Towyn and Kinmel Bay, and Rhyl and Prestatyn are all located in the flat Coastal and Estuarine Flats landscape type and consist mainly of one or two storey properties, with some three or four storey properties along the seafront at Rhyl. The seawall along the majority of this coastline screens ground level views from properties, and seafront properties with views of the sea from upstairs windows, screen views of the sea from properties immediately behind. As a result, very little of the offshore construction site activities, structures or associated boat activities will be visible from residential properties in these towns. Therefore, the construction phase will not result in significant changes in the views for residents and visitors staying in properties in these towns.

West Kirby and Hoylake, on the Wirral, are both at relatively low elevations but coastal properties in these two towns do have views of the sea in the direction of the offshore construction site. However, the construction site will in the far distance and will occupy a small proportion of the overall panorama. Therefore, the construction phase will not result in significant changes in the views for residents and visitors in properties in these towns.

Promenades

From Llandudno promenade (Viewpoint 20), the existing view of the sea is similar to that from the properties on the town's seafront. The construction site will introduce activities and structures into the middle distance and will occupy over a quarter of the framed view of the sea. Therefore, the construction phase will result in significant short-term changes in the views for people on the promenade.

From Colwyn Bay promenade (Viewpoint 21), the construction site will be seen "side on". As a result, it will occupy a relatively wide field of view in the middle distance. Although the views of the sea are very wide, they are relatively featureless and the construction phase will result in significant short-term changes in the views for people on the promenade.

From Rhyl promenade (Viewpoint 16), which is further eastwards, the construction site will be in the distance and seen "end on". As a result, it will occupy a relatively narrow field of view. Therefore, the construction phase will not result in significant changes in the views for people on the Rhyl promenade.

Beaches

The beaches along much of this coastline provide open and panoramic views of the sea and coastline. The curvature of the earth will screen the sea level offshore construction activities from the beaches but the taller structures will be visible.

From the beach at Benllech (Viewpoint 19) the construction site will in the far distance and the cranes and structures will occupy a relatively narrow field of view. Therefore, the construction phase will not result in significant changes in the views for people on these beaches.

From the beach in Llandudno Bay the cranes and taller structures will be in the middle distance and will occupy over a quarter of the framed view of the sea. Therefore, the construction phase will result in significant short-term changes in the views for people on this beach.

From the beaches around Penrhyn Bay (Viewpoint 14), Rhos-on-Sea, Colwyn Bay and Llanddulas (Viewpoint 22), the cranes and taller structures will be in the middle distance and the site will be "side on" to the beach. As a result, the structures will occupy a relatively wide field of view in the middle distance. Although the views of the sea are very wide, they are relatively featureless and the construction phase will result in significant short-term changes in the views for people on these beaches.

From the beaches along the coast from Abergele to Kinmel Bay, from Rhyl to Point of Ayr (Viewpoint 23), and at Hoylake (Viewpoint 24), the cranes and taller structures will be an increasing distance from the shore and the site will be "end on" to the shoreline. As a result, the structures will be small and distant objects, occupying a relatively narrow field of view and a very small proportion of the overall panoramic seascape. Therefore, the construction phase will not result in significant changes in the views for people on these beaches.

Tourist Facilities

For tourists visiting the various attractions on the Great Orme (ski centre, cable car, tramway, restaurant, visitor centre, Country Park), the views of the sea to the northeast are an attractive backdrop, but only part of the attraction and only visible from parts of these facilities. Therefore, the construction phase will not result in significant changes in the views for visitors to these attractions.

For visitors to the Llandudno and Colwyn Bay piers, being on a structure over the sea is part of the attraction, but the activities do not depend on the view. Therefore, the construction phase will not result in significant changes in the views for visitors to these attractions.

The holiday villages and camping and caravan parks in the coastal strip between Abergele and Prestatyn are mainly behind the seawall and visitors will not have a view of the sea level activities on the offshore construction site. Some of the taller cranes and structures will be visible over the wall, but the density of the development in these parks will result in intermittent and restricted views of these structures. Therefore, the construction phase will not result in significant changes in the views for holidaymakers in these holiday centres.

The purpose of the Sky Tower is to provide visitors with elevated 360° views of the sea, coastline, Snowdonia, the hinterland behind Rhyl and the Clwydian Range. The glazed pod rises to around 60mAOD and rotates twice before descending. This will provide land-based viewers with one of the nearest and most elevated views of the construction site. As such, the site is likely to be considered a feature of interest, and even a reason for taking the pod to the top. From the top, however, the site will still occupy a relatively small proportion of the overall view, and the construction phase will not result in significant changes in the views for visitors to the tower.

The Oceanarium and Sun Centre, Rhyl and Nova Centre, Prestatyn are essentially indoor facilities, although large glass walls do provide views of the sea from the Sun Centre. However, views of the sea are not the main attraction at any of these facilities and the construction phase will not result in significant changes in the views for visitors to these facilities.

Elevated Vantage Points

In views from Conwy Mountain (Viewpoint 1), the site will be 15km+ from the viewer, will occupy a small proportion of the overall panoramic view of the sea, will be seen over a deep foreground of intervening land and will be seen almost entirely against a background of the sea. As a result, the construction phase will not result in significant changes in the views for walkers on Conwy Mountain.

In views from the Great Orme (Viewpoint 2), the site will be 10km+ from the viewer, will occupy a small proportion of the overall panoramic view and will be seen almost entirely against a background of the sea. As a result, the construction phase will not result in significant changes in the views for walkers on the Great Orme.

In views from the Little Orme (Viewpoint 3), the site will be 8km+ from the viewer, will occupy nearly 35° of the panoramic view and, in this relatively close and elevated view of the construction site, the cranes and structures will be seen partly against the sky. As a result, the construction phase will result in significant short-term changes in the views for walkers on the Little Orme.

Views of the construction site from Bryn Euryn (Viewpoint 4) will be similar to those from Little Orme, as Bryn Euryn is a similar distance from the site and at a similar elevation to the top of the Little Orme. Therefore, the construction phase will also result in significant short-term changes in the views for walkers on Bryn Euryn during the construction phase.

In views from Moelfre Isaf (Viewpoint 6), the site will be 13km+ from the viewer, will occupy a small proportion of the overall panoramic view of the sea, will be seen over a deep foreground of intervening land and will be seen almost entirely against a background of the sea. As a result, the construction phase will not result in significant changes in the views for walkers on Moelfre Isaf.

Graig Fawr, Prestatyn Hillside viewpoint, Penycloddiau and Thurstaston Hill are all 15km+ from the construction site, which will occupy only a small proportion of the overall panoramic view of the sea. As a result, the construction phase will result in significant short-term changes in the views for walkers and viewers on these elevated viewpoints.

- *Linear Route Receptors*

Road network	The only open views of the construction site from the road network will be from the A55 (T), for motorists travelling in both directions between Colwyn Bay and Abergele. However, due to the speed of travel, and the obliqueness of the views, there will not be a significant change in the view for motorists on this highway during the construction phase.
Railway	There will be a similarly open but more sustained view of the construction site for travellers on the coastal railway from Colwyn Bay to Towyn. Passengers along this route are currently able to observe the wide sweep of the coastline and the deep and wide panorama of sea and sky. The site will be 8-12km from the line and parallel to the direction of travel so will occupy 30° of this view throughout the journey. Although oblique to the direction of travel, passengers will be able to concentrate on the view and could, therefore, observe the construction site for most of this journey. Therefore, there will be a significant short-term change in the view for rail travellers on this section of the line during the construction phase. However, passengers might find this slightly elevated view of the construction site quite interesting.
Cycleway and footpaths	From the Sustrans cycle route and North Wales Path, which run alongside the railway line around Colwyn Bay, cyclists and walkers currently gain a fairly low elevation, but very open and sustained view of the sweep of the coastline and the wide panorama of sea and sky. The view of the construction site will be

	oblique to the direction of travel and cyclists, in particular, need to concentrate on the path ahead. However, both cyclists and walkers travel at a relatively slow pace and can stop to admire the view whenever they wish, so they will have plenty of opportunity to observe the construction activities and structures, which will be seen against the sky. Therefore, as with train travellers, the construction phase will result in a significant short-term change in the view for cyclists and walkers on this section of these routes. For walkers on the Offa's Dyke Path through the Clwydian Hills, the construction site will be in the far distance and the construction phase will not result in a significant change in the view for walkers on this long distance path.

- *Marine Based Receptors*

Llandudno Bay and Colwyn Bay seascape marine zones	Marine based receptors on the shipping and ferry routes through these seascape marine zones and the fishermen, yachtsmen, recreational sailors and water sports enthusiasts in the inshore waters around Llandudno Bay and Colwyn Bay will see most of the construction site and associated activities. Therefore, the construction phase will result in a significant short-term change in the view for marine based receptors in the Llandudno Bay and Colwyn Bay seascape marine zones.

8.8.4 Operational Effects

The following assessment of effects on the seascape, landscape and visual amenity of the study area draws on the seascape character assessment (see *Section 7.9* and *Annex K3*), the landscape character assessment (*Annex K4*), the schedule of potential effects and mitigation for the operational phase (*Section 8.1.2* and *Annex K5*) and the viewpoint analysis (*Annex K6* and *K7)*. The assessment of operational effects is summarised in *Tables 8.7* and *8.8*.

Operational Effects on Seascape Units

- *Red Wharf Bay*

The Red Wharf Bay Seascape Unit will be 20 – 35km from the offshore wind farm. However, as a result of the north-east orientation of the coastline of this seascape unit, the site will be within views of the sea from most of the coastline, but in the far right of views and seen alongside the distant and more elevated coastline.

In these views, the lattice towers of the meteorological masts will not be visible and the substation, the lower half of the turbine towers, all navigation buoys and sea level activities will be screened by the curvature of the earth. The upper half of the turbine towers and blades will be against the sky but, at this distance, the rotation of the blades will be barely visible, even in excellent visibility conditions. At night, the red lights on the turbine hubs may be visible (depending on the size and intensity of the lights) in conjunction with lights on the nearby land. The array will occupy a very small proportion of the wide panorama of land, sea and sky visible from along the coastline in this seascape unit. This is illustrated by the view from Benllech, *Viewpoint 19, Volume IV*.

The viewpoint analysis for this viewpoint (*Annex K7*), predicts a magnitude of change in the view that will be *slight/negligible* and the wind farm will not have a significant effect on the character of the Red Wharf Bay Seascape Unit.

- *Conwy Bay Seascape Unit*

The Conwy Bay Seascape Unit coastline will be separated from the offshore wind farm by the intervening landforms of the Great Orme, the Little Orme and the northern part of Snowdonia National Park. These will largely screen the wind farm from view from most of the marine, coastal and low-lying hinterland zones of this seascape unit.

There will be distant and elevated views (15km +) of the wind turbines and associated structures from the northeast and north facing slopes of Penmaen-bach and Conwy Mountain (*Viewpoint 1, Volume IV*). In these views, the lattice towers of the meteorological masts will be seen against a background of the sea and barely visible, the turbine towers, the substation, all navigation buoys and sea level activities will be seen against a background of the sea, and the rotation of the blades will be barely visible against the sky, except in excellent visibility conditions. At night, the red lights on the turbine hubs and the yellow lights on the platforms will be visible in conjunction with lights on the intervening land.

The viewpoint analysis for Viewpoint 1 (*Annex K7*) predicts a magnitude of change in the view that will be *moderate/slight*. However, this change will occur only in views from elevated locations that form the backdrop to this seascape unit. From the majority of the seascape unit, there will be few views of the wind farm and so the wind farm will not have a significant effect on the character of the Conwy Bay Seascape Unit.

- *Llandudno Bay Seascape Unit*

The Llandudno Bay Seascape Unit coastline will be 8km+ from the offshore wind farm site. In coastal views from around sea level, such as on the beach and promenade at Llandudno (*Viewpoint 20, Volume IV*), the buoys and sea level activities will be over the horizon, but the substation, meteorological masts and turbines will be visible beyond the horizon and against the sky. In views from more elevated locations in this seascape unit, such as the footpath on the Great Orme (Viewpoint 2, *Volume IV*), the majority of the wind farm will be visible against the sea with just the blades visible against the sky.

At these distances, the rotation of the blades will be visible in good visibility conditions. At night, the red lights on the turbine hubs and the yellow lights on the platforms will be visible in conjunction with lights on the nearby land.

From Llandudno promenade, the array will occupy more than a quarter of the view of the sea within the overall panorama, which is framed by the higher land of the Great and Little Ormes and the viewpoint analysis for Viewpoint 20 (*Annex K7*) predicts a *substantial/moderate* change in the view from this location. From more elevated locations in this seascape unit, the array will occupy a relatively small proportion of the wide panorama of land, sea and sky and the viewpoint analysis for Viewpoint 2 (*Annex K7*) predicts a *moderate* change in the view from this location. However, a key characteristic of this relatively small Regional seascape unit is its close relationship with the sea, with sea views from much of the coastal zone and hinterland and the turbines will be visible in most of these views. Therefore, the wind farm will have a significant effect on the character of the Llandudno Bay Seascape Unit.

- *Colwyn Bay Seascape Unit*

The Colwyn Bay Seascape Unit is an extensive linear area. There are several linear routes that follow close to the coastline – the North Wales Path and Sustrans Route, the railway line and the A55 (T). From these routes there are sustained views of the sea to the north and an impression of a seascape unit that has a close relationship with the sea. However, along almost the entire length of the coastline, the hinterland is separated (both physically and visually) from the coastal zone by the railway and A55 (between the towns of Colwyn Bay and Abergele), and by the seawall (from Abergele to Prestatyn). These form a raised physical barrier and screen views of the sea from immediately inland and from most of the low lying Coastal and Estuarine Flats that form the eastern half of the hinterland, from Abergele to Prestatyn.

As a result, this is a seascape unit with a very close and direct visual relationship between the coastal and marine zones, but a very intermittent and slightly detached visual relationship between these two zones and its hinterland.

The Colwyn Bay Seascape Unit will contain the offshore wind farm, which will be a new and substantial feature in this seascape unit. Views of the sea currently contain the distant oil and gas platforms, passing ships and small boat activity. However, these are generally in the far distance.

In views from the beaches towards the extremities of this long coastline, such as from Point of Ayr (*Viewpoint 23, Volume IV*), the navigation buoys and sea level activities will be over the horizon, the meteorological masts will not be visible and the turbines will be small and distant objects against the sky. The rotation of the blades will not be visible from this distance.

From the nearer beaches, such as near the site of St Trillo's Chapel (*Viewpoint 14, Volume IV*) and Llanddulas (*Viewpoint 22, Volume IV*), from the promenade at Colwyn Bay (*Viewpoint 21*, *Volume IV*), and from the relatively low-lying coastal cycle, footpath road and rail routes (*Viewpoints 11 and 12*, *Volume IV*), all the wind farm will be visible against the sky. The rotation of the blades will be discernible in good visibility, the array will occupy 30° – 40° of the overall panorama and the turbines will be most noticeable in mid to late afternoon, when the sun is in the south to southwest and on the turbines.

From the seafronts at Rhyl (*Viewpoint 16*, *Volume IV*) and Prestatyn (*Viewpoint 17*, *Volume IV*), virtually all the wind farm will be visible against the sky, but will appear quite different in arrangement, as the rows will be seen "end-on" and will, therefore, occupy a much smaller proportion of the overall view (9° – 13°). The rotation of the blades will be discernible in good visibility and the turbines will be most noticeable in early to mid morning, when the sun is in the east to southeast and on the turbines.

From the more elevated locations in the west and south of this seascape unit, such as from the Little Orme (*Viewpoint 3*, *Volume IV*), Bryn Euryn (*Viewpoint 4*, *Volume IV*), Berth-y-Glyd (*Viewpoint 5*, *Volume IV*) and Moelfre Isaf (*Viewpoint 6*, *Volume IV*), all the wind farm will be visible, partially against the sea and partially against the sky, and the array will occupy 20° – 35° of the overall panorama. The rotation of the blades will be discernible in good visibility and the turbines will be most noticeable from noon through to late afternoon, when the sun is in the south to west and on the turbines.

From elevated locations in the east of the seascape unit, such as Graig Fawr (*Viewpoint 7*, *Volume IV*) and Prestatyn Hillside (*Viewpoint 8*, *Volume IV*), virtually all the wind farm will be visible, partially against the sea and partially against the sky, but the array will occupy a much smaller proportion of the overall panorama (7° – 8°). The rotation of the blades will be discernible in good visibility and the turbines will be most noticeable in early to mid morning, when the sun is in the southeast and on the turbines.

In all these views, at night, the red lights on the turbine hubs and the yellow lights on the platforms will be visible in conjunction with lights on the land and the lights on the distant oil and gas platforms.

The viewpoint analysis (*Annex K7*) for the viewpoints in this seascape unit predicts *substantial* changes to views along the closest sections of the coastline (Little Orme to Abergele) declining to *slight* in the east (Point of Ayr, Viewpoint 23), with *moderate* or *moderate/slight* changes to views from the elevated inland locations.

The Colwyn Bay Seascape Unit is an extensive linear area and, as explained earlier, whilst it has a very close and direct visual relationship between the coastal and marine zones, it has a very intermittent and slightly detached visual relationship between these two zones and its hinterland. However, although views of the sea are fragmented, they are still one of the key characteristics of the coastal zone and of the more elevated parts of the hinterland and the presence of the offshore wind farm will have a significant effect on the character of the Colwyn Bay Seascape Unit.

- *Dee Estuary Seascape Unit*

The Dee Estuary Seascape Unit will be at least 20km from the offshore wind farm and the coastline will be separated from the offshore wind farm by intervening land. As a result, the wind farm will be screened from view from all but the northeastern part of the unit, on the Wirral side of the estuary.
In these views, the lattice towers of the meteorological masts will not be visible and the substation, the lower half of the turbine towers, all navigation buoys and sea level activities will be screened by the curvature of the earth.

The upper half of the turbine towers and blades will be against the sky but, at this distance, the rotation of the blades will be barely visible, even in excellent visibility conditions. At night, the red lights on the turbine hubs will be visible in conjunction with lights on both sides of the estuary, along the Colwyn Bay coastline, on the distant offshore oil and gas platforms and on the industrial complexes at Connah's Quay. The array will occupy a very small proportion of the wide panorama of land, sea and sky visible from along the coastline in this seascape unit. This is illustrated by the existing and predicted views from Thurcaston Hill (*Viewpoint 10*, *Volume IV*) and West Kirby marine boating lake (*Viewpoint 18*, *Volume IV*).

The viewpoint analysis for these viewpoints (*Annex K7*), predicts a *slight/negligible* magnitude of change in the view and the wind farm will not have a significant effect on the character of the Dee Estuary Bay Seascape Unit.

- *Liverpool Bay Seascape Unit*

The Liverpool Bay Seascape Unit will be 27 - 37km from the offshore wind farm. However, as a result of the northwest orientation of the coastline of this seascape unit, the site will be within views of the sea from most of the coastline, but in the far left of views and seen alongside the distant and more elevated coastline.

In these views, the lattice towers of the meteorological masts will not be visible and the substation, the lower half of the turbine towers, all navigation buoys and sea level activities will be screened by the curvature of the earth. The upper half of the turbine towers and blades will be against the sky but, at this distance, the rotation of the blades will be barely visible, even in excellent visibility conditions. At night, the red lights on the turbine hubs will be visible in conjunction with lights on the land to the west, the lights of Liverpool and the docks to the east, the lights on the shipping traffic from the port of Liverpool and the lights on the distant offshore oil and gas platforms. The array will occupy a very small proportion of the wide panorama of land, sea and sky visible from along the coastline in this seascape unit. This is illustrated by the existing and predicted views from Hoylake, *Viewpoint 24*, *Volume IV*.

The viewpoint analysis for this viewpoint (*Annex K7*), predicts a magnitude of change in the view that will be *slight/negligible* and the wind farm will not have a significant effect on the character of the Liverpool Bay Seascape Unit.

Operational Effects on Landscape Types

As the result of the seascape assessment and the zone of visual influence (ZVI) for the final turbine layout, the landscape assessment (*Annex K4*) has concentrated on the landscape units that make up the coastal and hinterland zones of the Llandudno Bay and Colwyn Bay seascape units. All these landscape units are remote from the offshore wind farm. However, as explained in the methodology (*Annex K2*), a development can have a significant effect on the character of a landscape unit that is remote from the development where views are a key characteristic of that landscape unit and the proposed development will result in significant changes to those views. Accordingly, for the landscape units where views of the sea (or the sky above the sea) are a key characteristic, the following assessment examines whether the operational phase will bring about significant changes to these views. However, significant effects on landscape character are not necessarily unacceptably adverse.

- *Coastal and Estuarine Flats*

The Coastal and Estuarine Flats are a large, very low-lying area of farmland with an almost continuous fringe of coastal resort towns. Views of the sea are occasional, very low aspect and largely screened by intervening vegetation, the seawall and built development. As a result, views of the sea are not a key characteristic of this landscape type, although views of the sky above the sea are. However, the vegetation, seawall and built development will screen views of the wind farm from the majority of this landscape unit, so the offshore wind farm will not have a significant effect on the character of the Coastal and Estuarine Flats landscape type.

- *Coastal Slopes*

The Coastal Slopes landscape type occupies two locations in the study area – one is a section of the coast and hinterland from Llandudno Bay to Old Colwyn where it consists almost entirely of resort towns, and the second is a section of hinterland between the Coastal and Estuarine Flats and the Trelawnyd Plateau, inland of Prestatyn, where it is predominantly a pastoral landscape. The key characteristics of this landscape type include its sloping topography, woodland, development and panoramic views of the sea, and the offshore wind farm will be visible from various locations in this landscape type.

In the case of the first area (from Llandudno to Old Colwyn), the wind farm will be 8 – 10km offshore and visible against the sky. The array will occupy 30° – 40° of the overall panorama and the rotation of the blades will be discernible in good visibility. The viewpoint analysis (*Annex K7*), predicts a *substantial* magnitude of change in views from one location in this section of the Coastal Slopes (Viewpoints 11), which will be a significant change in the view. As a result, the wind farm will have a significant effect on the character of this section of the Coastal Slopes landscape type.

In the case of the second area (inland of Prestatyn), the wind farm will be 15km+ distant, visible partly against the sky and partly against the sea, with the rows "end-on". As a result, the array will occupy only 7° - 9° of the overall panorama and the rotation of the blades will be discernible only in very good visibility. The viewpoint analysis (*Annex K7*), predicts a *moderate/slight* magnitude of change in a view from this section of the Coastal Slopes (Viewpoint 8), which will not be a significant change in the view. As a result, whilst the wind farm will be visible in views, it will not have a significant effect on the character of this section of the Coastal Slopes landscape type.

- *Limestone Farmlands*

The Limestone Farmlands landscape type occupies a section of coast and hinterland between Old Colwyn and Abergele, and then a strip of hinterland behind the Coastal and Estuarine Flats between Abergele and St Asaph. The key characteristics of this landscape type include its undulating topography, woodland, past and present mines and quarries, and elevated views of the sea (between Old Colwyn and Abergele only).

From the section between Old Colwyn and Abergele, the wind farm will be 8km+ offshore and visible against the sky. The array will occupy 30° – 40° of the overall panorama and the rotation of the blades will be discernible in fair/good visibility. The viewpoint analysis (*Annex K7*), predicts a *substantial* magnitude of change in views from one location in this section of the Limestone Farmlands (Viewpoints 12), which will be a significant change in the view. As a result, the wind farm will have a significant effect on the character of this section of the Limestone Farmlands landscape type.

The section between Abergele and St Asaph turns inland away from the coast and is well wooded on the slopes facing the sea. As a result, views of the sea are distant and not a key characteristic of this section of the landscape type. Therefore, the offshore wind farm will not have a significant effect on the character of this section of the Limestone Farmlands landscape type.

- *Limestone Escarpment and Hills*

The Limestone Escarpment and Hills landscape type is a series of prominent steep limestone escarpments and hills, and the key characteristics of this landscape type include its steep and rugged topography, semi-natural grassland and scrub, past and present mines and quarries, and open panoramic views of the sea to the north and the land to the south.

From the Great Orme, the wind farm will be 11km+ offshore and visible mainly against the sea. The array will occupy 20° – 25° of the overall panorama and the rotation of the blades will be discernible in good visibility. The viewpoint analysis (*Annex K7*) predicts *moderate* and *substantial/moderate* magnitude of change in views from two locations on this hill (Viewpoints 2 and 13), which will be a significant change in these views. However, the wind farm will not be visible in the more spectacular views of Snowdonia and will be visible in its entirety from a limited area on the northeastern side of the hill. As a result, the wind farm will not have a significant effect on the character of this section of the Limestone Escarpment and Hills landscape type

From Little Orme, Bryn Euryn (behind Rhos-on-Sea), and Cefn yr Ogof (behind Llanddulas), the wind farm will be 8km+ offshore and visible partially against the sea and partially against the sky. The array will occupy 20° – 35° of the overall panorama and the rotation of the blades will be discernible in good visibility. The viewpoint analysis (*Annex K7*) predicts *moderate* and *substantial* magnitude of change in views from locations on these hills (Viewpoints 3 and 4), which will be a significant change in these views.

As a result, the wind farm will have a significant effect on the character of this section of the Limestone Escarpment and Hills landscape type.

From Y Foel and Graig Fawr (behind Prestatyn), the wind farm will be 15km+ offshore and visible partially against the sea and partially against the sky. The rows will be "end-on" and so the array will occupy only 8° of the overall panorama and the rotation of the blades will be discernible only in very good visibility. The viewpoint analysis (*Annex K7*) predicts *moderate/slight* magnitude of change in view from Graig Fawr (Viewpoint 7), which will not be a significant change in this view. As a result, the wind farm will not have a significant effect on the character of this section of the Limestone Escarpment and Hills landscape type.

- *Vale Farmlands, Lowland Hills, Eastern Lowlands*

There are few views of the sea from the Vale Farmlands, Lowland Hills and Eastern Lowlands landscape types, which are essentially remote from the sea. Views of the sea are not a defining characteristic of these landscape types and so the wind farm will not have a significant effect on their landscape character.

- *Aled Hiraethog Hills and Upland Plateau*

The Aled Hiraethog Hills and Upland Plateau landscape types are quite remote from the sea. There are distant views of the sea from these elevated locations but seaward views are not a key characteristic of these landscape types. Therefore, the wind farm will not have a significant effect on the character of the Aled Hiraethog Hills and Upland Plateau landscape types.

- *Trelawnyd Plateau*

The Trelawnyd Plateau landscape type is an extensive area of high, relatively flat land inland of Prestatyn. The key characteristics of this landscape type are its open and exposed nature, its undulating plateau landform with occasional dry valleys, the influence of the underlying limestone in buildings, dry stone walls, local outcrops and unimproved limestone grassland, thorn hedgerows, sparse tree cover and nucleated settlement pattern. It has an open and exposed character and the spectacular views of the sea and surrounding lower land are possible from the plateau edge to the north and of the Dee Estuary from the plateau edge to the east. Whilst these panoramic and long distance views are characteristic of the plateau edge, they are not a key characteristic of the landscape type as a whole. Also, the wind farm will be at a considerable distance from this landscape type and it will not have a significant effect on the character of the Trelawnyd Plateau landscape type.

- *Hill Slopes and Moorland Ridge*

The Hill Slopes and Moorland Ridge landscape types are the hill slopes and tops of the Clwydian Range. The spectacular views of the surrounding land and distant sea, particularly from the ridges and summits, are a key characteristic of these landscape types. However, the wind farm will be at a considerable distance from these landscape types and so it will not have a significant effect on their character.

8.8.5 *Operational Effects on Landscape Designations*

The following assessment has examined whether the proposed wind farm will have a significant effect on the purposes of the National landscape designations in the study area.

- *Snowdonia National Park*

As explained earlier, under construction effects, there is the potential for significant effects on the second purpose of Snowdonia National Park, *"the promotion of opportunities for the understanding and enjoyment of the special qualities of the Park by the public"*, if the proposed development brings about significant changes to views ***of*** or views ***from*** the National Park.

The only location where the offshore wind farm will come within views ***of*** Snowdonia Park, will be for viewers at sea, such as on the proposed re-aligned Mostyn – Dublin ferry route and other commercial shipping routes further offshore. In such views of the Park, such as in the vicinity of the North Rhyl Buoy (*Viewpoint 25, Volume IV*), the turbines will in the foreground with the Park as a distant backdrop behind the Great and Little Ormes. Although the viewpoint analysis predicts that the wind farm will bring about a *very substantial/substantial* change in the view from such locations (Viewpoint 25, *Annex K7*), receptors on the ferry will see this view for only a short time as the ferry passes by and much more spectacular views of the coastal hills and high peaks of Snowdonia are obtained from further westwards, as the ferry passes the entrance to Conwy Bay. As the ferry passes by the wind farm, it is likely that the turbines will be the focus of peoples' attention, rather than the Park. They may not even notice the Park in the background. Therefore, although the presence of the wind farm will result in a significant change to the view for ferry travellers on a short section of this route, this effect will occur only in views of the Park from a relatively small area of the sea to the north of the wind farm, and the wind farm will not result in a significant change to the majority of the views of the Park.

In views ***from*** the Park, the wind farm will be visible from the coastal hills, such as Conwy Mountain (*Viewpoint 1, Volume IV*) and from high peaks much further into the Park. However, in all these views, the wind farm will be 15km+ from the viewer, will occupy a small proportion of the overall panoramic view of the sea, will be seen over a deep foreground of intervening land and will be seen almost entirely against a background of the sea. The viewpoint analysis for Viewpoint 1 (*Annex K7*) predicts a *moderate/slight* magnitude of change in the view as a result of the wind farm, which will not result in a significant change in the view for walkers at this location. From further into the park, the wind farm will be even more distant and occupy even less of the view, and from most of the Park, there will not be a view of the wind farm at all. As a result, there will not be a significant change in most of the views from the Park.

As there will not be a significant change in most views of or from the Park, the wind farm will not have a significant effect on the understanding and enjoyment of the special qualities of the Park by the public.

Therefore, the wind farm will not have a significant effect on the purposes of Snowdonia National Park.

- *Isle of Anglesey AONB*

The wind farm will be 20 – 35km from the Isle of Anglesey AONB and will not affect its natural beauty, so the wind farm will not have any effects on the purpose of the AONB.

- *Clwydian Hills AONB*

The wind farm will be 15km+ from the Clwydian Hills AONB and will not affect its natural beauty, so the wind farm will not have any effects on the purpose of the AONB.

- *Great Ormes Head Heritage Coast*

As explained earlier, the Great Ormes Head Heritage Coast is a non-statutory designation outside any national statutory designations. According to PPG20, there are 44 stretches of Heritage Coast, covering one third of the open coastline of England and Wales (about 1,500 km). Of these, 8 are in National Parks and 29 are in AONBs. Only 7 are without statutory status and the Great Ormes Head Heritage Coast is one of these.

The Heritage Coast designation provides a lower level of protection in landscape terms than National Parks and AONBs and the objectives of the designation are also more wide ranging. For example, as well as, *"to conserve, protect and enhance the natural beauty of the coasts"* and *"to facilitate and enhance their enjoyment, understanding and appreciation by the public"*, the objectives include *"improving and extending opportunities for recreational, educational, sporting and tourist activities"* and *"promoting sustainable forms of development"* (PPG20).

As the wind farm will be more than 10km from the Heritage Coast, it will not affect the natural beauty of this designated coastline.

Elevated, long distance views are a key characteristic of this landscape and part of peoples' enjoyment of visiting the Great Orme. In the most spectacular of these views, over Conwy Bay to Snowdonia, the wind farm will not be visible. In the panoramic views along the Colwyn Bay coastline and northwards to the open sea, such as from Viewpoints 2 and 13 (*Volume IV*), the site will be 10km+ from the viewer, will occupy 20° - 25° of the overall panoramic view and will be seen almost entirely against a background of the sea. Although the Great Orme is well developed, the coastline and views of the sea are essentially devoid of manmade structures and, as a result, the viewpoint analysis predicts a *moderate* and a *substantial/moderate* magnitude of change for these two views. For visitors to the Great Orme, who could be stationary or moving at walking pace along the paths, who could be orientated towards the wind farm, and who could be visiting the Great Orme to enjoy the view, a *moderate* or *substantial/moderate* change in views to the northeast from part of the northern coastline will be a significant change in the view. However, this level of change will occur in views from only a small part of the Great Orme designated area. Also, the acceptability of this level of effect will depend on public perception of offshore wind energy schemes and tolerance thresholds for changes in views (see the discussion on valency and public perception in the Conclusions section).

The majority of visitors to the Great Orme arrive by car, by tram or by cable car and the top of the Orme is occupied by the car park, tram station and visitor centre/shop/restaurant complex. The popularity of the Orme has resulted in the provision of all these facilities which, in themselves, now define the visitor experience. It is not possible to visit the Orme for the sort of remote coastal experience that is possible in undeveloped stretches of coastline elsewhere in Wales, such as in coastal National Parks. The nature of the Great Orme means that it will attract people who are looking for gentle exercise and entertainment, rather than the wilderness experience. The wind farm may be seen by some as a sustainable form of development that will attract them to the Great Orme and will, therefore, even extend the opportunities for recreational, educational and tourist activities on the Great Orme.

Therefore, the wind farm will not affect the natural beauty of this designated coastline, will not be visible in the more spectacular views from the Orme, and will be visible from only a small part of the designated area. Furthermore, it has the potential to extend opportunities for recreational, educational and tourist activities without affecting the natural beauty of the coastline. Therefore, the wind farm will not have a significant effect on the objectives of the Great Ormes Head Heritage Coast designation.

Operational Effects on Visual Amenity

The following assessment has examined whether the proposed wind farm will bring about significant changes in the view for fixed viewpoint, linear route and marine-based receptors in the study area. Significant changes in a view do not necessarily bring about unacceptably adverse effects on visual amenity, and this is discussed in more detail in the Conclusions section.

- *Fixed Viewpoint Receptors*

Settlements	The settlements of Moelfre and Benllech on the Isle of Anglesey are at least 34km from the offshore site. Residents and visitors have panoramic views from these settlements northwards over the open sea and eastwards along the coastline towards mainland Wales, such as from Viewpoint 19, *Volume IV*. In this view, navigation buoys, sea level activities and the lower half of the turbine towers will be screened by the curvature of the earth and the wind turbine rotors will be very small and distant, will occupy a very small proportion of the view and will only be visible in excellent visibility conditions. As a result, the viewpoint analysis for this viewpoint (*Annex K7*), predicts a magnitude of change in the view that will be *slight/negligible*. Even for residents who are familiar with the view and will see it every day, or for

visitors who may be there specifically for the view, this will not be a significant change in the view.

From the settlement of Beaumaris on the Isle of Anglesey, the Great Orme, the Little Orme and the land between these two hills screen views of the sea in Colwyn Bay. As a result, navigation buoys and sea level activities at the wind farm will be screened and only the upper parts of the turbines will be visible over the intervening lower land between the Ormes. The turbines will be small and distant objects, barely visible even in very good visibility. The rotation of the blades will not be visible and, although the red lights on some of the turbine hubs may be visible at night, these will be seen in the context of the lights on the intervening land. Therefore, the wind farm will not result in a significant change to the views for residents and visitors to Beaumaris.

Llandudno is approximately 10km from the wind farm. It occupies the lower land between the Ormes with some properties built on the lower slopes of the Great Orme. The buildings along the seafront are tall (3 or 4 storey) Victorian hotels and houses, which largely obscure views of the sea from the rest of the town behind. Residents and visitors in properties along the seafront and on the lower slopes of the Great Orme currently have views of Llandudno Bay framed by the cliffs of the Great and Little Ormes. In this view, such as Viewpoint 20, *Volume IV*., the wind turbines will be in the middle distance, but will occupy over a quarter of the seaward horizon and will be visible in good visibility conditions during the day, with the lights visible at night. As a result, the viewpoint analysis for Viewpoint 20 (*Annex K7*) predicts a *substantial/moderate* magnitude of change to the view. For residents in the seafront and hillside properties in Llandudno who are familiar with the view and will see it whenever visibility allows, or for visitors who may be there specifically for the view, this will be a significant change in the view.

The seaside towns of Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas are all situated on the gentle sea-facing slopes of the Coastal Slopes and Limestone Farmlands landscape types, and will all be 8 - 13km from the wind farm. In views from the upper slopes of these towns, as illustrated by Viewpoint 3, *Volume IV*, the wind farm will be in the middle distance and will occupy more than 35° of the seascape, will be seen mainly against the sky, and, at this distance, the rotation of the blades will be visible in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis (*Annex K7*) predicts a *substantial* magnitude of change to the view from Viewpoint 3 and the wind farm will result in a significant change in the view for residents and visitors in properties with views of the sea, in the seaside towns of Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas.

Abergele, Pensarn and Belgrano, Towyn and Kinmel Bay, and Rhyl and Prestatyn are all located in the flat Coastal and Estuarine Flats landscape type and consist mainly of one or two storey properties, with some three and four storey properties along the seafront at Rhyl. The seawall and railway embankment along the majority of this coastline screen ground level views from properties, and the seafront properties with views of the sea from upstairs windows screen views of the sea from properties immediately behind. As a result, the wind turbines will be visible from very few residential properties in these towns.

Where the turbines will be visible, for example, in views from the seafront in Rhyl, such as Viewpoint 16 (*Volume IV*), the wind farm will be "end-on", will occupy just over 13° of the view, will be against the sky, but will be seen only in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis (*Annex K7*) predicts a *moderate* magnitude of change to the view. However, for residents in the taller properties along the seafront at Rhyl who are familiar with the view and will see it whenever visibility allows, or for visitors who may be there specifically for the view, this will be a significant change in the view.

In contrast, as is illustrated by Viewpoint 17 (*Volume IV*), for properties along the seafront at Prestatyn, the wind farm will be further away and will occupy slightly less of the view so, although they will be against the sky, they will be seen only in very good visibility. As a result, the viewpoint analysis (*Annex K7*) predicts a *moderate/slight* magnitude of change to the view from this viewpoint and the wind farm will not result in a significant change in the view for residents and visitors in properties with views of the sea, in Prestatyn.

Therefore, whilst there will be a significant change in the view for residents and visitors in a few properties along the seafront in Rhyl, the wind farm will not result in a significant change in the view for residents and visitors in the majority of properties in these seaside towns.

West Kirby and Hoylake, on the Wirral, are both at relatively low elevations but some properties have views of the sea in the direction of the wind farm. However, the turbines will be in the far distance and will occupy a small proportion of the overall panorama. Therefore, the wind farm will not result in a significant change in the view residents and visitors in properties in these towns.

Promenades

From Llandudno promenade (Viewpoint 20, *Volume IV*), the existing view of the sea is similar to that from the properties on the town's seafront. The wind farm will result in a *substantial/moderate* magnitude of change to the view. For people strolling along the promenade for the purpose of enjoying the seascape, this will be a significant change in the view.

From Colwyn Bay promenade (Viewpoint 21, *Volume IV*), the wind farm will be in the middle distance, will occupy over 35° of the view, will be against the sky and will be seen in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis (*Annex K7*) predicts a *substantial* magnitude of change to the view. For people strolling or driving along the promenade for the purpose of enjoying the seascape, this will be a significant change to the view.

From Rhyl promenade (Viewpoint 16, *Volume IV*), which is further eastwards, the wind farm will be a similar distance away and against the sky, so will be seen in good visibility, but will be "end-on" and so will occupy just over 13° of the view. As a result, the viewpoint analysis (*Annex K7*) predicts a *moderate* magnitude of change to the view. However, for people strolling or driving along the promenade for the purpose of enjoying the seascape, this will be a significant change in the view.

Beaches

The beaches along much of this coastline provide open and panoramic views of the sea and coastline. The curvature of the earth will screen the lower parts of the towers and the sea level activities and, from the more distant beaches, the substation also, but the upper parts of the towers and the rotors will be above the horizon and against the sky.

From the beach at Benllech the upper parts of the turbines will in the far distance and against the sky, will occupy a small proportion of the view and will be visible only in excellent visibility conditions. From the beach, slightly less of the turbine towers will be visible than from the road above (Viewpoint 19, *Volume IV*) and, at this distance, the wind farm will have a *slight/negligible* magnitude of change in the view that, even for people who are on the beach for the purposes of enjoying the seascape, will not be a significant change in the view.

From the beach in Llandudno Bay the wind turbines will be in the middle distance and will occupy over a quarter of the framed view of the sea. From the beach, slightly less of the turbine towers will be visible than from the promenade (Viewpoint 20, *Volume IV*), but the wind farm will still result in a *substantial/moderate* magnitude of change to the view. For people who are on the beach for the purposes of enjoying the seascape, this will be a significant change in the view.

From the beaches around Penrhyn Bay, Rhos-on-Sea, Colwyn Bay and Llanddulas the two rows of turbines will be "side on" and will occupy 35° - 40° of the view. From the beaches, slightly less of the turbine towers will be visible than from the promenades above (Viewpoint 14, 21 and 22, *Volume IV*), but the wind farm will still result in a *substantial* magnitude of change to the view. For people who are on the beach for the purposes of enjoying the seascape, this will be a significant change in the view.

From the beaches along the coast from Abergele to Kinmel Bay, the two rows of turbines will be diagonal to the shore and will occupy a decreasing proportion of the view (from west to east). As a result, the magnitude of the change to the view will decrease from west to east, from *substantial* just west of Abergele (Viewpoint 12, *Volume IV*) down to *moderate* at Rhyl (Viewpoint 16, *Volume IV*). For people who are on the beach for the purposes of enjoying the seascape, this will be a significant change in the view.

From the beaches along the coast from Rhyl to Point of Ayr, and at Hoylake, the wind turbines will be an increasing distance from the shore and will be "end on" to the shoreline. As a result, the magnitude of the change to the view will decrease from west to east, from *moderate* at Rhyl (Viewpoint 16, *Volume IV*) to *slight* at Point of Ayr (Viewpoint 23, *Volume IV*) to *slight/negligible* at Hoylake (Viewpoint 24, *Volume IV*). For people who are on the beach for the purposes of enjoying the seascape, magnitudes of change of *moderate/slight* or less will not be a significant change in the view.

Tourist facilities

For tourists visiting the various attractions on the Great Orme (ski centre, cable car, tramway, restaurant, visitor centre, Country Park), the views of the sea to the northeast are an attractive backdrop, but only part of the attraction and only visible from parts of these facilities. However, in views of the sea to the northeast from the northern half of the Country Park, such as Viewpoint 2, *Volume IV*, the wind turbines will occupy just over 23° of the view, will be visible in very good conditions, mainly against the sea, and the magnitude of change would be *moderate*. For people who are on the Great Orme for the purposes of enjoying the seascape, this will be a significant change in the view. However, the Great Orme is the highest point on this section of the coast and, once the wind farm is built, some may visit the Great Orme for the elevated views of the wind farm.

The Llandudno Pier provides visitors with views of Llandudno Bay, similar to Viewpoint 20 (*Volume IV*), where the magnitude of change will be *substantial/moderate*. For visitors who are strolling along the pier for the purposes of enjoying the seascape, this will be a significant change in the view. For visitors to Victoria Pier in Colwyn Bay, the section of the pier beyond the entertainment building is not accessible and there would not be open views of the sea from the building. Therefore, the wind farm will not result in significant changes in the view for visitors at this attraction.

The holiday villages and camping and caravan parks in the coastal strip between Abergele and Prestatyn are mainly behind the seawall and visitors will not have a view of the sea level activities and the lower parts of the turbine towers. The upper parts of the towers and the movement of the rotors will be visible over the wall in good visibility and the red hub lights will be visible at night. However, the height of the seawall and the density of the development in these parks will result in intermittent and restricted views of the turbines. Therefore, the wind farm will not result in significant changes to the view for holidaymakers whilst they are in these holiday centres (assessment of effects on views for these holidaymakers when walking along the North Wales Path on top of the seawall and when on the beach, is discussed under other sections of this assessment).

From the top of the Sky Tower (Viewpoint 15, *Volume IV*), the turbines will occupy a relatively small proportion of this elevated 360° view. They will be seen partly against the sky and partly against the sea, in a deep wide seascape. The viewpoint analysis (*Annex K7*) predicts a *moderate* magnitude of change in the view from the top of the tower that, for viewers at the top of the tower, will result in a significant change in the view. However, the purpose of the Sky Tower is to provide visitors with elevated 360° views of the sea and land and will provide land-based viewers with one of the nearest and most elevated views of the wind farm. The view already contains built development and the wind farm is more likely to be considered a feature of interest, and even a reason for taking the pod to the top. Therefore, whilst there will be a significant change in the view, it is likely that the majority of visitors to the tower will not consider this change to bring about an unacceptable adverse effect on their visual amenity.

The Oceanarium and Sun Centre, Rhyl and Nova Centre, Prestatyn are essentially indoor facilities, although large glass walls do provide views of the sea from the Sun Centre. However, views of the sea are not the main attraction at any of these facilities. Indeed, people are more likely to visit these facilities when the weather is not suitable for bathing on the beach, or strolling along the promenade and the visibility out to sea is, as a result, quite poor. Therefore, the wind farm will not result in a significant change in the view for visitors to these facilities.

Elevated vantage points

In views from Conwy Mountain (Viewpoint 1, *Volume IV*), the wind farm will be in the distance, will occupy just over 20° of the overall panoramic view of the sea, will be seen over a deep foreground of intervening land and will be seen almost entirely against a background of the sea. The turbines and the movement of the rotors will be visible only in very good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) predicts a *moderate/slight* magnitude of change in the view. Even for walkers climbing these coastal hills to appreciate the scenery, this will not result in a significant change in their views.

In views from the Great Orme (Viewpoint 2), the site will be 10km+ from the viewer, will occupy just over 23° of the overall panoramic view and will be seen almost entirely against a background of the sea. The turbines and the movement of the rotors will be visible only in very good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) predicts a *moderate* magnitude of change in the view. For people visiting the Great Orme to enjoy the views along the coast and out to sea, this will be a significant change in the view.

In views from the Little Orme (Viewpoint 3, *Volume IV*), the wind farm will be in the middle distance, will occupy nearly 35° of the panoramic view and, in this relatively close and elevated view of the wind farm, the turbines will be seen partly against the sky and partly against the sea. The turbines and the movement of the rotors will be visible in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) predicts a *substantial* magnitude of change in the view. For people visiting the Little Orme to the views along the coast and out to sea, this will be a significant change in the view.

Views of the wind farm from Bryn Euryn (Viewpoint 4, *Volume IV*) will be similar to those from Little Orme, although with more land and built development in the foreground. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) also predicts a *substantial* magnitude of change in the view and for people visiting Bryn Euryn to enjoy the seaward views this will be a significant change in the view.

In views from Moelfre Isaf (Viewpoint 6, *Volume IV*), the wind farm will be in the distance, over a deep foreground of intervening land, semi-framed by the high land along the coastline and will be seen almost entirely against a background of the sea. The turbines and the movement of the rotors will be visible only in very good visibility and mainly against the sea, with the turbine lights visible at night. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) predicts a *moderate* magnitude of change in the view. For people visiting Moelfre Isaf to enjoy the seaward views, this will be a significant change in the view.

Graig Fawr (Viewpoint 7, *Volume IV*) and Prestatyn Hillside viewpoint (Viewpoint 8, *Volume IV*) are both 15km+ from the wind farm, which will occupy only a small proportion of the overall panoramic view of the sea. The turbines and movement of the rotors will be visible only in very good visibility, partly against the sea and partly against the sky, with the turbine lights visible at night. As a result, the viewpoint analysis for these viewpoints (*Annex K7*) predicts *moderate/slight* magnitudes of change in the views. For people visiting these distant elevated vantage points for the seaward views, this will not be a significant change in the view.

Penycloddiau (Viewpoint 9, *Volume IV*) and Thurstaston Hill (Viewpoint 10, *Volume IV*) are both 27km+ from the wind farm, which will occupy only a very small proportion of the overall panoramic view from these locations. The turbines will be visible only in excellent visibility, mainly against the sky, and the movement of the rotors will not be visible. At night, the red lights on the turbine hubs may be visible, depending on the size and intensity of the lights and the visibility conditions. As a result, the viewpoint analysis for these viewpoints (*Annex K7*) predicts *slight/negligible* magnitudes of change in the views. For people visiting these very distant elevated vantage points for the seaward views, this will not be a significant change in the view.

- *Linear Route Receptors*

The only open views of the wind farm from the road network will be from the A55 (T), for motorists travelling in both directions between Colwyn Bay and Abergele. Although the views will be oblique, most of this route has a speed limit of 50mph, and there are several sustained views of the sea to the north from this route. Two examples of views from just above the A55 are Viewpoint 11 (*Volume IV*) and Viewpoint 12 (*Volume IV*) and the viewpoint analysis for these viewpoints (*Annex K7*) predicts a *substantial* magnitude of change in the view from these locations. As a result of both the magnitude of change and the sustained nature of the views, there will be significant changes in the views for motorists on this highway.

There will be intermittent views from other A, B and minor roads in the study area. However, all these are very transient and fragmented views which, for motorists travelling at or near the national speed limit, will be experienced for very short times and over very small proportions of the routes. As a result, the wind farm will not result in significant changes in the views for motorists on the majority of the highways in the study area.

There will be very open and sustained views of the wind farm for travellers on the coastal railway from Colwyn Bay to Towyn. Passengers along this route are currently able to observe the wide sweep of the coastline and the deep and wide panorama of sea and sky. As illustrated by Viewpoint 12 (*Volume IV*), which is taken from close to the railway line, the two rows of turbines will be in the middle distance and parallel to the direction of travel so will occupy approximately 30° of this view throughout most of the journey. The turbines will be seen almost entirely against a background of the sky and the movement of the rotors will be visible in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis for Viewpoint 12 (*Annex K7*) predicts a *substantial* magnitude of change in the view from this location. Although oblique to the direction of travel, passengers will be able to concentrate on the view and could, therefore, observe the wind farm for most of this journey. Therefore, there will be significant changes in the views for rail travellers on this section of the line. However, not all passengers will consider this change to have an unacceptably adverse effect on their visual amenity, as some might find this slightly elevated and sustained view of the wind farm particularly interesting.

From the section of the Sustrans cycle route and North Wales Path, which run together from Penrhyn along the coast as far as Kinmel Bay, cyclists and walkers currently gain a fairly low elevation, but very open and sustained views of the sweep of the coastline and the wide panorama of sea and sky. The view of the wind farm will be oblique to the direction of travel and cyclists, in particular, need to concentrate on the path ahead. However, both cyclists and walkers travel at a relatively slow pace and can stop to admire the view whenever they wish, so they will have plenty of opportunity to observe the wind farm. As illustrated by Viewpoints 14, 21 and 22 (*Volume IV*), which are taken from these two routes, the two rows of turbines will be in the middle distance and parallel to the direction of travel so will occupy 35° - 38° of this view throughout this section of the two routes. The turbines will be seen entirely against a background of the sky and the movement of the rotors will be visible in good visibility, with the turbine lights visible at night. As a result, the viewpoint analysis for Viewpoints 14, 21 and 22 (*Annex K7*) predicts a *substantial* magnitude of change in the views from these locations. Although oblique to the direction of travel, cyclists and walkers will be able to observe the wind farm at most points on this section of the Sustrans cycle route and North Wales Path. Therefore, there will be significant changes in the views for cyclists and walkers on this section of these routes. However, there will not be a significant change in the views for cyclists on the Sustrans route from Bangor to Colwyn Bay, or on walkers on the North Wales Path west of the Great Orme or inland of Rhyl and Prestatyn.

For walkers on the Offa's Dyke Path through the Clwydian Hills, the wind farm will be in the far distance and only visible from a few short sections of the path. From Penycloddiau (Viewpoint 9, *Volume IV*), the wind farm will be in the far distance, the turbines will occupy a very small proportion of the view, will be seen against a background mainly of the sea and will be visible only in excellent visibility. As a result, the viewpoint analysis for this viewpoint (*Annex K7*) predicts a *slight/negligible* magnitude of change in the view. Although there will be other views of the wind farm from the Offa's Dyke path, these will all be at least 15km+ distant, the closest being similar to the view from Graig Fawr (Viewpoint 7, *Volume IV*) in which there will be a *moderate/slight* magnitude of change in the view. For walkers on this long distance path, the views of the wind farm will be very intermittent, from only a few locations on the route and, with magnitudes of change in the view in any one location of *moderate/slight* or less, the wind farm will not result in a significant change in the views for walkers on this long distance path.

- *Marine Based Receptors*

Marine based receptors on the shipping and ferry routes through the Llandudno Bay and Colwyn Bay seascape marine zones, and the fishermen, yachtsmen, recreational sailors and water sports enthusiasts in the inshore waters around Llandudno Bay and Colwyn Bay will see most of the wind farm and associated activities. Depending on the location of the marine receptors, the turbines will be seen against the sky or partly against the land and partly against the sky, and from varying distances and so will occupy varying proportions of the view. However, both during the day and at night, in all but heavy fog, the wind farm will be a very noticeable feature in the seascape in views from this part of the sea and will result in a significant change in the views for marine based receptors in the Llandudno Bay and Colwyn Bay seascape marine zones.

8.8.6 Cumulative Effects

In assessing the cumulative effects of the proposed Rhyl Flats and North Hoyle offshore wind farms, it has been assumed that the two construction phases will be in consecutive summers, the 20-year operational phases will overlap by 19 years and the two decommissioning phases will be in consecutive summers.

As the operational lives of the two schemes are over very similar timescales, the assessment has taken the existing environment as the baseline (*ie* no offshore wind farms) and considered the total effects of adding the two offshore wind energy schemes to this baseline.

Cumulative construction effects

The potential for cumulative construction effects will arise as the result of timescales, and the location and nature of the works proposed.

- *Cumulative Effects on Seascape Units*

Both schemes will be located in the Colwyn Bay Seascape Unit, with the North Hoyle site partially within the overlap between the Colwyn Bay and the Dee Estuary Seascape Units.

The North Hoyle site is too distant from the Red Wharf Bay and Conwy Bay Seascape Units for the construction activities and site to be clearly visible from these units. Therefore, there will not be a significant effect on the character of these two seascape units.

The North Hoyle construction site and activities will add to the length of time in which construction activities will be visible from elevated locations in the Llandudno Bay Seascape Unit, but will be too distant to result in a significant increase in the effect on the character of the Llandudno Bay Seascape Unit. Therefore, there will be a significant short-term effect on the character of the Llandudno Bay Seascape Unit, but not significantly more than the effect of the Rhyl Flats construction phase alone.

The combination of the North Hoyle and Rhyl Flats construction phases will result in construction activities for the majority of two years in the Colwyn Bay Seascape Unit. The activities will transfer from the eastern side of the Bay in the first year (on the North Hoyle site) to the western half of the Bay in the second year (Rhyl Flats site). Taken together, these two construction phases will have a significant medium-term effect on the character of the Colwyn Bay Seascape Unit that will be greater than the effects of the Rhyl Flats construction phase only.

There will be distant views of the North Hoyle construction site and activities from elevated locations in the Dee Estuary and Liverpool Bay Seascape Units (such as Thurstaston Hill, Viewpoint 10), and even more distant views of the Rhyl Flats construction site and activities. However, in these views, both sites will be very distant and only visible in excellent visibility, so there will not be a significant effect on the character of these two seascape units.

- *Cumulative Effects on Landscape Types*

The construction site activities and structures will be visible from various locations in the landscape types with views of the sea, such as the Coastal Slopes, Limestone Farmlands, Limestone Escarpment & Hills, Aled Hiraethog Hills, Upland Plateau, Trelawnyd Plateau, Hill Slopes and Moorland Ridge. However, as the result of the distance and time between the construction phases of the two sites, the views of each construction site will short-term and will not become a defining characteristic of these landscapes, so there will not be a significant effect on the character of these landscape types.

- *Cumulative Effects on Landscape Designations*

The construction sites and activities will be remote from the nationally designated landscapes in the study area and will be visible only in very good or excellent visibility from elevated locations in these designated areas. The construction sites will be visible in views of these designated landscapes only from the sea. Therefore, there will not be a significant cumulative effect on the purposes of these designations.

- *Cumulative Effects on Visual Amenity*

As a result of firstly the North Hoyle construction phase, followed by the Rhyl Flats construction phase, there will be construction activities and structures visible in Colwyn Bay for a period of nearly 2 years and this will result in significant medium-term changes in the views for receptors that currently view the coastal and marine zones of this seascape unit. For example:

- Hillside and seafront properties in Llandudno, Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas, and seafront properties in Rhyl.

- People on the promenades at Llandudno, Colwyn Bay and Rhyl.

- People on the beaches at Llandudno, Penrhyn Bay, Rhos-on-Sea, Colwyn Bay and Llanddulas and on the long stretch of beach from Llanddulas to Point of Ayr.

- People on the Little Orme, on Bryn Euryn, on Graig Fawr and at the Prestatyn Hillside viewpoint.

- Users of the coastal routes, such as the A55, the railway from Colwyn Bay to Towyn, the Sustrans cycle route and the North Wales Path.

- Marine-based receptors on the shipping and ferry routes, fishing boats, yachting routes and recreational water sports in inshore waters.

Cumulative Operational Effects

The potential for cumulative operational effects will depend on the distance to each wind farm, the scale of each development, the cumulative sectors in which each site is located and the angles between them (if any). This information for the two proposed offshore wind farms is presented in Annex K8, Volume V.

The cumulative sectors are illustrated on the cumulative ZVI, *Volume IV*, as follows:

Where the Rhyl Flats turbines will be the closest:

Sector A – Separate: Rhyl Flats and North Hoyle turbines with a gap between.
Sector B - Partial overlap: Rhyl Flats and North Hoyle turbines partially overlapped.
Sector C - Complete overlap: North Hoyle turbines entirely behind Rhyl Flats turbines.

Where the North Hoyle turbines will be the closest:

Sector D - Separate: North Hoyle and Rhyl Flats turbines with a gap between.
Sector E – Partial overlap: North Hoyle and Rhyl Flats turbines partially overlapped.
Sector F – Complete overlap: Rhyl Flats turbines entirely behind North Hoyle turbines.

Between the two wind farms:

Sector G – 180° separation: Rhyl Flats and North Hoyle turbines.

In general terms, if both offshore schemes are developed:

- Sectors A, B and D –effects are likely to be greater than the effects that will arise as the result of the Rhyl Flats wind farm only. This is the result of the wider angle of view that will be occupied by turbines in views from these sectors.

- Sector C – effects are unlikely to increase as the North Hoyle turbines will be completely behind the Rhyl Flats wind farm and in the far distance.

- Sector G – applies to the marine zone between the two wind farms only, where effects are likely to be greater than the effects that will arise as the result of the Rhyl Flats wind farm only.

The effects on receptors in Sectors E, F and G have not been assessed, as Sectors E and F are outside the study area and Sector G is a small area of sea between the two wind farms.

- *Cumulative Effects on Seascape Units*

The North Hoyle wind turbines will be in the far distance and largely screened by the curvature of the earth in views from the Red Wharf Bay Seascape Unit, and will be screened by intervening land from all but the highest locations in the Conwy Bay Seascape Unit, so the two wind farms will not have a significant effect on the character of these two seascape units.

The coastal and hinterland zones of the Llandudno Bay Seascape Unit will be within Sector C where the North Hoyle turbines will be largely behind the Rhyl Flats turbines and in the distance. In such views, the combination of the two wind farms will result in a similar change to the view as the Rhyl Flats wind farm only. There will be locations in the marine zone of the seascape unit where the two wind farms will partially overlap (Sector B) or will be separate (Sector A). However, these sectors are towards the seaward extent of the seascape unit. Therefore, there will be a significant effect on the character of the Llandudno Bay Seascape Unit as the result of the two proposals, but not significantly greater than with the Rhyl Flats wind farm only.

The coastal and hinterland zones of the Colwyn Bay Seascape Unit will be largely within Sectors A, B and D, where the Rhyl Flats and North Hoyle turbines will either partially overlap or will have a gap between. However, from the coastline, the maximum angle between the sites will be around 65° (Viewpoint 16, *Annex K8*), so most views of the sea (from the land) and most views of the land (from the sea) will include wind turbines, at least within the periphery of the view. As a result, wind turbines will become a key characteristic of this seascape unit and the two wind farms will result in a significant effect on the character of the Colwyn Bay Seascape Unit that will be greater than the effect arising as the result of either one of the proposals.

There will be distant views of the North Hoyle wind turbines from elevated and coastal locations in the Dee Estuary and Liverpool Bay Seascape Units (such as Thurstaston Hill, Viewpoint 10), and even more distant views of the Rhyl Flats turbines. However, in these views both sites will be very distant and only visible in excellent visibility, so there will not be a significant effect on the character of these seascape units.

- *Cumulative Effects on Landscape Types*

The cumulative ZVI (*Volume IV*) suggests that the Rhyl Flats and North Hoyle wind turbines will be visible from broadly similar inland zones, but the addition of two wind farms into sea views from these zones and the positions of the two wind farms in different parts of the Colwyn Bay Seascape Unit will result in significant effects to the character of some of the landscape units that would not be affected if only one of the sites were developed.

For example, the development of both sites will result in significant effects on the character of the Coastal Slopes landscape type in both the Llandudno Bay to Old Colwyn section and the section inland of Prestatyn, and on the Limestone Escarpment & Hills (including Y Foel and Graig Fawr but not the Great Orme). There will also be significant effects on the character of the Limestone Farmlands (Old Colwyn to Abergele), and on the plateau edge of the Trelawnyd Plateau.

However, there will not be significant effects on the character of the other landscape types as a result of the two developments.

- *Cumulative Effects on Landscape Designations*

The two wind farms will be visible in elevated views from the Great Ormes Head Heritage Coast, but this designation is entirely within Sector C where the North Hoyle wind turbines will be behind the Rhyl Flats wind farm and in the distance. Therefore, there will not be a significant effect on the objectives of the Heritage Coast designation as the result of the two proposals.

The two wind farms will be remote from the National statutory designations in the study area (Snowdonia National Park, Isle of Anglesey AONB and Clwydian Hills AONB) and will be visible only in very good or excellent visibility from elevated locations in these designated areas. The wind farms will be visible in views of these designated landscapes only from the sea. Therefore, there will not be a significant effect on the purposes of these designations as the result of the two proposals.

- *Cumulative Effects on Visual Amenity*

As a result of the North Hoyle and Rhyl Flats wind farms, there will be offshore wind turbines visible in Colwyn Bay for a period of around 21 years and this will result in significant long-term changes in the views for receptors that currently view the coastal and marine zones of this seascape unit. For those in Sectors A, B and D, the changes will be greater than if only Rhyl Flats wind farm were developed, whilst for those in Sector C, the effect will be the same as if the Rhyl Flats wind farm only were developed. For example:

In Sectors A and D:

- Hillside and seafront properties in Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas, and seafront properties in Rhyl.
- People on the promenades at Colwyn Bay and Rhyl.
- People on the beaches at Rhos-on-Sea, Colwyn Bay and Llanddulas and on the long stretch of beach from Llanddulas to Point of Ayr.
- People at the top of the Sky Tower.
- People on Bryn Euryn, Graig Fawr and at the Prestatyn Hillside viewpoint.
- Users of the coastal routes, such as the A55, the railway from Colwyn Bay to Towyn, the Sustrans cycle route and the North Wales Path.
- Marine-based receptors on the shipping and ferry routes, fishing boats, yachting routes and recreational water sports in inshore waters.

In Sector B:

- Hillside and seafront properties in Penrhyn Bay.
- People on the beach and in the water off Penrhyn Bay.
- Users of the Sustrans cycle route and the North Wales Path around Penrhyn Bay.

In Sector C:

- Hillside and seafront properties in Llandudno.
- People on the promenade at Llandudno.
- People on the beach at Llandudno.
- People at the Great Orme visitor facilities and on Llandudno Pier.
- People on the Great Orme and Little Orme.
- Users of the North Wales Path around Llandudno Bay and the Great Orme.

- Marine-based receptors on the shipping and ferry routes, fishing boats, yachting routes and recreational water sports in inshore waters in the Llandudno Bay Seascape Unit.

However, significant long-term changes in views will not necessarily have an unacceptable adverse effect on visual amenity and this is discussed in the Conclusions section.

The assessments of significant effects on seascape and landscape character and significant changes to views are summarised in Tables 8.9 and 8.10 below.

Table 8.9 Summary of Significant Effects on Seascape and Landscape Character

		Rhyl Flats only		Cumulative effects	
Receptor type	**Locations**	**Construction phase [1]**	**Operational phase [3]**	**Construction phases [2]**	**Operational phases [3]**
Seascape units	Red Wharf Bay				
	Conwy Bay				
	Llandudno Bay	√	√	√	√
	Colwyn Bay	√	√	√	√ [4]
	Dee Estuary				
	Liverpool Bay				
Landscape types	Coastal & Estuarine Flats				
	Coastal Slopes		Llandudno - Old Colwyn		√ [4]
	Limestone Farmlands		Old Colwyn – Abergele		Old Colwyn – Abergele
	Limestone Escarpment & Hills		Little Orme, Bryn Euryn, Cefn yr Ogof		Little Orme, Bryn Euryn, Cefn yr Ogof, Y Foel and Graig Fawr [4]
	Vale Farmlands				
	Lowland Hills				
	Eastern Lowlands				
	Aled Hiraethog Hills				
	Upland Plateau				
	Trelawnyd Plateau				[4] northern plateau edge
	Hill Slopes				
	Moorland Ridge				
National landscape designations	Snowdonia National Park				
	Isle of Anglesey AONB				
	Clwydian Hills AONB				
	Great Ormes Head Heritage Coast				

√ = Significant effect

1. *Significant effects will be short-term and temporary.*
2. *Significant effects will be medium-term and temporary.*
3. *Significant effects will be long-term and reversible.*
4. *Cumulative effects will be greater than as the result of Rhyl Flats wind farm only.*

Table 8.10 Summary of Significant Changes to Views

Receptor type	Locations	Rhyl Flats only		Cumulative effects	
		Construction phase [1]	**Operational phase** [3]	**Construction phases** [2]	**Operational phases** [3]
Settlements	Moelfre				
	Benllech				
	Beaumaris				
	Llandudno	Seafront and hillside properties [5]	Seafront and hillside properties [5]	Seafront and hillside properties [5]	Seafront and hillside properties [5]
	Penrhyn Bay	Seafront and hillside properties [5]	Seafront and hillside properties [5]	Seafront and hillside properties [5]	Seafront and hillside properties [4, 5]
	Rhos-on-Sea				
	Colwyn Bay				
	Old Colwyn				
	Llanddulas				
	Abergele				
	Pensarn				
	Belgrano				
	Towyn				
	Kinmel Bay				
	Rhyl		only seafront properties [5]	only seafront properties [5]	only seafront properties [4, 5]
	Prestatyn				
	West Kirby				
	Hoylake				
Promenades	Llandudno	√ [5]	√ [5]	√ [5]	√ [5]
	Colwyn Bay	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Rhyl			√ [5]	√ [4, 5]
Beaches	Benllech				
	Llandudno	√ [5]	√ [5]	√ [5]	√ [5]
	Penrhyn Bay	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Rhos-on-Sea	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Colwyn Bay	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Llanddulas	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Abergele to Point of Ayr		Abergele to Rhyl [5]	Llanddulas to Point of Ayr [5]	Llanddulas to Point of Ayr [4, 5]
Tourist facilities	Great Orme visitor attractions		√ [5]		√ [5]
	Llandudno Pier		√ [5]		√ [5]
	Victoria Pier, Colwyn Bay				
	Holiday centres, Abergele to Prestatyn				

Receptor type	Locations	Rhyl Flats only Construction phase [1]	Rhyl Flats only Operational phase [3]	Cumulative effects Construction phases [2]	Cumulative effects Operational phases [3]
	Sky Tower		√ [5]		√ [4, 5]
	Oceanarium, Sun Centre				
	Nova Centre, Prestatyn				
Elevated vantage points	Conwy Mountain				
	Great Orme		√ [5]		√ [5]
	Little Orme	√ [5]	√ [5]	√ [5]	√ [5]
	Bryn Euryn	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Moelfre Isaf		√ [5]		
	Graig Fawr			√ [5]	√ [4, 5]
	Prestatyn Hillside viewpoint			√ [5]	√ [4, 5]
	Penycloddiau				
	Thurcaston Hill				
Linear routes	A55		√ [5]	√ [5]	√ [4, 5]
	Other A, B & minor roads				
	Coastal Railway from Colwyn Bay to Towyn	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Sustrans route	√ [5]	√ [5]	√ [5]	√ [4, 5]
	North Wales Path	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Offa's Dyke Path				
Marine based locations	Shipping & ferry routes	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Fishing boats	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Yachts	√ [5]	√ [5]	√ [5]	√ [4, 5]
	Inshore waters	√ [5]	√ [5]	√ [5]	√ [4, 5]

√ = Significant effect

1. *Significant effects will be short-term and temporary.*
2. *Significant effects will be medium-term and temporary.*
3. *Significant effects will be long-term and reversible.*
4. *Cumulative effects will be greater than as the result of Rhyl Flats wind farm only.*
5. *Significant effects will depend on peoples' tolerance threshold and acceptability of changes in views.*

8.8.7 *Conclusions*

This assessment has examined the potential effects of the construction and operational phases of the offshore components of the proposed Rhyl Flats offshore wind farm on the seascape, landscape and visual amenity of a study area that extends from Moelfre on the Isle of Anglesey to Hoylake on the Wirral. It has also considered the potential cumulative effects of this development in conjunction with another proposed offshore wind energy scheme, North Hoyle Offshore Wind Farm, approximately 11 km to the east-northeast.

Construction effects

The assessment of the construction effects of the Rhyl Flats offshore wind farm suggests that the construction phase will result in significant short-term effects on the following:

- Character of the Llandudno Bay and Colwyn Bay seascape units.
- Views for residents and visitors in seafront properties in Llandudno and in the towns situated on the Coastal Slopes, with open views of the sea, for example, parts of Llandudno, Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas.
- Views for people on Llandudno and Colwyn Bay promenades.
- Views for people on the closest beaches, such as in Llandudno Bay, Penrhyn Bay, Rhos-on-Sea, Colwyn Bay and Llanddulas.
- Views for visitors to two elevated vantage points - the Little Orme and Bryn Euryn.
- Views for rail travellers on the coastal railway between Colwyn Bay and Towyn, for cyclists on Sustrans route No 5 and for walkers on the coastal section of the North Wales Path.
- Views for marine-based receptors in the Llandudno Bay and Colwyn Bay seascape marine zones, for example, people on the shipping and ferry routes, on fishing boats, yachts and those involved in inshore water-based activities.

However, the significant effects will be short-term and temporary and, in themselves will not have an unacceptable adverse effect on the seascape character, landscape character or visual amenity of the study area.

Furthermore, the construction phase will not result in any significant effects on the following:

- Character of the Red Wharf Bay, Conwy Bay, Dee Estuary or Liverpool Bay seascape units.

- Character of the 12 landscape types in the Llandudno Bay and Colwyn Bay seascape units.

- Purposes of the national statutory and non-statutory landscape designations in the study area - Snowdonia National Park, Isle of Anglesey AONB, Clwydian Hills AONB and the Great Ormes Head Heritage Coast.

- Views for residents and visitors in Moelfre, Benllech and Beaumaris on the Isle of Anglesey, Abergele, Pensarn, Belgrano, Towyn, Kinmel Bay, Rhyl and Prestatyn, or in West Kirby and Hoylake on the Wirral.

- Views for people on Rhyl promenade.

- Views for people on the long stretches of beach from Abergele to Kinmel Bay, or Rhyl to Point of Ayr, at Hoylake or on the beach at Benllech.

- Views for visitors to the many visitor facilities in the study area.

- Views for visitors to the other elevated vantage points in the study area, such as in Conwy Mountain, the Great Orme, Moelfre Isaf, Graig Fawr, Prestatyn Hillside viewpoint, Penycloddiau and Thurcaston Hill.

- Views for walkers on the Offa's Dyke Path or for motorists, cyclists or walkers on the road network in the study area.

- Views for marine-based receptors further from the site.

Operational effects

The assessment of the operational effects of the Rhyl Flats offshore wind farm suggests that the operational phase will result in significant long-term effects on the following:

- Character of the Llandudno Bay and Colwyn Bay seascape units.

- Character of parts of three of the 12 landscape types - the Coastal Slopes (from Llandudno to Old Colwyn), the Limestone Farmlands (from Old Colwyn to Abergele), and the Limestone Escarpment & Hills (Little Orme, Bryn Euryn and Cefn yr Ogof).

- Views for residents and visitors in seafront and hillside properties in Llandudno, Penrhyn Bay, Rhos-on-Sea, Colwyn Bay, Old Colwyn and Llanddulas, and seafront properties in Rhyl.

- Views for people on Llandudno and Colwyn Bay promenades.

- Views for people on the closest beaches such as in Llandudno Bay and from the long stretch of beach from Penrhyn Bay to Rhyl.

- Views for visitors to the Great Orme visitor attractions, to Llandudno Pier and to the Sky Tower.

- View for visitors to three elevated vantage points - Great Orme, the Little Orme, to Bryn Euryn and to Moelfre Isaf.

- Views for motorists on the A55, rail travellers on the coastal railway between Colwyn Bay and Towyn, cyclists on Sustrans route No 5 and walkers on the coastal section of the North Wales Path.

- Views for marine-based receptors in the Llandudno Bay and Colwyn Bay seascape marine zones, for example, people on the shipping and ferry routes, on fishing boats, yachts and those involved in inshore water-based activities.

However, significant effects will not necessarily have an unacceptable adverse effect on the seascape character, landscape character or visual amenity of the study area, and this is discussed later in this section.

Furthermore, the operational phase will not result in any significant effects on the following:

- Character of the Red Wharf Bay, Conwy Bay, Dee Estuary or Liverpool Bay seascape units.

- Character of the Coastal Slopes (inland of Prestatyn), the Limestone Farmlands (from Abergele to St Asaph), the Limestone Escarpment & Hills (Great Orme, Y Foel and Graig Fawr) and the remaining nine landscape types.

- Purposes of the national statutory designations in the study area - Snowdonia National Park, Isle of Anglesey AONB and Clwydian Hills AONB and on the objectives of the non-statutory designation, the Great Ormes Head Heritage Coast.

- Views for residents and visitors in Moelfre, Benllech and Beaumaris on the Isle of Anglesey, Abergele, Pensarn, Belgrano, Towyn, Kinmel Bay, Prestatyn and the remainder of Rhyl, or in West Kirby and Hoylake on the Wirral.

- Views for people on Rhyl promenade.

- Views for people on the more distant beaches, such as Prestatyn to Point of Ayr, at Hoylake or on the beach at Benllech.

- Views for visitors to the many other visitor facilities in the study area.

- Views for visitors to the other elevated vantage points in the study area, such as Conwy Mountain, Graig Fawr, Prestatyn Hillside viewpoint, Penycloddiau and Thurcaston Hill.

- Views for walkers on the Offa's Dyke Path or for motorists, cyclists or walkers on the remainder of the road network in the study area.

- Views for marine-based receptors further from the site.

Cumulative Effects

The development of both the North Hoyle and the Rhyl Flats offshore wind farms will result in a slight increase in the extent and intensity of the effects on seascape and landscape character. For example, the two construction phases will result in medium-term (rather than short-term) effects on the character of the Colwyn Bay Seascape Unit, and the two operational phases will result in greater effects on the character of the Colwyn Bay Seascape Unit, plus more extensive effects on the character of the Coastal Slopes and Limestone Escarpment & Hills landscape types.

There will also be a slight increase in the extent and intensity of the changes to views, particularly in views from properties, promenades, beaches, elevated vantage points and linear routes from the Little Orme to Point of Ayr, and also on marine-base receptors in the Colwyn Bay Seascape Unit.

Overall Conclusions

Although it is predicted that there will be some significant changes in views, it should be noted that the changes described above are not necessarily unacceptably adverse.

Virtually the entire coastline of Wales is designated as National Park, AONB or Heritage Coast, the main exceptions being (PPG20):

- In South Wales - Chepstow to Barry, Porthcawl to Swansea, and Llanelli to Pendine.

- In West Wales - four short sections of the Ceredigion coastline.

- In North Wales - Portmadog to Abersoch and Pontlyfni to Bangor (on the Lleyn Peninsular) and Colwyn Bay.

Despite these undesignated sections of coastline, there are virtually no marine areas within territorial waters around Wales that cannot be viewed from a designated landscape. At over 30 km long, the Colwyn Bay coastline is the longest of the undesignated sections and, being only slightly concave and very open to the sea, is not closely overlooked on both sides by statutorily designated headlands or coastlines, as is the case with most of the other undesignated sections.

A visibility study undertaken on behalf of CCW, as part of the seascapes research (Miller & Morrice 2001), suggests that the marine zone of Colwyn Bay is some of the least visible of the coastal waters around Wales as the result of the flat coastal plain (inland of Abergele). This is illustrated by *Figure 8.11* in the CCW report, reproduced below with the permission of CCW, which indicates the relative visibility of sea from land. The green areas are the land from which the most extensive views of the sea are possible, blue areas are land with the lowest extents of sea visible, and the white areas are land from where there are no views of the sea.

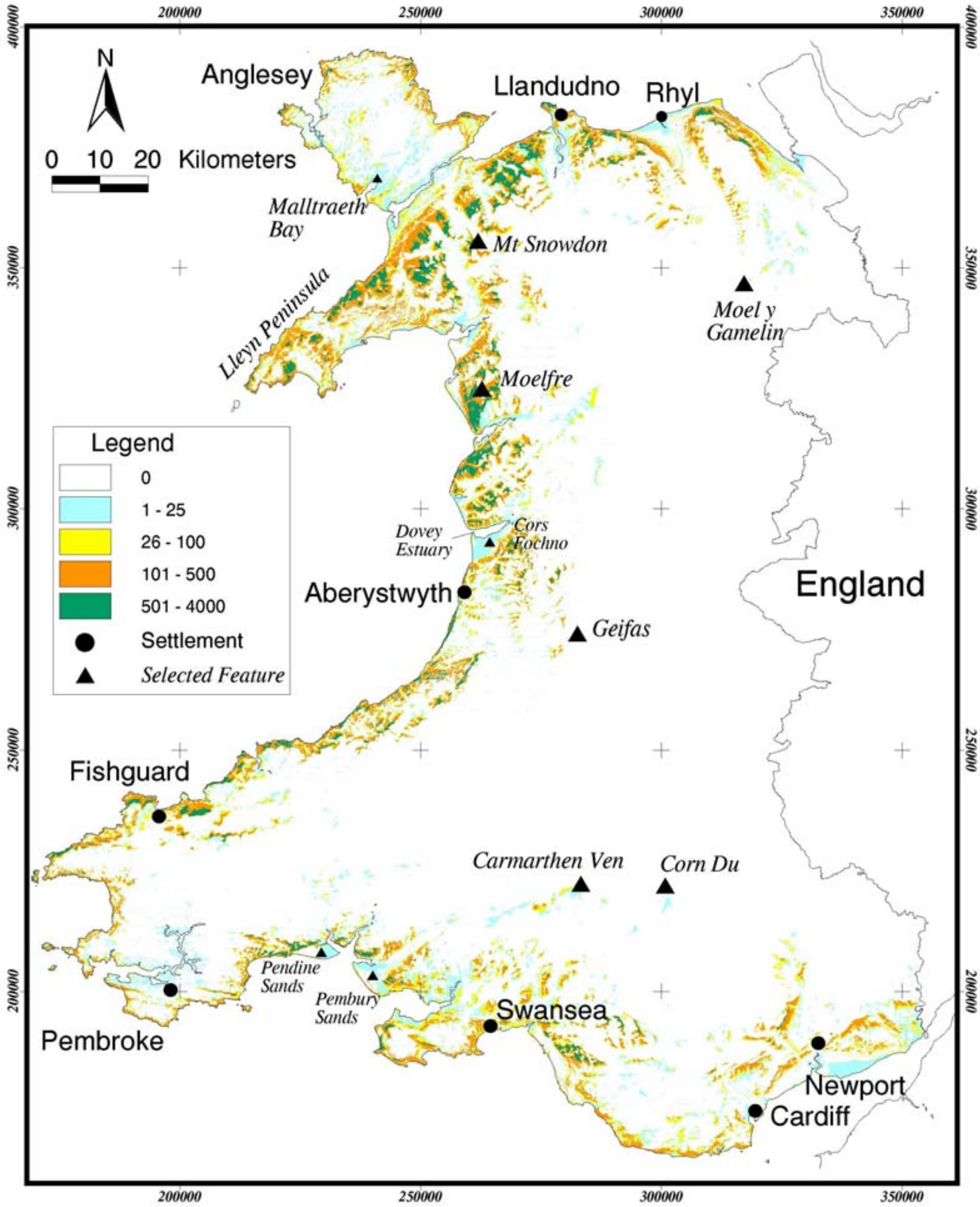
The generally low level of visibility in the study area is also the result of the high land close to the coast, which screens views of the development from all but distant elevated locations further inland. Further to the topographically based ZVIs on which this report is based, the high seawall and railway embankment along the Colwyn Bay coastline will screen views from much of the immediate low lying hinterland and, therefore, the visibility of the sea along this coastline is even less than suggested by this report, or the ZVIs presented in this ES.

Both the CCW visibility study and this assessment have assumed excellent visibility out to the full extent of the ZVIs (>30km). However, the very changeable weather around the UK coastline combined with the generally higher moisture content of the air over the sea (relative to the land) means that visibility out to sea is very variable and can often be less than under similar weather conditions on land.

Offshore wind turbines will be a new feature in our offshore environment and will bring about a change in the view that will be very noticeable when they are first commissioned. In harnessing the power of the wind, offshore wind turbines will have an obvious and direct relationship with the exposed and elemental nature of the sea. For some people, who see the sea as one of the last untamed wildernesses, the turbines may be seen as man-made and intrusive structures, but for others they will be a feature of interest, a reason for taking a ferry that passes the site, or for paying to go up to an elevated vantage point, like the Great Orme or the Sky Tower, for a better view.

Valency is a term used to describe peoples' opinions of developments such as wind farms. People who are in favour of wind energy developments are described as having a *positive valency* and people who are opposed to wind energy developments are described as having a *negative valency*. A person's valency may be determined by purely aesthetic and perceptual considerations, by financial considerations, by their understanding of the technical performance of wind energy installations, or by a combination of these and other factors.

Figure 8.11 Geographical distribution of the visibility of the sea from the land (Miller & Morrice 2001)



Valency affects peoples' tolerance of change. People with a positive valency will have a higher threshold of acceptability, that is, they are likely to consider a higher magnitude of change in views to be acceptable than those with a negative valency, who may consider even a slight magnitude of change to have an unacceptable adverse effect on their visual amenity.

Time is also an important factor, as peoples' opinions, or valency, can vary over time, as a result of changes in their understanding of a subject and/or as a result of their increasing familiarity with a particular scene. For example, over time, people who see a particular view everyday begin not to notice certain elements in the view. For views of wind turbines in the distance, this can often be the case, although if the turbines are close and the visibility sufficient to see the movement of the rotors, this movement will tend to draw the eye and make the turbines noticeable even in a familiar view.

There are currently no published, independent public attitude surveys on which to gauge public opinion on the acceptability of offshore wind energy schemes in seascape, landscape and visual amenity terms. However, there has been a number of public opinion surveys carried out in relation to onshore wind energy developments. These surveys have consistently concluded that, whilst the majority of those surveyed do not think that they are going to like a wind farm when one is proposed in their locality, the majority are in favour once it has been constructed. This suggests that, in general, people who display a negative valency towards an anticipated and relatively unfamiliar change to their visual amenity often, in the case of wind energy developments, acquire a positive valency once that change has occurred. The recent Scottish Executive survey (S3SR 2000) also showed a high proportion in favour of additional wind farms in their area, which suggests that this positive valency is not reversed when there is a proposal to site further wind farms in an area.

In the case of the Rhyl Flats and North Hoyle offshore wind farms, they will be situated in a relatively large seascape unit in which shipping routes and views of offshore installations are already a part of its character, off a section of coastline that is relatively distant from national statutory landscape designations, and in an area of sea which is visible from a relatively small hinterland. As such, the wind farms will be sited in one of the least visible and least sensitive stretches of coastal waters suitable for the siting of an offshore wind farm off the coast of Wales, and the predicted changes to seascape character, landscape character and visual amenity will be acceptable.