
CHAPTER 6: HUMAN ENVIRONMENT

6.1 Socio-Economics

6.1.1 Existing

This section assesses the potential impact of Burbo Offshore Wind Farm on the socio-economic character of the local area. The wind farm will be situated 6.4km from the Crosby coast, 7.2km from North Wirral and approximately 9km from the city of Liverpool. The site is also 15km from the country of Wales, the closest district being Flintshire.

Merseyside is one of the largest metropolitan counties in England, with a population of over 1.4 million people. Merseyside consists of the coastal area to either side of the River Mersey, including the Wirral peninsula bordered to the west by the River Dee. The local area is dominated by the City of Liverpool, which has a population of 461,500 (Liverpool District, 1998).

The hinterland consists of small coastal towns, such as Southport, Formby, Hoylake, which are popular seaside resorts or retirement areas. More affluent areas can be found on Wirral, further south towards Cheshire, such as Heswall, Gayton and Parkgate. Much of the coastal area is urbanised, except for areas around Formby. Inland to the north of Liverpool there is much farmland on the flat, fertile coastal plains. Satellite towns, such as Ormskirk, Skelmersdale, St. Helens and Widnes, form part of the commuter belt for workers in Liverpool.

The country is well serviced by road, rail and air links. The M62 and M58 motorways connect Liverpool to the M6, whilst rail links to the West Coast Main Line provide easy access to the rest of the country. Liverpool has an active port, with national and international trade taking place on a daily basis. Ferries regularly leave Liverpool for Northern Ireland, Eire and the Isle of Man. Liverpool John Lennon Airport provides an international flight network with plans to expand from 2002 to increase traffic through the area.

The history of Liverpool and Merseyside is one of affluence through the 18-19th Centuries, leading to a decline in industry following World War II up to the present day. Liverpool's first dock was opened in 1715 and the city emerged as an important international port and trading centre. By 1807 the Port of Liverpool was in control of three-sevenths of the worlds trade. Growth increased in the city exponentially and many of the city's important landmarks were constructed during this time. Liverpool was targeted heavily during the Second World War, suffering considerable damage to industry and losing many historic landmarks. Rebuilding brought Liverpool back to its former glory, but industry in the city was in decline. Shipbuilding and international trade shifted their focus from Liverpool, leading to increasing unemployment and poverty in Merseyside.

The overall population of Merseyside has been falling due to economic decline. The population decreased from 1.45 million in 1991 to 1.40 million in 1999, a -3.2% change. Merseyside has one of the highest unemployment rates in the country (9.6%) compared to the national average. The decline in the local economy over the last 50 years has meant more people leaving the area to seek work elsewhere.

6.1.2 Assessment of Impact

The development of such a substantial project as Burbo Offshore Wind Farm will have an effect on the local economy and infrastructure. Impacts will relate to the development of the wind farm, construction, operation and, ultimately, decommissioning. Overall the impact of the wind farm will be positive for the local economy.

6.1.2.1 Development

The design phase leading up to the production of the Environmental Statement requires considerable technical input from a range of consultants. Where possible, work has been (and will continue to be) contracted out to organisations in the Merseyside area. For example, much of the environmental assessment has been carried out by Casella Stanger who have offices in Liverpool. Survey work requiring the use of manpower and equipment, such as boats to ferry people offshore, has also been placed locally.

The design of the wind farm has led to the direct and indirect employment of local labour necessary to carry out the required work. Supply chain cascade effects will take place, but on a small scale as the number of contractors at this stage is relatively small. Indirect effects relate to outside contractors not local to the region visiting Merseyside to carry out the work, leading to expenditure within the local economy.

6.1.2.2 Construction

The most labour-intensive phase of the wind farm cycle, Burbo Offshore's construction will have a strong impact on the local economy. Impacts relate to investment in the region, the sourcing of materials, equipment and services locally and to the direct employment of local labour.

The project has an estimated cost of £90 million, which is based on the overall costs associated with design, development, construction and decommissioning. Construction is expected to take 4-6 months over the summer period in 2004, with economic impacts which will extend beyond that timeframe. The financial benefit to Merseyside is difficult to predict. During the construction phase there will be numerous vessels and personnel working on the wind farm, so the benefits will be from an increased spend in the local economy.

As the project is still in its development phase, predicting the placement of orders and the primary contractor is difficult. Where possible, SeaScape Energy will source all direct and indirect resources required to carry out construction within the Merseyside area. In those cases where no local supplier is available, UK-based firms will be utilised if at all possible. For example, the wind turbines will be manufactured by Vestas at their Scottish factory – the only UK-based manufacturer. Equipment for installation will be supplied by suitable firms, but ancillary services could be provided by firms in the local area.

Contractors appointed to work on the construction of the wind farm will most likely supply their own labour force to carry out the work. It is difficult to predict the number of jobs which may be created as a consequence of the wind farm. There are advantages in using local labour to aid with construction over this time period.

The influx of construction workers and associated individuals will bring short-term income into the local economy. This is likely to create additional, indirect employment related to the wind farm across a variety of employment sectors.

6.1.2.3 Operation

Once operational, the turbines will require regular maintenance and servicing. This will require skilled technical labour on a regular basis. During periods of heavy maintenance, additional staff will be required to assist with the work. Such personnel could come from the local labour pool.

Operation of the wind farm will require two full-time staff to manage and oversee the administration of the site. These will be based close to the development and should be sourced from the local labour pool.

Over the 20 year lifespan of the project, there will be regular expenditure in the local economy as contractors work in the area. A significant proportion of this will be direct expenditure to purchase goods and services related to servicing and maintenance requirements.

Additional income could be generated by an expanded tourist industry, with people visiting the region to see the wind farm. This can lead to ancillary increases in tourist services, with the growth of boat trips, coastal visitor attractions, food and accommodation requirements.

6.1.2.4 Decommissioning

At the end of its life, the wind farm will be decommissioned and all associated structures removed where necessary. The procedure is the reverse of the installation of the turbines. Similar equipment and manpower will be required to take out all the turbines over several months, bringing income into the area during this period.

With the removal of the wind farm, the impacts on the local economy could potentially be negative, with a loss of income as a consequence. If the wind farm is seen as a tourist attraction, then its removal has to be seen as harmful. Jobs which were created specifically as a consequence of the wind farm will no longer be required, unless there are additional renewable energy developments further offshore.

6.1.3 Cumulative Impact

The development of several wind farms in the North West as a whole offers considerable potential to the Merseyside area and Liverpool in particular. The growth of offshore wind farms will require an associated service industry to support them throughout their lifespan. Access to port facilities for boat-based work is critical and Liverpool is well placed to offer those services.

Although the number of jobs required to help service and maintain the offshore wind farms is not directly proportional to the number of wind farms, there would certainly be a requirement for more trained staff. It could be possible to consider a regional-based service industry, focusing on offshore wind farms, perhaps evolving from the oil and gas industry.

SeaScape Energy is supportive of any attempts to focus the offshore wind farm service industry in Merseyside and the surrounding area.

6.1.4 Mitigation

The development of the Burbo Offshore Wind Farm will have a positive effect on the local economy. It has the potential to create new jobs and provide revenue to other associated industries and services located in Merseyside. SeaScape Energy's only mitigation will be to ensure that as much of the work as possible is placed locally, minimising outside contractors where at all possible.

6.2 Marine Recreation and Amenity

6.2.1 Existing

Liverpool Bay and the surrounding area has historically been an active area for sea-based activities. There are several yacht clubs along the coast and recreational angling is popular in the area, as is diving. The majority of sea users, although based in and around Liverpool, travel farther afield to pursue their activities however. Very few individuals can be seen sailing or windsurfing in and around the Great Burbo Bank, most likely due to the volume of traffic using the port.

The majority of yachts head out of Liverpool towards the North Wales coast and Anglesey, where the sailing is more enjoyable and there are fewer commercial shipping vessels.

Diving also takes place on many of the wrecks in Liverpool Bay. Though there are many wrecks close to Great Burbo Bank, the visibility is poor and most have been dispersed by MDHC for safety reasons. Divers will operate in deeper water, where visibility is better and the wrecks are more intact.

Fishing and angling in particular takes place across the entire Liverpool Bay area. Fishermen tend to avoid heavy traffic, so they fish farther offshore or towards the North Wales coast. The proximity of the Burbo Offshore Wind Farm to the Mersey Channel and the presence of sand banks means the majority of fishermen avoid this area.

Inshore activities include wind surfing, jet-ski and small (less than 4.5m) dinghy sailing boats. Activities of these types do not stray far from the shore and would not be active over the wind farm site.

6.2.2 Assessment of Impact

The development of the wind farm requires the adoption of a 10km² area of the seabed. The combined area of the thirty wind turbines is 377m² or a very small fraction of the overall wind farm site. The turbine spacing, over 500m between each one, means that recreational and some commercial activities can still take place within the proposed site.

During construction, it will be necessary to prevent unauthorised vessels entering the wind farm site to reduce the risk of accident. This will be a temporary exclusion zone to maintain public safety. Once the wind farm has been cleared of construction vessels, then the site will be made available once more.

Recreational users of the sea can continue to operate within the wind turbine site. It is thought that the addition of scour protection material will increase the marine habitat around the base of the turbines, providing opportunities for fishing and, possibly, diving. Boat users wishing to sail between the turbines can do so as long as they do not approach or anchor on the turbine foundations.

6.2.3 Mitigation

The wind farm will be constructed with all necessary safety features as recommended by Trinity House and the Marine and Coastguard Agency (MCA). SeaScape Energy will ensure that all marine users are kept informed of the development of the wind farm. The site and turbine positions will be marked on all Admiralty Charts and other maps as appropriate to ensure all sea users are made aware of the wind farm's

location. Notices to Mariners will be issued and adverts placed in the relevant trade and recreational user journals and papers.

6.3 Tourism and Leisure

6.3.1 Existing

Tourism in Merseyside generates £604 million spending in the local economy at a variety of attractions, shops and accommodation. The tourist industry supports 21,800 jobs in the region, of which 74% are directly related to tourism (Merseyside Visitors Survey 2000/1). There were 2.4 million overnight trips to Merseyside in 2000, 0.58 million by overseas visitors.

In 2001, 0.6 million visitors came to Liverpool because of the Beatles, spending about £20 million in the local economy. Cultural tourism is very popular, attracting 1.28 million people for arts or cultural events and spending £42.2 million in the area.

The top five paid and free attractions in Merseyside are listed in the following table (6.3.1), together with the number of visitors in 2001 (Tourism on Merseyside, 2001).

Table 6.1: Top visitor attractions in Merseyside

Paid Attraction	Visitors	Free Attraction	Visitors
Mersey Ferries	675,584	Albert Dock	4.5 million
Knowsley Safari Park	400,000	Southport Pleasureland	2.6 million
Merseyside Maritime Museum	246,457	Heritage Market, Stanley Dock	750,000
Liverpool Museum	165,426	Tate Gallery	653,789
Croxteth Hall and Country Park	132,440	Bluecoat Arts Centre	650,000

Local residents and people from the surrounding areas are likely to visit Merseyside and Liverpool in particular for specific attractions. They are also likely to make use of coastal amenities, such as coastal walks, nature reserves and conservation areas. International visitors are less likely to make use of these amenities, spending their time and money on specific attractions, most likely active (e.g. shops and museums) rather than passive (e.g. walking).

6.3.2 Assessment of Impact

It is anticipated that, as with onshore wind farm experiences, the construction of an offshore wind farm will prove an attraction to visitors. Tourists will actively travel to coastal areas or elevated positions (such as the Anglican Cathedral or Thurstaston Common) to get a view of the development. This provides an opportunity for SeaScape Energy to

provide educational information on the benefits of wind farms and renewable energy.

Besides passive observance of the Burbo Offshore Wind Farm, there is scope for active tourism relating to the site. The lack of an exclusion zone around the wind farm offers the potential for boat trips to the site. These can be simply trips to see the wind turbines up close, or for bird watching or fishing purposes. The attraction of seeing the wind farm, leading to increased tourism, means increased spending in the area. Such tourism will focus on areas where there would be a good view of the wind farm, such as New Brighton, Hoylake and Crosby.

The construction of the wind farm could potentially reduce the number of tourists visiting the area, discouraging people from visiting Merseyside. This is highly unlikely as the vast majority of visitors to the region will be doing so to visit specific attractions, such as the Maritime Museum or Beatles Story. The primary attractions will generally be physical attractions. The wind farm will provide a secondary attraction, encouraging people to the coastal areas, such as New Brighton or Formby, from where they will be able to see the development. This may increase visitor numbers to these coastal locations as a consequence.

6.3.3 Recommendations

SeaScape Energy will work closely with the Merseyside Tourist Board, Mersey Partnership and other related organisations to maximise the potential of the wind farm in tourism. SeaScape wishes to actively promote the Burbo Offshore Wind Farm in the area, providing educational materials and information for distribution through appropriate outlets, such as museums and information centres.

6.4 Fisheries

6.4.1 Introduction

This section examines fishing activities in a regional context, as well as within the specific proposed area of the wind farm. The extent of existing fishing activity in the area is considered, along with the effects of the proposed wind farm development on commercial fishing activities. The assessment of impacts is based on DEFRA catch data, interviews with fishermen operating in the area, and interviews with staff at statutory agencies involved with enforcement in the area. Mitigating measures are also considered along with issues relating to cumulative effects of other proposed wind farm developments in the area.

6.4.2 Existing Environment - Commercial Fishing Activity

6.4.2.1 Types, Characteristics, and Numbers of Vessels

Three main types of fishing vessels operate in the wind farm area to the west of Burbo Bank.

Beam Trawlers (< 330 kW)

Beam trawlers operating in the area are indigenous to the English south coast and to Fleetwood, and are generally small. They are typically 9-12m in length, 30–60 GTs, with engine sizes of 200 – 220 kW. These vessels attach the nets to a derrick, which extends from the port and starboard side of the deck in the case of visiting beamers. Each net is separated by a beam, which is dragged along the seabed. Many of the smaller, and less powerful, local beamers use beams over the stern of the vessel. The distance of the net from the vessel is some 3 to 4 times the depth of water, with each beam around 6m metres in length. Visiting vessels use “stone mats” while many of the smaller local beamers use “open” gear. Vessels fish continuously for several days at a time before landing catches, and fish for a total of around 200-220 days per year. The main species caught are sole, plaice, turbot, brill, skate and monkfish.

Gill Netters

Gill net, or tangle net, vessels anchor nets to the seabed and tend to fish in specific areas, with relatively little movement in search of fish. They have small engines to keep costs down, as they are not towing fishing nets and do not therefore require the extra power. Fishing gear is “passive” in that relies on capturing fish that try to swim through it. Gear can be left in the water for considerable periods with periodic checking, and is thus susceptible to damage by trawlers fishing through the area in which nets have been left. Target species are typically bass, skate, roker and cod, with some sole fishing using specialist sole nets. Full-time vessels fish for about 180 days each year.

Demersal/Otter Trawlers

All demersal trawlers in the area are single rigged trawls. Typically trawl nets are towed in a maximum of about 15m of water, 60m behind the boat, and with trawl doors about 25m apart keeping the mouth of the net open. In areas of seabed which are rocky/lumpy, or when the weather is bad, nets are towed closer to the vessel. Vessels tend to fish for 1-2 days before landing their catch, and typically fish for 180-200 days per year. Important target species are cod and whiting.

There are currently 10 over 17m vessels, 27 10-17m vessels, and 153 under 10m vessels licensed to fish in the North West region. However, many are not currently operational, some only operate part-time or are now recreational craft, and others are located considerable distances from Burbo Bank and rarely fish there. Many use fishing methods that are not appropriate for the Burbo Bank or target species that are not to be found there in commercial quantities. No vessels of over 13.7 metres are allowed to fish in the Irish Sea under Sea Fisheries Committee byelaw regulations.

Boats based in the Dee and Mersey Estuaries fish for bass, shrimp and cockles within the estuaries, and with the exception of one small beamer, do not fish in the area of the proposed wind farm. Only one of the under 10m vessels at Hoylake is a full-time commercial vessel, trawls all year, and is based for significant periods at Fleetwood. Vessels at Southport principally target shrimp, bass, cockles and mussels (i.e. not the Burbo Bank area). It is unlikely that many small vessels based further north than Fleetwood make the trip south to fish the Burbo Bank.

Based on interviews and discussions conducted as part of this study, fishing in the area of the proposed wind farm appears to be relatively low. It is estimated that there is one indigenous vessel, a small “pocket” beamer, which depends heavily on the area (especially for sole from March to June, skate and plaice from June to August, and brill June to July). This vessel spends as much as half its fishing time, and earns as much as 50% of its earnings, from the Burbo Bank area. It is also estimated that there are two indigenous vessels that regularly fish in the area for around 30 days per year on average, one from North Hoyle (an under 10m trawler) and one from Fleetwood (a “pocket” beamer/trawler), both targeting the sole fishery in particular. In addition there are perhaps an additional 10 vessels based in the region (mostly trawlers, but some netters and “pocket” beamers) which fish the Burbo Bank for an average of perhaps 3-5 days per year. The proposed wind farm area is fished most heavily from April for a period of 2-3 months when fishing for sole and plaice is good.

It is estimated that there are also three or four small beamers from the south coast (Plymouth and Brixham) that have been fishing for sole in Liverpool Bay for a few weeks each year over the last few years. Effort in the Burbo Bank area is difficult to accurately quantify, but it is thought that these vessels fish the Burbo Bank area for perhaps 5 days each a year, again, principally during May and June. The larger Belgian trawlers operating in the area are prohibited from fishing within 6 nautical miles of the coast, and also do not therefore fish in the Burbo Bank area.

While the vessels using the Burbo Bank for only a few days per year do not rely on the area for significant contributions to overall yearly income, the possibility of being able to fish there provides an important strategic opportunity. This is the case when catches are found to be poor in areas in which they usually operate, or when prices for other species which they may be targeting start to fall. The presence of the area as a possible fishing ground is therefore an important risk management tool in ensuring overall yearly incomes. However the overall area of the wind farm is only a small proportion of the available fishing grounds. The ability to continue fishing within the site reduces the impact the wind farm would have were an Exclusion Zone put in place instead.

6.4.2.2 Catch Data

Fishing in ICES VIIa (Figure 6.1) has historically targeted more than 40 species. Catches over the last three years have been 28,136 tonnes valued at £34 million (1999), 26,480 tonnes valued at £27 million (2000), and 38,782 tonnes valued at £38 million (2001). Catches by UK vessels have accounted for 86,232 tonnes of the total 93,398 tonnes caught over the period i.e. 92%.

Each ICES area is divided into rectangles of 4,116km² and recorded catches in VIIa are divided into those made in each rectangle. The proposed wind farm will be located in rectangle 35E6, approximately 50% of which includes dry land in North Wales. The northern boundary of the proposed wind farm area actually lies on the border between 35E6 and 36E6 to the north. The volume and value of catches for 35E6 between 1999-2001 were 1,968 tonnes (i.e. 5% by volume and 4% by value of catches for VIIa as a whole), at a value of £1.4 million. By comparison, 6,294 tonnes valued at £10.9 million were caught in rectangle 36E6 directly to the north during 1999-2001. Even allowing for the fact that a proportion of 35E6 is dry land, a comparison of recorded catches in the two rectangles provides a strong indication (at least for the over 10m fleet) of the relative lack of fishing activity in rectangle 35E6. Given known catch rates for under 10m vessels, these figures suggest that catches for the under 10m fleet are significantly under-represented in DEFRA catch data, even if vessels only spend part of the time fishing in 35E6.

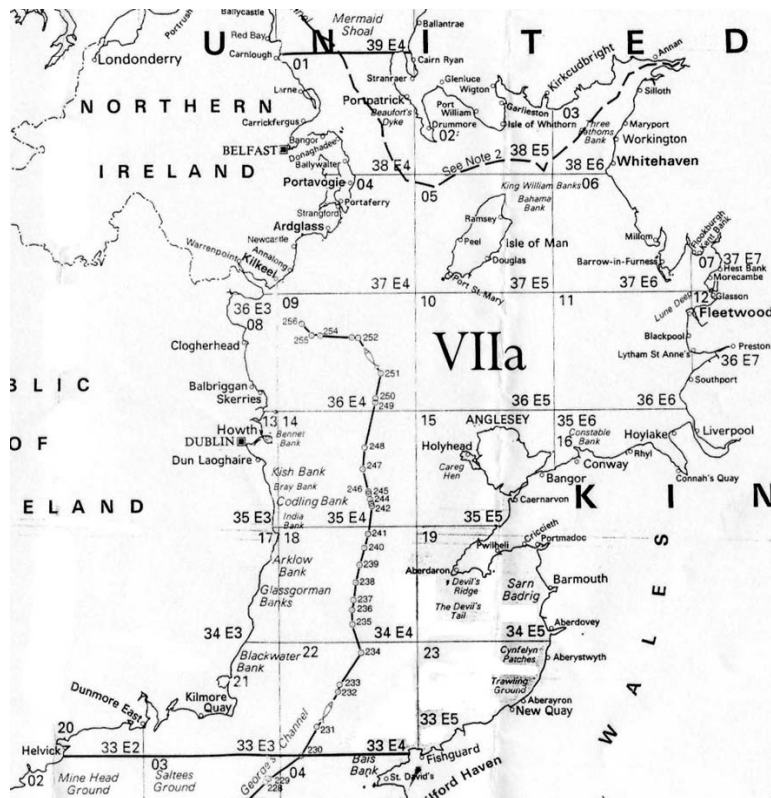


Figure 6.1: ICES VIIa (Irish Sea) area designation

There has been an increase in catches over the last three years in rectangle 35E6, with monthly peaks in volume and values in 2001 being attributable to surface picking of cockles and mussels. The most important species in terms of the volumes of landings are cockles, mussels, queen scallops and skates/rays, which together accounted for 93% of catches in 2001. In value terms the picture is very similar, except that sole contributed an important 8% of the total value for last year. Again, caution should be noted about relying on these data given the likely under-representation of the under 10m fleet.

6.4.3 *Environmental Impact - Effects on Commercial Fishing*

6.4.3.1 Operational Phase

Safety

Fishermen consulted during this study have raised concerns over operating within the area of the wind farm. With turbines evenly spaced 500m apart within the area of the wind farm, and with scour protection around the base of turbines being only 13 m in diameter, trawlers could technically operate within the area, and pick a straight line through the turbines. However, given seabed “fasteners” in the area, possible trawl lines could be reduced. In addition, the turbines are unlikely to be aligned exactly with tidal flows. Given the strength of tidal flows in the area, potential sea conditions in bad weather, and the likelihood that vessels would at times be drifting in the area while hauling nets, conducting emergency repairs, or idling for other reasons, issues arise about the possibility of collision with the turbines. A number of fishermen consulted during this study thus feel that even if there was no Exclusion Zone around the area, they would probably choose to avoid it. This may also be the case for commercial fishing navigation, for those vessels wishing to pass through the area on their way to other fishing grounds.

Discussion has also taken place with the MCA as part of this study. While the MCA do not currently have a policy to recommend the imposition of Exclusion Zones around offshore wind farms, they have not ruled out such a policy in the eventuality that accidents involving fishermen and turbines appear to be frequent. On a positive note, safety concerns can be partially allayed given the proximity to the Crosby coastguard station, and the fact that the wind farm would be sited within a major port area, and would thus benefit from accompanying safety facilities and equipment. As the area falls under the authority of the Mersey Docks and Harbour Company, the Company would also have the ability to impose an Exclusion Zone on the whole area if they felt there was a safety risk of vessels operating there. In discussion as part of this study, they have stated that they have no plans to do so at the outset, but would reserve the right to do so at a later date if they perceived that there were unacceptable safety risks of vessels operating in the area.

A separate issue is the potential of cables within the wind farm area, and from the wind farm to the shore sub-station, to become exposed due to changes in seabed conditions if they are not buried deep enough. In such circumstances there is the possibility that trawl gear could become caught on the exposed cables, which presents a safety risk for fishing vessels operating close to the wind farm and cable route.

Financial Impacts

In the event that there is no Exclusion Zone around the wind farm, with fishermen able to operate within the area and trawl/net between the turbines, there are not expected to be any significant direct effects on fishermen's' incomes (see also comment below on possible impacts of early hauling of nets). Given that a number of fishermen have indicated that they would avoid the area due to safety reasons even if an Exclusion Zone was not imposed, an assessment of the impacts of not operating in the area becomes particularly pertinent. This is especially so, given statements by the MCA and the Mersey Docks and Harbour Company, which have not ruled out the possibility of an Exclusion Zone at some stage in the future. In the event that there is an Exclusion Zone imposed around the area, then potential financial impacts become more likely, but are still unlikely to be substantial.

Some additional points related to potential financial impacts are also worth noting. They include:

- Reduced trawl lengths.
- The potential impact on trawl operations of obstructions/"fasteners" such as exposed cables, or items discarded by vessels belonging to the wind farm operators working in the area.
- The possible impact on gill net activity from the settlement of fines/sediments reducing the efficiency of the net. However, it is noted that the existing marine environment is already one of high dynamism, with considerable amounts of turbidity and sediments already in the water column.
- Concerns over navigation through the wind farm area for vessels not fishing, but travelling to other fishing grounds, and the possibility of an Exclusion Zone, mean that some additional fuel costs, and costs associated with lost time, might result from vessels having to by-pass the area. These costs are thought to be minimal and difficult to quantify.
- Finally, some fishermen have raised the question as to whether their insurance will cover them for operating within the wind farm. This question has been raised with Sunderland Marine, a major shipping insurance firm that insures large numbers of fishing vessels. The firm stated that they do not currently have, nor do they have any plans to have in the future, any clauses in their policies to state that vessels will not be covered if operating within, or near, offshore installations.

6.4.3.2 Construction/Decommissioning Phase

Safety risks will be present during construction and decommissioning from the presence of construction vessels and jack-up barges in the area. But it is expected that fishermen will have few problems in avoiding these vessels.

Cable laying within the wind farm area, and along the cable route from the wind farm to the shore sub-station will impact on both static gear and trawl fishing, as fishermen will be forced to avoid these areas. Given the short time-period involved with laying cables, any significant impacts on fishermen are discounted.

The possibility exists for anchor mounds to form around anchors used during construction and decommissioning, and for debris to be discarded during the construction process. Both eventualities would impact on trawling operations, with debris providing both a safety and operational hazard. The presence of anchor mounds is however not thought to a major concern given the short time that jack-up barges and vessels will remain in any one place during construction and decommissioning.

There will need to be some form of exclusion area for fishing vessels during construction/decommissioning, to avoid the risk of collision with construction/decommissioning vessels and jack-up barges. This will therefore involve some loss of access to fishing grounds. However, it is expected that it will not be necessary to exclude fishing vessels from the entire wind farm area at once. A small safety-zone could be declared around the construction/decommissioning vessels as they progress across the site. Given the comments made above about the likely reluctance of fishermen to operate in the area, the financial impacts will be essentially be those calculated above for yearly losses in value-added, except that the full yearly losses will not be experienced in the first year if construction can be rolled out across the site.

6.4.4 *Mitigating Measures*

6.4.4.1 General Procedures

SeaScape will inform fishermen in the area in advance of all works likely to have an impact on commercial fishing activities. Appropriate charts and information on safety zones will accompany notification of these works and activities. Fishing vessels will also be used wherever possible, under contract and on agreed terms, to undertake any work required within the wind farm area during construction, operational and decommissioning phases.

6.4.4.2 Construction and Decommissioning Phase

A safety/buffer zone around vessels working in the area and around the jack-up barges will help to mitigate against accidents and collisions. All

vessels and barges will be adequately lit and marked, and appropriate night-time lighting provided for work after dark.

As stated above, anchor mounds are not thought to present a significant problem due the use of jack-up barges being in place for short periods of time. The discarding of construction debris on the seabed, will be mitigated by the requirement for an audit of equipment brought onto, and off, the site by all contractors. Both possibilities (anchor mounds and debris) will also be mitigated by conducting a trawl sweep across the area following construction, with a vessel towing a chain between trawl doors across the area to flatten any anchor mounds and identify any discarded debris.

A roll-out of the foundations and turbine installation being done together, rather than all the foundations first and then all the turbines, will help to minimise disruption to fishing activities and therefore financial losses. It is not unfortunately possible to mitigate against disruption by carrying out construction/decommissioning during winter months due to the need to complete these phases during good weather.

6.4.4.3 Operational Phase

The ability to remotely shut down the turbines will be essential for the safe operation of the wind farm and in times of emergency. It would also be ensured that all turbines can be shut down so that helicopter rescue can be used if necessary. Lighting will play a key part in reducing safety risks. All turbines will be fitted with downward sea-lighting to illuminate turbine foundations during night-time hours. The perimeter of the wind farm will also be lit, and steps will be take to ensure that each turbine can be fully lit if necessary in the event of sea-rescue.

All cables within the wind farm, and from the wind farm to the shore sub-station, will be laid at a depth of 2-3 metres to avoid any possible exposure. The location of the wind farm in an area that is not heavily fished, is itself a mitigating measure to reduce the financial impacts on fishermen. The safety measures described will also help to encourage fishermen that it is safe to operate in the area, as well as to travel through it. Ensuring that turbines are evenly spaced, rather than randomly placed will also reduce safety concerns, and thus possible financial losses if fishermen can be encouraged to operate in the area. This will ensure that tows can be made across the area.

6.4.5 Cumulative Effects

6.4.5.1 Impacts on Fishing Operations

It is noted that fishermen have expressed considerable concerns about the cumulative impacts of wind farm developments on their commercial activities. The presence of a wide range of possible fishing grounds is important to maintain fishing options, and thus earnings, in light of different seasons, weather conditions, use of alternative fishing gear, changing

market prices for different species, and so on. Given that there are now six possible wind farm sites being discussed in the Eastern Irish Sea, the cumulative impacts on these developments could be considerable if Exclusion Zones are imposed at some stage in the future.

As SeaScape Energy is not proposing to enforce an Exclusion Zone around the site, fishing can continue within the area. Therefore Burbo Offshore Wind Farm will have little cumulative effect with other wind farms. The overall area covered by the wind farm is small in comparison to the size of the fishing grounds in Liverpool Bay.

6.4.5.2 Mitigation

SeaScape, either independently or in consultation with other developers in the area, will seek to address issues around the cumulative impacts of developments on fishermen. In particular, as a member of the British Wind Energy Association, SeaScape will continue to provide support for, and input into, the BWEA Workgroup on Fisheries which is investigating the potential cumulative effects of wind farms on fisheries, and BWEA participation in Fisheries Liaison Meetings which are already taking place to agree and discuss issues of best practice, co-operation, co-ordination, communication, minimisation of disruption, navigation and exclusion zones, and health and safety. SeaScape will uphold any agreements reached through the BWEA Workgroup to the benefit of local fishermen.

6.3.6 Conclusion

The proposed development of the Burbo Offshore Wind Farm is unlikely to have a significant environmental effect on the fishermen and fisheries in Liverpool Bay. The lack of a proposed Exclusion Zone ensures regular fishing can continue, so long as the fishermen personally feel it is safe to do so.

6.5 Noise

6.5.1 Introduction

The relevant guidance for shore-based wind turbine developments is found in ETSU-R-97 report "The Assessment and Rating of Noise from Wind Farms" but this was not formulated with offshore wind power developments in mind.

The noise output from turbines of size and rating comparable with those likely to be installed at Burbo Bank was taken from manufacturers' published data. Calculations were performed in order to determine the contributions made by 30 turbines in an array some 6km to 12km offshore to the overall noise levels along the coast.

6.5.2 Assessment Criteria

6.5.2.1 PPG22

This Planning Policy Guidance Note specifies the issues that should be taken into account by local planning authorities when assessing the development of renewable energy projects. Regarding wind energy in particular, the guidance states that “the nature of noise emissions from the turbines” is one of four distinctive features of this type of development that must be taken into account in planning and development control.

Paragraph 13 in the Annex on Wind Energy requires that wind farms are located so that increases in ambient noise levels are kept to acceptable levels. It suggests that this objective may be achieved by good turbine design, and by allowing sufficient separation between the turbines and noise-sensitive locations (this would primarily be residential property, but buildings such as schools and hospitals would also be considered where relevant). Noise levels from operating turbines “are generally low” and under most conditions the turbines noise would be masked by a normal background of wind-generated noise. No guidance is offered, however, on what would constitute “acceptable levels”.

At paragraphs 41, 42 and 43 the distinction is drawn between mechanical noise from the gearbox, generator and drive train, and aerodynamic noise from the passage of the turbine blades through the air.

The next five paragraphs of Annex on Wind Energy deal with BS.4142:1990 [sic] but cautions that the use of this standard to assess wind turbine noise may be inappropriate. The reasons given are discussed in Section 2.3 below. If the provisions of BS.4142 are regarded as doubtful or inappropriate, the combined effect of the wind turbines is to be determined by reference to the particular character and sensitivity of the area. It is suggested that there is unlikely to be a significant noise problem for any residential property situated further than 350 to 400 metres from the nearest turbine.

Paragraphs 48 to 51 provide guidance on the assessment of background noise levels and the prediction of noise from a wind farm development. The use of the IEA Recommended Practice to determine the sound power emissions from a particular turbine type is regarded as the best practice.

6.5.2.2 PPG24

Planning Policy Guidance Note 24 relates to noise in general. It replaces previous guidance (Circular 10/73, which is now cancelled) and provides advice on how the planning system can be used to minimise the adverse impact of noise without placing unreasonable restrictions on development.

General guidance is provided on how noise may be assessed and controlled, and mitigation measures are suggested. These are of particular

relevance to conventional industrial noise sources, since they include the provision of noise barriers or enclosures, the protection of noise-sensitive buildings, measures such as allowing adequate source-to-receiver distances, and limitations to the permitted operating times of noise sources. It admits at paragraph 18 that there may be circumstances when it is acceptable to allow noise-generating activities near noise-sensitive properties, but renewable energy is not specifically mentioned in this context.

Noise exposure categories for new dwellings are specified at Annex 1 to PPG24, but these are intended for situations where new noise-sensitive property is planned in an existing noise environment, and are not therefore relevant to a wind farm development.

Annex 2 gives explanations of the noise exposure categories, and how they were derived. Annex 3 considers the assessment of noise from different sources, including road traffic, railways, aircraft, military aerodromes, helicopters, industrial and commercial developments, construction sites, recreational activities and waste disposal.

Annex 4 gives examples of planning conditions designed to limit noise emissions, but there is no condition designed expressly for wind farm developments.

Annex 5 discusses how noise limits should be specified, and reference is made to BS.4142:1990 and its application to conventional industrial developments. Information on other noise control regimes such as the Noise Act 1996 and the Environmental Protection Act 1990 is provided at Annex 7, and relevant Statutory Instruments are listed at Annex 8.

6.5.2.3 BS.4142:1997

As discussed above, the usual basis for assessing noise of industrial origin is BS.4142:1997, which calls for a comparison of the “new” noise with the pre-existing background noise expressed as the LA90 index. This is the A-weighted noise level which is exceeded for 90% of the measurement period, generally accepted in the UK as the underlying background noise level. The previous version of the standard (dated 1990) is cited in PPG22 as mentioned above. To summarise, complaints from local residents are only considered likely where a development gives rise to noise levels that exceed the previous ambient noise by 10dB or more. Where the “new” noise is 10dB quieter than the present ambient noise levels, this is to be taken as a positive indication that justifiable complaints will not occur. Differences of 5dB are regarded as being of marginal significance. In practical terms this means that there is a band of uncertainty at least 10dB wide, and probably nearer 20dB wide, within which neither developers nor the enforcement authorities have clear guidance they may rely on.

There are also several problems with the direct application of BS.4142:1997. Wind farms are usually situated in a rural and windy

environment where the conditions stipulated by the standard are often difficult to satisfy. Firstly, the area is not a mixed residential and industrial area as envisaged by the authors of the standard. Secondly, situations where background noise levels are below 30dBA are specifically excluded, but this is usually the case when the wind speed falls away. As will be discussed below, ETSU-R-97 recommends caution in the strict application of BS.4142 and goes on to recommend more applicable limits. Thirdly, it is recommended that noise measurements should not be taken in weather conditions where wind speed is greater than 5ms⁻¹. Since these are the wind speeds of particular interest, great care is necessary in measuring noise levels in order to eliminate wind noise on the microphone.

It is in the very nature of wind turbines that they do not operate below a certain wind speed: this “cut-in” speed is usually in the range 3.5 to 5 ms⁻¹. Therefore any noise limits on wind turbine developments could only be applicable above this critical wind speed. These circumstances were not foreseen by the authors of BS.4142, who assumed that for practical purposes (where any industrial noise generated is not wind-dependant) the conditions under which complaints from local communities are most likely are those when background noise is at a minimum, which would be during a calm night. Under those conditions it would be impossible for wind turbines to generate any noise at all, since they would be stationary.

6.5.2.4 ETSU-R-97

The ETSU report describes a framework for the measurement of wind farm noise and indicates desirable noise levels, so that without placing unreasonable restrictions of wind farm development, neighbouring residential properties can gain protection from excessive noise. A primary objective of the report is to suggest noise limits in a form suitable for adoption as planning conditions. The Noise Working Group that produced the report considered that absolute noise limits regardless of wind speeds are not suited to wind farms in the UK, and that it is more appropriate in the majority of cases to set noise limits relative to background noise. The background noise levels are to be measured over a range of wind speeds so that the impact of turbine noise, which is also wind-speed dependant, can be evaluated.

No specific method for the calculation of wind farm noise is recommended, although there is a basic requirement for turbine sound power level to be determined by a standard test method (such as the IEA Recommended Practice). Once the noise levels at critical locations have been calculated, it is recommended by ETSU that wind farm noise should not exceed the background noise at the same wind speed by more than 5dB. However, in low-noise environments it is recommended that a minimum absolute noise limit of 35dBA should apply.

There is no mention of noise from sources other than the turbines themselves in this guidance document.

6.5.3 Background Noise

6.5.3.1 General Remarks

ETSU recommends that measurements of ambient noise are made 24 hours a day for at least a week (preferably longer) at residential properties most likely to be affected by the development. In practice this means that for a conventional onshore wind farm, automatic noise monitoring takes place for 10 to 14 days at the closest dwellings to the site – typically these might be between 500m and 1km away from the nearest turbine. The noise measurements are synchronised with wind speed measurements on site, and ten-minute averages are recorded of the average wind speed and the LA90 statistical noise index. The correlation between wind speed and noise level is then investigated.

This approach was not considered appropriate for an offshore wind farm development, the main reason being the separation distances involved. For example, if the wind speed at the offshore location is 10ms⁻¹ and the wind direction is directly onto the shore, the wind will take 700 seconds – nearly 12 minutes – to travel a distance of 7km. During those 12 minutes the wind will vary somewhat in direction and speed, so noise level readings onshore would not correlate with offshore wind measurements. If the wind were tending to blow at an oblique angle to the shoreline, the time lapse would be even longer, and if the direction were reversed, the noise measurements would be an unknown time before the wind speed was registered offshore. The wind speed at each individual turbine is the main factor determining its noise emission at any instant.

Nevertheless, in order to gain an impression of the nature of the noise climates in areas most likely to be affected by noise from the offshore wind farm, spot measurements were made at three locations near relevant coastlines. This was not a full ambient noise survey as envisaged by ETSU-R-97 and described above, but was intended merely to gain an impression of the type of area and the noise levels that might be expected.

The day was chosen by considering weather reports and forecasts: a day was sought that was sufficiently windy offshore to operate wind turbines, but would not be considered windy onshore. These are the conditions under which wind farms are most likely to be heard by a casual observer, since there is insufficient wind to increase the background noise levels and thus mask the turbine noise.

6.5.3.2 Details of Noise Survey

Weather

Survey work was carried out on the afternoon of 15 April 2002 which was fine with a typical air temperature of 12°C and an intermittent light westerly breeze at a speed of approximately 2ms⁻¹ at ground level. There was cloud cover of approximately 1/8 and there was no rain during the course

of the measurements. Road surfaces were dry. High tide at Liverpool on that day was at approximately 13:30hr, so throughout the measurements the tide was fairly high but on the ebb.

Instrumentation

A Bruel and Kjaer type 2260 Investigator (precision integrating sound level meter) was used for all measurements. It was fitted with a type 4183 condenser microphone and a foam windshield.

Calibration was checked before and after the survey using a type 4231 electronic calibrator, and no drift was observed. The entire measurement chain is subject to regular laboratory calibration, the most recent having been in October 2001.

The sound level meter was mounted on a tripod with its microphone 1.2m above ground level. It was pre-set to take 10-minute samples during which the usual statistical noise indices were recorded.

Measurement Locations

The locations selected for sample measurements were (1) the junction of Park Drive and The Serpentine, Blundellsands, and (2) Coastal Drive, New Brighton. However, it quickly became clear that the noise levels at the latter were dominated by road traffic on Kings Parade (the promenade) so another location (3) was selected in the car park between Wallasey Golf Club and Mockbeggar Wharf.

6.5.3.3 Results

Table 6.2: Sample measurements of ambient noise, 15 April 2002

location	start	end	LAeq	LA90	LA50	LA10
Park Drive,	12:41	12:51	62.7	36.4	40.4	66.2
Blundellsands	12:51	13:01	63.45	34.2	42.8	68.4
	13:01	13:11	63.9	35.6	41.8	68.6
	13:11	13:21	63.2	34.8	43.8	68.2
	13:21	13:31	64.0	31.4	39.8	68.2
	13:31	13:41	63.3	32.0	42.2	68.0
Coastal Drive,	14:23	14:33	61.1	41.0	45.0	61.2
New Brighton	14:33	14:43	61.8	42.4	47.8	62.8
Mockbeggar Wharf,	14:49	14:59	49.7	45.4	46.8	49.8
New Brighton	14:59	15:09	47.1	44.4	46.0	48.2
	15:09	15:19	46.2	42.6	44.4	49.0
	15:19	15:29	47.8	42.8	45.0	49.2

The typical daytime LA90 values at Blundellsands were in the range 31 to 36 dB. It would be very unusual for daytime background noise levels to fall below 31dB if there were sufficient wind at the offshore location to operate wind turbine generators.

The daytime LA90 values at the two New Brighton locations were very similar, being in the range 41 to 45 dB. However, there was a marked difference in the measured LAeq values as the Coastal Drive location was subject to considerable road traffic noise, whereas the Mockbeggar Wharf car park was not. It is worthy of note that the road surface along Kings Parade was unusually noisy because of its surface roughness.

No further background noise surveys were undertaken for comparison with wind turbine noise levels, as the predicted contributions from the turbines discussed in Section 4.6 were so much lower. If turbine noise were 15 to 20 dB below background there would be no change in level and thus no environmental noise impact during the day.

The ETSU report recommends that the night-time noise impact of a wind energy development is assessed against sleep disturbance criteria, because it is assumed that residents would suffer loss of amenity inside their homes, rather than outside. The difference between the background noise level and the contribution from the turbines would still be the main issue. However, the turbine noise will be at such a low level that when the attenuation provided by the building envelope is taken into account (even with the window open), there will be no measurable change inside the property. Accordingly there was no need to undertake time-consuming studies of the background noise levels in various wind conditions.

The possible noise impact of onshore aspects of the development (particularly the electrical substation) is discussed in Chapter 8 of this volume.

6.5.4 Wind Turbine Noise Assessment

6.5.4.1 Characteristics of Wind Turbine Noise

Noise from wind turbines is typically made up of three distinct elements: a reasonably steady, broad-band noise of aerodynamic origin, which depends on blade tip speed; a tonal noise element from mechanical components within the nacelle; and a regular, pulsed element resulting from the interaction of blade and tower (blade thump).

6.5.4.2 Turbine Noise Data

Sound Power Emissions

It is Seascope Energy's intention to use Vestas V90 (or similar) wind turbines at this site. The Vestas V90 is a pitch-regulated upwind wind turbine with active yaw and a three-blade rotor 90m in diameter. It has a power output of approximately 3MW. The hub height is approximately 85m above sea level, the swept area of the blades is 6362m² and the rotor is governed to a maximum of just under 17rev/min. Its cut-in wind speed is 4ms⁻¹, nominal speed is 16ms⁻¹, and the blades stop moving once wind speeds reach 25ms⁻¹.

The base data for the wind turbine was taken from actual measurements by others on a similar V80 machine (the V90 is currently at the prototype stage and no certified noise data was available at the time of writing). The method used to obtain sound power data conformed with International Energy Agency (IEA) recommended practice, the most commonly used procedure, which calls for measurements close enough to the turbine that background noise is insignificant. Spherical sound radiation was therefore assumed for the certification tests. The data was then extrapolated for a hub height of 100m

The overall sound power level of the Vestas V90 wind turbine will be 105dBA at the reference wind speed of 8ms⁻¹. This emitted sound power depends on wind speed: the sound power increases at approximately 0.7dB per ms⁻¹ above a wind speed of 8ms⁻¹ but falls off more steeply at lower wind speeds. Sample sound power levels against wind speeds measure at a height of 10m are shown in Table 2.

Table 6.3: Sound power emissions at various wind speeds, Vestas V90

wind speed ms-1	turbine sound power dB
4	94.0
6	101.5
8	105.0
12	108.0
15	110.0

The turbine will have a directivity index of 0dB in all directions, so the individual noise source has no significant directional characteristics. However, the directional characteristics of the whole development are determined by two factors: wind direction and the shape of the turbine array. Wind direction affects the way in which sound propagates over large distances: this is discussed in more detail in Section 6.5.4.4 below. The geometry of the array is taken into account in the calculations by treating each turbine as a separate noise source.

6.5.4.3 Calculation Procedure

The method adopted for the prediction of noise from the offshore wind farm assumes hemispherical sound radiation from each turbine. This is because although the hub height will be in excess of 100m above sea level, the propagation distances are great in comparison. There is assumed to be no significant attenuation from ground effects: a still water surface is an extremely good sound reflector, although the presence of waves on the surface of the sea tends to scatter incident sound.

Two typical reception points were adopted, one at Blundellsands (national grid reference 330200E, 399850N) and the other at New Brighton (329900E, 394300N). The locations have no special significance and are arbitrary points for calculation purposes chosen to be the closest distance

between land and the geometric centre of the wind turbine array in each case. No housing is closer to the turbines than is the appropriate arbitrary point.

Air absorption varies with frequency and distance, and with temperature and relative humidity, so certain assumptions must be made in order to keep the predictive calculations manageable. The attenuation data published in CONCAWE 4/81, the propagation of noise from petroleum and petrochemical complexes to neighbouring communities, provides valuable guidance, since it provides actual observations of the sound-absorbing properties of atmospheric air in a variety of climatic conditions. During the long-term measurements conducted on behalf of CONCAWE, the air temperature varied between 0°C and 30°C, and the relative humidity from 55% to 100%. In general it was confirmed that increasing air temperature tends to increase the amount of acoustic absorption, and increasing the relative humidity tends to reduce the absorption.

In order to calculate the steady noise from the proposed offshore wind farm the combined effect of thirty wind turbines is calculated. The turbines will be set out in an array, and the separation distances (to the nearest 50m) from the point of view of the two closest sections of coastline are shown in Table 6.4. The nearest turbine is number 23, which is some 6.5km from the coast in the Crosby area, and 7.6km from the Wirral coastline.

Table 6.4: Separation distances

turbine no.	distance (m) from:		turbine no.	distance (m) from:	
	Blundellsands	New B'ton		Blundellsands	New B'ton
T1	9050	11100	T16	8350	9750
T2	10100	11950	T17	9400	10650
T3	11150	12800	T18	10450	11550
T4	8600	10550	T19	6950	8350
T5	9650	11400	T20	8000	9200
T6	10700	12250	T21	9000	10100
T7	8150	10000	T22	10050	11000
T8	9200	10850	T23	6550	7800
T9	10250	11700	T24	7600	8650
T10	11300	12600	T25	8650	9550
T11	7750	9450	T26	9700	10450
T12	8800	10300	T27	7250	8100
T13	9850	11150	T28	8300	9000
T14	10850	12100	T29	9350	9950
T15	7300	8900	T30	9000	9400

6.5.4.4 Effect of Wind Direction

The direction of the wind makes the noise from the turbines effectively directional, since downwind, the noise from the wind farm will increase with wind speed, and upwind, the noise will be attenuated with increasing wind speed. Measurements on actual turbines are always made downwind of the turbine, so at a cross-wind location there would be a degree of

attenuation which also depended on the distance from the source. Upwind, there would be more attenuation. The attenuation due to wind direction is also affected by air temperature and surface scattering, so the actual effect of wind direction may be subject to a small variation. However, at distances of between 6.5km and 15km, the noise levels will be at their maximum when the receiver is anywhere substantially downwind of the array of turbines.

6.5.4.5 Effect of Atmospheric Absorption

Another important factor determining the noise levels at kilometric distances is the degree of attenuation due to air absorption. This in turn depends on the atmospheric temperature and relative humidity, as well as the frequency content of the sound. The trends are that as air temperature increases (in a normal UK range between 0°C and 30°C) the atmospheric absorption increases, and as the relative humidity increases from 50% to 100%, the absorption decreases slightly. Frequency effects are such that increasing the frequency (ie decreasing wavelength) greatly increases the amount of atmospheric absorption. This is the reason why low-frequency sounds carry much better over long distances – foghorns at sea are low-pitched, not high-pitched.

The effects of the atmosphere were allowed for in the calculations by assuming three representative cases of low, medium and high absorption. A typical spectrum of wind turbine noise for a large Vestas turbine was then used to determine the frequency effects, so that the atmospheric absorption applicable to the overall A-weighted noise levels could be calculated. The results of this exercise are shown in Table 6.5.

Table 6.5: Atmospheric absorption over large distances

Atmospheric condition	Air temperature	Relative humidity	absorption per km
low	0°C	100%	1.5dB
medium	10°C	75%	2.1dB
high	20°C	55%	2.8dB

6.5.4.6 Results

The LAeq values resulting from the operation of all 30 turbines together, received at the two arbitrary locations, are shown in Table 6.6.

Table 6.6: Predicted noise level contributions LAeq dB at coastal residential properties, assuming low, medium or high air absorption

wind speed ms-1	Blundellsands			New Brighton		
	low	medium	high	low	medium	high
4	9.3	4.4	-1.1	6.1	0.5	-5.8
6	16.8	11.9	6.4	13.6	8.0	1.7
8	20.3	15.4	9.9	17.1	11.5	5.2
12	23.3	18.4	12.9	20.1	14.5	8.2
15	25.3	20.4	14.9	22.1	16.5	10.2

It should be noted that the values in Table 6.6 are the noise levels that would result from the operation of the offshore wind farm alone, disregarding any background noise that would already be present at the reception point. In order to calculate the noise level that would be measured at a location under particular wind conditions, it is necessary to know the pre-existing noise level due to wind effects and other activity (such as road traffic). If the wind farm noise contribution were more than 20dB lower than the background noise, there would be no effect whatsoever on the measured level. If wind farm noise were more than 10dB but less than 20dB below background, there would theoretically be a very slight increase in the resultant noise level. This increase would be approximately 0.4dB if the difference were 10dB, but only 0.05dB if the difference were 19dB. Changes of less than 1dB could not be reliably detected by a field measurement.

6.5.4.7 Discussion

The calculations show that the noise levels received at the nearest critical locations would generally be in the range 10 to 20 dBA at wind speeds up to 8ms⁻¹. The level of background noise would then be in excess of 30dBA, thus exceeding turbine noise by a minimum of 10dB, and probably much more. It follows that turbine noise will have no discernible or measurable effect on overall noise levels, and that the turbines will be inaudible even when the wind blows directly onshore.

6.6 Archaeology

6.6.1 Introduction

The assessment of the archaeological impact of the project was confined to a study of the available documentary, cartographic and photographic sources and followed recommendations received from the Royal Commission on the Historical Monuments of England.

The following bodies were consulted:

- Merseyside Sites and Monuments Record
- The National Monuments Record
- National Museums and Galleries on Merseyside, Merseyside Maritime Museum
- National Museums and Galleries on Merseyside, Maritime Archives and Library
- Liverpool Record Office
- Archaeological Diving Unit (website)

Details of individual specialists contacted are given in the full report (see Technical Appendix F).

In addition data gathered during the geophysical survey of the area was examined and the land-based sub-station site visited. However, no invasive fieldwork was undertaken on any of the sites.

Marine archaeology forms an important part of the national heritage and includes single artefacts, inundated earthworks, midden sites, shipwrecks, ancient harbours and submerged villages. These range in date from the end of the Ice Age to the 20th century. The evidence also includes sediments containing pollen and other important indicators of the environment in the past. There can be a considerable degree of overlap between terrestrial and marine sites and the latter should not be viewed in isolation from more 'conventional' terrestrial archaeology, but rather as a continuum.

Off-shore archaeological sites can be covered by a number of pieces of Government legislation including; The Protection of Wrecks Act (1973), The Merchant Shipping Act (1995), The Ancient Monuments and Archaeological Areas Act (1979), The Protection of Military Remains Act (1986) (Oxley and O'Regan 2001). In general these Acts provide statutory protection for specific wreck sites, though the Merchant Shipping Act is primarily concerned with salvage rights and the Military Remains Act with war graves. The National Heritage Act (2002) extended English Heritage's remit to cover all types of sites from the low-water mark to the 12-mile limit around England, the Act's implications, in particular with regard to English Heritage policy, are summarised in Roberts and Trow (2002). The most important of these is the provision for Scheduled Ancient Monument protection for off-shore sites.

6.6.2 Archaeological Assessment of Burbo Bank

Two broad classes of archaeological remains are likely to be present within the limits of the wind farm site. The first consists of buried deposits of peat or similar organic material containing evidence relating to the Prehistoric environment and ecology of the area. The second consists of shipwreck sites dating from the Prehistoric to the present day.

Very little research has been conducted into the potential for off-shore buried archaeological deposits off the coast of North-West England, though it has been possible to make some extrapolation from the results of work on land based sites and the geophysical survey conducted for this project.

Documentary sources regarding the location of shipwrecks are generally piecemeal and fragmentary. Although documents regarding shipping in the region survive from the early medieval period, few accurate locations exist prior to the mid-18th century and official recording of wrecks only began in the mid-19th century. Even then, the very nature of the losses meant that most wreck sites could not be accurately recorded and detailed records will often only exist for inshore losses, even into the 20th century. Many

early wrecks occurred because of navigation errors and in addition the ships log will have been lost with the vessel, making location impossible.

Official documentation of wreck sites in Liverpool Bay only began about 1860, following the foundation of the Merseyside Docks and Harbour Board. Earlier records exist, though these are confined to press reports, insurance company records and individual accounts. A number of wreck sites were located as the result of the geophysical survey conducted for this project.

6.6.3 *Summary of Archaeological Assessments*

6.6.3.1 Offshore Archaeology

The Burbo Bank area potentially contains deposits relating to the early post-glacial environment of the area. The most significant of these are likely to be deposits of peat or similar material at the interface between the Boulder Clay and the overlying sands. These deposits are buried c. 10 m below the sands composing the bank and will probably only be accessible by bore-hole or similar surveys.

The study area contains no Designated Wreck Sites and no War Grave Sites. However, it is located close to major shipping routes in and out of the Mersey which have been in use since at least the 16th century, probably earlier, and close to the Roman and medieval shipping routes into Chester. Only three documented wreck sites can be accurately located within the wind farm study area from documentary records. However, numerous losses have been recorded on the Burbo Bank since the early 18th century and the accurately located sites in the area will represent only a small percentage of the actual losses on the bank.

The geophysical survey located nine potential wreck sites within the wind farm site, two of which can be positively identified with known losses. One of these is a ketch, the 'Sarah' lost in 1917 and partly dispersed by the Mersey Docks and Harbour Company (MDNC) shortly afterwards. The other identifiable wreck is that of the 'Thornton' a steamer which sank in 1867. No detailed records of this vessel were traced. The remaining sites identified by the geophysical survey are either unrecorded losses since c.1860 or the sites of earlier losses.

None of these sites lie on the proposed locations of turbines, the closest is at least 50 m distant.

6.6.3.2 Foreshore Archaeology

The settlement at Meols was occupied from the Iron Age to the late medieval period and is the most important of its type in Northern England. Finds relating to the earlier Prehistoric settlement have also been made on the foreshore. However, most of the associated archaeological deposits have either been eroded by the sea or lie deeply buried beneath the

sands. In addition, the main concentration of finds occurred c. 5km to the west of the cable landing site. However, finds were made all along the north Wirral coast from the 1840's to the present day, the most notable of these in the current context is the circular hut recorded by Cox (1895) as being located close to Wallasey.

6.6.4 *The Potential Environmental Effects of the Development*

6.6.4.1 Construction Phase

Four classes of monument or archaeological deposit are at risk of potential damage or disruption during construction of the wind farm, the associated cable runs and sub-station. Shipwreck sites identified from documentary sources and geophysical survey at risk of damage or disruption during piling operations by the driving of piles, the use of 'jack-up barges' and the positioning of anchors. Laying of cables also poses a risk to exposed or buried wreck sites. Buried deposits of peat containing important information relating to the past environment of Liverpool Bay likely to be present in the area of the wind farm may also be disturbed during the driving of piles. However, this is likely to be confined to the pile core, any such sediments are likely to be sufficiently deeply buried to avoid damage as a result of the use of jack up barges and/or anchors. Deposits on the foreshore relating to the settlement at Meols may be disturbed by the laying of cables across that area.

6.6.4.2 Operational Phase

Little disruption is likely to occur during the operational phase of the wind farm. The only potential effect is disturbance to adjacent wrecks or deposits of peat as a result of increased erosion due to scour around the base of the foundations. However, the potential peat deposits are sufficiently deeply buried for this to be unlikely and no recorded wrecks are located within 50 m of any of the turbine bases.

6.6.4.3 Cumulative Impact

Very little off-shore development has taken place in Liverpool Bay and the surrounding region and given the relatively poor state of knowledge of the archaeology in the area it is difficult to make an accurate assessment of the cumulative impact of this and other developments in the area. However, given that the mitigation measures (see below) specify the avoidance of the detected wreck sites and that the area of potential peat deposits directly affected is a small proportion of the total, the cumulative impact of this development is very low. There will be no cumulative impacts with other wind farm developments in the North West due to the localised nature of the impacts. In fact the potential for recovery of samples of peat from otherwise inaccessible deposits of peat suggests a net potential benefit to archaeology from the development.

6.6.5 *Impact Avoidance, Mitigation and Monitoring*

The exact nature of any buried palaeo-environmental deposits on Burbo Bank is currently unknown. Monitoring of boreholes for construction has the potential to greatly enhance our understanding of the immediate post-glacial landscape and as such could be regarded as being of a net benefit to archaeology. Borehole samples taken on Burbo Bank will be investigated for their archaeological and paleo-environmental content. Such work would need to be conducted by an appropriately qualified specialist. No known shipwrecks on the bank or cable route are directly affected by any of the proposed turbines. However, it is possible that wrecks close to turbine sites would be affected by construction works, for example anchor points and jack-up barges. The contractor will be made aware of the location of wrecks and the sites will be avoided. The layout of cables within the wind farm site will be designed to avoid wreck sites. As all of the sites can be avoided, no further investigation of the sites will be required as part of this project, though interested parties (MMR, MSMR) will be informed of their presence.

The foreshore and land based section of the cable route passes through an area which may contain deposits relating to the prehistoric and later settlement of the area. However, the construction method used to breach the sea wall mean that any disruption caused will be minimal and no deposits will be brought to the surface.

No post-construction monitoring will be required for the off-shore components of the scheme.

6.6.7 *Conclusion*

This study has been confined to the available documentary and cartographic sources, supplemented by a geophysical survey of the area. Whilst the documentary sources are fragmentary, particularly for early periods, they show that the construction of the wind turbines on Burbo Bank is very unlikely to have a significant effect on any known archaeology within the development site. However, it is likely that significant palaeo-environmental data will be recovered from boreholes and this may significantly enhance our understanding of the post-glacial environment of the region. This should be regarded as a net benefit. The cable route will be routed to avoid any direct impact on known archaeological sites.

6.7 Shipping and Navigation

6.7.1 *Introduction*

6.7.1.1 Background

In order to identify the existing uses of the proposed offshore site area in terms of shipping and navigation, Seascope commissioned Anatec UK to

assess the existing activity in the proposed area and estimate the potential impact and risks to shipping as a result of the development. The Mersey Docks and Harbour Company (MDHC) at the Port of Liverpool were consulted during the preparation of this document and provided a supporting study .

6.7.1.2 Objectives

The objectives of the study were to satisfy the requirements of the guidance issued within the Coast Protection Act for the locating of offshore installations as well as the recent draft guidance issued by the Maritime and Coastguard Agency on assessing the navigational impact of offshore wind farms. The study also determined the likely effect of the development on navigation for the purposes of the Environmental Impact Assessment Regulations.

The detailed objectives of this assessment were as follows:

- Identify the main merchant shipping routes passing the proposed offshore wind farm.
- Review the likely effect of the development on merchant shipping navigation.
- Quantify the shipping collisions risks associated with the wind farm.
- Perform a qualitative review of recreational sailing activity in the area.
- Review additional issues associated with the construction and decommissioning phases.
- Address other navigational issues relating to the wind farm, such as access for emergency services.
- Present recommendations to manage the risks and minimise disruption to shipping.

6.7.1.3 Location Overview

The proposed wind farm will consist of 30 turbines located at Burbo Bank within Liverpool Bay.

Figure 6.2 presents a chart overview of the wind farm position whilst Figure 6.3 shows a detailed view of the planned 30 turbine locations. There are approximately 550 metres between turbines within each column. The overall area of the wind farm boundary is approximately 10 square kilometres.

The charted water depth within the wind farm boundary varies from under 2m to 6m above chart datum. However, the approaches to Liverpool have one of the largest tidal ranges in the UK and during extreme Spring Tides the range can be in excess of 9.5m.

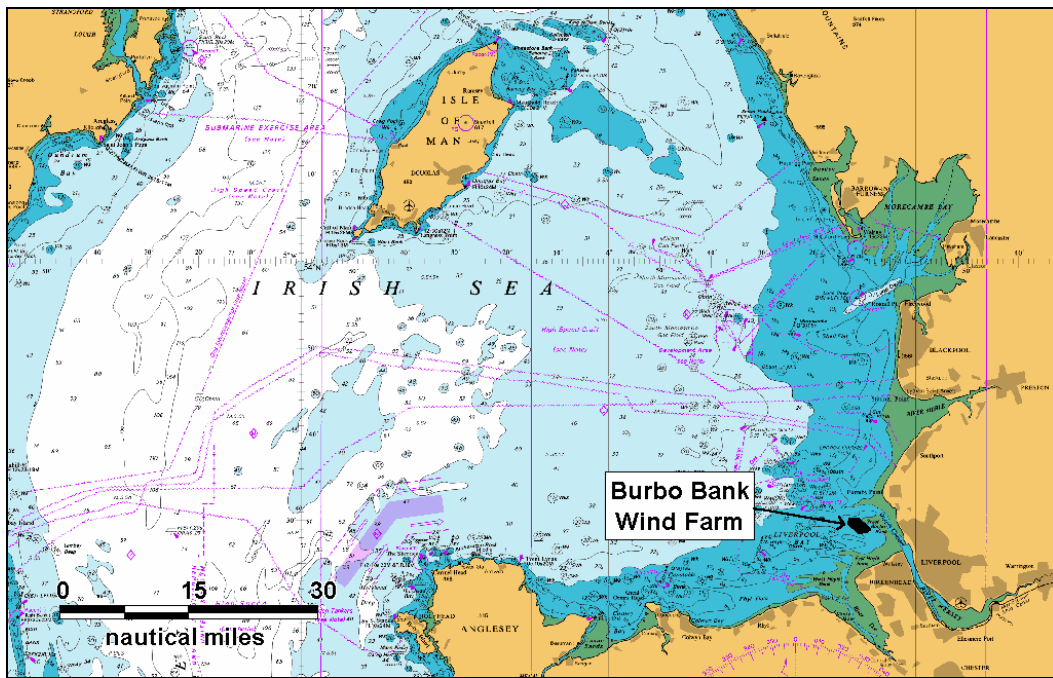


Figure 6.2: Chart overview of planned Burbo Offshore Wind Farm

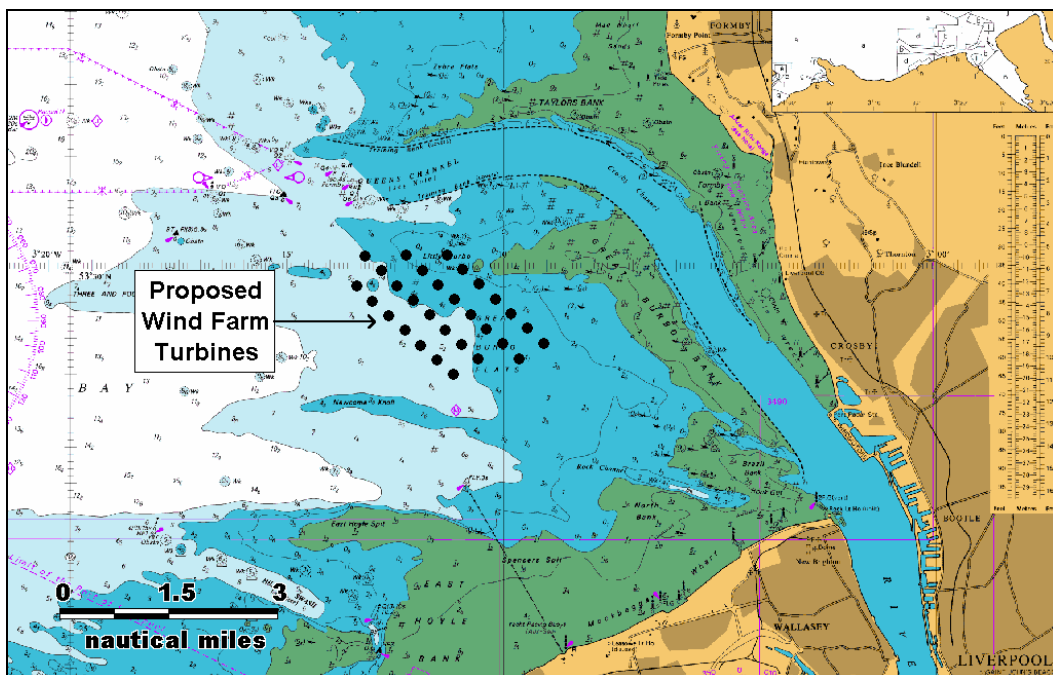


Figure 6.3: Detailed chart of wind farm turbine locations

6.7.2 Shipping and Navigation

6.7.2.1 Introduction

The most up-to-date shipping data available has been used to assess the effect of the proposed Burbo Bank development on merchant shipping.

This was extracted from ShipRoutes, which contains comprehensive information on ship routing within UK waters. This data has been verified against data from MDHC.

6.7.2.2 Ship Routing

ShipRoutes was interrogated to identify all shipping routes to/from Liverpool passing the Burbo Bank Offshore Wind Farm. All the routes were identified to use the Queens Channel and hence passed the wind farm at a common mean Closest Point of Approach of 1.1nm to the North of the Northern row of turbines, as shown in Figure 6.4. In total, 12,340 vessels per year are estimated to pass through the Queens Channel on this route, corresponding to an average of 34 vessels per day.

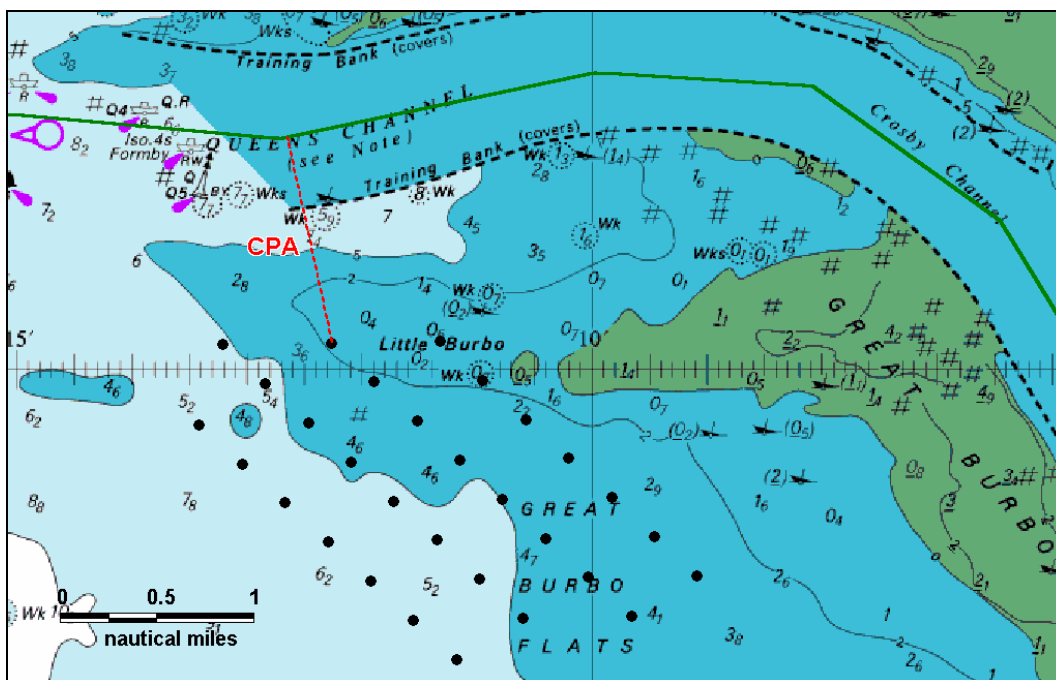


Figure 6.4: Mean CPA of Liverpool routes passing Burbo Bank

Farther to the West in Liverpool Bay this traffic splits into 13 main routes as described in Table 6.7 and Figure 6.5.

Table 6.7: Routes to and from the Mersey

Route No.	Description	Ships per Year	% of Total
1	Mersey-Mostyn	188	1.5%
2	Mersey-Dredging Area	320	2.6%
3	Point Lynas-Mersey	799	6.5%
4	Mersey-Skerries TSS (1)	3772	30.6%
5	Mersey-Skerries TSS (2)	2900	23.5%
6	Mersey-Douglas Field	26	0.2%
7	Mersey-Skerries TSS (3)	1301	10.5%

Route No.	Description	Ships per Year	% of Total
8	Mersey-Hamilton Field	26	0.2%
9	Mersey-North Channel	1800	14.6%
10	Mersey-Douglas, Isle of Man	1036	8.4%
11	Mersey-Hamilton North Field	26	0.2%
12	Mersey-Morecambe Field	54	0.4%
13	Mersey-Solway Firth	92	0.7%
Total		12,340	100%

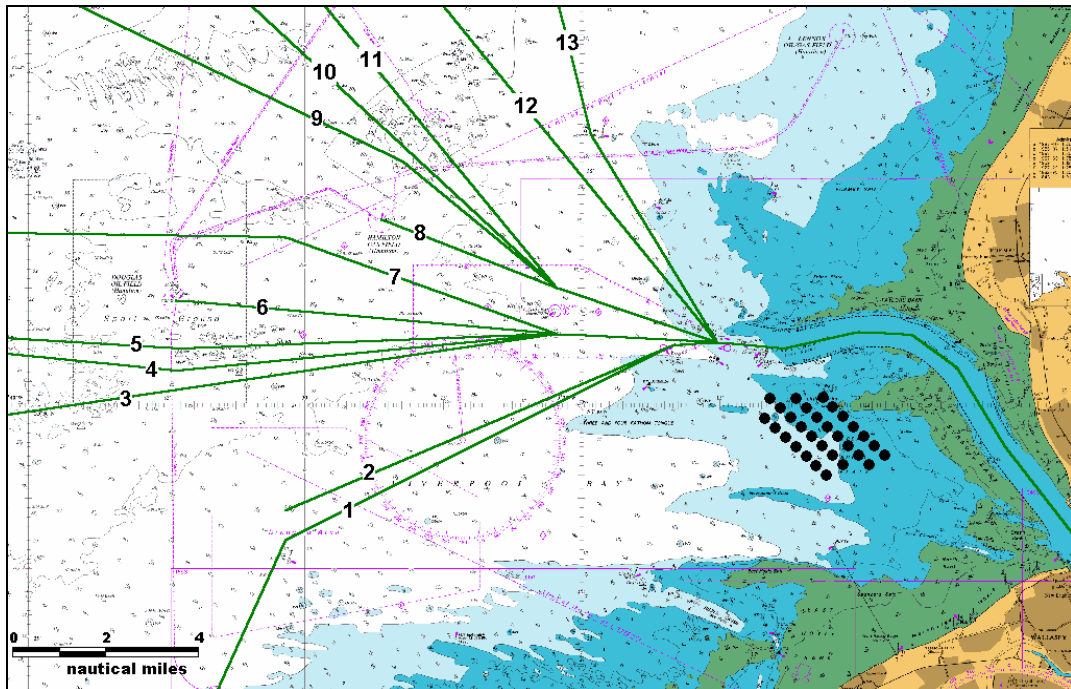


Figure 6.5: Mean route positions to and from the Mersey

The majority of the traffic (65%) is heading via The Skerries TSS off Anglesey (Routes 4, 5 and 7).

To illustrate the variation in shipping density in the area, Anatec's GIS-based shipping density model was used to estimate the number of vessels per day passing through a grid of cells encompassing the area of interest. Each grid cell is 500m by 500m. A colour-coded plot of the shipping density is presented in Figure 6.6, which also shows the grid boundaries (land-based cells were excluded).

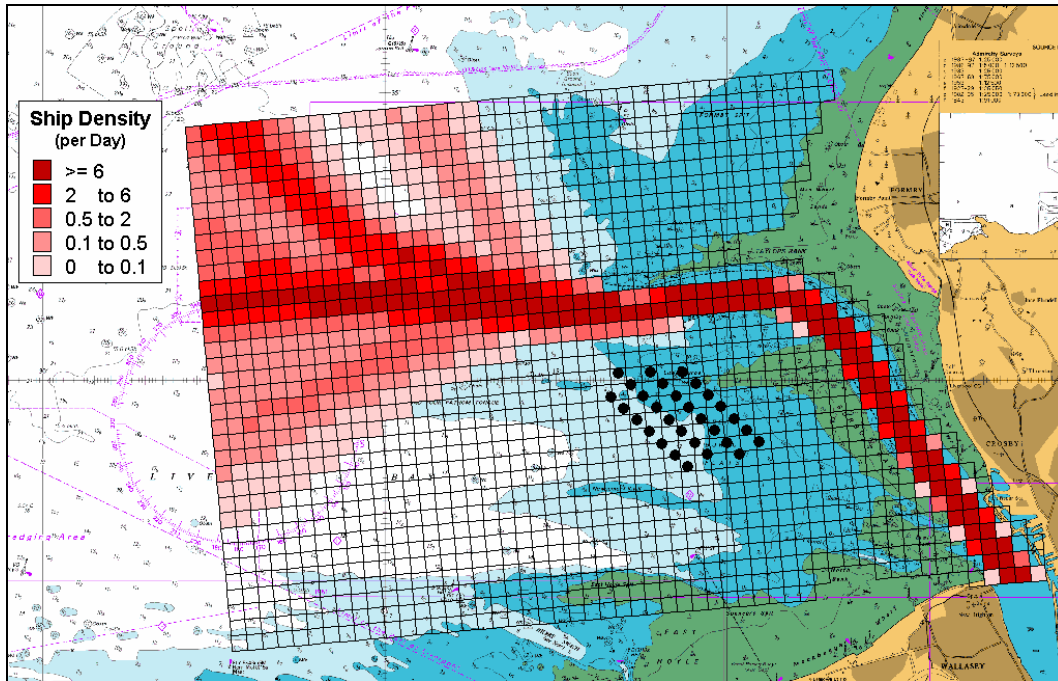


Figure 6.6: Shipping density grid in Liverpool Bay

6.7.2.3 Review of Shipping Navigation

The main navigational features in the vicinity of the proposed Burbo Bank Offshore Wind Farm are presented in Figure 6.7.

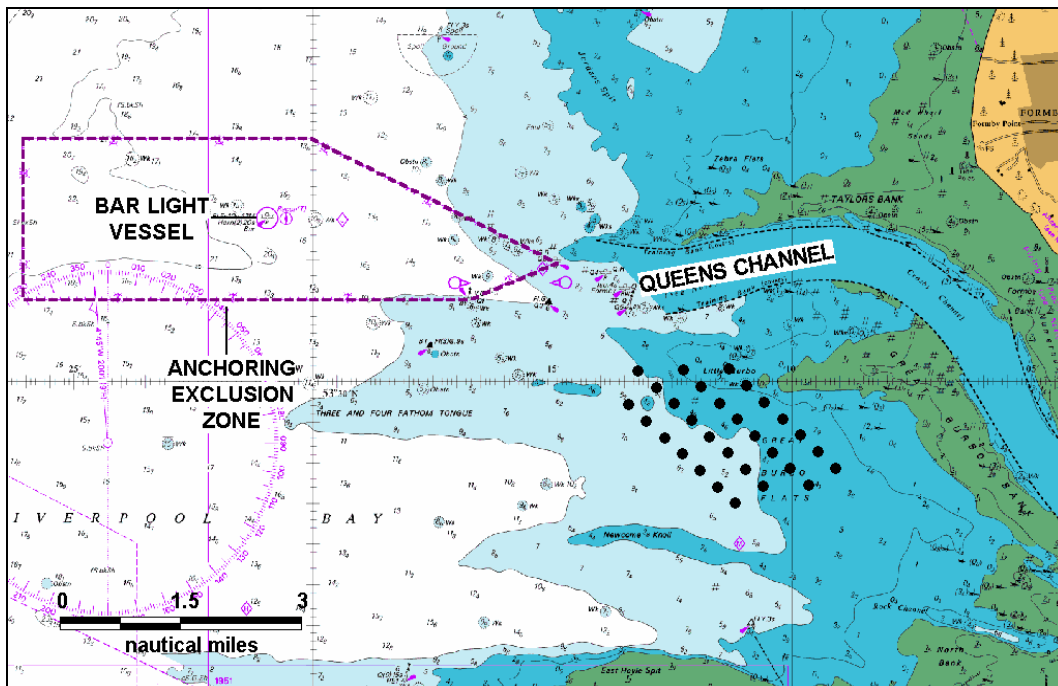


Figure 6.7: Existing navigational features in the area

To warn mariners of the wind farm the development will be marked in accordance with IALA recommendations for marking offshore wind farms

under the supervision of Trinity House Lighthouse Service, the lighthouse authority for England and Wales. The main points are as follows:

- The wind farm will be marked as a unit.
- The perimeter of the wind farm will be marked with special buoys with flashing yellow lights with 5nm range.
- All buoys will be fitted with radar reflectors.
- A foghorn will be installed at the centre of the array with an audible range of at least two miles.

The potential ranges of the lights and foghorn are illustrated in Figure 6.8 based on the IALA recommended ranges. There are no plans to have an exclusion zone around the wind farm.

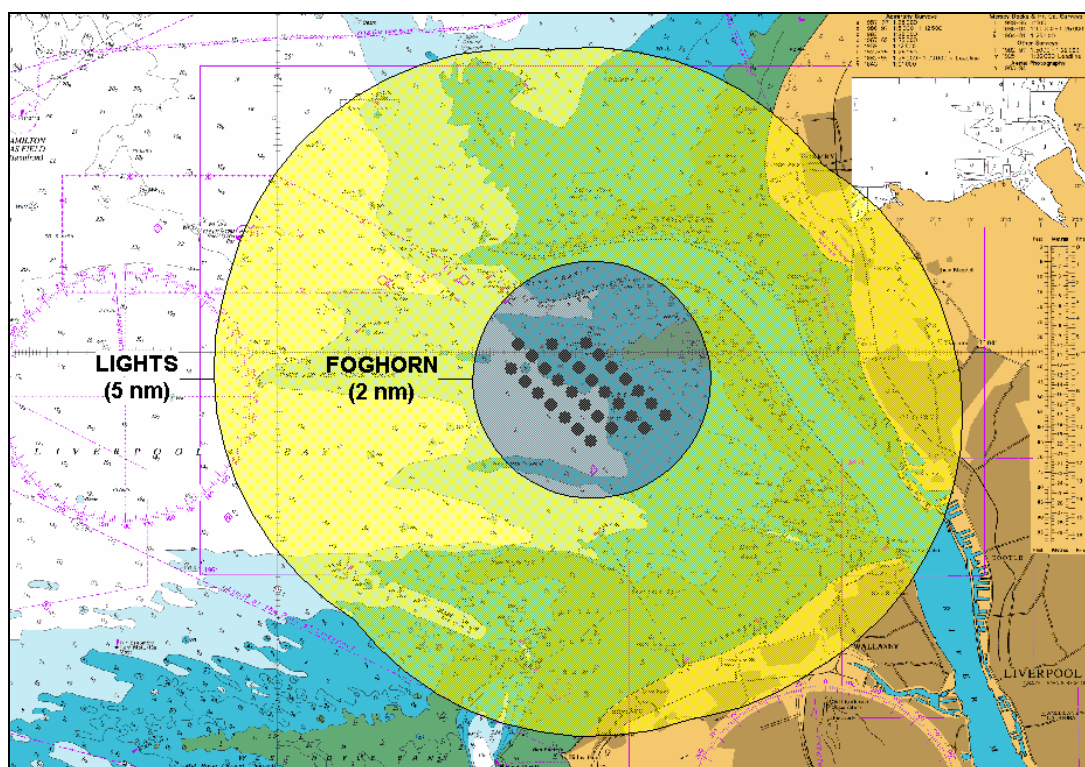


Figure 6.8: Range of light and sound signals (based on IALA ranges)

It was estimated that an average of 34 vessels per day are passing at a mean distance of 1.1nm from the nearest proposed row of wind turbines. However, due to the traffic converging at the Queens Channel entrance, which is 0.8nm wide between the training banks, it is normal for vessels to pass at a distance of around 1.1nm without their routeing being affected by the proposed wind farm.

The site may cause some reduced visibility between vessels at either end of the Queens Channel. However, this is over several miles distant and commercial vessels will normally have a Pilot (or Master with a PEC) on board and be in communication with Port Operations Control at this stage, who provide radar coverage of the area. It is not considered that the site

will greatly affect visibility of any navigational features on the coastline and, overall, the potential impact on the navigation of passing shipping is assessed to be minimal.

6.7.3 Risk Assessment

6.7.3.1 Introduction

The following risks to shipping were identified to be introduced by the proposed wind farm development:

- Passing Powered Ship Collision
- Drifting Ship Collision
- Fishing Vessel Collision

Therefore, quantitative modelling of these risks was performed using Anatec's COLLRISK models with shipping, wind farm and weather data as input.

6.7.3.2 Passing Powered Vessel Collision

The ship/wind farm passing powered collision model was run using the area represented by the perimeter turbines as the collision hazard. Based on this the annual powered ship collision frequency for the wind farm at Burbo Bank is estimated to be 3.9×10^{-5} , corresponding to a collision return period of 26,000 years. This is considered to be conservative, as there is the potential for an errant vessel to pass through the wind farm area and not collide with a turbine.

The historical average annual passing vessel collision frequency for offshore platforms on the UKCS is 9.2×10^{-4} per installation-year. Therefore, the collision risk at the Burbo Bank Wind Farm is over an order of magnitude lower.

6.7.3.3 Drifting Vessel Collision

The risk of a passing vessel losing power or an anchored vessel dragging anchor and drifting into a wind farm structure was estimated to be 2.6×10^{-4} per year, an average of one collision in 3,800 years.

A thematic map of the drifting collision frequency per turbine is presented in Figure 6.9. This illustrates that the turbines along the Northern row of the wind farm have the highest risk of a drifting vessel collision, which is a reflection of the prevailing wind which is a South-westerly. The figure also indicated that the inner turbines tend to have lower collision risk since they are shielded to an extent by the outer structures.

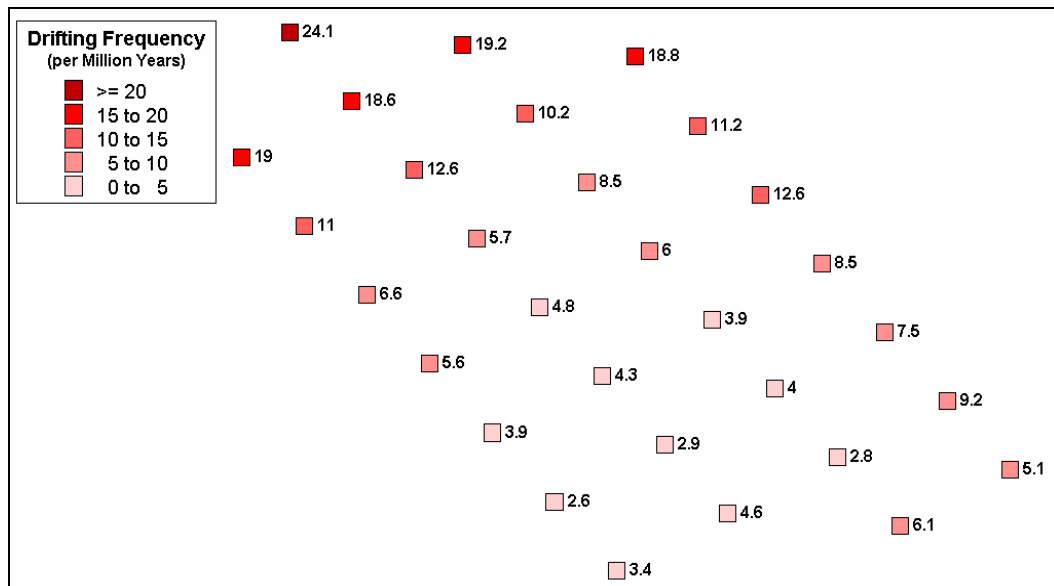


Figure 6.9: Drifting collision frequency (passing and anchoring) for turbines (per Million Years)

6.7.3.4 Fishing Vessel Collision

The fishing vessel collision frequency assessment was carried out using the fishing risk module of Anatec's COLLRISK model. This is a density-based model that has recently been calibrated for UK waters.

Based on the fishing activity levels in proximity to the wind farm identified primarily from surveillance data, the collision frequency associated with fishing vessels was estimated to be 3.0×10^{-5} , an average of 1 collision every 33,000 years. This is very low and reflects the low level of fishing activity in the area compared with the rest of Liverpool Bay.

6.7.4 Recreational Sailing Activity

6.7.4.1 Introduction

This section presents an overview of the recreational craft activity in the vicinity of the Burbo Bank wind farm development. Quantitative risk modelling has not been carried out owing to the small size of these vessels and the lack of comprehensive accident or activity data for recreational vessels.

6.7.4.2 Marinas

No official figures are available on the yachting activity in the UK, therefore, marina facilities have been analysed to provide an indication of the level of yachting activity in the Burbo Bank area compared to the rest of the UK.

It is recognised that marinas alone do not provide a complete estimate of yachting activity, as boats may also be sheltered in rivers or creeks or kept onshore. However, the extent of these facilities is considered to provide a useful guide to the activity levels in the area. For this review the marina locations are defined as pontoons, quays or river berths where it is possible to walk ashore in all states of tides.

The highest densities of marinas in the UK are on the South and SE coasts of England, especially around the Solent. The area around Liverpool has much fewer developments. The marinas located in NW England and North Wales are shown in Figure 6.10.

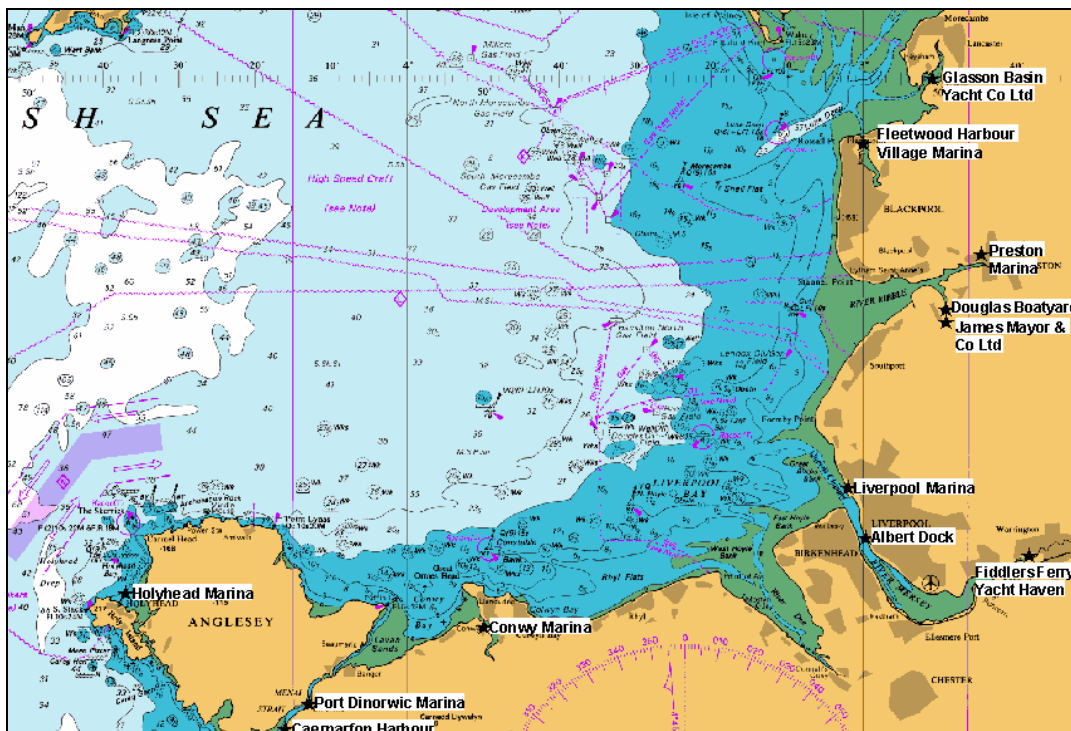


Figure 6.10: Marina locations in NW England and North Wales

In total, there are 12 marinas in NW England and North Wales with approximately 2,000 berths. This compares to 172 marinas in the UK, with an estimated total capacity of 40,000 berths.

6.7.4.3 Consultation

In addition to the marinas identified from the RYA guide, other recreational activity was identified through consultation with the Welsh and North West Regions of RYA. These regional centres circulated details to obtain feedback from the local clubs. Communication with the RYA has indicated that although some recreational activity takes place within the area of the proposed wind farm, the overall effect was not likely to be significant.

It was also indicated that communications with the regional RYA in this area should be maintained as a measure of good practice. The aim of this is to ensure that information on any significant changes to the proposed

design of the wind farm is circulated to the local groups so that further feedback can be obtained.

6.7.5 Construction and Decommissioning

There may be additional potential impacts during the construction and decommissioning phases of the project. During these phases there will be an increased level of activity in terms of vessels, mobile cranes, service boats, tugs and barges which will be operating in the area. This introduces additional risks in terms of ship-to-ship encounters on passage to/from the site and the base port. In addition, there are risks associated with construction vessels navigating in proximity to existing structures once the wind farm is partially developed.

To manage these risks and assist in project planning a workshop will be carried out to consider these phases. The objectives of the workshop will be to identify all of the different activities which will be taking place and identify any potential hazards. The workshop will propose mitigation and operating procedures additional to those already in place.

This process will also help build understanding of the activities and operating constraints of the different parties involved and allow effective procedures to be developed.

6.7.6 Other Navigational Issues

6.7.6.1 Introduction

This section presents a discussion on other navigational issues including those raised in the guidelines on Navigational Impact of Offshore Wind Farms issued by the Maritime and Coastguard Agency.

6.7.6.2 Tides and Tidal Streams

This is considered in Chapter 4 of the Environmental Statement and Technical Appendix A.

6.7.6.3 Communication, Radar and Positioning Systems

The effect of the wind farm on these systems is considered in Chapter 8 of the Environmental Statement.

6.7.6.4 High Speed Ferries

High speed ferries (in excess of 30 knots) are operated by The Steam Packet Company on their Liverpool/Dublin and Liverpool/Douglas services. During calm conditions the wake produced by these vessels can create a wave that may carry for long distances. Experienced offshore contractors will be aware of such conditions and this will not affect their activities when constructing the wind farm. The Masters of the vessels will

be made aware of the development/construction activity and discussions will be held to ensure that the risks to construction crew are minimised.

6.7.6.5 Access for Emergency Services

In the event of an incident within the site, access will be potentially be required by a Coastguard helicopter, tug or RNLI lifeboat. To ensure the turbine rotors do not inhibit this process SeaScape Energy, Crosby Coastguard Station and/or Mersey Docks and Harbour Company will be able to shut down one or all of the turbines.

It is noted that RNLI lifeboats are most likely to respond to an incident in this coastal area. These boats have a high degree of manoeuvrability and should not have a problem operating around the turbines. Also, the separation distances between the turbines (at least 550m) will not restrict such vessels from accessing the site.

6.7.6.6 Additional Voyage Time/Distance

The proposed development is assessed to have minimal impact on merchant shipping navigation therefore no additional distance or voyage time will be incurred by passing ships.

6.7.6.7 Cumulative Impacts

The proposed North Hoyle (National Wind Power) and Rhyl Flats (COWL) Offshore Wind Farms are located approximately 8nm and 15nm South West of Burbo Bank, respectively. No cumulative impacts are anticipated although during construction and decommissioning there may be increased traffic levels passing in proximity to the Burbo Bank site.

There is a dredging area approximately 10nm West of the proposed wind farm site. The dredger routeing has been taken into account within this assessment based on the latest estimated activity levels of Mersey Sand Supplies. There will be no direct impact on dredging activity or vessel movements by the construction of the wind farm.

6.7.6.8 Markings

The wind farm will be marked with navigational aids as per the IALA standards under the direction of the Trinity House Lighthouse Service and confirmed with MDHC. Lighting of the wind farm will be designed so that it can clearly be distinguished from onshore lighting to prevent confusion. An Automatic Identification System (AIS) transreceiver will be used to mark the site if deemed necessary by Trinity House.

6.7.6.9 Risk to Population

Based on the minimal impact on merchant shipping, and low risk of an accident, no significant risk to the population ashore is envisaged.

6.7.6.10 Prescribed Routeing Schemes

There are no prescribed routeing schemes in the area and the sites are not near a prescribed or conventionally accepted separation zone between two opposing routes.

6.7.7 Conclusions and Mitigation

6.7.7.1 Conclusions

The proposed Burbo Offshore Wind Farm is located approximately 1nm South of the Queens Channel, which is used by vessels to/from the Port of Liverpool and surrounding ports. An average of 34 vessels per day were identified in ShipRoutes to pass through the Queens Channel at a mean distance of 1.1nm to the North of the Northern row of turbines.

It is considered unlikely that ships on this route will interact with the proposed wind farm since vessels are converging at the Channel, which is around 0.8nm wide. Therefore, the potential impact on the navigation of passing shipping is assessed to be minimal.

Quantitative risk modelling was used to estimate the shipping collision risks associated with the proposed wind farm. Table 6.8 presents a summary of the results.

Table 6.8: Shipping collision risk summary table

Accident Event	Annual Frequency	Return Period (Years)
Powered Passing Ship Collision	3.9×10^{-5}	25,600
Drifting Ship Collision	2.6×10^{-4}	3,800
Fishing Vessel Collision	3.0×10^{-5}	33,300
Total	3.3×10^{-4}	3,000

Therefore, the increase in ship collision frequency in the area due to the Burbo Bank Offshore Wind Farm is estimated to be 3.3×10^{-4} per year, or an average of one collision per 3,000 years. The majority of this risk is associated with drifting vessels (67%), with a relatively low proportion contributed by powered passing vessels and collision due to vessel drifting from their anchor (both 12%). Fishing vessels were assessed to be the smallest contributors to the risk (9%).

Overall, the risks to shipping posed by the Burbo Bank Offshore Wind Farm are assessed to be low. The following section presents recommendations to help further mitigate the risk and minimise disruption to shipping.

6.7.7.2 Mitigation

General

- Information on the development will be circulated directly to MDHC and more generally to mariners via Navtex, Notices to Mariners and marking on Admiralty Charts.
- Appropriate navigational markings will be used under the guidance of Trinity House Lighthouse Service and confirmed with MDHC.
- Regular dialogue will take place with MDHC to gain awareness of any operational developments that could affect the shipping activity and routing in the area.
- Shipping activity around the site will be monitored periodically following establishment of the wind farm to analyse vessel behaviour and ensure the measures in place to minimise the risks to shipping are sufficient. It is recommended that an initial review be performed during the construction phase and, following this, at periods of no greater than 2 years.
- SeaScape will continue to liaise with the RYA clubs in this area to ensure there is a good level of awareness surrounding the proposed development and opportunity is provided for the clubs to provide further input.

Construction / Decommissioning

- A workshop will be held 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. This process will also help build a mutual understanding of the activities and operating constraints of the different parties involved. The outcome of this will be a report to ensure that each party is well informed on the construction process and can pass this information to the local marine fraternity. Any mitigation measures/procedures will be identified within the report.
- Once construction has commenced information on progress will be provided to each party so they are aware when there are changes in the proposed plan and can circulate information accordingly.
- During construction it is essential that craft involved in these operations have set procedures to follow, which give account to the local marine activity in this area and ensure unnecessary risks are not introduced.

- A vessel involved in the construction operation will be tasked with monitoring traffic around the site during the construction phase, especially in periods of reduced visibility. MDHC Port Operations Control staff will actively monitor shipping in proximity to the wind farm as part of their regular operational activities.
- All vessels taking part in any activities related to the wind farm, including commissioning, cable laying, maintenance and decommissioning will be equipped with a dual Channel Maritime VHF radio. A permanent listening watch will be maintained on Channel 16 and Channel 12 for Liverpool.
- Appropriate emergency response procedures will be developed and practised.
- Appropriate mitigation measures will also be put in place for any ad-hoc maintenance operations being carried out at the site.

6.8 Offshore Oil and Gas Fields

6.8.1 Existing

Liverpool Bay has several oil and gas operations taking place at present, owned and operated by BHP Billiton Petroleum Ltd. The Liverpool Bay Asset (LBA) is a near shore oil and gas facility, consisting of the following installations (Table 6.9). The LBA fields are expected to produce over 150 million barrels of oil and 1 trillion cubic feet of gas over a 20 year period.

Table 6.9: Liverpool Bay Asset associated installations

Installation	Latitude	Longitude
Douglas Complex	53° 32'	03° 34'
Lennox Platform	53° 38'	03° 10'
Hamilton Platform	53° 34'	03° 27'
Hamilton North Platform	53° 39'	03° 27'
Oil Storage	53° 41'	03° 33'

The location of the facilities are also shown in Figure 6.11. The LBA also consists of a number of onshore installations, the combination of which carry out the extraction, transportation, storage and distribution of the oil and gas reserves.



Figure 6.11: Offshore oil and gas facilities in Liverpool Bay (Courtesy of www.ipicea.org)

6.8.2 Assessment of Impact

Positioned as it is, close to the Mersey Estuary, Burbo Offshore Wind Farm will have no impact on the offshore oil and gas fields. The closest facility to the wind farm is the Hamilton Platform, approximately 16km to the NW. No cable or pipelines from the Liverpool Bay Asset pass through, or close to, the proposed wind farm site.

6.8.3 Mitigation

Due to the distance from the Liverpool Bay Asset and the nearest facility (Hamilton Platform) no mitigation measures are required.

6.9 Dredging

6.9.1 Existing

The presence of sand, gravel and other geologically important minerals on and in the seabed of the Liverpool Bay has led to the granting of extraction licences by the Crown Estate. A licence for extraction has to follow a similar EIA procedure and will only be granted assuming no detrimental effects will arise. Figure 6.12 shows the location of such licences.

In 1994, 290,846 tonnes of marine aggregate were extracted from the Northern Irish Sea (JNCC, 1996). Extraction in Liverpool Bay has been carried out since the 1960's. MDHC undertakes an annual dredging of the Mersey to ensure the channel remains deep enough for shipping. Around 2-3 million tonnes of sediment is removed each year and disposed in Liverpool Bay.

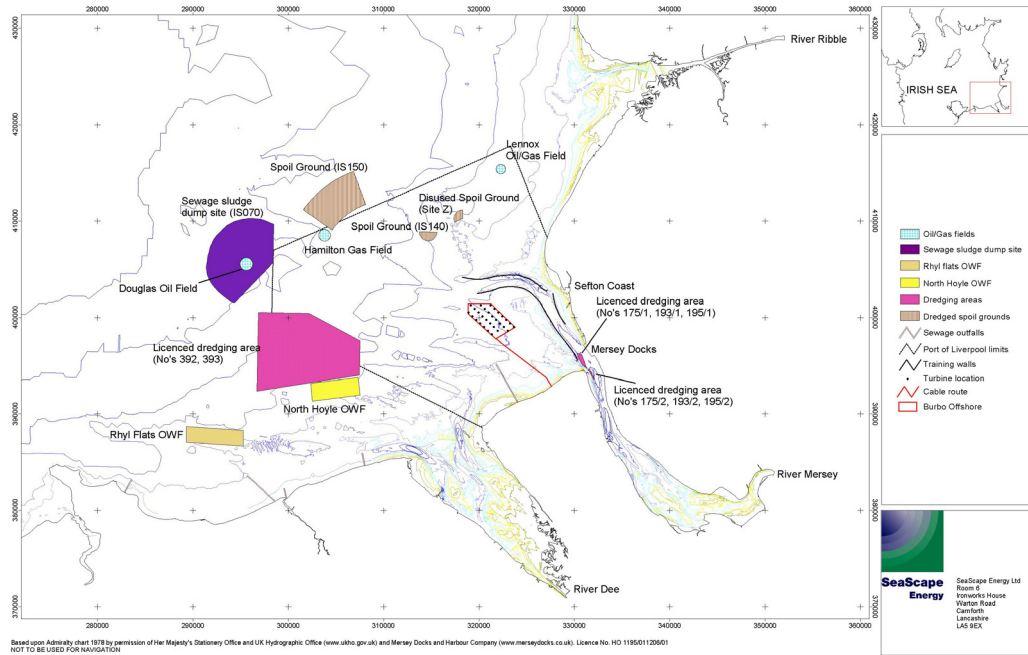


Figure 6.12: Proximity of activities within Liverpool Bay to Burbo Offshore

United Marine Dredging Ltd and Norwest Sand and Ballast Company operate a 50km² area 15km north of Rhyll. This site is approximately 15km from the Burbo Offshore Wind Farm. There are also two smaller licences to extract building sand at the mouth of the Mersey Estuary, 8km from the Burbo Offshore Wind Farm.

6.9.2 Assessment of Impact

The installation of the turbines will cause a localised disturbance to the sediment around the foundations. Long-term effects during the operational phase are the development of scour pits around the individual turbines (see Chapter 4). This will release sediment into the local area, but not affect aggregate dredging areas, coastal sediments or increased deposition in the Mersey Channel.

The amount of sediment that will be released into the water column will be a very small fraction of that which enters the system daily through wave and tidal action. The Great Burbo Bank is a dynamic sand bank, with tides continuously stirring up sediment into the water column. This is exacerbated during storm conditions. The addition of the Burbo Offshore Wind Farm will not affect this balance (see Chapter 4).

6.9.3 Mitigation

The presence of the Burbo Offshore Wind Farm will not affect the aggregate dredging industry which operates in Liverpool Bay.

6.10 Cables and Pipelines

6.10.1 Existing

There are a number of cables and pipelines which cross the Irish Sea. Telephone cables cross Morecambe Bay from Blackpool to the Isle of Man and gas pipelines travel from the Douglas Platform to the Point of Ayr.

The closest pipeline to Burbo Offshore is the sewage outflow pipe from North Wirral which extends 3km NNW into Liverpool Bay. The pipeline comes within 1km of the southern extent of the proposed wind farm location. Burbo Offshore will have no direct impact on this pipeline.

6.10.2 Assessment of Impact

The construction of the wind farm requires the installation of subsea cables to connect the turbines and also bring the power to shore. These cables will not interfere with any existing cables or pipelines. The closest pipeline is the sewage outflow pipe from the North Wirral coast, but there will be no impact from the wind farm.

6.10.3 Mitigation

As the wind farm and the offshore power cables do not impact on any existing cables or pipelines, no mitigation is required.

6.11 Waste Disposal and Dumping

6.11.1 Existing

The dumping of waste at sea requires a licence under Part IIA of FEPA. The dumping of sewage sludge at sea was halted in 1998, but has historically taken place in Liverpool Bay.

Dredged material accounts for the majority of material deposited in the Bay each year. MDHC annually maintains the Mersey Channel by dredging, depositing the extracted sand and gravel approximately 14km to the NW of Liverpool.

6.11.2 Assessment of Impact

The location of the wind farm is not within any known areas of disposal or dumping. Once the wind farm has been constructed, there should be no significant input of sediment into the water column from its operation due to the use of scour protection material.

If drilling is used to install the foundations, then the material which is removed from the seabed will be disposed of onshore or offshore as appropriate. Sediment will be prevented from entering the water column by

using a steel casing to contain the drilling to contain the sediments. Care will be taken with the disposal of sediments due to the likely presence of chemicals and heavy metal contamination washed out from the Mersey River. The appointed contractor will be required to assess the contamination of material in the upper seabed and remove the material for safe disposal where necessary.

It is possible that waste material from the turbines (such as oil) will be generated during regular maintenance and servicing. This will be disposed of onshore by appropriately licensed contractors and would not enter the water column.

6.11.3 Mitigation

Appropriate measures during installation and operation will ensure that there is no significant input of waste material into the water. The appointed contractor will be expected to dispose of any arisings following UK and EU regulations on the disposal of waste material.

6.12 Military Operations

6.12.1 Existing

The Irish Sea and Liverpool Bay is frequently used for military activity. Military aircraft regularly over fly the area, surface vessels operate out of a number of ports and submarines are known to operate from Barrow-in-Furness. Military radar installations are located at Walton and at St. Annes. The closest military aviation installation is at Warton, near Preston, where BAe Systems is undertaking research on the Eurofighter aircraft.

6.12.2 Assessment of Impact

The Burbo Offshore Wind Farm is suitably distant from the St. Annes, Walton and Warton military operations to have no direct impact. Consultation with the Ministry of Defence has concluded that there is no objection to the proposed wind farm development. The position of the wind farm will not impact on aviation, surface or sub-surface military operations in Liverpool Bay.

6.12.3 Mitigation

As prior discussion has taken place with all appropriate military organisations, no mitigation measures are required. All organisations will be kept informed of the progress of the wind farm to ensure they are aware of the stages of development. Once operational, accurate positional information will be passed on for inclusion in appropriate charts and documentation.

6.13 Civil Aviation

6.13.1 Existing

The two closest civil aviation airports to Burbo Offshore Wind Farm are located at Liverpool John Lennon Airport (25km) and Harwarden Airport at Broughton, west of Chester (33km). Blackpool Airport is located to the north of the wind farm, approximately 33km distant.

6.13.2 Assessment of Impact

Consultation has been undertaken with all airports, National Air Traffic Service (NATS) and the Civil Aviation Authority (CAA). The location of the wind farm has been determined through careful consideration of the potential impacts on radar and flight control systems in the area. NATS have confirmed that there are no safeguarding issues relating to the position of the wind farm on Burbo Bank. Similarly, the CAA have no concerns over the position of the wind farm.

Liverpool Airport have expressed concerns about the wind farm, relating to the effect of the turbines on their radar. The rotational movement of the turbine blades can show up on radar, representing a false signal. However, the presence of buildings and hills within the area will screen the majority of the turbines from the nearby airports.

6.13.3 Mitigation

Continued discussion will take place with nearby airports to ensure that the development of the wind farm has no detrimental effect to their operations. Neither Blackpool nor Harwarden have expressed concerns about the wind farm.

It is anticipated that the distance of the proposed wind farm from Liverpool John Lennon Airport will result in no effect on operations through interference with airport radar. SeaScape Energy have agreed with Liverpool Airport to monitor the effect of the turbines on radar following construction.

6.14 EMI

6.14.1 Existing

Research has been carried out into the interference of television and radio signals by the placement of wind turbines (Hall, 1992). Moving vertical structures as large as offshore turbines (up to 130m tall) can scatter and reflect the signals. This can cause interference, leading to degradation and possible loss of the signal. Reflected waves which have 'bounced' off an object can also be picked up by receivers, resulting in a secondary, delayed and weaker signal (e.g. a secondary television picture).

Radio reception and microwave links could also be affected. There are no known microwave links in proximity to the wind farm which could be subject to interference. The Crosby Coastguard Station and the MDHC Port Operations unit are both close to the proposed wind farm development and use radio links to communicate with vessels operating in Liverpool Bay.

6.14.2 Assessment of Impact

Due to the size and scale of the development, it was necessary to liaise with the appropriate communication groups to ensure the wind farm would not cause interference.

Where television reception is an issue, consultation was made with the BBC (Crown Castle International) and Independent Television Commission (ITC). Neither organisation believed the proposed wind farm would affect television signals in the area.

In terms of mobile telecommunications, consultation was undertaken with Orange, Cable and Wireless, Vodafone and BT. All organisations accepted the development of the wind farm would not have a detrimental affect on remote signal users.

The Radiocommunications Agency (RA) similarly had no concern with the proposed wind farm location. There are no fixed links or similar which the wind farm would impact upon.

6.14.3 Mitigation

As there are no direct impacts caused by the wind farm, mitigation is not required. SeaScape Energy will monitor the local area following construction to ensure that no unanticipated effects arise as a consequence of the presence of the wind farm.

6.15 Ground-based Radar

6.15.1 Existing

The entrance to the Mersey Channel from Liverpool Bay is overseen by Mersey Docks and Harbour Company (MDHC), who are the Port Authority. MDHC operate a radar monitoring system for all boats entering or leaving the Mersey Channel. The radar station is based to the north of Liverpool, close to the six onshore wind turbines at Seaforth Docks.

6.15.2 Assessment of Impact

The construction of the wind farm at Burbo could potentially interfere with the operation of radar. Radar cannot penetrate the turbines and can also

be reflected, or 'bounced' from structure to structure, creating false images or 'ghosts' on radar screens.

Such substantial structures as wind turbines can impede the radar signal, reducing the effectiveness of the system to pick up objects directly behind the wind farm. Depending on the direction the blades are facing, interference can vary from day to day. Weather conditions will also affect the interference caused.

The wind farm could also cause the radar signal to 'bounce' from the turbines, onto another object (e.g. a ship), back onto the turbines and be received at the radar station. This has the potential to create a false signal on the radar screen, which then has to be interpreted by the operator. Such reflectance could also occur amongst the turbines themselves. These false returns are much weaker than true signals and can easily be interpreted as such by experienced operators.

Vessels operating with transponders will not be affected, as they will have a strong signal regardless of their position relative to the wind farm. These vessels will show up on radar as strong signals.

6.15.3 Mitigation

SeaScape Energy are undertaking an assessment of potential radar interference in consultation with MDHC. There are several mitigation measures which could be used to reduce or remove the impact of the turbines on port radar.

6.15.3.1 Radar-absorbing paints

Special absorbent paints could be used on the towers and blades to reduce or remove the reflectance of the radar signal from the wind turbines. The paint absorbs the radar signal, due to its material construction, which will significantly reduce any false returns on the port radar.

6.15.3.2 Software engineering

Certain radar software can be designed or upgraded to remove false signals or flag them up on the radar screen, so that operators do not have to interpret the signals.

6.15.3.3 Additional radar station

The addition of a second radar station further up the coast will allow false returns to be removed from the radar display. The existing and new radar stations will be linked together, so that the software which produces the radar image at the control room can interpret the signal from both stations.

A true return, such as a boat, will appear in the same position in the signals from both radar stations. A false return, such as the reflection of a boat from one of the turbines, will be in different positions on the two radar signals. Therefore, because the two signals do not correlate, the false return can be removed by the software.

Another benefit of the additional radar station is the ability to reduce the shadow effect of the turbines. By positioning the radar further north, both stations can cover a much greater area.

This range of options ensures that the radar interference can be minimised, if not removed entirely.

6.15.3.4 Radar repeater station

Similar to a large-scale radar station, a repeater station can be sited on the NW turbine platform. This would cover the Bar Light Vessel and Anchoring Exclusion Zone at the entrance to the Mersey. The repeater would be a small-scale version of a radar, sited to enhance the signal beyond the wind farm. It would be linked into the existing radar system at MDHC.

6.15.4 Conclusion

Any impacts the wind farm has on ground based radar can be mitigated. SeaScape will work with MDHC to establish the most appropriate method for Therefore the wind farm will have no significant effect.

NOTES