Environmental Impact Assessment Report

Volume 3 of 3 – Appendices

For

LACKAN WIND FARM

INISHCRONE, COUNTY SLIGO

Prepared for:
Lackan Wind Energy Ltd,
Lackan
Inishcrone
County Sligo

Prepared by:
Keohane Geological & Environmental Consultancy
Ivy House
Clash
Carrigrohane
County Cork

October 2022

Environmental Impact Statement

Volume 3 of 3 – Appendices

For

LACKAN WIND FARM

INISHCRONE, COUNTY SLIGO

LIST OF APPENDICES

Appendix 1-1: Consultation

Appendix 4-1: Health & Wind Turbines

Appendix 7-1: Geological Heritage Site Report

Appendix 9-1: Archaeological Testing Report – 2003

Appendix 1-1

Consultation

dankeohaneivyclash@hotmail.com

From: Dan Keohane
Sent: Tuesday 22 March 2022 11:44
To: Duty Geologist; Duty.Geologist@gsi.ie
Cc: jkwenvironmental@gmail.com; Katie Neary
Subject: Lackan Wind Farm, County Sligo
Attachments: Lackan WF - Site Layout.pdf; Lackan WF - Site Location.pdf

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

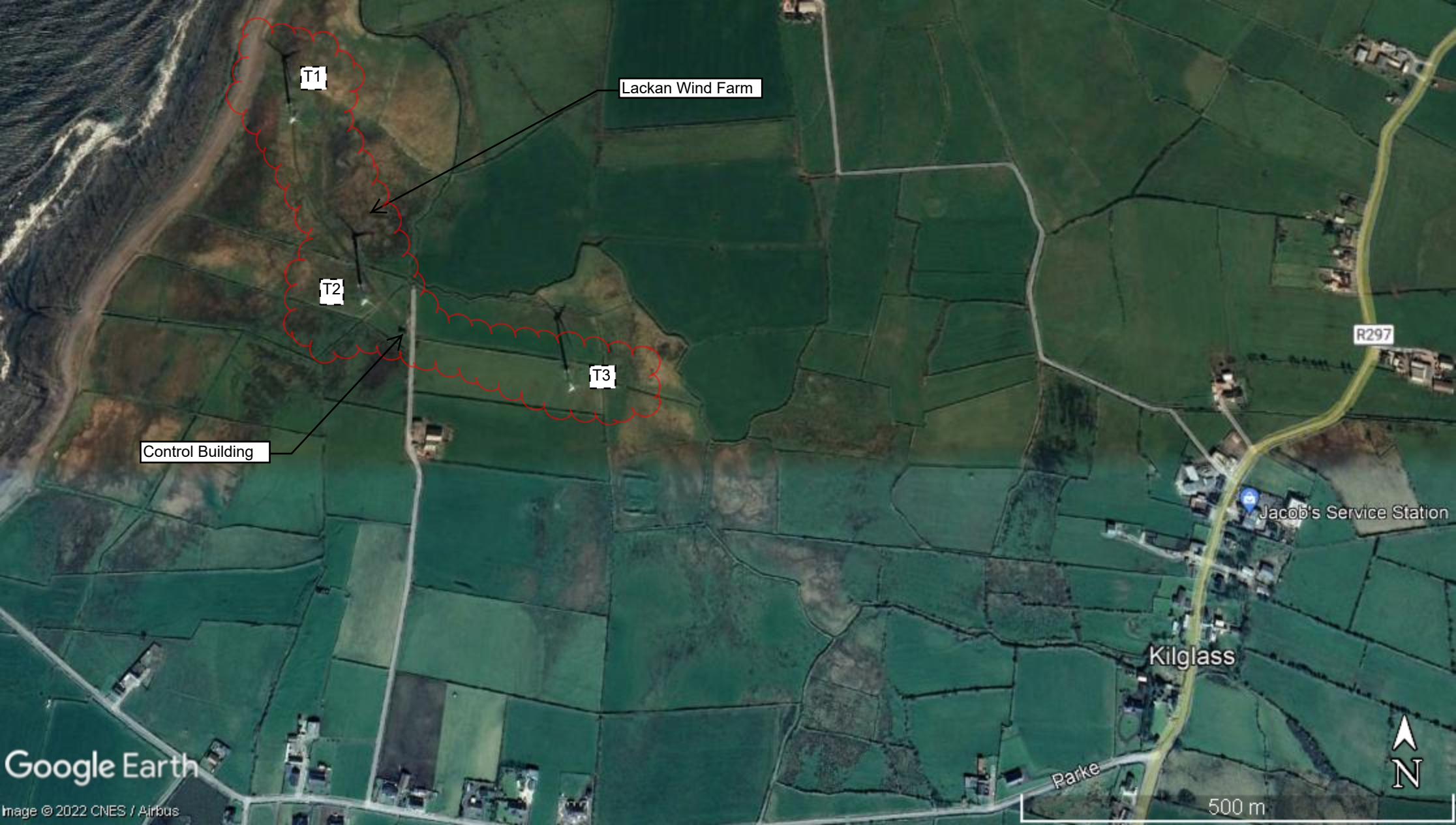
The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

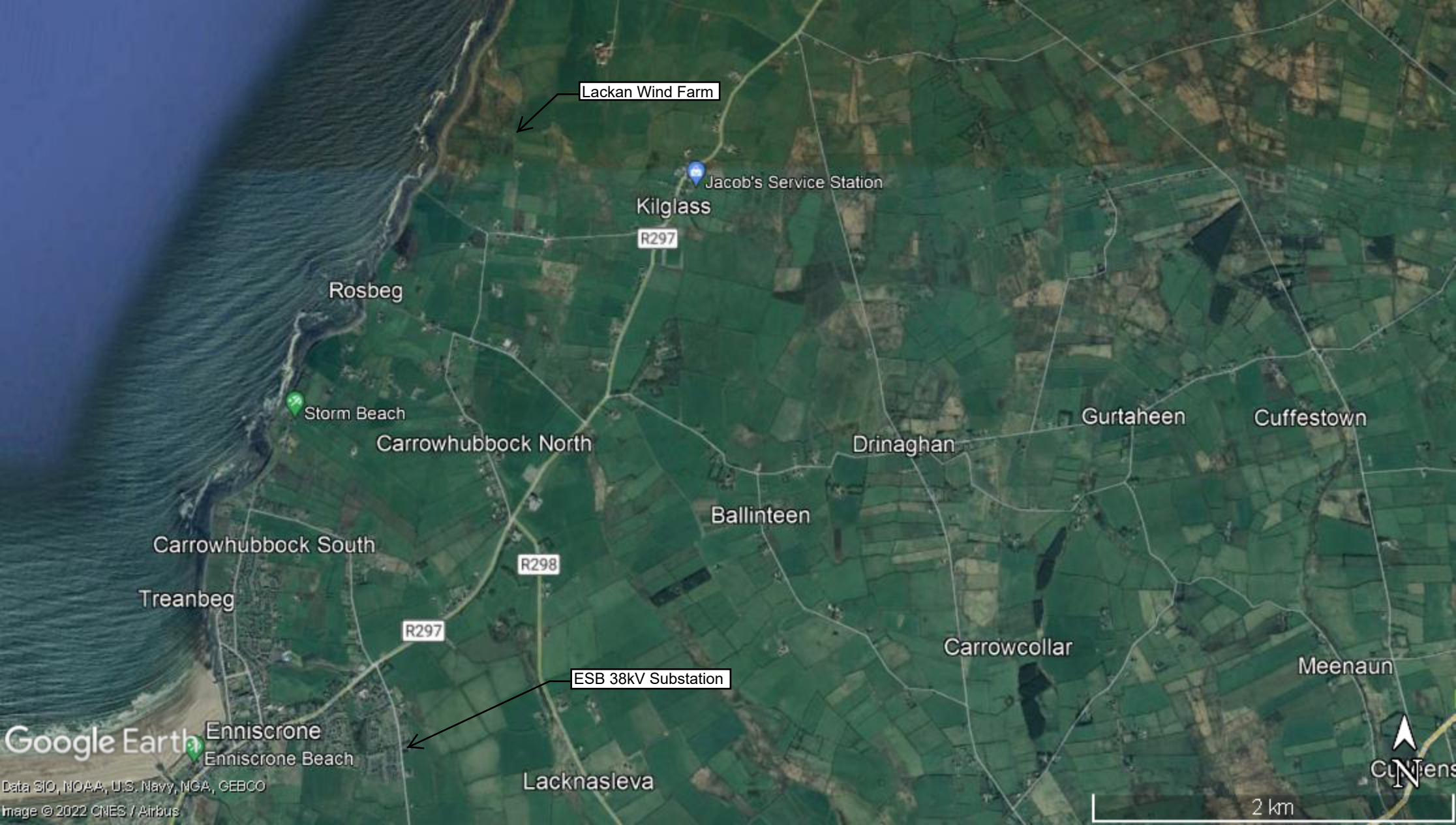
- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.
- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the Geological Survey of Ireland might have with this proposed development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com


T1
Lackan Wind Farm
T2
T3
Control Building
R297
Jacob's Service Station
Kilglass
Parke
N
500 m
Google Earth
Image © 2022 CNES / Airbus


Lackan Wind Farm
Jacob's Service Station
Kilglass
R297
Rosbeg
Storm Beach
Carrowhubbock North
Drinaghan
Gurtaheen
Cuffestown
Ballinteen
Carrowhubbock South
R298
Treanbeg
R297
Carrowcollar
Meenaun
ESB 38kV Substation
Google Earth
Enniscrone
Enniscrone Beach
Lacknasleva
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2022 CNES / Airbus
N
2 km

dankeohaneivyclash@hotmail.com

From: Matthew Craig <matthew.craig@2rn.ie>
Sent: Friday 25 March 2022 09:53
To: Dan Keohane
Cc: windfarms@rte.ie; Johnny Evans
Subject: RE: Lackan Wind Farm, County Sligo

Hi Dan,

As the site has been running without any problems from our side for many years and no alteration is planned to the existing structures, we have no objections to its continued operation.

Regards

Matthew Craig

Project Engineer
Projects and Coverage Planning
2RN
Block B, Cookstown Court, Old Belgard Road, Tallaght, Dublin 24, Ireland D24 WK28
Phone: + 353 (0) 1 2082261 Mobile: + 353 (0) 87 7509955

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: Tuesday 22 March 2022 12:23
To: windfarms@rte.ie
Cc: Matthew Craig <matthew.craig@2rn.ie>
Subject: FW: Lackan Wind Farm, County Sligo

[CAUTION: This email originated from outside of the organisation. Do not click links or open attachments unless you recognise the sender and know the content is safe]

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.

- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the RTE / 2rn might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

dankeohaneivyclash@hotmail.com

From: Housing Qcsofficer <qcsofficer@housing.gov.ie>
Sent: Thursday 19 May 2022 11:29
To: Dan Keohane
Subject: Automatic reply: Lackan Wind Farm, County Sligo

A Chara

Thank you for your email to the Quality Customer Service mailbox of the Department of Housing, Local Government and Heritage. We will examine your query and endeavour to resolve it within 15 working days, in accordance with our Customer Charter.

We will use the information and details you have provided to us to examine and respond to your query. Your email will be kept in the QCS mailbox which is password protected and accessible only to those officials working on the QCS account. Emails to this account are retained for no longer than one year, unless it is necessary to retain them for a longer period in the context of the ongoing resolution of an issue.

Go raibh maith agat as ucht do ríomhphoist chuig Seirbhís Ardchaighdeáin do Chustaiméirí na Roinne Tithíochta, Rialtais Áitiúil agus Oidhreachta. Bíonn sé d'aidhm againn do cheist a fhreagairt faoi cheann15 lá oibre.

Kind regards

Quality Customer Service Office

dankeohaneivyclash@hotmail.com

From: Wexford Receptionist <REC_WEX@epa.ie>
Sent: Thursday 19 May 2022 13:04
To: Dan Keohane
Subject: RE: Lackan Wind Farm, County Sligo

A Chara,

Your correspondence on May 19th has been forwarded for attention.

Kind Regards,

Ruth O'Connor

Duty Receptionist / Programme Officer I Organisational Services Team
Office of Communications and Corporate Services, Wexford
Fáilteoir ar Dualgas / Oifigeach Cláir I Foireann Seirbhísí Eagraíochtúla
An Oifig Cumarsáide agus Seirbhísí Corparáideacha,Loch Garman

053-9160600 (Direct dial)
info@epa.ie
www.epa.ie

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: Thursday 19 May 2022 11:17
To: Wexford Receptionist <REC_WEX@epa.ie>
Subject: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Inishcrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 12 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Inishcrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 12 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.
- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.

- Connection to National grid at the ESB's 38kV substation in Inishcrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the EPA might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

dankeohaneivyclash@hotmail.com

From: planning applications <planning.applications@failteireland.ie>
Sent: Monday 4 April 2022 09:56
To: Dan Keohane
Subject: RE: Lackan Wind Farm, County Sligo
Attachments: Fáilte Ireland EIAR Guidelines.pdf

Hello Dan,

Thank you for your email and for bringing to our attention that Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm.
Please see attached a copy of Fáilte Ireland's Guidelines for the Treatment of Tourism in an EIA, which you may find informative for the preparation of the Environmental Impact Assessment for the proposed project. The purpose of this report is to provide guidance for those conducting Environmental Impact Assessment and compiling an Environmental Impact Assessment Reports (EIAR), or those assessing EIARs, where the project involves tourism or may have an impact upon tourism. These guidelines are non-statutory and act as supplementary advice to the EPA EIAR Guidelines outlined in section 2.

Regards,

Yvonne

Yvonne Jackson
Product Development-Environment & Planning Support | Fáilte Ireland

88-95 Amiens Street, Dublin 1, D01 WR86
Currently working Remotely | **M** +353 (0)86 0357590

Fáilte Ireland

LinkedIn | Twitter | YouTube | Facebook

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: Tuesday 22 March 2022 12:24
To: planning applications <planning.applications@failteireland.ie>
Subject: FW: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord

Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.
- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the Failte Ireland might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

dankeohaneivyclash@hotmail.com

From: O Doherty, Darragh <Darragh.P.ODoherty@garda.ie>
Sent: Thursday 28 April 2022 12:28
To: 'dankeohaneivyclash@hotmail.com'
Cc: McDonnell, Michael
Subject: RE: Lackan Wind Farm, County Sligo

Mr Keohane,

After raising ticket with Tetra Ireland;

Colin Fennessy from TI has advised no RF issues predicted, nearest site is Easkey GS over 8km away.

Kind Regards,

Darragh O'Doherty | Executive Officer | NDRS | Garda Headquarters, Phoenix Park, Dublin 8, Ireland, D08 HN3X |
Email Darragh.P.ODoherty@garda.ie | Tel: 01 6662205 | Mobile: 086 0465564 | http://www.garda.ie/

From: McDonnell, Michael
Sent: Thursday 24 March 2022 11:49
To: O Doherty, Darragh <Darragh.P.ODoherty@garda.ie>
Subject: FW: Lackan Wind Farm, County Sligo

Hi Darragh

Can you raise ticket with TETRA Ireland for report please.

Can you inform Mr Dan Keohane, Keohane Geological & Environmental Consultancy 086 – 8289167 that the matter is raised with TETRA Ireland for the impact assessment report.

Rgds

Mick

From: ICT_Executive_Director
Sent: Wednesday 23 March 2022 11:41
To: Telecoms_DS <Telecoms_DS@garda.ie>
Cc: ICT_Executive_Director <ICT_Executive_Director@garda.ie>; McDonnell, Michael <michael.mcdonnell@garda.ie>
Subject: FW: Lackan Wind Farm, County Sligo

CIO_03-146270/22

A/Superintendent
Telecoms

The below correspondence from Dan Keohane, Keohane Geological & Environmental Consultancy is forwarded for your information and attention, please.

Sent on behalf of the Chief Information Officer.

Regards
Sibeal

Sibéal Byrne| Clerical Officer |Office of the Executive Director ICT| Garda Headquarters, Phoenix Park, Dublin 8, Ireland, D08 HN3X |
Email sibeal.r.byrne@garda.ie | Tel: + 353 (0) 1 6661453 | http://www.garda.ie/

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: Tuesday 22 March 2022 12:17
To: ICT_Executive_Director <ICT_Executive_Director@garda.ie>
Subject: (External) FW: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

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- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the Garda might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

dankeohaneivyclash@hotmail.com

From: GSI Planning <GSIPlanning@GSI.ie>
Sent: Tuesday 26 April 2022 09:14
To: 'dankeohaneivyclash@hotmail.com'
Cc: Clare Glanville; GSI Planning
Subject: RE: EIS 22/94 Extension of lifespan of Lackan Wind Farm County Sligo

Dear Dan,

With reference to your email dated 22 March 2022, regarding the extension of lifespan of Lackan Wind Farm County Sligo, please note that Geological Survey Ireland has no specific comment or observations to make on this matter at this time.

If you have any further queries or if we can be of further assistance, please do not hesitate to contact me Trish Smullen, or my colleague Clare Glanville at GSIPlanning@gsi.ie.

Yours sincerely,

Trish Smullen
Geological Survey Ireland

From: GSI Planning
Sent: 23 March 2022 11:08
To: Clare Glanville; Sophie O'Connor; Brian McConnell; Monica Lee; Taly Hunter Williams; Sean Cullen; Charise McKeon; Jim Hodgson; Eoin McGrath; Trish Smullen
Cc: GSI Planning
Subject: EIS 22/94 Extension of lifespan of Lackan Wind Farm County Sligo

EIS 22/94

Notification of intent to apply to extend lifespan of Lackan Wind Farm, Co. Sligo. Request for observations from Keohane Geological & Environmental Consultancy. Letter and site information enclosed.

Regards,
Erin

From: Dan Keohane [mailto:dankeohaneivyclash@hotmail.com]
Sent: 22 March 2022 11:44
To: Duty Geologist; Duty Geologist
Cc: jkwenvironmental@gmail.com; Katie Neary
Subject: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted

lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

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- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the Geological Survey of Ireland might have with this proposed development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

dankeohaneivyclash@hotmail.com

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 30 March 2022 15:35
To: dankeohaneivyclash@hotmail.com
Subject: Lackan Wind Farm, County Sligo

FAO Mr. Dan Keohane

Re: Lackan Wind Farm, County Sligo

Dear Mr. Keohane,

Thank you for your email and the attached documents relating to the intention to apply for permission to extend the lifespan of the existing Lackan Wind Farm (3 No. turbines with 100m tip height) at Kilglass, Enniscrone County Sligo.

Based on the information provided, it is likely that SRD Aerodromes will have no observations to submit during the formal planning process.

Yours sincerely,

Deirdre Forrest
Corporate Affairs

dankeohaneivyclash@hotmail.com

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Tuesday 29 March 2022 11:21
To: dankeohaneivyclash@hotmail.com
Subject: Lackan Wind Farm, County Sligo

Re: Lackan Wind Energy Ltd (LWEL)

Dear Mr. Keohane

Thank you for your email and note that Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission for the above development, details of which were received by the Irish Aviation Authority.

The Irish Aviation Authority (IAA) Air Navigation Services Division (ANSD) does not get involved in the planning process. The IAA ANSD is to be notified as detailed hereafter:

According to S.I. 215 of 2005, Irish Aviation Authority (Obstacles to Aircraft in Flight), the IAA ANSD requires any person who seeks to erect a manmade object to notify the aerodrome operator of the intended operation **at least thirty days** in advance if the structure is to be erected in the vicinity of the aerodrome or the areas around the aerodrome and other protected surfaces associated with the aerodrome. Aerodrome Operators can be contacted via IAA AIP AD 1.3 INDEX TO AERODROMES AND HELIPORTS, to evaluate the impact of the intended operation on the protected airspace established for the aerodrome.

Additionally, any person who seeks to erect a manmade object in excess of 45 metres anywhere within the state above ground or water surface level must also notify the IAA ANSD of the intended crane erection **at least thirty days** in advance, as a crane operating at or above this height may constitute an obstacle to air navigation. The IAA ANSD can be contacted via airspace@iaa.ie.

The State requires electronic terrain and obstacle data (eTOD) in accordance with International Civil Aviation Organisation (ICAO) Annex 15 requirements which shall be surveyed by Ordnance Survey Ireland (OSi). The cost of this OSi surveyed data is to be borne by the developer. Additionally, the following data is to be supplied once construction is planned or commenced or available to the airspace team via airspace@iaa.ie:

- The WGS84 coordinates (In degrees, minutes and seconds) for each turbine?
- Height above ground level (to blade tip) and elevation above mean sea level (to blade tip)?
- Verification if it's a standalone wind farm or is merged with others. Does the wind farm have any alternative names?
- Horizontal extent (rotor diameter) of turbines and blade length where applicable?
- Lighting of the wind farm, which turbine(s) is/are lit, and what type of lighting?

ICAO Light Type	Colour
Low-intensity Type A (fixed obstacle)	Red
Low-intensity Type B (fixed obstacle)	Red
Low-intensity Type C (mobile obstacle)	Yellow/Blue
Low-intensity Type D (follow-me vehicle)	Yellow
Low-intensity Type E	Red
Medium-intensity Type A	White
Medium-intensity Type B	Red
Medium-intensity Type C	Red
High-intensity Type A	White
High-intensity Type B	White

If you have any questions, please don't hesitate to contact the airspace team at airspace@iaa.ie.

Yours sincerely

_____
Deirdre Forrest
Corporate Affairs

Dan Keohane
Keohane Geological & Environmental Consultancy
Ivy House
Clash
Carrigrohane
Cork
T12 T32C

Iascach Intíre Éireann
Inland Fisheries Ireland

24th May 2022

Re: - Extension of duration planning application for Lackan Wind Farm, County Sligo

Dear Mr Keohane,

Inland Fisheries Ireland (IFI) is the state body responsible for the protection, management and conservation of the inland fisheries and sea angling resource in Ireland. Protection of the aquatic environment and habitat is a vitally important element of IFI's work.
The Lackan wind farm lies close to a stream flowing into Killala Bay which is a migratory route for salmon, sea trout, lamprey and eel into the River Moy system.

In relation to the proposed extension of duration IFI request that the following are considered:

1. The adjacent stream should be assessed in terms of aquatic biodiversity with particular emphasis on habitat in for fish.

2. Any on-site drainage system and the adjacent stream should be assessed to ensure there is no pollution, sedimentation, or erosion due to the existing infrastructure. Maintenance or mitigation measure may be required.

3. A survey for the presence of invasive species should be carried out and a management plan put in place where found.

IFI looks forward to further consultation in relation to this development in due course.

Yours sincerely

_____

Aisling Donegan
Senior Fisheries Environmental Officer
Abbey Street
Ballina
Co. Mayo

dk-l-wf-0522

Iascach Intíre Éireann
Inland Fisheries Ireland

dankeohaneivyclash@hotmail.com

From: Aisling Donegan <Aisling.Donegan@fisheriesireland.ie>
Sent: Tuesday 24 May 2022 14:37
To: dankeohaneivyclash@hotmail.com
Subject: FW: Lackan Wind Farm, County Sligo
Attachments: Lackan WF - Site Layout.pdf; Lackan WF - Site Location.pdf; dk-l-wf-0522.docx

Dear Mr Keohane,

I have attached IFI comments in relation to the proposed extension of Lackan Wind Farm.

Kind Regards

Aisling Donegan
Senior Fisheries Environmental Officer

Iascach Intíre Éireann
Inland Fisheries Ireland

Tel +353 (0)96 22788
Mob +353 (0) 87 126 4446
Fax +353 (0)96 70543
Email aisling.donegan@fisheriesireland.ie
Web www.fisheriesireland.ie
Ardnaree House, Abbey Street, Ballina, Co. Mayo, Ireland F26 KO29

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: 19 May 2022 11:11
To: Ballina Office <Ballina@fisheriesireland.ie>
Subject: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Inishcrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 12 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Inishcrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 12 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.
- Control building.

- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Inishcrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the OPW might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

Gmail

dau

Compose

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Sent

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Labels

Lackan Wind Farm - Consultation

Inbox ×

Katie Neary <katie.jkwenvironmental@gmail.com>
to manager.dau

Dear Sirs

Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission t
planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits th
the planning permission has reduced the permitted lifespan of the wind far
commissioning. The purpose of this application is to extend the lifespan of

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, cor
12 years is currently undergoing environmental impact assessment. I attac

- 3 No. turbines with tip height of 100m and with a total generating
- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control
- Connection to National grid at the ESB's 38kV substation in Enni

Apart from routine maintenance of the site infrastructure, no construction w

--
Regards,
Katie

JKW ENVIRONMENTAL
Katie Neary BSc
Mob: 0861992799
Email: katie.jkwenvironmetal@gmail.com

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Drafts 17
More

Labels

Housing Manager DAU <Manager.DAU@housing.gov.ie>

to me

Our Ref: G Pre00065/2022 (Please quote in all related correspondence

A Chara

I acknowledge receipt of your recent consultation.
In the event of observations, you will receive a co-ordinated heritage-rel

The normal target turnaround for pre-planning and other general consul
Programmes) Regulations 2004 to 2011, the Department endeavours to

If you have not heard from DAU and wish to receive an update, please e

Regards,

Simon Dolan

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage
Executive Officer
Aonad na nIarratas ar Fhorbairt
Development Applications Unit
Oifigí an Rialtais
Government Offices
Bóthar an Bhaile Nua, Loch Garman, Contae Loch Garman, Y35 AP90
Newtown Road, Wexford, County Wexford, Y35 AP90

From: Katie Neary <katie.jkwenvironmental@gmail.com>

dankeohaneivyclash@hotmail.com

From: Info Opw <info@opw.ie>
Sent: Tuesday 22 March 2022 12:00
To: Dan Keohane
Subject: Automatic reply: Lackan Wind Farm, County Sligo

Thank you for your email to the Office of Public Works.
Your query has been forwarded to the relevant section within the OPW for direct reply.
If you do not receive a response within 20 working days, please email this address again for further assistance.

All Media queries should be emailed to pressoffice@opw.ie

This is an automated response. Please do not respond to this email.

Go raibh maith agat as an ríomhphost uait chuig Oifig na nOibreacha Poiblí.
Seoladh do cheist chuig an rannóg chuí taobh istigh den OPW a thabharfaidh freagra díreach duit.
Sa chás nach bhgaigheann tú freagra taobh istigh de 20 lá oibre, seol ríomhphost chuig an seoladh seo arís le do thoil, chun cúnamh breise a fháil.

Ba chóir ceisteanna meáin a sheoladh trí ríomhphost chuig pressoffice@opw.ie

Is freagra uathoibrithe é seo. Ná seol freagra ar an ríomhphost seo le do thoil.

Communications

Oifig na nOibreacha Poiblí
Office of Public Works

Sráid Jonathan Swift, Baile Átha Troim, Co na Mí, C15 NX36
Jonathan Swift Street, Trim, Co Meath, C15 NX36

T +353 46 942 6000
https://www.opw.ie

dankeohaneivyclash@hotmail.com

From: INFO <Information@tii.ie>
Sent: Wednesday 30 March 2022 11:18
To: Dan Keohane
Subject: RE: Lackan Wind Farm, County Sligo

Dear Mr. Keohane,

I wish to acknowledge receipt of your email of 22 March 2022 regarding the above and advise that TII has no specific observations to make in relation to the development.

Yours sincerely,

Mark Byrne
Regulatory & Administration Unit
Address: Parkgate Business Centre, Parkgate Street, Dublin 8, D08 DK10

From: Dan Keohane <dankeohaneivyclash@hotmail.com>
Sent: Tuesday 22 March 2022 12:14
To: INFO <Information@tii.ie>
Subject: Lackan Wind Farm, County Sligo

Dear Sirs
Lackan Wind Energy Ltd (LWEL) intends to apply for planning permission to extend the lifespan of the existing Lackan Wind Farm at Kilglass, Enniscrone County Sligo. The wind farm was granted planning permission by An Bord Pleanala on 28 October 2003 – planning numbers PL 02/816 and PL 21.203388 refer. Condition 2 limits the lifespan of the permission to 20 years from the date of the order unless, prior to the end of the period, planning permission shall have been granted for a further period. The wording of the planning permission has reduced the permitted lifespan of the wind farm to approximately 17 years, placing it at a commercial disadvantage with other wind farms. Conditions defining the lifespan of wind farms are now typically up to 30 years from the date of commissioning. The purpose of this application is to extend the lifespan of the wind farm by 15 years to bring it into line with recent permissions granted to similar infrastructure.

The Lackan Wind Farm consists of 3 No. turbines with 100m tip height, control building, site roads, hardstand areas, and grid connection to the Enniscrone 38kV ESB substation. The wind farm was commission in 2007. The extension of the wind farm lifespan by 15 years is currently undergoing environmental impact assessment. I attach two google earth aerial maps showing the site location and site layout. The development consists of:

- 3 No. turbines with tip height of 100m and with a total generating capacity of 6MW.
- Control building.
- Internal site tracks, hardstand areas and site drainage.
- Internal underground cabling, linking each turbine to the Control building.
- Connection to National grid at the ESB's 38kV substation in Enniscrone.

Apart from routine maintenance of the site infrastructure, no construction works are proposed. Can you advise of any issues / concern that the TII might have with this development.

thank you
Dan Keohane
Keohane Geological & Environmental Consultancy
086 – 8289167

dankeohaneivyclash@hotmail.com

Appendix 4-1

Health & Wind Turbines

Wind Turbine Sound and Health Effects
An Expert Panel Review

Prepared by (in alphabetical order):

W. David Colby, M.D.

Robert Dobie, M.D.

Geoff Leventhall, Ph.D.

David M. Lipscomb, Ph.D.

Robert J. McCunney, M.D.

Michael T. Seilo, Ph.D.

Bo Søndergaard, M.Sc.

Prepared for:

American Wind Energy Association

and

Canadian Wind Energy Association

December 2009

Executive Summary

People have been harnessing the power of the wind for more than 5,000 years. Initially used widely for farm irrigation and millworks, today's modern wind turbines produce electricity in more than 70 countries. As of the end of 2008, there were approximately 120,800 megawatts of wind energy capacity installed around the world (Global Wind Energy Council, 2009).

Wind energy enjoys considerable public support, but it also has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences.

In response to those concerns, the American and Canadian Wind Energy Associations (AWEA and CanWEA) established a scientific advisory panel in early 2009 to conduct a review of current literature available on the issue of perceived health effects of wind turbines. This multidisciplinary panel is comprised of medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom. The objective of the panel was to provide an authoritative reference document for legislators, regulators, and anyone who wants to make sense of the conflicting information about wind turbine sound.

The panel undertook extensive review, analysis, and discussion of the large body of peer-reviewed literature on sound and health effects in general, and on sound produced by wind turbines. Each panel member contributed a unique expertise in audiology, acoustics, otolaryngology, occupational/ environmental medicine, or public health. With a diversity of perspectives represented, the panel assessed the plausible biological effects of exposure to wind turbine sound.

Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions:

- There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.
- The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.
- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

SECTION 5

Conclusions

Many countries have turned to wind energy as a key strategy to generate power in an environmentally clean manner. Wind energy enjoys considerable public support, but it has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences.

The objective of the panel was to develop an authoritative reference document for the use of legislators, regulators, and citizens simply wanting to make sense of the conflicting information about wind turbine sound. To this end, the panel undertook extensive review, analysis, and discussion of the peer-reviewed literature on wind turbine sound and possible health effects. The varied professional backgrounds of panel members (audiology, acoustics, otolaryngology, occupational and environmental medicine, and public health) were highly advantageous in creating a diversity of informed perspectives. Participants were able to examine issues surrounding health effects and discuss plausible biological effects with considerable combined expertise.

Following review, analysis, and discussion, the panel reached agreement on three key points:

- There is nothing unique about the sounds and vibrations emitted by wind turbines.
- The body of accumulated knowledge about sound and health is substantial.
- The body of accumulated knowledge provides no evidence that the audible or subaudible sounds emitted by wind turbines have any direct adverse physiological effects.

The panel appreciated the complexities involved in the varied human reactions to sound, particularly sounds that modulate in intensity or frequency. Most complaints about wind turbine sound relate to the aerodynamic sound component (the swish sound) produced by the turbine blades. The sound levels are similar to the ambient noise levels in urban environments. A small minority of those exposed report annoyance and stress associated with noise perception.

This report summarizes a number of physical and psychological variables that may influence adverse reactions. In particular, the panel considered "wind turbine syndrome" and vibroacoustic disease, which have been claimed as causes of adverse health effects. The evidence indicates that "wind turbine syndrome" is based on misinterpretation of physiologic data and that the features of the so-called syndrome are merely a subset of annoyance reactions. The evidence for vibroacoustic disease (tissue inflammation and fibrosis associated with sound exposure) is extremely dubious at levels of sound associated with wind turbines.

The panel also considered the quality of epidemiologic evidence required to prove harm. In epidemiology, initial case reports and uncontrolled observations of disease associations

need to be confirmed through controlled studies with case-control or cohort methodology before they can be accepted as reflective of casual connections between wind turbine sound and health effects. In the area of wind turbine health effects, no case-control or cohort studies have been conducted as of this date. Accordingly, allegations of adverse health effects from wind turbines are as yet unproven. Panel members agree that the number and uncontrolled nature of existing case reports of adverse health effects alleged to be associated with wind turbines are insufficient to advocate for funding further studies.

In conclusion:

1. Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans.
2. Subaudible, low frequency sound and infrasound from wind turbines do not present a risk to human health.
3. Some people may be annoyed at the presence of sound from wind turbines. Annoyance is not a pathological entity.
4. A major cause of concern about wind turbine sound is its fluctuating nature. Some may find this sound annoying, a reaction that depends primarily on personal characteristics as opposed to the intensity of the sound level.

renewableUK
The voice of wind & marine energy

www.RenewableUK.com

Wind Turbine Syndrome (WTS)

An independent review of the state of knowledge about the alleged health condition

July 2010

Status of this document
Health and Safety briefings are intended as a basic overview of a particular technical, legal or policy issue relevant to the core membership base of RenewableUK. Briefings provide general Health and Safety information on the topic concerned, and where appropriate offer basic guidance about how the issues can be addressed. Health and Safety briefings will not normally be subject to regular review or updating, and so the accuracy of the briefing can only assumed to be relevant and up-to-date at the time of publication. Attention is also drawn to the disclaimer below.

Disclaimer
The contents of this briefing are intended for information and general guidance only, do not constitute advice, are not exhaustive and do not indicate any specific course of action. Detailed professional advice should be obtained before taking or refraining from action in relation to any of the contents of this briefing, or the relevance or applicability of the information herein.

RenewableUK

RenewableUK (formerly known as BWEA) is the UK's leading trade association representing the renewable energy sector.

RenewableUK has made a commitment to ensuring that Health and Safety, including public health and safety, is given top priority in the wind, wave and tidal industry. We recognise our responsibility to take a lead on Health and Safety matters as they directly relate to the risks particular to our sector. This briefing is in response to the profile and media attention given to the alleged condition known as Wind Turbine Syndrome (WTS) that developed towards the end of 2009.

RenewableUK's initial assessment of the alleged health condition was that it had no scientific basis and could not be supported by the available evidence. RenewableUK had received no independent reports on the condition or the alleged symptoms being cited. However, as a responsible trade body, we needed to be confident that we presented a fair, accurate and independent assessment of the issues involved. RenewableUK therefore instructed three independent experts to review the evidence available on WTS and present their conclusions.

This briefing sets out:

- the background presenting the context of the alleged condition;
- the scope of the reviews conducted;
- the executive summaries of the reviews; and
- a RenewableUK commentary on the issues involved.

Wind Turbine Syndrome – Background

RenewableUK has monitored the developing state of knowledge on a range of health and environment issues in recent years, which could be relevant to renewable energy generation and in particular wind turbines

"WTGs generate infrasound that directly causes a range of physical sensations"

Concerns that noise radiating from wind turbines could contain sufficiently high levels of low frequency energy that may pose a threat to human health have been subject to significant scientific and public debate for several years. However, the consistent and scientifically robust conclusion has always been that there is no independent evidence to demonstrate any significant health effects from noise at the levels of that generated by wind turbines.

Towards the end of 2009 a few high-profile media articles were published in response to the pre-publication of a book titled *Wind Turbine Syndrome* [1]. This publication provided the industry with an opportunity to update its state of knowledge of the science concerned. The central premise of the book is that WTGs generate infrasound that directly causes a range of physical sensations (e.g. tinnitus, headaches etc.) and effects (e.g. sleeplessness, anxiety etc.).

The independent reviews conducted sought to determine if there is any robustness or efficacy in the science and aetiology [2] proposed.

Reviews

RenewableUK instructed three independent experts to carry out reviews of the issues, and this specifically included an assessment of the:

- suitability, efficacy and robustness of the research conducted by Dr Pierpont, with particular emphasis on the strength or otherwise of any cited causal links, and with reference to recognised statistical, analytical and epidemiological techniques applied;

- underlying scientific and acoustic principles being cited for infrasound/low frequency noise generated by wind turbines; and

- medical/audiological evidence that infrasound/low frequency noise from wind turbines is the probable cause of the alleged new health condition known as Wind Turbine Syndrome.

Summaries of the reviews conducted are overleaf [3].

1 Pierpont N., Wind Turbine Syndrome – A Report on a Natural Experiment (pre-publication draft – June 2009), now published by K-Selected Books, Santa Fe, NM.
2 The cause and origins of disease.
3 Copies of the full reports will be made available on request (note: final versions are currently being formatted).

Executive Summaries

Expert Opinion 1: Evaluation of Scientific and Epidemiological Methodology

Author: Richard J.Q. McNally, BSc, MSc, DIC, PhD

Dr McNally is a Reader in Epidemiology at the Institute of Health and Society, Newcastle University. He has particular expertise in spatial epidemiology and the analysis of disease clusters and clustering and he has published extensively in internationally recognised peer review journals.

"Dr Pierpont's use of epidemiological and statistical methods is seriously flawed. "

Scope of the review:

Dr McNally was instructed to provide:

- a summary of the basic methods carried out by Dr Pierpont;
- an assessment of the competence and independence of the author;
- commentary on the adequacy and reliability of the methods;
- an assessment on the validity, veracity and relevance of the cited case histories;
- commentary on the reliability of conclusions drawn by Dr Pierpont;
- an evaluation of the general quality and efficacy of the research performed; and
- analysis of the critical evidential and epidemiological gaps in the methodology performed.

Executive summary:

The overall objective of the report was to independently review the state of knowledge about the alleged health condition known as WTS. The specific aim was to critically evaluate the scientific and epidemiological methodology. In addition to carrying out the instruction above, Dr McNally critically evaluated each part of the report and specifically critically assessed the epidemiological and statistical methods.

Dr McNally's summary is presented below:

- Dr Pierpont's report is based on a highly selected small case series.
- She has defined the alleged WTS by a set of vague clinical symptoms (this approach is not an accepted technique for researching the causes of diseases – a precise a priori case definition is required).
- The method of comparison is invalid; she has no clear prior hypotheses.
- She has interviewed members of 10 highly selected families.
- She has used a structured questionnaire for her interviews, but the questionnaire is not included in the report.
- She has compared symptoms in cases before and after exposure to wind turbine noise. Dr Pierpont has looked for associations between symptoms of the alleged WTS and exposure to wind turbine noise.
- Dr Pierpont has repeatedly used simple chi-squared statistics to evaluate putative associations. These statistical techniques are not robust enough in this field – there is the problem of multiple testing resulting in incorrect p-values, and also the possibility of some associations being due to confounding.
- She has only reported selected results of the chi-squared analyses.
- Dr Pierpont has concluded that there is an association between certain symptoms and exposure to wind turbine noise.
- I do not find that Dr Pierpont has either the necessary independence or the relevant competence with regard to scientific approach or epidemiological analysis.
- Dr Pierpont's use of epidemiological and statistical methods is seriously flawed.
- Dr Pierpont's conclusions are completely unreliable.
- A high-quality epidemiological study should always include a range of experts including epidemiologists and biostatisticians. Dr Pierpont has attempted to conduct a study, by herself, and without including appropriate experts.

In conclusion, the positive findings are based on a flawed design and flawed analysis, and he would not recommend publication.

Expert Opinion 2: Infrasound and Low Frequency Sound from Wind Turbines and Wind Turbine Syndrome – an Assessment

Author: Geoff Leventhall, MSc, PhD, FinstP, HonFIOA

Dr Leventhall is an independent consultant in noise, vibration and acoustics. He specialises in low frequency noise, infrasound and vibration and has extensive experience in assessing the effects of wind turbine noise. He is an Honorary Fellow of the UK Institute of Acoustics and a former President of the Institute. He is also a Member of the Acoustical Society of America and a Distinguished International Member of the American Institute of Noise Control Engineering.

"Dr Pierpont makes the common mistake of taking a one-dimensional view of sound, considering only frequencies and ignoring the importance of levels. "

Scope of the review:

Dr Leventhall was instructed to provide:

- a simple description of the terms and terminology (infrasound/low frequency noise) and their application to wind turbines;
- a summary of the peer-reviewed evidence of infrasound/low frequency noise and wind turbines;
- discussion on the audibility and physiological response to infrasound/low frequency noise;
- a summary of the basic noise and acoustic principles cited by Dr Pierpont;
- an assessment of the validity of the scientific and acoustic evidence being presented by Dr Pierpont; and
- conclusions on the available state of knowledge about any significant acoustic effects from wind turbines.

Executive summary:

- The Wind Turbine Syndrome being cited is based on the assumption that infrasound from wind turbines upsets the balance systems in the body and deceives the body into thinking that it is moving, resulting in various distressing effects, which are collected together as the syndrome.

- A review of published measurements of infrasound from wind turbines shows the levels to be low and inaudible. However, Pierpont assumes that infrasound at 1–2Hz and at 4–8Hz is the cause of the effects she noted, incorrectly basing this on previous work on whole body vibration, which is not relevant to excitation by sound. She also bases her theories on work for the Apollo Space Program, when potential astronauts were exposed to very high levels of infrasound in the 120–140dB range, which is also not relevant to the inaudible infrasound from wind turbines.

- Pierpont makes the common mistake of taking a one-dimensional view of sound, considering only frequencies and ignoring the importance of levels. A weakness of her work is the absence of decibel levels or threshold levels for the effects that she claims. This is a serious failing, as urban dwellers are exposed to similar levels of infrasound to that from wind turbines.

- The results of her case studies are credible reports from the small group of people who responded to Pierpont's telephone interviews. However, the symptoms described have been known previously as due to stress effects, which arise in a few sensitive persons when exposed to an adverse element in their environment. There is no evidence that they are patho-physiological effects of wind turbine noise.

- Complaints of wind turbine noise result mainly from audible aerodynamic modulation, typically in the 500Hz to 1,000Hz range. The effects of wind turbine noise are similar to the effects of other noises.

Expert Opinion 3: Effects of Low Frequency Noise from Wind Turbines on Humans

Author: Mark E. Lutman, PhD, BSc, MSc

Mark Lutman is Professor of Audiology at the University of Southampton. He has led internationally recognised research projects on the effects of noise on the auditory system and has published extensively in internationally recognised peer review journals in his field.

"Responses to low frequency vibration only occur when the vibration is applied directly to the head, causing shaking."

Scope of the review:

Dr Lutman was instructed to provide a review of:

- the patho-physiology being cited by Dr Pierpont, with specific reference to the physiological pathways and symptoms being cited;
- the clinical and audiological validity of the symptoms being cited, and the availability of evidence to support a link to low frequency noise;
- commentary on the robustness of the clinical methodology applied and the veracity of the conclusions being drawn; and
- conclusions as to the existence of any substantiated evidence to indicate the existence of the alleged condition known as WTS.

Executive summary:

- The review considered whether low frequency noise from wind turbines might cause adverse physiological effects on people living in proximity, within a mile or so. The review examines the contention put forward by Dr Pierpont that there is a specific and newly identified physiological syndrome (Wind Turbine Syndrome) that is directly related to low frequency wind turbine noise and mediated via the vestibular system.
- The relevant properties of sound and its impacts on the human auditory system are outlined and contrasted with the functioning of the human vestibular system, which is responsible for perceiving posture and motion. It is demonstrated how

the auditory system is specialised for sound and the vestibular system is specialised for motion, showing that the vestibular system is extremely unresponsive to low frequency sound, undermining any connection between low frequency sound and the symptoms of Dr Pierpont's respondents.

- The mechanisms of noise generation from wind turbines are outlined, showing that they do not create material low frequency noise. Instead, they create broadband noise that is modulated at low frequencies, leading to the characteristic "swishing" sound. The argument that wind turbine noise causes physiological symptoms in humans through low frequency noise therefore fails.

- The evidence for response of the human vestibular system to acoustic stimulation is reviewed and it is shown that such responses only occur for high intensities of sound, much greater than created by wind turbines. Responses to low frequency vibration only occur when the vibration is applied directly to the head, causing shaking. These findings further indicate that noise from wind turbines cannot contribute to the symptoms reported by Dr Pierpont's respondents, by the mechanism that she proposes.

The most-likely explanation for the reported symptoms, which are probably exceedingly rare, is a psychological reaction to the intrusion of wind farms, with consequent somatic (felt in the body) effects mediated by stress and anxiety.

RenewableUK Commentary

RenewableUK is committed to understanding all relevant technical and scientific evidence about potential health risks connected to the industry.

Experience has demonstrated that the reputation of and confidence in an industry can only be earned through open and honest debate on the issues concerned, based on the most reliable and up-to-date information available. As a responsible industry it is appropriate to consider societal concerns (actual and perceived) about a given technology, such as wind turbines. However, judgements and conclusions about what risks are acceptable must be evidence led.

The independent reviews on the alleged condition known as Wind Turbine Syndrome, summarised above, represent a robust and reliable state of knowledge on the issues involved. The experts conclude that:

- the scientific and epidemiological methodology and conclusions drawn are fundamentally flawed;
- the scientific and audiological assumptions presented by Dr Pierpont relating infrasound to WTS are wrong; and
- noise from wind turbines cannot contribute to the symptoms reported by Dr Pierpont's respondents by the mechanisms proposed.

These conclusions are further reinforced by two recently published independent reports.

The publication *Wind Turbine Sound and Health Effects – An Expert Panel Review 2009* [4] involves an extensive review, analysis and discussion of the large body of peer-reviewed literature on sound and health effects in general, and on sound produced by wind turbines. The principle conclusions drawn by this expert panel are:

- there is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects;

- the ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans; and

- the sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

"There is no reason to believe that the sounds from wind turbines could plausibly have direct adverse health consequences."

The Health Protection Agency (HPA) publication *Health Effects of Exposure to Ultrasound and Infrasound – Report of the Independent Advisory Group in Non-Ionising Radiation 2010* [5] is another key source of information.

This comprehensive report presents a robust and expert state of knowledge on the health effects of ultrasound and infrasound. The most significant conclusion it presents relevant to the wind sector is that "…there is no consistent evidence of any physiological or behavioural effect of acute exposure to infrasound in humans".

All wind turbines will generate both mechanical and aerodynamic noise and vibration. Mechanical noise is not typically a significant source of noise for modern wind turbines. Aerodynamic noise will arise at all frequencies, from the infrasound range over low frequency sound to the normal audible range, and is the dominant source. Whilst wind turbines are a source of noise and vibration, any residual risks can be effectively mitigated by technical or organisational means.

Advice to industry:

RenewableUK recommends that a proactive approach be taken by the industry in addressing what is a complex and emotive subject. Whilst there is no scientific evidence that wind turbines have any patho-physiological health effects, it is important to understand that certain individuals and interested parties may, despite this evidence, perceive that health effects remain. Although it is difficult to counter these views, the industry can still take a number of actions that can assist in alleviating some or all of these concerns. Examples RenewableUK would encourage the industry to consider include:

Consultation

- Early dialogue and communication with the public and key stakeholders on any proposed development;
- Recognising and understanding that lay perceptions of health risks are valid and should be taken into account.

Planning

- Ensuring environmental impact assessments include a robust evaluation of the noise and vibration risks of the project;
- Taking specific account of any sensitive receptors (e.g. local residents) that may have concerns particular to the project.

Design

- Ensuring the design of the turbine, and where appropriate the wind farm, takes account of the relevant project and environmental issues concerned;
- Ensuring that suitable mitigation measures are considered following completion of risk assessment to address any residual risks where they exist.

Monitoring

- Ensuring a regular programme of environmental noise measurements are performed;
- Ensuring, post consent, that there is regular community engagement, and there are mechanisms in place to address any general or specific concerns relating to noise and related issues.

In the vast majority of cases the above summary merely reflects what is existing good practice operated by developers and operators throughout the UK.

4 Prepared for American Wind Energy Association and Canadian Wind Energy Association (http://www.awea.org/newsroom/releases/AWEA_CanWEA_SoundWhitePaper_12-11-09.pdf).
5 http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE14HealthEffectsofExposuretoUltrasouRCE14/.

RenewableUK
Greencoat House, Francis Street
London SW1P 1DH, United Kingdom

Tel: +44 (0)20 7901 3000
Fax: +44 (0)20 7901 3001
Web: www.RenewableUK.com
Email: info@RenewableUK.com

Our vision is of renewable energy playing a leading role in powering the UK.

RenewableUK is the UK's leading renewable energy trade association, specialising in onshore wind, offshore wind and wave & tidal energy. Formed in 1978, we have an established, large corporate membership ranging from small independent companies, to large international corporations and manufacturers.

Acting as a central point of information and a united, representative voice for our membership, we conduct research; find solutions; organise events, facilitate business development, lobby and promote wind and marine renewables to government, industry, the media and the public.

RenewableUK is committed to the environment.
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NHMRC PUBLIC STATEMENT

JULY 2010*

Wind Turbines and Health

Wind power has been gaining prominence as a viable sustainable alternative to other forms of energy production. Studies have found that there is increasing population demand for 'green' energy[1,2]. In Australia, this has been encouraged by the introduction of the Renewable Energy (Electricity) Act in 2000 and the Renewable Energy Target Scheme in 2009.

As with any new technology, wind turbines are not without controversy. Those who oppose the development of wind farms contend that wind turbines can adversely impact the health of individuals living in close proximity.

Do wind turbines impact on health?

Concerns regarding the adverse health impacts of wind turbines focus on infrasound noise, electromagnetic interference, shadow flicker and blade glint produced by wind turbines.

While a range of effects such as annoyance, anxiety, hearing loss, and interference with sleep, speech and learning have been reported anecdotally, there is no published scientific evidence to support adverse effects of wind turbines on health.

Reported health concerns primarily relate to infrasound (sound that is generally inaudible to the human ear) generated by wind turbines. The World Health Organization states that 'There is no reliable evidence that sounds below the hearing threshold produce physiological or psychological effects'[3]. A recent expert panel review in North America found no evidence that audible or subaudible sounds emitted by wind turbines have any direct adverse physiological effect[4]. The principal human response to perceived infrasound is annoyance[5].

There is currently no published scientific evidence to positively link wind turbines with adverse health effects.

A study of three UK wind farms also supports this conclusion, finding that sound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour[6]. However, there is also the argument that if people are worried about their health they may become anxious, causing stress related illnesses which are genuine health effects arising from their worry, but not from the wind turbine itself. For this reason, NHMRC recommends that people who believe they are experiencing any health problems should consult their GP promptly.

The situation is further complicated by findings that people who benefit economically from wind turbines were less likely to report annoyance, despite exposure to similar sound levels as people who were not economically benefiting[2].

Inside

*Since July 2010, additional scientific literature has been published and is currently being reviewed. It is expected that a new Statement will be issued in 2013.

How much sound do wind turbines produce?

Sound is composed of frequency expressed as hertz (Hz) and pressure level expressed as decibels (dB). Human sensitivity to sound is variable and people will exhibit variable levels of tolerance to different frequencies, including those below the normal range of human hearing[7].

Noise can be defined as any undesirable or unwanted sound. The perception of the noise is influenced by the attitude of the hearer towards the sound source[7]. A recent study found that noise annoyance was strongly associated with a negative attitude to the visual impact of wind turbines on the landscape[2].

Table 1 compares the noise produced by a ten turbine wind farm compared to noise levels from some selected activities.

Table 1: Noise levels compared to a ten turbine wind farm

Activity	Sound pressure level (dBA*)
Jet aircraft at 250m	**105**
Noise in a busy office	60
Car travelling at 64kph at 100m	55
Wind farm (10 turbines) at 350m	**35–45**
Quiet bedroom	35
Background noise in rural area at night	20–40

Based on these figures noise levels from wind turbines have been assessed as "negligible", that is, they appear to be no different to that found in other everyday situations[9]. Further, a survey of all known published results of infrasound from wind turbines found that wind turbines of contemporary design, where rotor blades are in front of the tower, produce very low levels of infrasound[10].

Are there other features of wind turbines that may have effects on health?

It has been suggested that phenomena such as shadow flicker and blade glint could have effects on health. Shadow flicker describes the flicking on and off of the wind turbine's shadow as the blades rotate[1]. The primary concern with shadow flicker is the potential to cause epileptic seizures. The evidence on shadow flicker does not support a health concern[1].

Blade glint happens when the surface of wind turbine blades reflects the sun's light[11]. All major wind turbine blade manufacturers coat their blades with a low reflectivity treatment which prevents reflective glint from the surface of the blade. The risk of blade glint from modern wind turbines is considered to be very low[11].

There has been some concern about electromagnetic radiation from wind turbines however the closeness of the electrical cables counters the electromagnetic field, as does shielding with metal armour[12].

Concerns regarding the adverse health impacts of wind turbines focus on infrasound, electromagnetic radiation, shadow flicker and blade glint produced by wind turbines, as discussed above. While there is currently no evidence linking these phenomena with adverse health effects, the evidence is limited.

Therefore it is recommended that relevant authorities take a precautionary approach and continue to monitor research outcomes. Complying with standards relating to wind turbine design, manufacture, and site evaluation will minimise any potential impacts of wind turbines on surrounding areas[13].

* The "A" represents a weighting of measured sound to mimic that discernable by the human ear, which does not perceive sound at low and high frequencies to be as loud as mid range frequencies[8].

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Wind Turbine Health Impact Study:

Report of Independent Expert Panel

January 2012

Prepared for:

Massachusetts Department of Environmental Protection

Massachusetts Department of Public Health

Expert Independent Panel Members:

Jeffrey M. Ellenbogen, MD; MMSc
Assistant Professor of Neurology, Harvard Medical School
Division Chief, Sleep Medicine, Massachusetts General Hospital

Sheryl Grace, PhD; MS Aerospace & Mechanical Engineering
Associate Professor of Mechanical Engineering, Boston University

Wendy J Heiger-Bernays, PhD
Associate Professor of Environmental Health, Department of Environmental Health,
Boston University School of Public Health
Chair, Lexington Board of Health

James F. Manwell, PhD Mechanical Engineering;
MS Electrical & Computer Engineering; BA Biophysics
Professor and Director of the Wind Energy Center, Department of Mechanical & Industrial
Engineering University of Massachusetts, Amherst

Dora Anne Mills, MD, MPH, FAAP
State Health Officer, Maine 1996–2011
Vice President for Clinical Affairs, University of New England

Kimberly A. Sullivan, PhD
Research Assistant Professor of Environmental Health, Department of Environmental Health,
Boston University School of Public Health

Marc G. Weisskopf, ScD Epidemiology; PhD Neuroscience
Associate Professor of Environmental Health and Epidemiology
Department of Environmental Health & Epidemiology, Harvard School of Public Health

Facilitative Support provided by Susan L. Santos, PhD, FOCUS GROUP Risk
Communication and Environmental Management Consultants

Table of Contents

List of Tables

The Panel Charge

The Expert Panel was given the following charge by the Massachusetts Department of Environmental Protection (MassDEP) and Massachusetts Department of Public Health (MDPH):

1. Identify and characterize attributes of concern (e.g., noise, infrasound, vibration, and light flicker) and identify any scientifically documented or potential connection between health impacts associated with wind energy turbines located on land or coastal tidelands that can impact land-based human receptors.
2. Evaluate and discuss information from peer-reviewed scientific studies, other reports, popular media, and public comments received by the MassDEP and/or in response to the *Environmental Monitor Notice* and/or by the MDPH on the nature and type of health complaints commonly reported by individuals who reside near existing wind farms.
3. Assess the magnitude and frequency of any potential impacts and risks to human health associated with the design and operation of wind energy turbines based on existing data.
4. For the attributes of concern, identify documented best practices that could reduce potential human health impacts. Include examples of such best practices (design, operation, maintenance, and management from published articles). The best practices could be used to inform public policy decisions by state, local, or regional governments concerning the siting of turbines.
5. Issue a report within 3 months of the evaluation, summarizing its findings.

   To meet its charge, the Panel conducted a literature review and met as a group a total of three times. In addition, calls were also held with Panel members to further clarify points of discussion.

Executive Summary

The Massachusetts Department of Environmental Protection (MassDEP) in collaboration with the Massachusetts Department of Public Health (MDPH) convened a panel of independent experts to identify any documented or potential health impacts of risks that may be associated with exposure to wind turbines, and, specifically, to facilitate discussion of wind turbines and public health based on scientific findings.

While the Commonwealth of Massachusetts has goals for increasing the use of wind energy from the current 40 MW to 2000 MW by the year 2020, MassDEP recognizes there are questions and concerns arising from harnessing wind energy. The scope of the Panel's effort was focused on health impacts of wind turbines *per se*. The panel was *not* charged with considering any possible benefits of avoiding adverse effects of other energy sources such as coal, oil, and natural gas as a result of switching to energy from wind turbines.

Currently, "regulation" of wind turbines is done at the local level through local boards of health and zoning boards. Some members of the public have raised concerns that wind turbines may have health impacts related to noise, infrasound, vibrations, or shadow flickering generated by the turbines. The goal of the Panel's evaluation and report is to provide a review of the science that explores these concerns and provides useful information to MassDEP and MDPH and to local agencies that are often asked to respond to such concerns. The Panel consists of seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering. All of the Panel members are considered independent experts from academic institutions.

In conducting their evaluation, the Panel conducted an extensive literature review of the scientific literature as well as other reports, popular media, and the public comments received by the MassDEP.

ES 1. Panel Charge

1. Identify and characterize attributes of concern (e.g., noise, infrasound, vibration, and light flicker) and identify any scientifically documented or potential connection between health impacts associated with wind turbines located on land or coastal tidelands that can impact land-based human receptors.
2. Evaluate and discuss information from peer reviewed scientific studies, other reports, popular media, and public comments received by the MassDEP and/or in response to the *Environmental Monitor Notice* and/or by the MDPH on the nature and type of health complaints commonly reported by individuals who reside near existing wind farms.
3. Assess the magnitude and frequency of any potential impacts and risks to human health associated with the design and operation of wind energy turbines based on existing data.
4. For the attributes of concern, identify documented best practices that could reduce potential human health impacts. Include examples of such best practices (design, operation, maintenance, and management from published articles). The best practices could be used to inform public policy decisions by state, local, or regional governments concerning the siting of turbines.
5. Issue a report within 3 months of the evaluation, summarizing its findings.

ES 2. Process

To meet its charge, the Panel conducted an extensive literature review and met as a group a total of three times. In addition, calls were also held with Panel members to further clarify points of discussion. An independent facilitator supported the Panel's deliberations. Each Panel member provided written text based on the literature reviews and analyses. Draft versions of the report were reviewed by each Panel member and the Panel reached consensus for the final text and its findings.

ES 3. Report Introduction and Description

Many countries have turned to wind power as a clean energy source because it relies on the wind, which is indefinitely renewable; it is generated "locally," thereby providing a measure of energy independence; and it produces no carbon dioxide emissions when operating. There is interest in pursuing wind energy both on-land and offshore. For this report, however, the focus is on land-based installations and all comments are focused on this technology. Land-based

wind turbines currently range from 100 kW to 3 MW (3000 kW). In Massachusetts, the largest turbine is currently 1.8 MW.

The development of modern wind turbines has been an evolutionary design process, applying optimization at many levels. An overview of the characteristics of wind turbines, noise, and vibration is presented in Chapter 2 of the report. Acoustic and seismic measurements of noise and vibration from wind turbines provide a context for comparing measurements from epidemiological studies and for claims purported to be due to emissions from wind turbines. Appendices provide detailed descriptions and equations that allow a more in-depth understanding of wind energy, the structure of the turbines, wind turbine aerodynamics, installation, energy production, shadow flicker, ice throws, wind turbine noise, noise propagation, infrasound, and stall vs. pitch controlled turbines.

Extensive literature searches and reviews were conducted to identify studies that specifically evaluate human population responses to turbines, as well as population and individual responses to the three primary characteristics or attributes of wind turbine operation: noise, vibration, and flicker. An emphasis of the Panel's efforts was to examine the biological plausibility or basis for health effects of turbines (noise, vibration, and flicker). Beyond traditional forms of scientific publications, the Panel also took great care to review other non-peer reviewed materials regarding the potential for health effects including information related to "Wind Turbine Syndrome" and provides a rigorous analysis as to whether there is scientific basis for it. Since the most commonly reported complaint by people living near turbines is sleep disruption, the Panel provides a robust review of the relationship between noise, vibration, and annoyance as well as sleep disturbance from noises and the potential impacts of the resulting sleep deprivation.

In assessing the state of the evidence for health effects of wind turbines, the Panel followed accepted scientific principles and relied on several different types of studies. It considered human studies of the most important or primary value. These were either human epidemiological studies specifically relating to exposure to wind turbines or, where specific exposures resulting from wind turbines could be defined, the panel also considered human experimental data. Animal studies are critical to exploring biological plausibility and understanding potential biological mechanisms of different exposures, and for providing information about possible health effects when experimental research in humans is not ethically

or practically possible. As such, this literature was also reviewed with respect to wind turbine exposures. The non-peer reviewed material was considered part of the weight of evidence. In all cases, data quality was considered; at times, some studies were rejected because of lack of rigor or the interpretations were inconsistent with the scientific evidence.

ES 4. Findings

The findings in Chapter 4 are repeated here.

Based on the detailed review of the scientific literature and other available reports and consideration of the strength of scientific evidence, the Panel presents findings relative to three factors associated with the operation of wind turbines: noise and vibration, shadow flicker, and ice throw. The findings that follow address specifics in each of these three areas.

ES 4.1 Noise

ES 4.1.a Production of Noise and Vibration by Wind Turbines

1. Wind turbines can produce unwanted sound (referred to as noise) during operation. The nature of the sound depends on the design of the wind turbine. Propagation of the sound is primarily a function of distance, but it can also be affected by the placement of the turbine, surrounding terrain, and atmospheric conditions.
    a. Upwind and downwind turbines have different sound characteristics, primarily due to the interaction of the blades with the zone of reduced wind speed behind the tower in the case of downwind turbines.
    b. Stall regulated and pitch controlled turbines exhibit differences in their dependence of noise generation on the wind speed
    c. Propagation of sound is affected by refraction of sound due to temperature gradients, reflection from hillsides, and atmospheric absorption. Propagation effects have been shown to lead to different experiences of noise by neighbors.
    d. The audible, amplitude-modulated noise from wind turbines (“whooshing”) is perceived to increase in intensity at night (and sometimes becomes more of a “thumping”) due to multiple effects: i) a stable atmosphere will have larger wind gradients, ii) a stable atmosphere may refract the sound downwards instead of upwards, iii) the ambient noise near the ground is lower both because of the stable atmosphere and because human generated noise is often lower at night.

2. The sound power level of a typical modern utility scale wind turbine is on the order of 103 dB(A), but can be somewhat higher or lower depending on the details of the design and the rated power of the turbine. The perceived sound decreases rapidly with the distance from the wind turbines. Typically, at distances larger than 400 m, sound pressure levels for modern wind turbines are less than 40 dB(A), which is below the level associated with annoyance in the epidemiological studies reviewed.
3. Infrasound refers to vibrations with frequencies below 20 Hz. Infrasound at amplitudes over 100–110 dB can be heard and felt. Research has shown that vibrations below these amplitudes are not felt. The highest infrasound levels that have been measured near turbines and reported in the literature near turbines are under 90 dB at 5 Hz and lower at higher frequencies for locations as close as 100 m.
4. Infrasound from wind turbines is not related to nor does it cause a "continuous whooshing."
5. Pressure waves at any frequency (audible or infrasonic) can cause vibration in another structure or substance. In order for vibration to occur, the amplitude (height) of the wave has to be high enough, and only structures or substances that have the ability to receive the wave (resonant frequency) will vibrate.

ES 4.1.b Health Impacts of Noise and Vibration

1. Most epidemiologic literature on human response to wind turbines relates to self-reported "annoyance," and this response appears to be a function of some combination of the sound itself, the sight of the turbine, and attitude towards the wind turbine project.
   a. There is limited epidemiologic evidence suggesting an association between exposure to wind turbines and annoyance.
   b. There is insufficient epidemiologic evidence to determine whether there is an association between noise from wind turbines and annoyance independent from the effects of seeing a wind turbine and vice versa.

2. There is limited evidence from epidemiologic studies suggesting an association between noise from wind turbines and sleep disruption. In other words, it is possible that noise from some wind turbines can cause sleep disruption.
3. A very loud wind turbine could cause disrupted sleep, particularly in vulnerable populations, at a certain distance, while a very quiet wind turbine would not likely disrupt even the lightest of sleepers at that same distance. But there is not enough evidence to provide particular sound-pressure thresholds at which wind turbines cause sleep disruption. Further study would provide these levels.
4. Whether annoyance from wind turbines leads to sleep issues or stress has not been sufficiently quantified. While not based on evidence of wind turbines, there is evidence that sleep disruption can adversely affect mood, cognitive functioning, and overall sense of health and well-being.
5. There is insufficient evidence that the noise from wind turbines is *directly (i.e., independent from an effect on annoyance or sleep)* causing health problems or disease.
6. Claims that infrasound from wind turbines directly impacts the vestibular system have not been demonstrated scientifically. Available evidence shows that the infrasound levels near wind turbines cannot impact the vestibular system.
    a. The measured levels of infrasound produced by modern upwind wind turbines at distances as close as 68 m are well below that required for non-auditory perception (feeling of vibration in parts of the body, pressure in the chest, etc.).
    b. If infrasound couples into structures, then people inside the structure could feel a vibration. Such structural vibrations have been shown in other applications to lead to feelings of uneasiness and general annoyance. The measurements have shown no evidence of such coupling from modern upwind turbines.
    c. Seismic (ground-carried) measurements recorded near wind turbines and wind turbine farms are unlikely to couple into structures.
    d. A possible coupling mechanism between infrasound and the vestibular system (via the Outer Hair Cells (OHC) in the inner ear) has been proposed but is not yet fully understood or sufficiently explained. Levels of infrasound near wind turbines have been shown to be high enough to be sensed by the OHC. However, evidence does not

exist to demonstrate the influence of wind turbine-generated infrasound on vestibular-mediated effects in the brain.

e. Limited evidence from rodent (rat) laboratory studies identifies short-lived biochemical alterations in cardiac and brain cells in response to short exposures to emissions at 16 Hz and 130 dB. These levels exceed measured infrasound levels from modern turbines by over 35 dB.

7. There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."
8. The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of psychological distress or mental health problems. There were two smaller, weaker, studies: one did note an association, one did not. Therefore, we conclude the weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems**.**
9. None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine.

ES 4.2 Shadow Flicker

ES 4.2.a Production of Shadow Flicker

Shadow flicker results from the passage of the blades of a rotating wind turbine between the sun and the observer.

1. The occurrence of shadow flicker depends on the location of the observer relative to the turbine and the time of day and year.
2. Frequencies of shadow flicker elicited from turbines is proportional to the rotational speed of the rotor times the number of blades and is generally between 0.5 and 1.1 Hz for typical larger turbines.
3. Shadow flicker is only present at distances of less than 1400 m from the turbine.

ES 4.2.b Health Impacts of Shadow Flicker

1. Scientific evidence suggests that shadow flicker does not pose a risk for eliciting seizures as a result of photic stimulation.

2. There is limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects.

ES 4.3 Ice Throw

ES 4.3.a Production of Ice Throw

Ice can fall or be thrown from a wind turbine during or after an event when ice forms or accumulates on the blades.

1. The distance that a piece of ice may travel from the turbine is a function of the wind speed, the operating conditions, and the shape of the ice.
2. In most cases, ice falls within a distance from the turbine equal to the tower height, and in any case, very seldom does the distance exceed twice the total height of the turbine (tower height plus blade length).

ES 4.3.b Health Impacts of Ice Throw

1. There is sufficient evidence that falling ice is physically harmful and measures should be taken to ensure that the public is not likely to encounter such ice.

ES 4.4 Other Considerations

In addition to the specific findings stated above for noise and vibration, shadow flicker and ice throw, the Panel concludes the following:

1. Effective public participation in and direct benefits from wind energy projects (such as receiving electricity from the neighboring wind turbines) have been shown to result in less annoyance in general and better public acceptance overall.

ES 5. Best Practices Regarding Human Health Effects of Wind Turbines

The best practices presented in Chapter 5 are repeated here.

Broadly speaking, the term “best practice” refers to policies, guidelines, or recommendations that have been developed for a specific situation. Implicit in the term is that the practice is based on the best information available at the time of its institution. A best practice may be refined as more information and studies become available. The panel recognizes that in countries which are dependent on wind energy and are protective of public health, best practices have been developed and adopted.

In some cases, the weight of evidence for a specific practice is stronger than it is in other cases. Accordingly, best practice* may be categorized in terms of the evidence available, as follows:

Descriptions of Three Best Practice Categories

Category	Name	Description
1	Research Validated Best Practice	A program, activity, or strategy that has the highest degree of proven effectiveness supported by objective and comprehensive research and evaluation.
2	Field Tested Best Practice	A program, activity, or strategy that has been shown to work effectively and produce successful outcomes and is supported to some degree by subjective and objective data sources.
3	Promising Practice	A program, activity, or strategy that has worked within one organization and shows promise during its early stages for becoming a best practice with long-term sustainable impact. A promising practice must have some objective basis for claiming effectiveness and must have the potential for replication among other organizations.

**These categories are based on those suggested in "Identifying and Promoting Promising Practices." Federal Register, Vol. 68. No 131. 131. July 2003.*
www.acf.hhs.gov/programs/ccf/about_ccf/gbk_pdf/pp_gbk.pdf

ES 5.1 Noise

Evidence regarding wind turbine noise and human health is limited. There is limited evidence of an association between wind turbine noise and both annoyance and sleep disruption, depending on the sound pressure level at the location of concern. However, there are no research-based sound pressure levels that correspond to human responses to noise. A number of countries that have more experience with wind energy and are protective of public health have developed guidelines to minimize the possible adverse effects of noise. These guidelines consider time of day, land use, and ambient wind speed. The table below summarizes the guidelines of Germany (in the categories of industrial, commercial and villages) and Denmark (in the categories of sparsely populated and residential). The sound levels shown in the table are

for nighttime and are assumed to be taken immediately outside of the residence or building of concern. In addition, the World Health Organization recommends a maximum nighttime sound pressure level of 40 dB(A) in residential areas. Recommended setbacks corresponding to these values may be calculated by software such as WindPro or similar software. Such calculations are normally to be done as part of feasibility studies. The Panel considers the guidelines shown below to be Promising Practices (Category 3) but to embody some aspects of Field Tested Best Practices (Category 2) as well.

Promising Practices for Nighttime Sound Pressure Levels by Land Use Type

Land Use	**Sound Pressure Level, dB(A) Nighttime Limits**
Industrial	70
Commercial	50
Villages, mixed usage	45
Sparsely populated areas, 8 m/s wind*	44
Sparsely populated areas, 6 m/s wind*	42
Residential areas, 8 m/s wind*	39
Residential areas, 6 m/s wind*	37

**measured at 10 m above ground, outside of residence or location of concern*

The time period over which these noise limits are measured or calculated also makes a difference. For instance, the often-cited World Health Organization recommended nighttime noise cap of 40 dB(A) is averaged over one year (and does not refer specifically to wind turbine noise). Denmark's noise limits in the table above are calculated over a 10-minute period. These limits are in line with the noise levels that the epidemiological studies connect with insignificant reports of annoyance.

The Panel recommends that noise limits such as those presented in the table above be included as part of a statewide policy regarding new wind turbine installations. In addition, suitable ranges and procedures for cases when the noise levels may be greater than those values should also be considered. The considerations should take into account trade-offs between

environmental and health impacts of different energy sources, national and state goals for energy independence, potential extent of impacts, etc.

The Panel also recommends that those involved in a wind turbine purchase become familiar with the noise specifications for the turbine and factors that affect noise production and noise control. Stall and pitch regulated turbines have different noise characteristics, especially in high winds. For certain turbines, it is possible to decrease noise at night through suitable control measures (e.g., reducing the rotational speed of the rotor). If noise control measures are to be considered, the wind turbine manufacturer must be able to demonstrate that such control is possible.

The Panel recommends an ongoing program of monitoring and evaluating the sound produced by wind turbines that are installed in the Commonwealth. IEC 61400-11 provides the standard for making noise measurements of wind turbines (International Electrotechnical Commission, 2002). In general, more comprehensive assessment of wind turbine noise in populated areas is recommended. These assessments should be done with reference to the broader ongoing research in wind turbine noise production and its effects, which is taking place internationally. Such assessments would be useful for refining siting guidelines and for developing best practices of a higher category. Closer investigation near homes where outdoor measurements show A and C weighting differences of greater than 15 dB is recommended.

ES 5.2 Shadow Flicker

Based on the scientific evidence and field experience related to shadow flicker, Germany has adopted guidelines that specify the following:

1. Shadow flicker should be calculated based on the astronomical maximum values (i.e., not considering the effect of cloud cover, etc.).
2. Commercial software such as WindPro or similar software may be used for these calculations. Such calculations should be done as part of feasibility studies for new wind turbines.
3. Shadow flicker should not occur more than 30 minutes per day and not more than 30 hours per year at the point of concern (e.g., residences).
4. Shadow flicker can be kept to acceptable levels either by setback or by control of the wind turbine. In the latter case, the wind turbine manufacturer must be able to demonstrate that such control is possible.

The guidelines summarized above may be considered to be a Field Tested Best Practice (Category 2). Additional studies could be performed, specifically regarding the number of hours per year that shadow flicker should be allowed, that would allow them to be placed in Research Validated (Category 1) Best Practices.

ES 5.3 Ice Throw

Ice falling from a wind turbine could pose a danger to human health. It is also clear that the danger is limited to those times when icing occurs and is limited to relatively close proximity to the wind turbine. Accordingly, the following should be considered Category 1 Best Practices.

1. In areas where icing events are possible, warnings should be posted so that no one passes underneath a wind turbine during an icing event and until the ice has been shed.
2. Activities in the vicinity of a wind turbine should be restricted during and immediately after icing events in consideration of the following two limits (in meters).

For a turbine that may not have ice control measures, it may be assumed that ice could fall within the following limit:

$$x_{\max,\, throw} = 1.5\left(2R + H\right)$$

Where: R = rotor radius (m), H = hub height (m)

For ice falling from a stationary turbine, the following limit should be used:

$$x_{\max,\, fall} = U\left(R + H\right)/15$$

Where: U = maximum likely wind speed (m/s)

The choice of maximum likely wind speed should be the expected one-year return maximum, found in accordance to the International Electrotechnical Commission's design standard for wind turbines, IEC 61400-1.

Danger from falling ice may also be limited by ice control measures. If ice control measures are to be considered, the wind turbine manufacturer must be able to demonstrate that such control is possible.

ES 5.4 Public Participation/Annoyance

There is some evidence of an association between participation, economic or otherwise, in a wind turbine project and the annoyance (or lack thereof) that affected individuals may express. Accordingly, measures taken to directly involve residents who live in close proximity

to a wind turbine project may also serve to reduce the level of annoyance. Such measures may be considered to be a Promising Practice (Category 3).

ES 5.5 Regulations/Incentives/Public Education

The evidence indicates that in those parts of the world where there are a significant number of wind turbines in relatively close proximity to where people live, there is a close coupling between the development of guidelines, provision of incentives, and educating the public. The Panel suggests that the public be engaged through such strategies as education, incentives for community-owned wind developments, compensations to those experiencing documented loss of property values, comprehensive setback guidelines, and public education related to renewable energy. These multi-faceted approaches may be considered to be a Promising Practice (Category 3).

Position Statement
Health and wind turbines

Purpose

The Climate and Health Alliance has developed this statement in response to claims that there are adverse health effects associated with human exposure to wind turbines.

Overview

Anthropogenic climate change poses serious and increasing risks to human health. Global average temperature increases resulting from the trapping of greenhouse gas in the Earth's atmosphere is leading to significant changes to Earth's systems.[1] These changes are predominantly associated with greenhouse gas emissions arising from the burning of fossil fuels, such as coal, oil and gas.[2] Reductions in emissions from fossil fuelled electricity generation and transport are required to reduce climate risks to all species, and the biosphere, and to reduce harm to human health.[3,4]

Renewable energy technologies offer Australia the opportunity to reduce its emissions from fossil fuels using its abundant natural resources. Wind and solar power technologies are currently available that make it possible for Australia to shift to 100% renewable energy for electricity generation in a relatively short time frame.[5]

Renewable energy generation such as wind power provides a safe and healthy alternative to fossils fuels. The balance of current scientific evidence indicates that while a small proportion of people may respond to annoyance from noise in some cases, on the whole no adverse physical health effects directly related to wind turbines have been demonstrated.[6]

The evidence

To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to them[7,8] There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency.[9] There is no evidence in the peer reviewed published scientific literature that suggests that there are any adverse health effects from 'infrasound' (a component of low frequency sound) at the low levels that may be emitted by wind turbines.

There is some evidence to suggest that audible noise from wind turbines at elevated sound pressure levels may be associated with disturbed sleep and negative emotions.[10] Annoyance levels may be expressed more about wind turbines than for comparable industrial noise, in particular when people hold pre-existing negative attitudes towards turbines.[11] Annoyance may also be related to visual cues.[12,13]

Fear and anxious anticipation of potential negative impacts of wind farms can also contribute to stress responses, and result in physical and psychological stress symptoms.[14]

In addition, some people experience distress when they perceive a threat to the place that they live in the form of changes to the landscape, like a wind farm, but also other industrial developments, such as new housing estates, coal mines, or supermarkets.[15]

Local concerns about wind farms can be related to perceived threats from changes to their place and can be considered a form of "place-protection action", recognised in psychological research about the importance of 'place' and people's sense of identity.[16] The literature has previously identified the upsetting nature of place change, leading to feelings of grief or loss.[17] However it is important not to presume that energy projects specifically, and proposals for place change more generally, will necessarily disrupt place attachments. How changes to places are interpreted, rather than the form of change per se, is critical in determining whether the pattern of association between place attachment and acceptance is positive or negative.[18]

Economic reward can also affect attitudes to wind turbines, with people economically involved with wind farms more likely to show a more positive attitude to wind power than those who are not.[19]

Health effects of fossil fuels

An examination of the health effects of *any* form of energy generation is meaningless unless it is placed into the context of alternative means of energy generation.

Australia's current energy systems are heavily reliant on the burning of fossils fuels such as coal and gas for electricity generation.[20] These energy sources are not only implicated in driving climate change but, particularly in the case of coal, also pose significant risks to human health. A shift away from fossil fuels to clean renewable energy to reduce greenhouse gas emissions will therefore also reduce risks associated with the mining, transportation and combustion of coal, which contributes to increased risk of developmental delays, lung cancer, heart disease, chronic obstructive pulmonary disease, asthma and other conditions.[21,22]

People who live and work in industries associated with mining, transportation and combustion of fossil fuels face health risks.[23] However, the cost associated with damage to human health and the natural environment from burning fossil fuels is not widely recognised, and is currently not reflected in the costs of electricity from coal and gas fired power in Australia.[24]

If these currently externalised costs of electricity on climate change and health from Australian power stations were accounted for, the cost of power generated by fossil fuels would be considerably higher. The additional climate and health costs that are presently unaccounted for are estimated at: $A19/MWh for natural gas, $A42/MWh for black coal and $A52/MWh for brown coal, while the external costs of wind are only $ $A1.50/MWh. This means the real costs of coal and gas fired electricity is more likely in the vicinity of $100/Mwh, while on-shore wind power is around $70/Mwh.[25]

Misinformation about wind power

Some sections of the community with vested interests may be ideologically opposed to wind power, and recognise that creating doubt and anxiety about health effects of wind power may be an effective form of opposition. Other people may be genuinely concerned after being influenced by stories they have heard in the media or read on the internet. However, this sort of anecdotal information is not an accurate way of making judgements about the safety of wind power and the community and policymakers should look to scientific studies and objective measurements to obtain a true picture.

Some of the anxiety and concern in the community stems originally from a self-published book by an anti-wind farm activist in the United States which invented a syndrome, the so-called 'wind turbine

syndrome'. This is not a recognised medical syndrome in any international index of disease, nor has this publication been subjected to peer review.[26]

There have also been efforts by anti-wind activists to argue that a lack of evidence directly linking wind turbines and physical health effects suggests the available research is not sufficient. Large scale commercial wind farms however have in operation internationally for many decades, often in close proximity to thousands of people, and there has been no evidence of any significant rise in disease rates.[27] In contrast, there has emerged a significant body of evidence relating to the health impacts from energy generation that relies on burning fossil fuels.[28]

It is relevant to note the links between some anti-wind campaigners and some organisations that promote doubt and scepticism in relation to the science of climate change. Further information is available at www.windhealthfacts.net, a resource currently being developed by Sydney University.

CAHA Position on Wind Farms

The Climate and Health Alliance:

- understands that despite the existence of large scale commercial wind turbines in densely populated areas for over 20 years, there is **no credible evidence** in the peer reviewed published scientific literature that there are any direct adverse physiological health effects from exposure to wind turbines;

- supports the deployment of wind turbines as an important source of zero emissions renewable energy for electricity generation to replace highly polluting and harmful fossil fuels to reduce climate risk as well as direct harm to human health;

- notes that wind power is associated with a high degree of safety compared to the significant and well documented adverse health impacts of fossil fuels and the risks of nuclear energy;

- acknowledges that a small proportion of individuals report what they believe to be adverse health effects related to wind turbines, and that audible noise appears to be the main exposure associated with this. Annoyance from this exposure appears to be influenced by a number of factors including views about wind power, perception, and psycho-sociological factors; `

- recognises that careful community consultation is vital to ensure that communities in the vicinity of wind turbines are appropriately consulted and involved in any proposed wind farm development and that accurate and timely information about health and other implications is provided;

- notes that some anti-wind activists are exploiting a range of factors to oppose the deployment of wind energy technologies, including community concerns that commonly accompany the introduction of new technologies;

- urges policy makers to carefully review claims of anti-wind campaigners in the light of credible peer reviewed published scientific evidence;

- supports rigorous well-designed and ethical research into the risks to human health from energy generation, with the priority given to energy sources where there is already significant evidence of harm, namely fossil fuels; and

- proposes that consideration be given to remunerative models where the benefits from wind farms are shared amongst the whole community, not just those on whose land they are sited.

This statement has been prepared by the CAHA Committee of Management and Expert Advisory Group on behalf of CAHA Members and released in February 2012. It will be reviewed in 2013.

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Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, "communicated disease" hypothesis.

Simon Chapman PhD FASSA
Professor of Public Health

Alexis St George MSc PhD
Research Fellow

Karen Waller BSc
Vince Cakic BSc (Hons)
Medical students

Sydney School of Public Health
University of Sydney
2006 Australia

Address for correspondence: simon.chapman@sydney.edu.au

Abstract

Background and objectives With often florid allegations about health problems arising from wind turbine exposure now widespread in parts of rural Australia and on the internet, nocebo effects potentially confound any future investigation of turbine health impact. Historical audits of health complaints across periods when such claims were rare are therefore important. We test 4 hypotheses relevant to psychogenic explanations of the variable timing and distribution of health and noise complaints about wind farms in Australia.

Setting All (n=51) Australian wind farms (with 1634 turbines) operating from 1993–2012.

Methods Records of complaints about noise or health obtained from wind farm companies regarding residents living near 51 Australian wind farms, expressed as proportions of estimated populations residing within 5km of wind farms, and corroborated with complaints in submissions to 3 government public enquiries and news media records and court affidavits.

Results There are large spatio-temporal variations in wind farm noise and health complaints. 33/51 (64.7%) of Australian wind farms including 18/34 (52.9%) with turbine size >1MW have never been subject to noise or health complaints. These 33 farms have some 21,592 residents within 5km of their turbines and have operated complaint-free for a cumulative total of 267 years. Western Australia and Tasmania have seen no complaints. Only 131 individuals across Australia representing approximately 1 in 250 residents living within 5km of wind farms appear to have ever complained, with 94 (72%) of these being residents near 6 wind farms which have been targeted by anti wind farm groups. About 1 in 87 (126/10901) of those living near turbines >1MW have ever complained. The large majority 104/131(79%) of health and noise complaints commenced after 2009 when anti wind farm groups began to add health concerns to their wider opposition. In the preceding years, health or noise complaints were rare despite large and small turbined wind farms having operated for many years.

Conclusions In view of scientific consensus that the evidence for wind turbine noise and infrasound causing health problems is poor, the reported spatio-temporal variations in complaints are consistent with psychogenic hypotheses that health problems arising are “communicated diseases” with nocebo effects likely to play an important role in the aetiology of complaints.

The attribution of symptoms and disease to wind turbine exposure is a contentious "modern health worry" (1) which has seen increasing attention from governments, their regulatory agencies and courts after organised opposition, predominantly in Anglophone nations. Two broad hypotheses have been advanced about those reporting symptoms they attribute to exposure to wind turbines.

1. that both audible noise and sub-audible infrasound generated by wind turbines can be harmful to the health of those exposed.
2. that psychogenic factors – including nocebo responses to the circulation of negative information about their putative harms – are likely to be relevant to understanding why of those exposed, only small proportions claim to be adversely affected.

Despite a profusion of claims mostly by wind farm opponents about harms to exposed humans and animals (currently numbering 216 different diseases and symptoms) (2), 18 reviews of the research literature on wind turbines and health published since 2003 (3-20) have all reached the broad conclusion that the evidence for wind turbines being directly harmful to health is very poor. Among their conclusions have been:

- Small minorities of exposed people – typically less than 10% - claim to be annoyed by wind turbines (15)
- The relationship between wind turbines and human responses is "influenced by numerous variables, the majority of which are non-physical" (15)
- As with the characteristics of "New Environmental Illnesses" (21) and "Modern Health Worries" (22), pre-existing negative attitudes to wind turbines and subjective sensitivity to noise are more predictive of annoyance and adverse health effects than are objective measures of actual exposure (15)
- Being able to see wind turbines (5, 23), and negative personal attitudes toward their impact on landscape aesthetics is similarly predictive of annoyance and intention to complain (24)
- Deriving income from turbines (25) or enjoying reduced power bills can have an apparent "protective effect" against annoyance and health symptoms ("Effective public participation in and direct benefits from wind energy projects (such as receiving electricity from the neighboring wind turbines) have been shown to result in less annoyance in general and better public acceptance overall.") (19)

Previous research has identified psychological factors such as having a "negative personality" (26), holding negative beliefs about wind turbines (27) or that they are ugly (23) as associated with being bothered by noise, complaining, or being opposed to wind farms in one's residential area.

A large literature on nocebo effects exists about reported pain (28), but these effects have also been documented for other invisible and inaudible agents such as electro-magnetic and radio frequency radiation (29, 30). Perceived proximity to base mobile telephone base stations and powerlines, lower perceived control and increased avoidance (coping) behavior were associated with non-specific physical symptoms in

a study which found there was no association between such symptom occurrence and actual distance to these sources of electromagnetic radiation (31).

A mass psychogenic illness model may be applicable to this phenomenon. Mass Psychogenic Illness (MPI) is described (31-33) as a constellation of somatic symptoms, suggestive of an environmental cause or trigger (but with symptoms without typical features of the contaminant, varying between individuals, and not related to proximity or strength of exposure) which occurs between two or more people who share beliefs related to those symptoms and experience epidemic spread of symptoms between socially connected individuals. The rapid development of fear and anxiety is key to the transmission of disease by disruption of behaviour and activities of those involved. Transmission or contagion is increased by the general excitement related to the phenomenon, including media reports, researcher interest, and labeling with a specific clinical diagnostic term. It is enhanced by monetary factors, and related to underlying personality types or stress.

“Labeling” of an illness is one of the key features associated with spread of mass psychogenic illness, along with community and media interest (31). There have been three attempts to popularize portentous quasi scientific names for health problems caused by wind turbines: Wind Turbine Syndrome, Vibro Acoustic Disease (34) and Visceral Vibratory Vestibular Disturbance (35), although none of these have gained scientific acceptance as diagnostic terms. As described earlier, many of these features apply to “wind turbine syndrome”. Furthermore, the most reported symptoms in over one third of all MPIs of nausea/vomiting, headache, and dizziness (31), are also frequently featured as common symptom complaints arising with wind turbines, suggesting these symptoms may be plausibly explained as psychogenic in origin.

In a recent New Zealand study (36), healthy volunteers exposed to both sham and true, recorded infrasound who had been previously given information about possible adverse physiological effects of infrasound exposure, reported symptoms aligned with that information. The adverse effects information provided to subjects was sourced from anti wind farm internet sites which the authors concluded indicated “the potential for symptom expectations to be created outside of the laboratory, in real world settings.” A similar study has shown nocebo effects from exposure to sham wifi (37).

Wind farm opponent groups have been very active in the last five years in three Australian states (Victoria, NSW and South Australia) publicizing the alleged health impacts of turbines. This has created insurmountable problems for researching the psychogenic and nocebo hypotheses using either cross-sectional or prospective research designs because it is unlikely that any communities near wind farms now exist who have not been exposed to extensive negative information. For this reason, audits of the history of complaints are essential because these allow consideration of whether health and noise complaints arose during years prior to the “contagion” of communities with fearful messages about turbines.

Earliest reports of health problems in Australia

Australia's first still operational wind farm commenced operation in 1993 at 10 Mile Lagoon near Esperance, Western Australia. However, objections to wind farms in Australia appear to date from the early years of the 2000s when press reports mentioned negative reactions of some in rural communities to their intrusiveness in bucolic country landscapes ("behemoths" (38)), bird and bat strikes, the divisiveness engendered in communities by the perceived unfairness of some landowners being paid hosting fees of up to $15,000 per year per turbine while neighbours got nothing, and debates about the economics of green energy. Unguarded, frank NIMBYism "I'm quite happy to admit that this is a not-in-my-backyard thing, because my backyard is very special" was also evident in 2002 (38).

Groups explicitly opposing wind farms ostensibly because of agendas about preserving pristine bush and rural environments were active from these early years and included many "branches" of the Australian Landscape Guardians (for example Prom Coast (2002), Spa Country (39), Grampians-GlenThompson (40), Western Plains, Daylesford and District). Key figures in the Landscape Guardians have links with mining and fossil fuel industries (41). Interests with overt climate change denial agendas also actively opposed wind farm developments, particularly in Victoria. Chief among these were the Australian Environment Foundation, registered in February 2005.

However, health concerns were marginal in these years, with one early report from September 2004 (39) noting "some objectors have done themselves few favours by playing up dubious claims about reflecting sunlight, mental health effects and stress to cattle."

An unpublished British report said to refer to data gathered in 2003 on symptoms in 36 residents near unnamed English wind farms is frequently noted by global wind turbine opponents as the first known report of health effects from wind turbines, although curiously, it does not appear to have produced until 2007 (42). The author, Amanda Harry, contacted the subjects, all of whom claimed to be suffering health problems as a result of their exposure. Her report gives no details about how these subjects were selected, although because all said they experienced adverse effects, it would appear they were purposefully, not randomly selected. The Daylesford and Districts Landscape Guardians referred to Harry's work in a 2007 submission opposing a wind farm at Leonards Hill (43).

In Australia, a rural doctor from Toora, Victoria, David Iser, produced another unpublished report (44) in April 2004 following his distribution of 25 questionnaires to households within 2km of the local 12 turbine, 21MW wind farm, which had commenced operation in October 2002. Twenty questionnaires were returned, with 12 reporting no health problems. Three reported what Iser classified as "major health problems, including sleep disturbances, stress and dizziness". Like that of Harry, Iser's report provides no details of questions asked; sample selection;

whether written or verbal information accompanying the delivery of the questionnaire may have primed respondents to make a connection between the wind turbines and health issues; whether those reporting effects had previous histories of the reported problems; nor whether the self-reported prevalence of these common problems were different to those which would be found in any age-matched population.

For example, sleeping problems are very common, with recent Australian and New Zealand estimates ranging from 34% (45), to moderately poor (26.4%) and very poor sleep quality (8.5%) (46). A German study undertaken to obtain benchmark reference data on common symptoms and illnesses experienced in the past 7 days in the general population for comparison with those experienced by clinical trial enrollees presents data on several problems most often attributed to wind turbines. These include headache (45.3%), insomnia (25.6%), fatigue and loss of energy (19.1%), agitation (18.4%), dizziness (17%) and palpitations (8.6%) (47).

A case brought before The Ontario Environmental Review Tribunal by residents claiming to be affected by a wind farm, collapsed when the Tribunal requested that complaints supply their medical records to determine whether their complaints pre-dated the operation of the wind farm (48).

While modern wind farms have operated since the early 1980s (49), the earliest claims alleging that wind turbines might cause health problems in those exposed appear to date from 2003 (see above); this increased rapidly after 2008 (Figure 1), following publicity given to a self-published book, "Wind Turbine Syndrome" (50), by US physician Nina Pierpont, who now runs a virulent anti wind farm website (51). Google Trends data of web-based searches for "Wind Turbine Syndrome" and the more general "wind turbine health" both rose together (Figure 1), suggesting the book generated this sudden interest in the phenomenon, rather than riding a wave of interest. This coverage rose some 24/18 months after a similar peak in interest was recorded for "wind turbine noise (s)". A 2007-11 Ontario study of newspaper coverage of wind farms showed that 94% of articles featured "dread" themes(52).

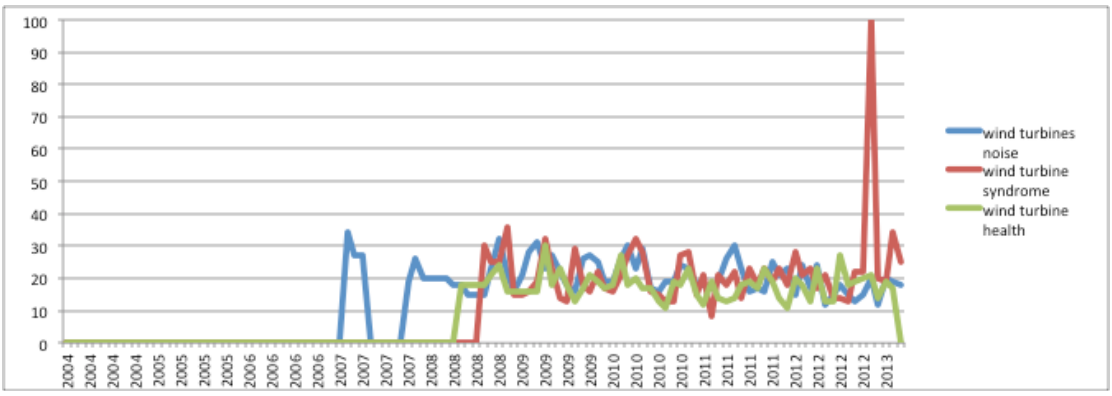

Figure 1: Global data from Google Trends on 3 search terms – "Wind turbines noise" (blue) "Wind turbine health" (gold) and "wind turbine syndrome" (red) over 2004 – 2013 (accessed March 9, 2013).

Acute effects Wind farm complainants name both acute and chronic adverse effects. Acute effects are of particular interest to the psychogenic hypothesis because it is often claimed that even brief exposure to wind turbines can cause almost immediate onset of symptoms. For example, a recent report describes a visit to turbine-exposed houses where people become immediately affected: “The onset of adverse health effects was swift, within twenty minutes, and persisted for some time after leaving the study area (53). Symptoms are said to disappear when those affected move away temporarily, only to return as soon as they come back. A highly publicized Lake Bonney complainant who had hosted turbines on his previous property without complaint for six years today claims he and his wife are affected but that symptoms disappear as soon as they leave their new home for one or two days (54).

If wind turbine exposure can cause such “instant“ problems, any history of delayed or non-reporting of such complaints or and the absence of any reports about such complaints in the news media, months or sometimes years after various wind farms began operating creates serious coherency problems for such claims. Such delays would be incompatible with there being widespread or important “acute” effects from exposure.

To date, there has been no study of the history and distribution of noise and health complaints about wind turbines in Australia. We sought to test 4 hypotheses relevant to the psychogenic argument.

1. Many wind farms of comparable power would have no history of health or noise complaints from nearby residents (suggesting that exogenous factors to the turbines may explain the presence or absence of complaints)
2. Wind farms which have been subject to complaints would have only a small number of such complaining residents among those living near the farms (suggesting that individual or social factors may be required to explain different “susceptibility”)
3. Few wind farms would have any history of complaints consistent with claims that turbines cause acute health problems (suggesting that explanations beyond turbines are needed to explain why acute problems are reported).
4. Most health and noise complaints would date from after the advent of anti wind farm groups beginning to foment concerns about health (from around 2009) and that wind farms subject to organised opposition would be more likely to have histories of complaint than those not exposed to such opposition (suggesting that health concerns may reflect “communicated” anxieties).

Methods

Information on the commencement of turbine operation, the number of turbines operating, average turbine size and the megawatt (MW) capacity of each wind farm was located from public sources such as wind farm websites.

Wind farm operators have clear interest in any reactions of nearby residents to the farms they operate. In the planning, construction and power generation phases of wind farm operation they monitor local community support and complaints submitted to them, in news media and via notifications from local government. In Victoria, companies are required by law to register all complaints with the state government. In September 2012 all wind farm owners in Australia were asked to provide information on:

- the actual or estimated number of residents within a 5km radius of each wind farm they operated. Google Maps and census data were also used to obtain this data.
- whether the company had received or was aware of any health and/or noise complaints, including sleeping problems, that were being attributed to the operation of their wind farms.
- the number of individuals who had made such complaints (direct complaints to the companies, those voiced in local media, to local government or state or national enquiries).
- the date at which the first complaint occurred after.
- whether there had been any anti-wind farm activity in the local area such as public meetings addressed by opponents, demonstrations or advertising in local media.

Any documentation of complaints such as internet links or news clips about public was requested. Companies were explicitly asked to not send details of any private complaints which could identify those complaining, unless these complaints had been made public by the complainants.

It is possible that wind companies may nonetheless be unaware of health and noise complaints about their operations or that they might downplay the extent of complaints and provide underestimates of such complaints. To corroborate the information on the number of complainants provided by the companies, we therefore reviewed all 1,594 submissions made to three government enquiries on wind farms: the 2011–2012 Senate enquiry into the Social and Economic Impact of Rural Wind Farms (1,818 submissions) (55); the 2012 NSW Government's Draft NSW Planning Guidelines for Wind Farms (359 submissions) (56); and the Renewable Energy (Electricity) Amendment (Excessive Noise from Wind Farms) Bill 2012 (217 submissions) (57). We searched all submissions for any mentions by residents living in the vicinity of operating wind farms (as opposed to those being planned) of their health or sleep being adversely affected or that they were annoyed by the sound of the turbines.

We also searched daily media monitoring records supplied to the Clean Energy Council by a commercial monitoring company from August 2011 (when the monitoring contract began) until January 2013. This monitoring covered print news items, commentary and letters published in Australian national, state and regional newspapers mentioning any wind farm, as well as television and radio summaries about all mentions of wind farms. It was important to use this source of monitoring

rather than use on-line databases like Factiva, as the latter do not cover all rural news media which is where much coverage of debate about rural wind farms was likely to be found.

Finally, a pre-print of this paper was published on the University of Sydney's e-scholarship repository on March 15 2013. In the next 12 days the paper was opened 5832 times, a weekly record for that repository. This generated considerable correspondence with us, and in one case (Hallett 2), information about extra complainants who had complained via a legal case was provided. These were then included.

In reviewing the submissions and media monitoring, only complaints from those claiming to be personally affected by the operation of an existing wind farm in Australia were noted. Expressed concerns about possible future adverse effects or that wind turbines *could* be harmful were not classified as evidence of personal experience of harm or annoyance. There were many of these. Third party statements, such as comments about unnamed neighbours with problems, were not accepted as evidence of harm.

Where the numbers of complainants determined from this corroborative public source searching exceeded the numbers provided to us by the wind companies, we chose the larger number. Where the numbers determined from public sources were less, we used the larger number provided by the companies. Nearly all those who publicly complained did not seek anonymity, being named in media reports or not electing to have their parliamentary submissions deidentified. However, we have chosen not to list their names in this report.

The companies provided estimates of the number of residents currently living within 5km of each wind farm. Again, some companies provided estimates of the number of individuals, while others provided data on the number of houses. In Table 1, we have multiplied cells showing the number of *houses* by 2.6, this being the average number of residents per household in Australia today, to give a total estimate of surrounding residents.

Results

Table 1 shows the history of complaints from all 51 Australian wind farms. Complaints came either from individuals or from households with several occupants each complaining. Some wind companies initially reported the number of complainants as *households*, while others reported individual complainant numbers. In these cases we sought clarification from companies about whether complaints came from single individuals, couples or more than two members of a family so as to report total the estimated total number of individual complainants.

Hypothesis 1: Many wind farms would have no history of complaints

Of all 51 wind farms, 33 (64.7%) had never been subject to health or noise complaints (Table 1), with 18 (35.3%) receiving at least one complaint since operations commenced. The 33 farms with no histories of complaints, and which today have some 21,592 residents within 5km of their turbines, have operated for a cumulative total of 267 years.

Of the 18 wind farms which had received complaints, 16 were larger wind farms (≥ 10MW capacity). In summary, 18/34 (52.9%) of larger wind farms, and 15/17 (88.2%) of small farms have never experienced complaints. Wind farm opponents sometimes argue that it is mainly very large, "industrial" wind turbines which generate sufficient audible noise and infrasound to cause annoyance and health problems. If 1MW is taken to define a "large" turbine, 18/34 (52.9%) of farms using large turbines had never attracted complaints while 15/17 (88%) of farms using smaller turbines had no histories of complaints.

The distribution of farms ever having received complaints is highly variable across Australia. Figure 2 shows no consistency between the percentages of farms receiving complaints in different states, whether they have many or few wind farms. Western Australia has 13 wind farms (3 with large turbines), including some of the longest running in Australia (Esperance 10 Mile Lagoon 1993, Denham 1998). No complaints have been received at any of these wind farms. Verve, which operates 8 farms in the state replied "we have never received any form of notification of health complaints in the vicinity of our wind farms." The three farms in Tasmania have also never received complaints.

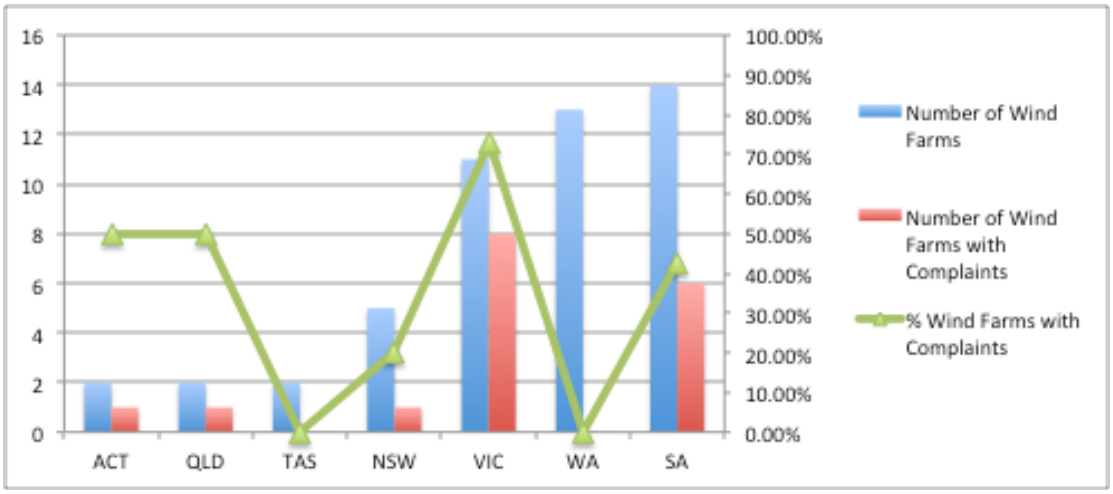

Figure 2: Wind Turbine Complaints by State or Territory.

Our hypothesis about many wind farms – including those with large turbines – having no history of complaints, with strong spatial (state) factors being associated with farms receiving complaints was thus strongly confirmed.

Hypothesis 2: A small number of complaining residents

Nationally, a total of 131 individuals in Australia appear to have ever formally or publicly complained about wind farm noise or health problems affecting them. Of these, well over half (94 or 72%) came from residents living near just six wind farms (Waubra=29, McArthur=21, Hallett 2= 13, Waterloo=11, Capital=10 and Wonthaggi ~10). Of the remaining farms which have experienced complaints, 9 had between 2 and 6 complainants, and 4 had only single complainants. Of 18 wind farms which had attracted complaints, 11 (72%) have had 6 or less complainants.

There are an estimated 32,739 people living within 5km of the 49 wind farms for which we obtained residential estimates. Most (20,405 or 62%) live near the 17 smaller wind farms, while 12,334 live within 5km of the 32 larger wind farms. In summary, nationally, an estimated 131 individuals have complained out of an estimated 32,739 nearby residents: a rate of about 0.4% or 1 in 250. Of the 34 wind farms with larger (>1MW) turbines, their 126 complainants represented some 1 in 98 of the surrounding 12,366 residents, with 6 of the main complainant attracting farms being responsible for 94/126 (75%) of these complainants. Large wind farms with relatively large surrounding rural populations and no histories of complaint include Wattle Point (560), Albany, Starfish Hill (each 200) and Challicum Hills (143).

Again, our hypothesis that the number of complainants living near those wind farms with any history of complaints would be a small proportion of the exposed population, was strongly confirmed.

Hypothesis 3: Few wind farms would have any history of complaints consistent with claims that turbines cause acute effects

First complaint timing ranged from immediately after turbines commenced operation (sometimes at only a fraction of full capacity) to several years later (eg: Crookwell, 13.5 years, Lake Bonney, over 7 years later). Of the 6 turbines recording their first complaint over one month after operation, 3 of these were over one year after operation. In five cases (Clements Gap, Hallet 2 & 4, Leonards Hill, Waubra), wind companies advised that complaints anticipating health problems were received before the farms commenced operation (see Box case study). Early complaints from a few turbines could be consistent with acute effects but also with nocebo effects caused by anticipation of adverse impacts(36). However, gaps of months or sometimes years between the commencement of turbine operation and complaints are inconsistent with turbines causing acute effects. If such effects were serious or common, clinical case reports would have almost certainly have appeared in peer reviewed journals, given how long turbines have operated.

Case Study: Leonards Hill, Victoria
Health concerns were publicised in the vicinity of Leonards Hill prior to the construction of the twin turbine wind farm. A small number of individuals (6 out of 232 population) claimed noise or health effects, one before wind farm operations began.

- Jun 2007: Health concerns raised in submission to planning appeal.
- Oct 5, 2010: Sarah Laurie of the Waubra Foundation gave a presentation on "Wind farms and their associated Health Effects" at a forum near Leonards Hill.
- Oct 8, 2010: The Australian Environment Foundation and Landscape Guardians held a protest at Leonards Hill. Two residents attended: P1 and P2 (President of local Landscape Guardians).
- Oct 14, 2010: P1 raised health concerns in a letter to the wind farm proponent.
- Nov 10, 2010: Sarah Laurie raises health concerns in front page article of local newspaper.
- Dec 3, 2010: P2 reported in national newspaper as taking medication in response to wind farm, prior to construction.
- Jun 24, 2011: Less than 2 days after commencing operation of single turbine at 25% load, on national television, P2 claims adverse affects over previous *3* nights.
- Aug 19, 2011: P1 claims adverse health effects in regional newspaper.

Hypothesis 4: Most complaints would date from 2009 or later, when opposition groups began to publicise health and noise effects

The nocebo hypothesis would predict that the spread of negative, often emotive information would be followed by increases in complaints and that without such suggestions, complaints would be less. In the 10 years between the commencement of operation of the first Esperance wind farm and the end of 2003 when the Harry and Iser health impact reports(42, 44) began being highlighted by turbine opposition groups, 12 more wind farms commenced operation in Australia. In that decade, besides two complainants from Toora, we aware of only one other person living near the north Queensland Windy Hill wind farm who complained of noise and later health soon after operation commenced in 2000. In that decade, the large turbined Albany, Challicum Hills, Codrington, Starfish Hill and Woollnorth Bluff Point farms commenced operation but never received complaints.

With the exception of Wonthaggi (~10 complainants in 2006, but none today) all other complaints date from after March 2009 – six years after Iser's Toora survey of health complaints(44) - and particularly from the most recent years when anti wind farm publicity from opposition groups focused on health has grown. Again, the nocebo hypothesis and models of mass psychogenic illness would predict this changed pattern and contagion of complaints, driven by increasing community

concern rather than an increase in wind turbines. Sixty nine percent of wind farms began operating prior to 2009 while the majority of complaints (82%) were recorded after this date.

Responding to the nocebo hypothesis and the view that opposition groups were fomenting a "communicated disease", the Waubra Foundation's Sarah Laurie stated: "There is also plenty of evidence that the reporting of symptoms for many residents at wind developments in Victoria such as Toora, Waubra and Cape Bridgewater *preceded the establishment of the Waubra Foundation* (emphasis in original). In the case of Dr David Iser's patients at Toora the time elapsed is some 6 years."(58)

This statement neglects to note that the Waubra Foundation's registration in July 2010 was preceded by several years of virulent wind turbine opposition – which included health claims -- by the Landscape Guardians and the Australian Environment Foundation, as discussed earlier in the paper. For example, in November 2009, 8 months before the formation of the Waubra Foundation the Western Plains Landscape Guardians published a full-page advertisement in the local Pyrenees Advocate newspaper headed "Coming to a house, farm or school near you? Wind Turbine Syndrome also known as Waubra Disease". It listed 12 common symptoms (eg: sleeping problems, headaches, dizziness, concentration problems). Peter Mitchell is the founding chairman of the Waubra Foundation and in 2009 and at least until February 2011, was also actively advocating for the Landscape Guardians(59).

Of the 18 wind farms which have seen complaints, 13 (72%) have experienced local opposition from anti wind farm groups such as local branches of the Australian Landscape Guardians or the Waubra Foundation. No wind farm with any history of wind turbine opposition avoided at least one health or noise complaint.

Discussion

We purposefully took a liberal view of what a "complainant" was, by including those who had voiced their displeasure about noise, sleep or health in news media or submissions even if they had never lodged a formal complaint with the relevant wind farm company. Despite this, the numbers complaining in Australia were very low and largely concentrated in a small number of "hotbeds" of anti wind farm activism.

A 2012 CSIRO report on 9 wind farm developments in three Australian states found widespread acceptance among local residents of both operating and planned farms, and noted that: "The vocal minority are more often prominent in the media .. These groups often contact local residents early in the project and share concerns about wind farms." And that "The reasons for opposition by some participants suggest that wind farms proposals are triggering a range of underlying cultural or ideological concerns which are unlikely to be addressed or resolved for a specific wind farm development. These underlying issues include pre-existing concerns that rural communities are politically neglected by urban centres, commitment to an anti-

development stance, and opposition to a ‘green’ or ‘climate action’ political agenda.”(60)

Our historical audit of complaints complements recent experimental evidence (36), that is strongly consistent with the view that “wind turbine syndrome” and the seemingly boundless range of symptoms associated with it has important psychogenic nocebo dimensions (2). While wind turbines have operated in Australia since 1993, including farms with >1MW turbines from 2001 (Codrington), health and noise complaints were very rare until after 2009, with the exception of Wonthaggi which saw about 10 complainants in 2006.

As anti wind farm interest groups began to stress health problems in their advocacy, and to target new wind farm developments, complaints grew. Significantly though, no older farms with non-complaining residents appear to have been targeted by opponents. The dominant opposition model appears to be to foment health anxiety among residents in the planning and construction phases. Health complaints can then appear soon after power generation commences. Residents are encouraged to interpret common health problems like high blood pressure and sleeping difficulties as being caused by turbines.

Boss’ review of factors promoting mass hysteria noted that “media reports are used as cues by potential cases for appropriate illness behavior responses and can initially alarm those at risk …Too often, it is the media-created event to which people respond rather than the objective situation itself … Development of new approaches in mass communication, most recently the Internet, increase the ability to enhance outbreaks through communication. “(31)

This study shows there are large spatio-temporal differences in the distribution of complainants to wind farms in Australia. There are many wind farms, large and small, with no histories of complaints and a small number where the large bulk of complaints have occurred. Just over half of wind farms with larger turbines have seen complaints, but nearly just as many have not. These differences invite explanations that lie beyond the turbines themselves.

Several wind farm operators reported that many former complainants had now desisted. For example, Waubra management advised that not all complainants identified by our public searches had complained to them, and that more than half of the 17 complainant households who had complained to them, had had their complaints resolved. Similarly, Wonthaggi management said that none of some 10 complainants from 2006/2007 were still complaining today. Some of these former complainants from different farms had had their houses noise tested with the results showing they conformed to the relevant noise standard, some received noise mitigation (eg:double glazing), while others simply stopped complaining.

Opponents sometimes claim that only “susceptible” individuals are adversely affected by wind turbines, using the analogy of motion sickness. Our data produce problems for that explanation: it is implausible that no susceptible people would live

around any wind farm in Western Australia or Tasmania, around almost all older farms, nor around nearly half of the more recent farms. No credible hypotheses other than those implicating psycho-social factors have been advanced to explain this variability.

Wind farm opponents frequently argue complainants are legally "gagged" from speaking publicly about health problems, thus underestimating true prevalence. This is said to apply to turbine hosts who are contractually gagged or to non-hosts who have reached compensation settlements with wind companies after claiming harm. The first claim is difficult to reconcile with the example provided by a high profile Lake Bonney wind farm host who continues to complain publicly without attracting any legal consequences(28). Confidentiality clauses are routinely invoked in any legal settlement to protect parties' future negotiating positions with future complainants. They usually refer to the settlement figure rather than to the reasons for it.

Limitations

The data we obtained on the number of individuals or occupied houses near the farms were current estimates. These numbers may have varied in different directions for different farms over the 20 year period that wind farms have operated in Australia. But no data are available on that variation. Our estimates of the ratios of complaints to population are therefore unavoidably fixed around the most current population estimates.

It is possible that there were other complainants who complained earlier than in the periods covered by our corroborative checks. However, this seems highly unlikely: Australian anti wind farm groups would have strong interests in widely publicizing such complainants, had they existed. The Waubra Foundation for example, repeatedly refers to the 2004 Iser report(44), in its efforts to emphasise that health concerns had been raised before the Waubra Foundation became established(58) As wind farm opponents have not highlighted more complainants than we have identified, this strongly suggests there were no earlier health or noise complainants.

It is also possible that some of the health complainants are disingenuous, thereby inflating the true number of people actually claiming to experience turbine-related health problems when their objections may be only aesthetic. Controversy arose when an anti wind farm activist who lives 17km from the Waterloo wind farm was recently accused of "coaching" residents who disliked the local wind farm to explicitly mention health issues (61).

We selected the 5km distance from turbines as a compromise between the 2km minimum setback distance designated by the Victorian government for future wind farm approvals, and the 10km often named by the Waubra Foundation as the advisable minimum distance. We also note here, that one prominent critic of wind farms claims to to be able to personally hear low frequency noise up to 100km away from wind turbines under certain conditions (62). Had we chosen the 10km distance

counseled by the Waubra Foundation, this would have significantly increased the numbers of people exposed but not complaining.

The estimates provided by the wind companies of the number of residents within 5km of wind farms need to be seen as approximations. Census data is available by local government areas and by the Australian Bureau of Statistics statistical regions. However, these do not correspond with the 5km zone of residence of interest here. The wind companies which provided this data obtained it from their own knowledge of the number of residences near their wind farms and we checked local township sizes from Australian census data. This information is typically obtained during the planning stages of wind farm development when development applications often require such estimations to be provided. At least one company used Google Earth photography to calculate their estimate of the number if dwellings. However, such estimates will always be imprecise and approximations only. They nonetheless provide “ballpark” denominators against which the known number of complainants can be compared.

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Table 1: Complainant numbers at 51 Australian wind farms, 1993-2013.

Farm name (state) owner	Installed Capacity (MW) + (number of turbines) + Av.turbine size MW	Commenced operation & total years (to Dec 2012)	Approx. population within 5km	Health or noise complainants (Y/N) & number	Date of first complaint (months since opened)	Local or visiting opposition group activity?
A: Farms with total > 10mw capacity						
1.Albany/Grasmere (WA) Verve	35.4 (18) 1.96	Oct 2001 (11y2m)	200	N	-	N
2.Bungendore / Capital/Woodlawn (NSW) Infigen	189 (90) 2.1	Nov 2009 (3y1m)	76 houses 198	Y:10	Dec 2009 (1m)	Y
3.Canunda (SA) International Power	46 (23) 2.0	Mar 2005 (7y10m)	20 houses 52	N	-	N
4.Cape Bridgewater (Vic) Pacific Hydro	58 (29) 2.0	Nov 2008 (4y1m)	68 houses 177	Y:6	2 Feb 2010 (16m)	Y
5.Cape Nelson South (Vic) Pacific Hydro	44 (22) 2.0	Jun 2009 (3y6m)	170 houses 425	Y:2	10 Feb 2010 (8m)	Y
6.Cathedral Rocks (SA) TRUenergy, Acciona & EHN	66 (33) 2.0	Sep 2005 (7y3m)	0	N	-	N
7.Challicum Hills (Vic) Pacific Hydro	52.5 (35) 1.5	Aug 2003 (9y4m)	55 houses 143	N	-	N
8.Clements Gap (SA)	56.7 (27)	Feb 2010	41	Y:3	On-going from	Y

Pacific Hydro	2.1	(2y10m)			earlier	
9.Codrington (Vic)	18.2 (14)	Jun 2001	50	N	-	N
Pacific Hydro	1.3	(11yr6m)				
10.Collgar/Merriden (WA)	206 (111)	May 2011	15	N	-	N
Collgar	1.85	(1yr7m)				
11.Cullerin Range (NSW)	30 (15)	Jul 2009	50	N	-	N
Origin	2.0	(3y5m)				
12.Emu Downs (WA)	80 (48)	Oct 2006	50	N	-	N
APA	1.66	(6y2m)				
13.Gunning/Walwa (NSW)	46.5 (31)	May 2011	25 houses	Y:1	Jan 2012	N
Acciona	1.5	(1yr7m)	65		(8m)	
14.Hallett 1/Brown Hill (SA)	95 (45)	Sep 2008	120	N	-	Y
AGL	2.11	(4y3m)				
15.Hallett 2/Hallett Hill (SA)	71.4 (34)	Mar 2010	120	Y:13*	On-going from	Y
AGL	2.1	(2y9m)			earlier	
16.Hallett 4/North Brown	132 (63)	May 2011	200	Y:1	On-going from	Y
Hill (SA) AGL	2.1	(1y7m)			earlier	
17. Hallett 5/Bluff Range	53 (25)	Mar 2012	140	Y:1	Apr 2012	Y
(SA) AGL	2.1	(9m)			(1m)	
18.Lake Bonney (SA)	278.5 (112)	Mar 2005	255	Y:2	June 2012	N
	2.8	(7y9m)			(7y3m)	
19.MacArthur (Vic)	420 (140)	Sep 2012	150	Y:8 houses= 21	2 days after	Y
AGL/Meridian	3.0	(3m)			2/140 turbines commenced operation	
20. Mortons Lane (Vic)	19.5 (13)	Dec 2012	14 houses	N	-	N

CGN Wind Energy Ltd	1.5		36			
21.Mt Millar (SA) Meridian	70 (35) 2.0	Feb 2006 (6y10m)	10 houses 26	N	-	N
22.Oaklands Hill (Vic) AGL	67.2 (32) 2.1	Feb 2012 (10m)	250	Y:6	On-going from earlier	Y
23.Snowtown (SA) Trust Power	100.8 (47) 2.14	Nov 2008 (4y1m)	4 houses 10	N	-	N
24.Starfish Hill (SA) Ratch	34.5 (23) 1.5	Sep 2003 (9y3m)	200	N	-	N
25.Toora (Vic) Ratch	21 (12) 1.75	Jul 2002 (10y5m)	674	Y:2	Early (precise date not known)	Y
26.Walkaway (Alinta) (WA) Infigen	89.1 (54) 1.65	Apr 2006 (6y8m)	3 houses 8	N	-	N
27.Waterloo (SA) TRUenergy	111 (37) 3.0	Dec 2010 (2y)	75 houses 195	Y:11	Feb 2011 (2m)	Y
28.Wattle Point (SA) AGL Hydro	91 (55) 1.65	Nov 2005 (7y1m)	560	N	-	N
29.Waubra (Vic) Acciona	192 (128) 1.5	Mar 2009 (3y10m)	283 houses 736	Y:29	13 Mar 2009 (immediate)	Y
30.Windy Hill (Qld) Ratch	12 (20) 0.6	Feb 2000 (12y10m)	200	Y:1	Early (precise date not known)	N
31.Wonthaggi (Vic) Transfield	12 (6) 2.0	Dec 2005 (7y)	6900	Y:~10	Feb 2006 (2m)	Y
32.Woolnorth:Bluff Point (Tas) Roaring 40s & Hydro Tas.	65 (37) 1.76	Aug 2002 (10y4m)	NI	N	-	N

33.Woolnorth:Studland Bay (Tas) Roaring 40s & Hydro Tas.	75 (25) 3.0	May 2007 (5yr7m)	NI	N	-	N
34.Yambuk (Vic) Pacific Hydro	192 (128) 1.5	Jan 2007 (5y11m)	88	N	-	N
Sub-total:34 farms	3130.3mw (1567 turbines)		12334	16 farms with 121 complainants		11
B: Farms with <10mw capacity						
35.Blayney (NSW) Eraring Energy	9.9 (15) 0.66	Oct 2000 (12y2m)	37	N	-	N
36.Bremer Bay (WA) Verve	0.6 (1) 0.6	Jun 2005 (7y6m)	250	N	-	N
37.Coober Pedy (SA) Energy Generation	0.15 (1) 0.15	1999 (13y)	3500 (turbine is 2.5km from town)	N	-	N
38.Coral Bay (WA) Verve	0.825 (3) 0.275	Oct 2006 (6y2m)	200	N	-	N
39.Crookwell (NSW) Union Fenosa/Eraring	4.8 (8) 0.6	Jul 1998 (14y5m)	200	Y:4	Jan 2012 (13y6m)	Y
40.Denham (WA) Verve	1.6 (4) 0.4	Jun 1998 (14y6m)	600	N	-	N
41.Esperance, 9 Mile Beach (WA) Verve	3.6 (6) 0.6	2003 (8y)	50	N	-	N
42.Esperance, 10 Mile Lagoon (WA) Verve	2.025 (9) 0.225	1993 (19y)	50	N	-	N
43.Hampton Park (NSW)	1.32 (2)	Sep 2001	150	N	-	N

Wind Corp.	0.66	(11y3m)				
44.Huxley Hill, King Island (Tas) Hydro Tas.	2.458 (5) 0.49	Feb 1998 (14y1m)	10 houses (26)	N	-	N
45.Hopetoun (WA) Verve	1.2 (2) 0.6	Mar 2004 (8y9m)	600	N	-	N
46.Kalbarri (WA) Verve	1.6 (2) 0.8	Jul 2008 (4y5m)	10	N	-	N
47.Kooragang, Newcastle (NSW) Energy Australia	0.6 (1) 0.6	1997 (15y)	3-4km from Mayfield 9900	N	-	N
48.Leonards Hill (Vic) Community owned	4.1 (2) 4.1	Jun 2011 (1y6m)	232	Y:6	On-going from earlier	Y
49.Mt Barker (WA) Mt Barker Power	2.4 (3) 0.8	Mar 2011 (1y9m)	2000	N	-	N
50.Rottnest Island (WA) Rottnest Island	0.6 (1) 0.6	Sep 2006 (6y3m)	150	N	-	N
51.Thursday Island (Qld) Egon Energy	0.225 (2) 0.113	Aug 1997 (15y5m)	2500	N	-	N
Sub-total:17 farms	38MW 67 turbines		20405	2 farms with 10 complainants		2
Total:51 farms	3168.3MW 1634 turbines		32739	18 farms with 131 complainants		13

NI= no information

* 13 residents submitted affidavits in a court case but only 2 complained to the company (AGL), and none to the local Council or Environmental Protection Agency
Average residents per house in 2011: 2.6 http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/0

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Appendix 7-1

Geological Heritage Site Report

SLIGO - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Inishcrone**		
Other names used for site			
TOWNLAND(S)	Carrowhubbuck		
NEAREST TOWN	Inishcrone		
SIX INCH MAP NUMBER	16		
NATIONAL GRID REFERENCE	128600 330500 = G 286 305		
1:50,000 O.S. SHEET NUMBER	24	**1/2 inch Sheet No.**	7

Outline Site Description
Foreshore rock exposures.

Geological System/Age and Primary Rock Type
Tertiary igneous intrusions and some contact or thermal metamorphism of host limestones.

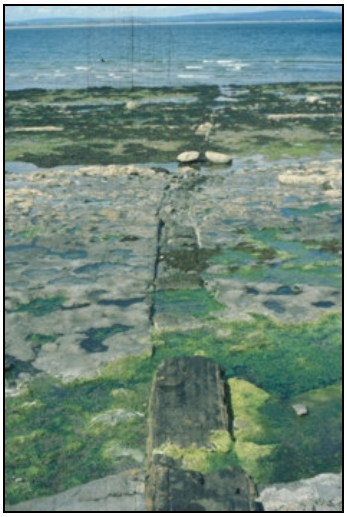
Main Geological or Geomorphological Interest
A good series of Tertiary dykes occur on the foreshore north of Inishcrone. These dykes formed approximately 58 million years ago when Europe and North America split apart to produce what is now the North Atlantic Ocean. Hot magma rose up along fractures and cracks that formed in the limestone as the North Atlantic opened up. The magma cooled and hardened as vertical sheets or dykes of dolerite baking the adjacent limestone as it cooled. Bands of white marble formed as a result of this contact metamorphism as did some skarn mineral deposits (calcium-rich ore deposits). This site is also the type area for the mineral Killalaite ($Ca_3Si_2O_7.O.5H_2O$), produced by contact (heat) metamorphism of limestones by the igneous dykes intruded as hot magma.

The site also shows interesting tectonic features and displacements of rock by glacial activity. This is a unique site showing new evidence for subglacial erosion and shearing, such as shunting of large slabs of Carboniferous limestone with brecciation and detachment along major bedding planes and northward displacement of a Tertiary dyke. This rock fracture is due to high porewater pressures under an ice sheet and not mechanical crushing as is normally envisaged for subglacial rock fracture.

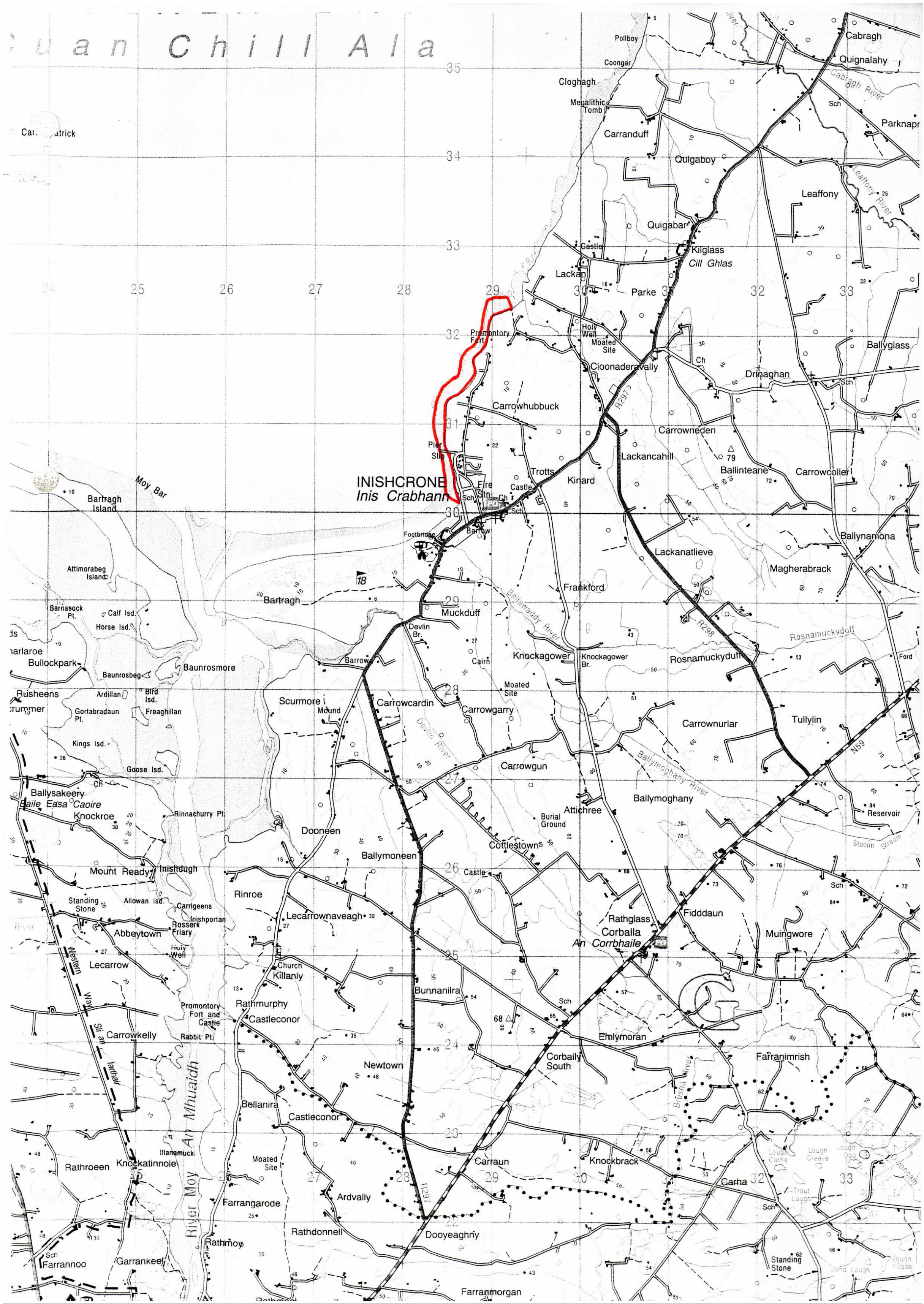
Site Importance
The site is of National importance and is to be proposed for NHA designation under the IGH11 Igneous Intrusion theme of the GSI's IGH Programme, and also probably under IGH7 Quaternary.

Management/promotion issues
As foreshore exposures there are few issues to be concerned with in relation to this site, although specific cliff sections at the back of the foreshore may need protection.

Tertiary dykes at Inishcrone



Inishcrone


Cuan Chill Ala
INISHCRONE
Inis Crabhann
Moy Bar
Bartragh Island
Carrowhubbuck
Cloonaderavally
Kinard
Trotts
Lackan
Parke
Kilglass
Cill Ghlas
Quigabar
Quigaboy
Carranduff
Cloghagh
Coongar
Pollboy
Cabragh
Quignalahy
Parknapr
Leaffony
Drinaghan
Ballyglass
Carrowneden
Lackancahill
Ballinteane
Carrowcoller
Ballynamona
Lackanatlieve
Magherabrack
Frankford
Muckduff
Bartragh
Knockagower
Rosnamuckyduff
Scurmore
Carrowcardin
Carrowgarry
Carrownurlar
Tullylin
Carrowgun
Ballymoghany
Attichree
Dooneen
Ballymoneen
Cottlestown
Rinroe
Lecarrownaveagh
Rathglass
Corballa
An Corrbhaile
Fidddaun
Muingwore
Killanly
Bunnanilra
Rathmurphy
Castleconor
Emlymoran
Farranimrish
Newtown
Corbally South
Bellanira
Carraun
Knockbrack
Carha
Ardvally
Farrangarode
Rathdonnell
Dooyeaghny
Farranmorgan
Ballysakeery
Baile Easa Caoire
Knockroe
Mount Ready
Inishdugh
Abbeytown
Lecarrow
Carrowkelly
Rathroeen
Knockatinnole
Farrannoo
Garrankeel
Rathmoy
River Moy
An Mhuaidh
Baunrosmore
Bullockpark
Rusheens
Western Way
Slí an Iarthair

Appendix 9-1

Archaeological Testing Report – 2003

MARY HENRY
ARCHAEOLOGICAL SERVICES LTD.

ARCHAEOLOGICAL ASSESSMENT AT LACKAN, ENNISCRONE, CO. SLIGO

Licensed Archaeologist: Mary Henry
Licence Excavation No. 03E0387
Planning Ref. No.PL02/816

17 Staunton Row, Clonmel, Co. Tipperary. Tel: 052 22355 Fax 052 82525
E-mail: mharch@oceanfree.net Website: www.maryhenry.ie

1. Introduction

This report is an Archaeological Impact Assessment of a proposed wind farm at Lackan, Enniscrone, Co. Sligo. Lackan Wind Energy Ltd. are presently seeking planning permission to construct a wind farm and this Impact Assessment was carried out pursuant to further information requested by Sligo County Council. The proposed development (Fig. 4 & 5) is to comprise three wind turbines of 60m hub height and 80m rotor diameter, an access trackway, 4.5m in width, a substation building and associated site development works at Lackan, Co. Sligo (see Appendix) .

2. Siting

The site of the proposed development is located in the townland of Lackan, in the parish of Kilglass, within the county of Sligo. Lackan is a small coastal hamlet situated off the Enniscrone-Easkey secondary route (R297). It is *circa* 4km north of the seaside resort of Enniscrone, which is a seaside resort on the Sligo-Mayo border 14km north of the town of Ballina. The area stretching from Enniscrone to Easkey, including the site of the proposed development, is an open coastal, windswept plain comprising a low-lying, treeless landscape sweeping across to the Atlantic.

3. Archaeological Background

The name Lackan is derived from Leacan and appears in three townlands in the parish of Kilglass. In the Ordnance Survey Letters of the late 1830s there are references to the *Clann Firbis* from the *Lecan-mac-Firbis*, the townland in which the complete Book of Chronology, Annals, Poems and History were compiled (OS Letters, Ed. 1928). According to O'Donovan in the Ordnance Survey Name Books the townland gives its name to the "Yellow Book of Lecan" (1391) and the "Great Book of Lecan" (1417). O'Donovan notes the presence of a castle (R.M.P. No. Sl010-018) within the townland remarking, "...nothing is seen but a heap of stones supposed to have been built in the 13th century by a person named O'Forbas (Mc Firbis), a great Irish writer. The castle is

referred to as *Caislean ic Fhribisig or Mac* Firbis's castle (O'Donovan OS Name Books, 1836, pg. 453). In the Ordnance Survey Letters it is noted that the castle was constructed in 1560 by the family of McFirbisses. Wood-Martin in his History of Sligo remarks that the castle was, "...a mere sod covered mound. It was built in 1560 by the O'Dowd's and in consequence of the events of 1641 was seized from them and granted to the family of Wood. Richard Wood was attainted by James, 1689, as of this place..." (1882, pg. 106). In the Down Survey Parish Map of 1633-6 there is a reference to the castle where it is stated that there is, "...a kind of ould castle upon it". Although built in 1560 it would appear to be in a state of ruin by 1633 (O'Rorke 1890, pgs. 418-19). The castle is marked as being ruined on the 1st Edition of the OS map (1837).

A total of seven of the recorded sites within 0.75 km of the development site are located in the townland of Lackan. In addition to the castle there are two moated sites within close vicinity of the development. Moated sites can be defined as defended farmsteads dating to the 13th-14th centuries. Although they had a defensive barrier, namely the moat, they did not have a military function *per se*. These earthen sites were constructed by the smaller landowners and seigniorial classes who could not afford the construction of stone castles (Barry 1977). They can be described as rectangular in shape with central platforms. Some have moats which would have held water and provided the defensive barrier. Moats varied greatly in width ranging from 2m to 10m. The upcast from the moat construction was used to build a bank or to raise the interior platform above ground level. Moated sites were constructed by the Anglo-Norman settlers who first arrived in Ireland in the late 12th century.

Three ringforts and one enclosure also survive within less than 1km of the proposed development site. The presence of ringforts in such a cluster and frequent numbers is not uncharacteristic in County Sligo, which has a high density of recorded monuments, and in particular ringforts. Ringforts are the most common monument type in Ireland, numbering in the region of 40,000 and can be defined as protected homesteads. They are most frequently circular, surrounded by a single bank and ditch (univallate) or multiple banks and ditches (multivallate) or by a rampart of stone (cashels). They vary in

diameter from *circa* 25m to 60m. A house, usually of timber or timber and wattle work, and probably cattle pens, stood inside its interior (O'Riordáin, 1979 and Herity & Eogan, 1977). They functioned as protected homesteads with very limited defensive purposes, dating predominantly to the second half of the first millennium or the period known as the early Christian period.

There is a least one, if not two, recorded fulachta fiadh from the townland of Lacken (R.M.P. Sl010-030). Fulachta fiadh or burnt mound may be derived from 'deer roasts', or *fulachta fiann* meaning cooking place of the Fianna. They are one of the most prevalent prehistoric monument type in Ireland. The name fulacht fiadh was sometimes used in the nineteenth century and thereafter applied to mounds of burnt stones believed to be the remains of these ancient cooking places which date to the late prehistoric and early historic period. Their function was probably for boiling meat in a stone or wooden trough inserted into a pit. A low grassy mound, usually horseshoe-shaped in plan, typifies the presence of such a monument type on the landscape. The mound would rarely exceed 2m in height and dimensions can range from a few metres to in excess of 25m. They are usually located close to a water source – a stream, lake or marshy ground. A source of sandstone is important, as it is the ideal stone type to be subjected to heat. It is not unusual to find such a monument type in clusters of two to six within a small area. Such monuments predominantly date to the Bronze Age, spanning 2000-800 BC and are the most prevalent monument type of the Irish Bronze Age.

The presence of prehistoric sites – fulacht fiadh -, early Christian sites – ringforts - and medieval sites – two moated sites and a towerhouse – indicate that the townland of Lackan has been a focus of settlement for centuries.

3.1 Catalogue of Archaeological Sites

The following catalogue lists all the known archaeological sites located within ¾km of the proposed development (Fig. 1 & 2).

R.M.P. No.:	**Sl010-015**
Townland	Carranduff
Parish	Kilglass
OS 6" Sheet No.	Sl010
Altitude	0-50 ft.
Type	Enclosure

Description:

Situated in a low-lying area of poor coastal pastureland this monument rises gently to the west and is adjacent to the abandoned village of Carranduff. Although levelled it is marked on the 3rd Ed. OS Map as an embanked area. There is presently no surface trace of the enclosure although a local man remembers that the site was known as a 'cattle pound'.

R.M.P. No.:	**Sl010-016**
Townland	Carranduff
Parish	Kilglass
OS 6" Sheet No.	Sl010
Altitude	0-50 ft.
Type	Ringfort

Description:

In a poor state of preservation and situated on a low-lying elevation in an area of generally level coastal pastureland this monument commands good views. It is levelled on the N side and a modern (E/W) aligned field boundary wall extends through the site.

Comprising a roughly circular raised area 17m in diameter, with an external height of 800mm on E and 1.4m on S. Although a platform pitted with burrows is visible there are

no traces of a bank or ditch. There may be a collapsed souterrain on the W side, as manifested by a deep hollow 6m (N/S) x 2.4m (E/W).

R.M.P. No.:	**SI010-017**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	10
Altitude	0-50ft.
Type	Rectangular enclosure (possible)

Description:

Situated in low-lying pastureland, the ground falls away very gently towards an area of poor, wettish pasture. Initially identified in an Aerial Photo (G.S.I. G18-19; Roll 156; Print 22), traces of a bank are visible on the ground measuring 40m N/S x 3.4m wide x 200mm high. Located 28m to the west of the bank is a N/S terrace or slope marking a drop in ground level to the west of 600mm. To the north is a modern E-W field boundary and roughly in line with the above terrace there is a low bank, which curves to the NE and measures 1m wide x 300-500mm high. Some of the features may be remnants of old field boundaries.

R.M.P. No.:	**SI010-018**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	10
Altitude	0-50ft.
Type	Tower house, kiln (possible) and building possible

Description:

This site is situated on a slight elevation in low-lying coastal pastureland commanding good views to the N, W and S. The tower house is almost totally destroyed, surviving as a mound of rubble and stone blocks measuring 10.5m (E/W) x 6m (N/S) with a maximum height of 1.4m and bisected by an E/W field wall. On the south and east some lower courses survive, with three courses surviving on the SE *circa* 600mm high. The eastern

wall extends for 6m to the north and survives for a height of 1.1m with a thickness of 800mm. There is slight evidence for a blocked doorway mid way along the southern wall, which is now in-filled with rubble. Traces of a low sod covered bank 2.8m wide x 400mm high on an E/W axis, are visible *circa* 70m to the north of the stone mound. Buried foundations of the north wall of the monument are apparent.

R.M.P. No.:	**Sl010-019**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	Sl010
Altitude	0-50 ft.
Type	Moated site

Description:

This site is situated in poorly drained rough, low-lying pasture. Identified by an aerial photograph (GSI, G103-4; Roll 157; Print 14) as a raised rectangular area defined by earthen bank, outer ditch and outer bank measuring 37m (N/S) x 30m (E/W). The inner bank of the monument is internally very low and partially levelled on the east side, although the outer bank is best preserved on the N/S axis, whilst eroded in places on the east side and partially levelled on the west. Measuring 3.9m in width, the inner bank has an internal height of 400mm on the south and 200mm on the north, an external height of 1.6m on the south and 1.4m on the north. The ditch had a width of 4.6m, with its outer bank measuring 72.m on the south and 4.3m on the north. It had an internal height of 1.6m on the south and 800mm on the north and an external height of 1.6m on the south and 700mm on the north.

The interior had an internal division in the form of a raised rectangular platform, which was defined by a low bank and constructed against the side bank in the SW corner of the interior. It measures 16m (E/W) x 9m (N/S). A low bank defines it on the N and E, which is 1.5m wide x 200mm high (internal) and 500mm high (external), with the southern half 400mm higher than the northern half.

R.M.P. No.:	**SI010-020**
Townland	Quigabar
Parish	Kilglass
OS 6" Sheet No.	SI010
Altitude	0-50 ft.
Type	Enclosures

Description:

The site is situated on low-lying coastal pastureland commanding good views, however, it has a tendency to be wet and rough. There are two enclosures of which the southern site is in a fair condition whilst the northern one is levelled. The southern enclosure consists a raised rectangular or sub-circular area with an uneven interior and no defined entrance enclosed by an earthen bank and outer ditch with a diameter of 24.5m N/S x 22.2m (E/W). Its bank was 4.7m wide on the south side and 3.3m on its north side, an internal height of 300-700mm and external height of 600-700mm. On the west side a shallow ditch 3-4m wide was evident separating the two enclosures. A possible house site in the NE quadrant consisted a raised platform measuring 10m x 4m and 500mm high. The second enclosure, immediately to the north of the above, is levelled, surviving as a sub-circular area with no banks and a diameter of 13-15m, with an external height of between 200mm and 500mm.

R.M.P. No.:	**SI010-021**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	SI010
Altitude	50-100 ft.
Type	Bivallate ringfort and possible souterrain

Description:

Situated on the SW edge of a low ridge in the midst of a low-lying coastal pasture and commanding good views, this site is in a poor state of preservation, especially on the east side. On the west side a ditch and outer bank survive but are covered in dense overgrowth. This monument consists a raised oval or circular area enclosed by a bank,

outer ditch and outer bank, with a diameter of 22.8m (NE/SW) and 26.8m (SE/NW). Measuring 4.3m in width, an internal height of 200mm and external height of 1.6m the inner bank is visible on all sides apart from the SW, with the associated ditch measuring 5.2m wide. The outer bank is 5m wide with an internal height of 700mmm and external height of 400mm on the SW and 1.2m on the W. Its interior is on a slight slope and there may be an entrance on the SSE, 2-3m wide. A possible souterrain may be on the site.

R.M.P. No.:	**SI010-030**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	SI010
Altitude	0-100 ft.
Type	Fulacht fiadh

Description:

Situated in low-lying, poorly drained rough, coastal pastureland this site consists a small horseshoe shaped mound measuring 5.4m (N/S) x 4m. To its south (4m) there is a low mound measuring 8.8m (E/W) x 3m (N/S) and 500mm high. The raised areas comprise small fragments of shattered stone on a matrix of black soil, representing a partially levelled fulacht fiadh.

R.M.P. No.:	**SI010-031**
Townland	Quigaboy
Parish	Kilglass
OS 6" Sheet No.	SI010
Altitude	0-100 ft.
Type	Moated site (possible) & mound

Description:

Located in poorly drained coastal pastureland this monument consists a circular mound with an iris-filled central hollow. The diameter of the mound is 6m, with a maximum height of 800mm. It has a central depression, the diameter of which is 1.6m and 400mm deep. The mound is on the NE end of a rectangular enclosure.

R.M.P. No.:	**Sl010-032**
Townland	Quigaboy
Parish	Kilglass
OS 6" Sheet No.	Sl010
Altitude	0-100 ft.
Type	Souterrain (possible)

Description:

Situated on a low rise in an area of relatively poor coastal pastureland the site is known locally as the 'fort field'. It consists a limestone-raised area 40m long x 11.5m wide x 600-900mm high. A local man recalls the site as once giving access to a souterrain.

R.M.P. No.:	**Sl016-001**
Townland	Carrowhubbuck North
Parish	Kilglass
OS 6" Sheet No.	Sl016
Altitude	0-100 ft.
Type	Promontory fort, houses sites, souterrain and field wall.

Description:

This site is situated on a cliff edge commanding excellent views overlooking Killala Bay with the ground falling away gently from the site on its southeast side. A small hillock to the north overlooks the site.

The site's popular name is 'Cahirmore fort' or 'Cathir Mór' – a great stone fort (O'Donovan OS Name Books). O'Donovan notes it is on the sea coast and it is said there was a cave in it which is now filled up.

In good condition, the cliff edge fort comprises a well-preserved interior bank and ditch with three banks and ditches surviving well on its northern side. It consists a large D-shaped multivallate cliff top enclosure defined on its straight western side by the cliff-

face. On the north, south and east sides it is enclosed by a substantial inner bank with large accompanying ditch, outside which are a series of three close set, less substantial banks and ditches. The outer bank appears to have a berm on its inner side. Measuring 70m NE/SW x 40m x 45m (interior dimensions) the fort interior is sub-divided. A line of large flat slabs, partially sod covered, extends from the south, near the entrance into the centre of the site from where it curves to the west. These slabs may be the remains of a souterrain. The remains of three hut sites appear on the raised interior in the SW quadrant of the site, each defined by a low wall/bank of sod-covered stones and a diameter of 3-4m. In the lower, eastern part of the interior is a fourth possible hut circle consisting a circular area defined by stones, but the diameter is only 2m. Elsewhere in the interior - on the north and east - there are several low sod-covered heaps, measuring 2m-3m in diameter x 500mm high, which appear to be the result of field clearance.

The souterrain is visible in section in the exposed cliff face. On the southern side the entrance consists a 2.4m wide gap with remnants of stone facing. Between the base of the hillock and the cliff edge on the north side of the site, there are the remnants of a small rectangular enclosure and disused field boundaries.

R.M.P. No.:	**Sl016-004**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	Sl016
Altitude	0-100 ft.
Type	Ringfort

Description:

Situated on the E edge of a low ridge in low-lying coastal pastureland this monument commands good views. In a poor state of preservation - part of the E side has been quarried away and cut by a road - it consists a circular raised area with no bank or ditch. Remnants of a field boundary abut it on the SW side. It has a diameter of 24m (N/S), an external height of 600mm on the N and 1m on the S and 1.4m on W.

R.M.P. No.:	**Sl016-068**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	Sl016
Altitude	0-100 ft.
Type	Ringfort

Description:

Situated in a low-lying poor to average pastureland, *circa* 300m from the seashore this monument commands very good views and consists a raised circular area with a diameter of 30m. No bank or ditch is evident. On top of the raised area on the NE is an area of collapse revealing an *in situ* stone lintel and part of a dry stone passage, which inclines downwards to the NE, 700mm wide. 12m to the SE there is a low mound of stones, with a diameter of 3m and 500mm high, enclosing a central area of collapse in which a lintel stone is visible.

On the E side of the raised area, measuring 6m x 5.5m x 1.4m high, there is a mound of small stones with some larger stones. This site appears to be a souterrain in a low raised area, which may be the remains of a levelled enclosure. The small mounds of loose stone appear to be the result of field clearance.

R.M.P. No.:	**Sl016-076**
Townland	Lackan
Parish	Kilglass
OS 6" Sheet No.	Sl016
Altitude	0-100 ft.
Type	Long cist

Description:

A grave, known locally as the 'Fisherman's Grave', which had been eroded out of a cliff face by storms and erosion, was situated above a storm beach. The partial remains of a skeleton were recovered during a rescue excavation, with the grave, 1m long and 500mm

wide, classified as a 'lintelled grave' probably dating to the 1st millennium AD. It was constructed of large blocks of limestone and water rolled stones.

4. Scope of Works

The proposed planning application is to construct three wind turbines (Fig. 4) 15m², built on hardstand bases measuring 40m², aligned approximately on the NW-SE axis, with a 60m hub height and 80m rotor diameter. An access road linking the turbines, measuring 4.5m wide will be constructed as well as associated site works.

Comprising a windswept, treeless plain subject to flooding, the area in and around the proposed development consists a very flat (0-100 ft. contour), open coastal expanse sweeping across to the Atlantic Ocean. One of the turbines (Turbine 1) will be sited near the coastline.

5. Method

Document research in the form of a desktop study was undertaken of the known archaeological sites and the history of the area. The archival files of Dúchas, the Heritage Service, topographic files from the National Museum and aerial photography from the Geological Survey of Ireland were consulted. In addition cartographic and historical sources were consulted.

A Field Walk Study was undertaken during early October 2002. Weather conditions were particularly favourable, being dry and sunny with good visibility. An existing mettled trackway facilitates access to the proposed development site, commencing in the small hamlet of Lackan. The three individual turbine sites were located in three different fields, the boundaries of which comprised earthen banks topped with brambles and occasional hazel bushes.

No apparent anomalies of archaeological potential were discovered within the field, where Turbine No. 1 will be sited.

Turbine No. 2 will be located in a field just west and approximately 280m from the coast. As with the site location for Turbine No. 1, no archaeological anomalies were visible in this featureless field. Apart from the field systems, the only evidence of human activity was the odd patch of modern in-fill consisting small to medium sized stone. This had been dumped into some of the more waterlogged parts of the site to facilitate vehicle access.

Turbine No. 3 will be sited 200m to the east of the present farm trackway. No archaeological anomalies were identified in the course of field walking. It is situated 120m northwest of the moated site (SL010-019) and *circa* 60m west of a fulacht fiadh (SL010-030).

6. Results for Pre-construction Testing

A testing strategy comprising the excavation of eleven trenches (Fig. 4) was implemented on 25th March 2003. Three trenches were cut on the footprint of the individual turbine bases in a 'Z' formation, and one along the line of each of the two access roads. All trenches were excavated by 360° back actor machine, with a toothless bucket, to natural layers. The weather varied between sunshine and slightly overcast conditions.

Due to the good weather, topography and land composition (marsh and semi bog) it was decided that Wind Turbine 2 was tested first, followed by Wind Turbine 1 and finally Wind Turbine 3, which is located on the slightly higher, dryer ground to the east. **The results of the testing will therefore be presented in the order that the trenches were cut.**

6.1 Wind Turbine 2

This turbine is located in a relatively wet marshy rectangular field spreading to the coastal shoreline to the west. Land cover comprises reeds, rushes and clumps of wild

grass. A drainage ditch, measuring approximately 3m wide and 0.65m deep, has been cut on a north – south axis across the top one third of the field, creating a triangle of higher quality agricultural land. Approximately 50m from the northeast corner the ditch has been filled with rubble, facilitating access to the rest of the field.

The field boundaries to the north and south comprise low grass banks topped with a two-strand barbed wire fence along their length. To the east the boundary is made of a grass covered dry stone wall with a two-strand barbed wire fence on top. A 3m wide gateway is located circa 35m from the northeast corner of this boundary. The western boundary is defined by a barbed wire fence, which separates the field from the adjacent coastal defences.

Land to the north of this proposed turbine site is a fairly expansive area of low-lying marshy, iris colonised ground, with Wind Turbine 1 located in the northwest corner. To the west, the sea defence consists irregular pieces of stone varying in size, the majority of which appears to have been sourced from plate bedrock. This stone plate formation is evident below the high tide mark along this part of the coast.

To the east a farm track way separates this field from the field containing Wind Turbine 3, the topography of which is described below. South of Wind Turbine 2 the land comprises an expansive wetland area of reeds, rushes and irises, although there are patches of marginally better-improved ground set within.

Test Trench 1 (Pl.1)

Alignment: **East - West**
Length: **20m**
Width: **1.5m**
Depth: **min: 700mm, max: 850mm**

Located parallel to the northern field boundary this trench was excavated from east to west. Sod and topsoil measured 190mm deep and comprised grass and reeds overlying a

very dark brown peat based loam. A large number of root fibrils were present in this deposit, which was otherwise sterile. Underlying the sod/topsoil was a compact black peat measuring 410mm thick. A layer of decaying vegetation, including fragmites, was recorded overlying a lens of grey/black/white-speckled gravel. These layers separated the upper peat from a further 200mm of peat, which overlay the natural at the base of the trench. Natural comprised a very compact layer of degrading limestone and sandstone within a darkish grey clay. No archaeological features were located within this trench.

Test Trench 2 (Pl.3)

Alignment: **Northeast - Southwest**
Length: **20m**
Width: **1.5m**
Depth: **min: 750, max: 950mm.**

The north end of this trench was located south of the eastern end of Trench 1 to form the diagonal bar of the 'Z'. Sod and topsoil comprised a dark brown slightly peaty loam bonding grass and rush roots. A formation of black peat underlay the topsoil to the base of the trench. As with Trench 1, a layer of fragmites was noticeable within the peat (Pl.2), although there was no trace of gravel. Natural at the base of the trench consisted a very compact layer of degrading limestone and sandstone within a darkish grey clay. No features of archaeological origin were located within this trench.

Test Trench 3

Alignment: **East - West**
Length: **20m.**
Width: **1.55m**
Depth: **750mm**

The western end of this trench lies south of the south - western terminus of Trench 2. Although no gravel was identified, stratigraphically this trench comprised the same

organic deposits as Trenches 1 and 2. No archaeological features were located within this trench.

Test Trench 4 (Pl.4)

Alignment: **Southeast- Northwest**
Length: **20.1m**
Width: **1.6m**
Depth: **400mm**

This trench was cut midway between Turbines 1 and 2 along the proposed roadway. The southwestern terminus was located five metres northeast of a large boulder approximately 2m in diameter. Sod and topsoil comprised a dark brown peaty loam with high root content bonding isolated rushes and grass measuring 100m thick. A dark brown black peat uniform to the base of the trench measuring 260mm deep underlay this. The trench base comprised a natural compact mid brown sandy clay with a very high silicate content. Towards the western end (2m from the western terminus) a natural ridge 1m wide ran on a north – south axis. No archaeological features were discovered in this trench.

6.2 Wind Turbine 1

Located in a wet, marshy low-lying field, this proposed turbine site is nearest to the sea. Ground cover in the immediate vicinity comprises extensive reed cover with substantial iris colonisation, particularly in the most westerly areas near the sea defences. One large boulder is situated in the middle of the field, in close proximity to Trench 4 (see above).

On an east – west alignment, the northern field boundary extends for approximately 200m from the sea defences and comprises a two-strand barbed wire fence adjacent and parallel to a 1m high dry stone wall. A two-strand barbed wire fence represents both the eastern and southern field boundaries, whilst the western boundary consists an irregular stone and boulder sea defence.

Four very large boulders are visible in the adjacent northern fields, the topography of which comprises semi improved, slightly undulating pasture gently sloping to the proposed site. The southern vista is dominated by a low-lying featureless expanse of marshland, with a cliff side fort visible in the distance. To the east lies the proposed site of Turbine 3 (see below).

Test Trench 5 (Pl.5)

Alignment: **North - South**
Length: **19m**
Width: **1.55m**
Depth: **min: 320, max: 350mm**

Of the three trenches cut on the proposed site of this turbine, Trench 5 was the nearest to the sea. Sod and topsoil comprised 20mm of matted root fibrils within a dark brown peat. The underlying deposit consisted a very dark brown black peat to the base of trench. Occasional lenses of very thin yellow brown sandy clay were identified below the peat and above the trench base. Natural at the base of trench consisted slightly undulating fractured and degrading limestone bedrock. The undulations in the natural are reflected by the variations in trench depth. No archaeological features were discovered in this trench.

Test Trench 6 (Pl.6)

Alignment: **Northwest - Southeast**
Length: **19.5m**
Width: **1.5m**
Depth: **min: 250mm, max: 340mm.**

Positioned to form the diagonal bar of the 'Z', the stratigraphy of this trench mirrors that of Trenches 5 and 7. No archaeology was found in this trench.

Test Trench 7 (Pl.7)

Alignment: **Northwest - Southeast**
Length: **19.5m**
Width: **1.5m**
Depth: **min: 250mm, max: 340mm**

This trench consists the same composition as both Trenches 5 and 6. No archaeology was discovered.

Test Trench 8 (Pl.8)

Alignment: **East - West**
Length: **20m**
Width: **1.55m**
Depth: **min: 250mm, max: 650mm**

This trench was located in the same field as Turbine 3 (see below) and cut on the line of the proposed roadway connecting Turbines 2 and 3. Immediately and parallel to the southern edge of this trench is a modern earth banked field boundary not represented on any of the maps. The western terminus of the trench was 66.5m from the eastern boundary of the farm track and 71m south of the northern field boundary.

Sod and topsoil measured 90mm deep and consisted a dark brown friable sandy clay with a very low silt content and extensive grass roots. Occasional small stones were also visible. The underlying layer, down to the base of trench, comprised a dark brown clean clay with no inclusions present. Undulating limestone across the trench bottom reflects the variation in the trench depth. No archaeological features were discovered.

6.3 Wind Turbine 3

The most easterly of the three proposed turbines, Turbine 3 lies in the northeast corner of a slightly elevated field comprising improved pasture. A number of undulations are visible within this field, which slopes from east to west. The farm track to the west separates the site of Turbine 2 from Turbine 3. All three trenches are positioned on the higher ground in the east of the field

A swiftly flowing stream (averaging 1.4m wide), flanked by a low external bank topped with barbed wire, forms a physical boundary to both the north and east. To the south a low earthen bank topped with a two-strand barbed wire fence acts as the boundary, whilst to the west the eastern bank of the farm track marks the extent of the field.

Land to the north of the site varies between semi improved and rough pasture with a high bank visible 50m from the perimeter fence. Patches of rushes scattered within the area of rough pasture suggest that some of the ground may well be marshy. The western bank of the farm track to the west marks the boundary with the location of Turbine 2 (see above). Semi improved pasture is evident to the south, which is located on a slight north – south aligned spine of slightly higher ground. Immediately to the east of the site the terrain consists marshy pasture, with a fulacht fiadh (SI010-030) positioned 60m from the eastern boundary. Approximately 120m to the southeast is the location of a moated site. Further to the east is a small hamlet visible on the horizon.

Test Trench 9 (Pl.9)

Alignment: **East - West**
Length: **21m**
Width: **1.5m**
Depth: **min: 300mm, max: 400mm**

This trench was cut along the eastern side of a field boundary that bisects the field of Turbine 3 but is not shown on any of the maps. An outcrop of natural limestone, 1.5m

wide on a north – south alignment, ran across the trench at the mid point. A distinct dichotomy was evident between the western and eastern halves of the trench, which will therefore be described separately.

In the western half of the trench sod and topsoil comprised short grass overlying a mid to dark brown slightly sandy clay, measuring 100mm thick, with extensive root matting. No inclusions were visible. This overlay a mid to light brown sandy clay subsoil measuring 200mm thick. Some grit was evident in this deposit. The natural on the base of this half of the trench comprised a mottled orange brown very gritty compact clay overlying bedrock.

Sod and topsoil in the eastern half of the trench comprised a very dark brown loamy clay, with extensive root matting, measuring 100mm thick. The underlying sub soil comprised a dark brown black sandy clay 130mm thick, which extends down to a light mid brown clay 100mm thick which overlying the natural at the base of trench. Natural in this half of the trench is a mottled yellow brown black heavy clay with low gravel content overlying fractured bedrock. No archaeology was present in this trench

Test Trench 10 (Pl.10)

Alignment: **Northeast - Southwest**
Length: **20.8m**
Width: **1.5m**
Depth: **min: 200mm, max: 380mm**

Cut to form the diagonal arm of the 'Z', this trench was deeper to the southwest. Topsoil consisted dark brown loamy clay with extensive root matter and measured 130mm thick. This overlay a very dark brown clay uniform to the base of trench. Natural comprised a dark yellow brown clay overlying fractured degrading bluish grey limestone bedrock. No archaeology encountered.

Test Trench 11 (Pl.11)

Alignment: **East - West**

Length: **22.2m**

Width: **1.5m**

Depth: **min:100mm, max: 200mm**

This trench proved to be the shallowest of all eleven. Topsoil comprising a very dark brown loam with root fibrils, contained no other inclusions and was uniform to the base of trench. Natural consisted undulating fractured degrading limestone. No archaeology was present.

7. Conclusion

All three trenches cut upon the footprint of Turbine 2 revealed a uniform composition of organic material. It is suggested that the gravel lens located in Trench 1 may well be the result of past flooding. There was no evidence at all of any human activity within any of these trenches. Considering the low-lying nature of the land it is possible that this area may have been reclaimed from the inter-tidal zone within a relatively recent period, which would account for the lack of archaeological evidence. It is interesting to note that the trenches upon the footprint of Turbine 1 are markedly shallower than those cut on the proposed site of Turbine 2. Considering the close proximity of the sea and the possibility of land reclamation within this area, it is possible that the location of Turbine 2 may be on the site of a dried-out lagoon.

As mentioned in the AIS, human habitation along this particular part of the low-lying western seaboard within the proposed development area of Turbines 1 and 2 is unlikely, although it would have proved the ideal location for seasonal wild fowling The hostile coastal terrain would have made fishing incredibly dangerous, if not impossible, due to the Ballina limestone coastal formation. There is evidence for previous human activity in the adjacent landscape (see above), especially to the south, with the tower house and cliff side fort, both of which would have required a relatively settled population.

Test trench depths on the footprint of Turbine 3 were relatively shallow, with a number of bedrock veins visible in the openings. Although in close proximity to a fulacht fiadh and moated site no archaeological features in any shape or form were discovered.

8. Impacts of the Development

The proposed development will be built on a surface hardcore base measuring 40m², which will extend to approximate depths of 1.5m. An existing metalled surface will be re-surfaced to provide a better access road to the development and a new hardcore access road, 4.5m wide, will link the turbines.

Ground works for the construction of the turbines is confined to three separate areas, re-surfacing of an existing metalled roadway and the building of access road between the turbines. Proposed ground works will have no direct impact on the known monuments recorded in the Record of Places and Monuments for Co. Sligo. However, the proposed works is in close proximity to one recorded monument RMP No. Sl010-030 (Fig. 2). The site is classified as a fulacht fiadh and situated in low-lying, poorly drained, rough pastureland close-by to the stream. It is apparent as a small horseshoe shaped mound, 5.4m (N/S) x 4m. Situated 4m to its south there is a low mound, 8.8m (E/W) x 3m (N/S) and 500mm high. It consists a raised area comprising small fragments of shattered stone on a matrix of black soil. The site may be a levelled, scattered fulacht fiadh or alternatively two distinct fulacht fiadh monument types. Turbine 3 will be sited away from the opposite side of the stream to that of the fulacht fiadh and is just outside its archaeological constraint area. Turbine 3 is *circa* 120m to the NW of the moated site – Sl010-019 and is outside its area of constraint. Turbines 1 and 2 are near no recorded site.

9. Visual Impact

This proposed windfarm development will have a direct visual impact on known archaeological sites within the area of the development (see Photos 725 – 735). For example two of the proposed wind turbines will be apparent on the horizon from the tower house site (Sl010-018), whereas all three turbines will be visible from the fulacht fiadh (Sl010-030) and the moated site (Sl010-019).

The physical remains of the tower house, possible building and possible lime kiln are almost non-existent. It is located 732m to the south of Turbine 1, 466m to the south of Turbine 2 and 515m southwest of Turbine 3. Turbines 1 and 2 will be visible from the towerhouse but turbine 3 will not, due to the physical presence of a natural ridge topped with a block house that will impair visibility.

Regarding the cliff edge fort and associated hut sites (Sl016-001), the three turbines will be visible as the fort is situated in a prominent location. It commands particularly good views to the north and west. This site is situated 1.95km to the south of the proposed windfarm. Given its prominent location on the landscape it is even possible to see the village of Easkey, *circa* 10km to the north of the fort.

The other monuments, such as fulacht fiadh, enclosures and moated sites, are apparent on the ground surface in the form of banks and mounds. Although the proposed development will be visible from the cliff edge fort and the towerhouse, it is nonetheless believed that, due to the evolving nature and use of the landscape, the visual impact of the turbines cannot be considered to detract in any way from these monuments in the immediate vicinity.

10. Recommendations[1]

No archaeological remains were found in the course of pre-construction testing. Due to the topography and landscape attributes of areas siting Turbines 1 and 2, it is most unlikely that there are any surviving archaeological remains. The reason being this area was probably subject to extensive sea incursion and flooding up until the time that the coastal defences were built. It is recommended that there is no further archaeological involvement with the construction of Turbines 1 and 2.

Regarding the siting of Turbine 3, its close proximity to known archaeological sites and improved land, merits monitoring of any ground works associated with its construction.

Mary Henry
30th March 2003

[1] All recommendations are subject to approval by Dúchas.

An Roinn Comhshaoil agus Rialtais Áitiúil.
The Department of the Environment and Local Government.

Dúchas The Heritage Service

Rannóg na nIarratas Forbartha
Development Applications Section

7 Plás Ely, Baile Átha Cliath 2, Éire
7 Ely Place, Dublin 2, Ireland

Teileafón +353 1 647 3000
Facsuimhir +353 1 678 8116
Glao Áitiúil 1890 321 421
Web www.environ.ie

Our Ref: DAS-2003-SL-SL-PL02/816

County Secretary,
Sligo County Council,
Riverside,
Sligo.

PLANNING SECTION
17 FEB 2003
CO.

Re: **Planning Application Reg. Ref. No. PL02/816 by Lackan Wind Energy for permission to construct 3 no. wind turbines, 60 metre hub height and 80 metre rotar diameter, access trackway 4.5 metres in width, a substation building and associated site development works at single storey control building and associated site works at Lacan Townland.**

A Chara,

We refer to the Council's notification in relation to the above-proposed development. Outlined below are the archaeological recommendations of Dúchas The Heritage Service of the Department of Environment and Local Government.

It is noted that the proposed development is located in the vicinity of a number of Registered Historic Monuments RMP SL010-01801- Tower House, Sl010-01802- Kiln Possible, SL010-01803 Building Possible, SL016-001 Archaeological Complex, SL016-00101- Cliff-Edge Fort, SL016-00102- Hut Site, SL016-00103- Hut Site, SL016-00104- Hut Site, SL016-00105- Hut Site, SL016-00106- Souterrain and Sl016-00107- Fields Wall (s). These are protected under the terms of the National Monuments Acts (1930-1994).

It is our recommendation that an Archaeological Impact Assessment to include a Visual Impact Assessment*, as described below, should be prepared to assess the potential impact, if any, on archaeological remains in the area where development is proposed to take place. The statement should be submitted as Further Information. This will enable Dúchas and the Planning Authority to formulate an informed archaeological recommendation before a planning decision is taken.

*You are advised to engage a suitably qualified Archaeologist to prepare the Visual Impact Assessment of the proposed wind farm . Please note Section 4.9 of Wind Farm Development Guidelines for Planning Authorities (DOELG 1996) which states that "assessment of visual impact should have regard to both immediate visual impact and views from a distance (especially from any adjacent areas of high landscape quality)". Furthermore, section 4.24 states that "regard should be had to the status of sites and areas subject to national or international designations Such areas

include World Heritage Sites and areas or monuments protected under the National Monuments Acts" (DOELG 1996)

Archaeological Impact Assessment should be compiled as follows :

1. The applicant is required to engage the services of a suitably qualified archaeologist to carry out an archaeological assessment of the development site. No sub-surface work should be undertaken in the absence of the archaeologist without his/her express consent.
2. The archaeologist should carry out any relevant documentary research and inspect the site. Test trenches may be excavated at locations chosen by the archaeologist (licensed under the National Monuments Acts 1930-1994), having consulted the site drawings.
3. The Visual should include views to and from these monuments. Appropriate techniques to facilitate assessment of visual impact should be adopted, such as the provision of photomontages and computer graphics
4. Having completed the work, the archaeologist should submit a written report to the Planning Authority and to Dúchas the Heritage Service in advance of the planning decision. Where archaeological material/features are shown to be present, preservation *in situ*, preservation by record (excavation) or monitoring may be required.

It should be borne in mind that, if significant archaeological remains are found, refusal might still be recommended, and/or further monitoring or excavation required. No decision should be made on this application until Dúchas and the Planning Authority has had the opportunity to evaluate the Archaeological Assessment. Dúchas will forward a recommendation based on the Archaeological Assessment to the Planning Authority.

Kindly forward to this office any Further Information or documentation received by the Council or in the event of a final decision being made please forward a copy of same to the following address as soon as it issues:

The Manager
Development Application Section
Dúchas, The Heritage Service
7 Ely Place
Dublin 2

In addition, please acknowledge receipt of this letter (as required under Article 29(2) of the Planning & Development Regulations 2001) and forward this relevent receipt to the address above. .

Mise le meas,

S. Harrington

Sinead Harrington,
Development Applications Section,
Dúchas the Heritage Service,
14 February 2003

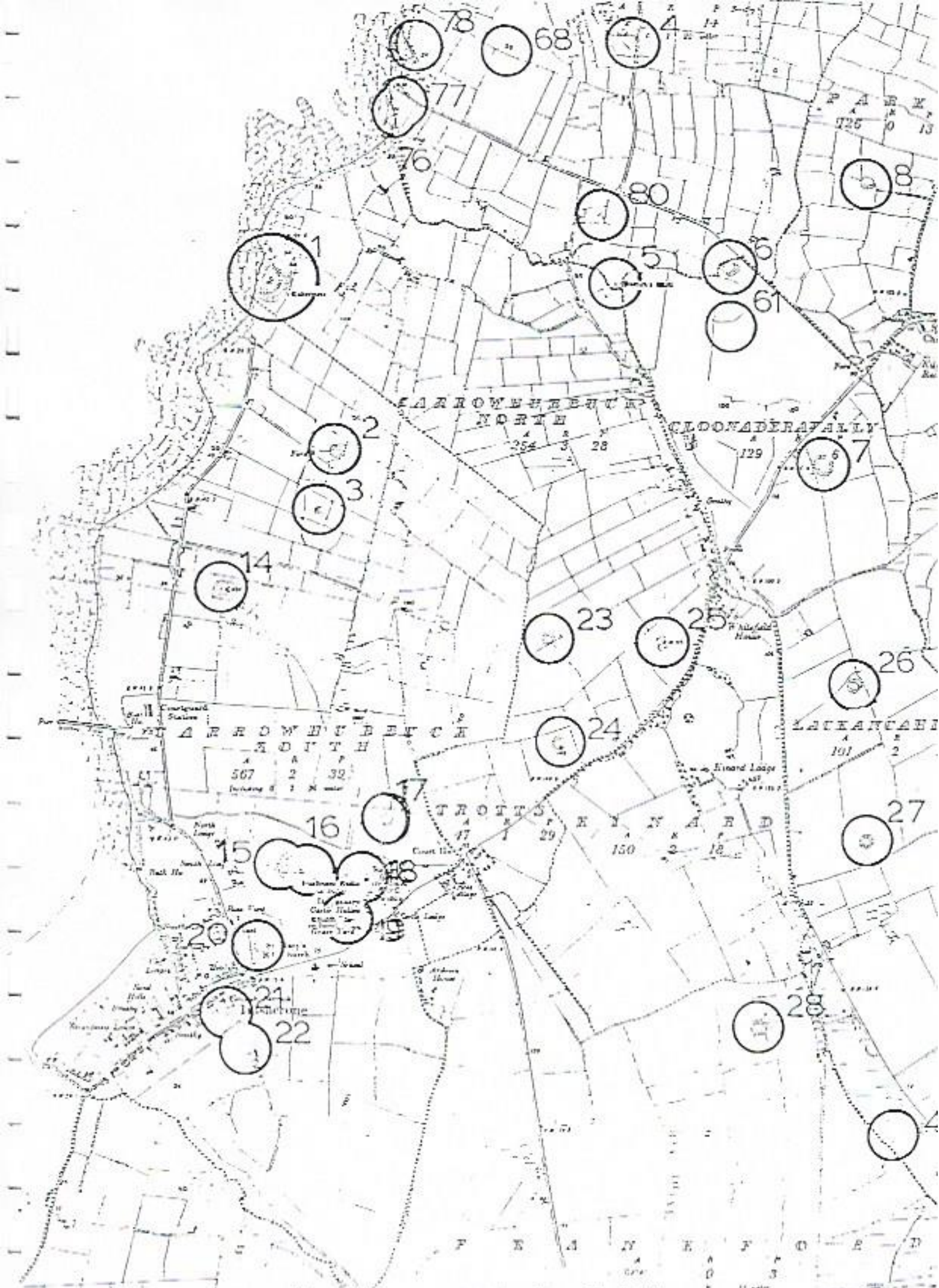


Fig. 1 RMP Map, Sheet No. 16 Sligo

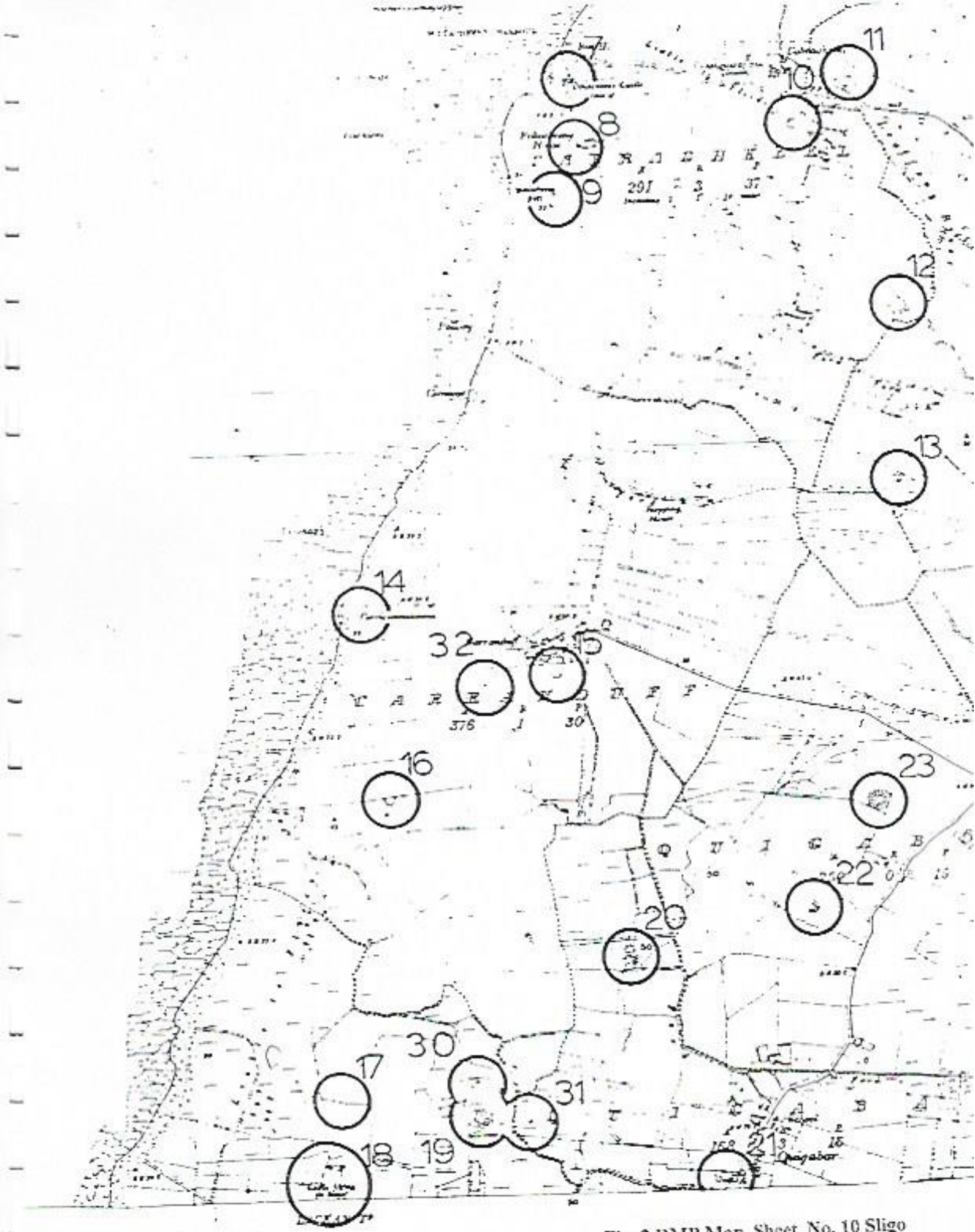


Fig. 2 RMP Map, Sheet No. 10 Sligo

Record PLACE Map

Fig. 3 OS Map, Sheet 16 Sligo, Scale 1:10560. Showing Site and Turbines

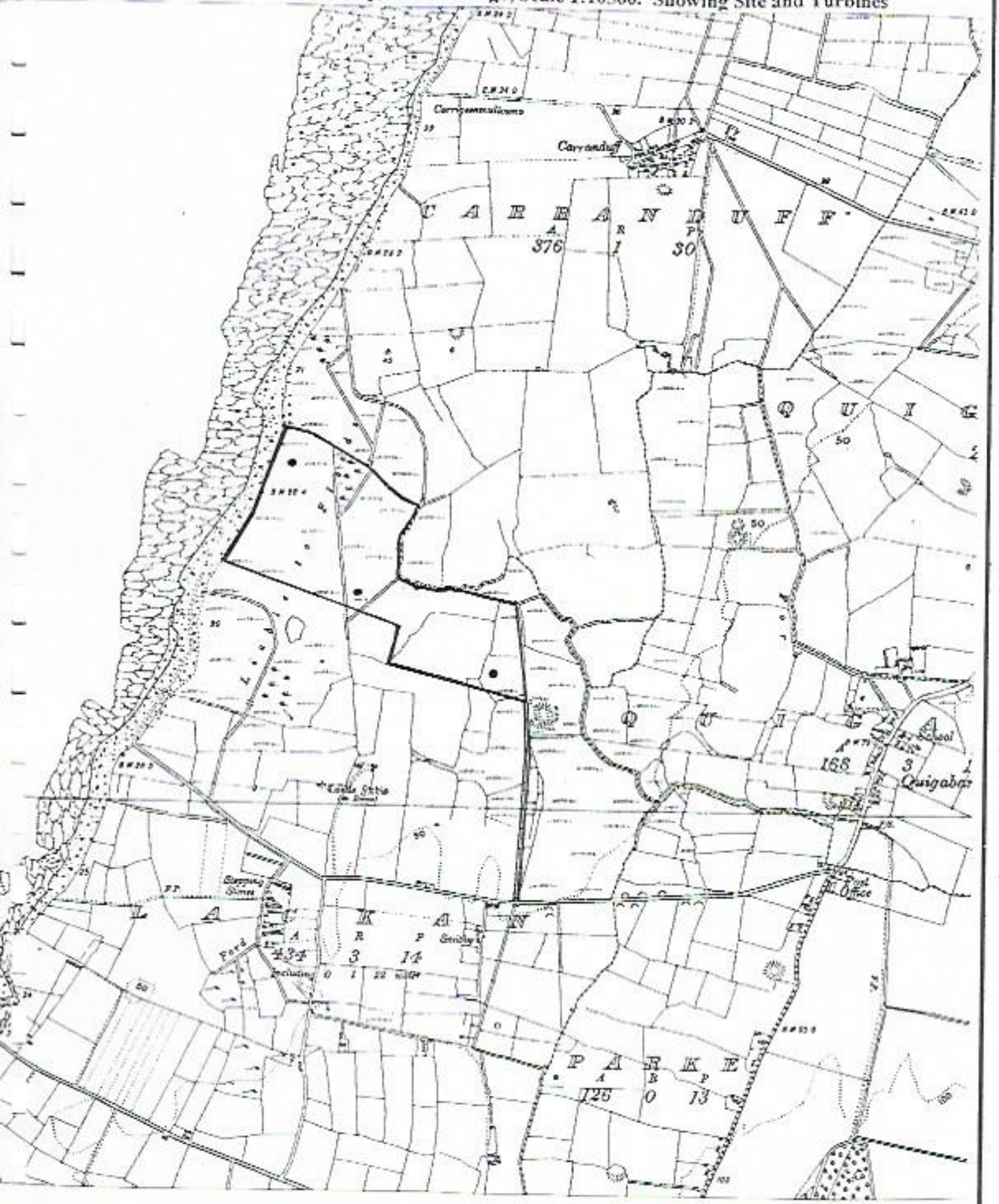


Fig. 5 : Discovery Series Map of Lacken.

Pl. 1 Looking East at East end of Trench No 1

Pl. 2 Looking at fragmits layer in Trench No. 2

Pl.3 Looking South West at Trench 3

Pl. 4 Looking West along Trench No. 4

Pl. 5 Looking North along Trench No. 5

Pl. 6 Looking North West along Trench No. 6

Pl. 7 Looking North along Trench No. 7

Pl. 8 Looking East along Trench No. 8

Pl. 9 Looking West along Trench No. 9

Pl. 10 Looking South-West along Trench No.10

Pl. 11 Looking West along Trench No. 11

Pl. 12 Looking South at remains of Tower House
SL 010 - 018

Pl. 13 Looking East at possible building (SL010-01803)

Pl. 14 Looking East at Kiln possible (SL 010 – 01802)

Pl. 15 Looking at Fulacht Fiadh (SL010-030)

Pl. 16 Looking South at Cliff edge fort SL016:001

Lackan Windfarm Photos Taken From Listed Sites

Tower House; SL 01-01801

Photo No	Coordinate X	Y	Bearing	Turbine	Distance
725			356	WT 1	732 M
726	30084	33077	12	WT 2	466 M
727			46	WT 3	515 M

Possible Building; SL 010-01803

730			355	WT 1	847 M
729	30104	32965	8	WT 2	573 M
728			37	WT 3	586 M

Killin SL; 010-01802

731			355	WT 1	827 M
732	30108	32984	8	WT 2	552 M
733			38	Wt 3	566 M

Cliff Edge Fort SL 016-001

				WT 1	
735	29003	31986	37	WT 2	1.95 Km
				WT 3	

PHOTO NO 725. COORDINATES X 30084 Y 33077 BEARING 356° WJ. 1 SITE SL: 01-01801

Photo No. 701 Coordinates V30081, V32077 Reading 12° WTG Site SL: 01 - 01801

PHOTO No 727. COORDINATES X 30084 Y 33077. BEARING 66° W.T. 3 SITE Ct.: 01 - 01801

PHOTO No 728. COORDINATES X 30104 Y 32965 BEARING 37° W.T. 3 SITE S L: 010-01803

2
1

PHOTO NO 720 COORDINATES X 38101 Y 37915 BEARING 265° WT 1 SITE S1 : 010-01803

PHOTO No 731. COORDINATES X 30108 Y 32984 BEARING 355° W.T. 1 SITE SL: 010 – 01802

PHOTO No 733 COORDINATES X 20148 Y 27081 BEARING 38° WTR Site Cl: 010-01082

PHOTO NO 735. COORDINATES, X29003 Y31986 BEARING 37° W.T. 2 SITE SL: 016-001