



INTERNATIONAL

Oweninny Wind Farm Development

Oweninny Power Limited (OPL)
Response to An Bord Pleanála
Further Information Request
Assessment of Alternative Option
Phase 1 and Phase 2 only

Document No.: QS-000169-02-R460-003

Date: 15/10/2015

ESB International, Stephen Court, 18/21 St Stephen's Green, Dublin 2, Ireland.

Phone +353 (0)1 703 8000

www.esbi.ie

File Reference:	QS-000169-02-R460-003	
Client Recipient:	/ Oweninny Power Limited (OPL)	
Project Title:	Oweninny Wind Farm Development	
Report Title:	Assessment of Alternative Option Phase 1 and 2 only	
Report No.:	QS-000169-02-R460-003	
Revision No.:	000	
Prepared by:	Jake Kinsella	Date:15/10/2015
Title:	Professional Engineer	
Verified by:	Paddy Kavanagh	Date: 15/10/2015
Title:	Planning and Environment Senior Team leader	
Approved by:	Neil Quinn	Date: 15/10/2015
Title:	Pre-Development Group Manager	

Copyright © ESB International Limited

All rights reserved. No part of this work may be modified, reproduced or copied in any form or by any means - graphic, electronic or mechanical, including photocopying, recording, taping or used for any purpose other than its designated purpose, without the written permission of ESBI Engineering & Facility Management Ltd., trading as ESB International.

Template Used: T-020-007-ESBI Report Template

Change History of Report

Date	New Revision	Author	Summary of Change
09/10/2015	001	PL	Legal Comments on Introduction incorporated
			Review and update of Cumulative Impacts in each Section

Contents

1	INTRODUCTION	1-1
1.1	SCOPE	1-2
1.2	General Overview Phase 1 and Phase 2 Development	1-4
1.2.1	Proposed Phase 1 and Phase 2 development	1-4
1.2.2	Changes to Cumulative Impact Projects	1-5
1.3	METHODOLOGY	1-6
1.4	ORAL HEARING INFORMATION	1-7
1.5	CONTRIBUTORS	1-7
1.6	CONSULTATION	1-8
2	DESCRIPTION	2-1
2.1	BACKGROUND	2-1
2.2	THE DEVELOPERS	2-1
2.3	THE SITE	2-1
2.3.1	Changes to general description compared to original application	2-3
2.4	PLANNING HISTORY	2-4
2.5	DESCRIPTION OF PHASE 1 AND PHASE 2 SCHEME	2-4
2.5.1	Scheme Components	2-4
2.5.2	Wind Turbines	2-5
2.5.2.1	Method of Operation	2-6
2.5.2.2	Locations	2-7
2.5.3	Transformers	2-11
2.5.4	Site entrance	2-11
2.5.5	Access Tracks	2-11
2.5.6	Crane stands	2-12
2.5.7	Electrical Substation	2-13
2.5.8	Meteorological masts	2-14
2.5.9	Overhead Transmission Lines and Underground Cables	2-15
2.5.10	Visitor Centre	2-16
2.5.11	Temporary Site Compound	2-18
2.5.12	Batching Plant	2-18

2.5.13 Wastewater treatment facilities	2-19
2.5.14 Borrow pit	2-19
2.5.15 Bord Gáis Network	2-20
2.5.16 Water supply	2-20
2.5.17 Electricity supply	2-20
2.5.18 River and stream crossings	2-20
2.6 MATERIAL QUANTITIES	2-21
2.7 PEAT STABILITY RISK ASSESSMENT	2-21
2.8 INDICATIVE PROJECT PHASING	2-23
2.8.1 Phasing	2-23
2.9 OPERATION, MAINTENANCE AND DECOMMISSIONING	2-24
2.9.1 Operation and Maintenance	2-24
2.9.1.1 Project Lifetime	2-24
2.9.2 Wind Farm Operation	2-24
2.9.3 Decommissioning	2-25
2.9.3.1 Options & Removal of Development	2-25
2.9.3.2 Costs of Decommissioning	2-26
2.10 MITIGATION OF POTENTIAL IMPACTS	2-26
2.11 OTHER DEVELOPMENTS	2-27
2.12 GRID CONNECTION	2-28
3 PROJECT IMPLEMENTATION	3-1
3.1 INTRODUCTION	3-1
3.2 PROJECT PHASING	3-1
3.2.1 Indicative Phasing	3-1
3.3 PROJECT CONSTRUCTION	3-1
3.3.1 Scope	3-1
3.3.2 Schedule	3-2
3.3.3 Construction Plant and Machinery	3-3
3.3.4 Construction and Environmental Management Plan	3-4
3.3.5 Site Management	3-5
3.4 TEMPORARY SITE FACILITIES	3-5
3.4.1 Contractor’s Compound	3-5
3.4.2 Temporary Concrete Batching Plant	3-5

3.4.3 Other temporary facilities	3-7
3.4.4 Emissions and emission control	3-7
3.4.4.1 Dust emissions.	3-8
3.4.4.2 Water	3-9
3.4.4.3 Waste Materials	3-10
3.4.4.4 Noise	3-10
3.4.5 Decommissioning	3-10
3.4.6 Control of Oils & Fuel	3-10
3.5 PUBLIC ROADS	3-11
3.6 TURBINE ACCESS AND CRANEPADS	3-12
3.6.1 Access tracks	3-12
3.6.2 Cranepads	3-13
3.7 WIND TURBINES	3-14
3.7.1 Turbine Bases	3-14
3.7.2 Turbine Installation	3-16
3.7.3 Commissioning	3-16
3.8 ELECTRICAL SUBSTATION	3-16
3.9 OPERATION AND MAINTENANCE (O&M) BUILDING	3-17
3.10 VISITOR CENTRE	3-18
3.11 METEOROLOGICAL MASTS	3-19
3.12 SITE DRAINAGE	3-19
3.13 ASSOCIATED WORKS	3-20
3.13.1 Tree Felling	3-20
3.13.2 Borrow Pit	3-21
3.13.3 Material import	3-22
3.13.3.1 Fill and aggregate	3-22
3.13.3.2 Concrete	3-22
3.13.3.3 Steel	3-22
3.13.3.4 Miscellaneous	3-22
3.14 CONSTRUCTION WASTE	3-22
3.15 REINSTATEMENT	3-24
3.16 MITIGATION OF IMPACTS	3-24
3.17 EMERGENCY RESPONSE PLAN	3-25

4	ALTERNATIVES	4-1
4.1	Alternative Electricity Generation	4-1
4.1.1	Benefits of Renewable Energy	4-1
4.1.2	Project Context	4-3
4.1.2.1	Scenario Worldwide	4-3
4.1.2.2	Irish Scenario	4-4
4.1.3	Other Renewable Energy Resources	4-5
4.1.4	Role and Benefits of Wind Energy	4-8
4.2	ALTERNATIVE SITES	4-9
4.2.1	Context	4-9
4.2.2	Site Suitability	4-10
4.2.2.1	Wind Speed	4-10
4.2.2.2	Size and Topography of Site	4-11
4.2.2.3	Other Factors	4-11
4.2.2.4	Renewable Energy Strategy	4-12
4.2.3	Previous Assessments of Site Suitability	4-12
4.2.3.1	Mayo County Council	4-12
4.2.3.2	An Bord Pleanála	4-12
4.2.4	Summary	4-13
4.3	ALTERNATIVE CONFIGURATIONS AND LAYOUTS	4-13
4.3.1	General Approach	4-13
4.3.2	Alternative turbine heights	4-14
4.3.3	Approved and Proposed Layout	4-15
4.3.3.1	Approved Layout	4-15
4.3.3.2	Development of Proposed Layout	4-15
4.3.3.3	Field Survey influence on the design	4-16
4.3.3.4	Scoping Exercise influence on design	4-17
4.3.3.5	Communication signal corridors	4-17
4.3.3.6	Impact of Trees	4-18
4.3.3.7	Final wind farm design	4-18
4.3.3.8	Micrositing	4-18
4.3.4	Proposed Arrangement – Other Components	4-18
4.3.4.1	Electrical Substation	4-18

4.3.4.2	Meteorological Masts	4-18
4.3.4.3	110 kV overhead Transmission Lines	4-18
4.3.5	Summary	4-21
4.3.6	Planning (Wind Energy) Guidelines	4-21
5	POLICY & PLANNING	5-1
5.1	INTRODUCTION	5-1
5.2	ENERGY POLICY – EUROPEAN CONTEXT	5-1
5.2.1	White Paper on Renewables	5-1
5.2.2	Green Paper on Security of Energy Supply	5-2
5.2.3	Renewable Energy Directives 2001 & 2009	5-2
5.2.4	European Commission Energy Roadmap 2050	5-3
5.2.4.1	Updates on EU Policy and Commitments	5-4
5.2.5	Climate Change	5-5
5.2.6	Summary	5-8
5.3	ENERGY POLICY – NATIONAL CONTEXT	5-8
5.3.1	Policy Evolution	5-8
5.3.2	National Development Plan 2007 - 2013	5-9
5.3.3	Renewable Energy Development - 2006	5-10
5.3.4	Energy White Paper – 2007	5-10
5.3.4.1	Update on the Energy White paper of 2007 – the Green Paper 2014	5-11
5.3.5	National Climate Change Strategy 2007 - 2012	5-12
5.3.6	Strategy for Renewable Energy, 2012 – 2020	5-12
5.3.7	National Renewable Energy Action Plan	5-13
5.3.8	NREAP First and Second Progress Report	5-15
5.3.9	Climate Action and Low Carbon Development Bill 2015	5-15
5.4	REGIONAL AND LOCAL PLANNING AND POLICY	5-16
5.4.1	Regional Planning Guidelines	5-16
5.4.2	Planning Policy - Mayo County Development Plan	5-18
5.4.3	Mayo County Development Plan 2014 – 2020	5-18
5.4.3.1	Development Policies and Objectives	5-19
5.4.4	County Landscape Policy	5-20

5.4.5	Mayo Renewable Energy Strategy	5-20
5.4.5.1	Strategic Environmental Assessment – Draft Renewable Energy Strategy County Mayo	5-21
5.5	CONCLUSIONS	5-22
6	HUMAN BEINGS	6-1
6.1	INTRODUCTION	6-1
6.2	METHODOLOGY	6-1
6.3	RECEIVING ENVIRONMENT	6-1
6.3.1	Population, Employment and Socio-economics	6-1
6.3.1.1	State population	6-1
6.3.1.2	Mayo Population	6-2
6.3.1.3	Population in District Electoral Divisions at Oweninny site	6-3
6.3.2	Socio-economics	6-4
6.3.2.1	Summary	6-5
6.3.3	Public Attitudes	6-6
6.3.4	Health and Safety	6-6
6.3.5	Electromagnetic Fields	6-7
6.3.6	Ice shedding	6-7
6.3.7	Shadow Flicker	6-7
6.3.8	Noise	6-8
6.4	POTENTIAL IMPACTS OF THE DEVELOPMENT CONSTRUCTION PHASE	6-8
6.4.1	Population, Employment and Socio-economics	6-8
6.4.1.1	Local Level	6-8
6.4.1.2	National Level	6-10
6.4.1.3	Avoidance of imported fossil fuels	6-11
6.4.1.4	Cumulative Impacts Population, Employment and socio economics	6-11
6.4.2	Public Attitude to Wind Farms	6-12
6.4.2.1	Ireland	6-12
6.4.2.2	Britain & Northern Ireland	6-13
6.4.3	Community Benefit	6-14

6.4.4	Health & Safety	6-17
6.4.4.1	Electromagnetic Radiation	6-17
6.4.4.2	Structural Integrity of Turbines:	6-20
6.4.4.3	Hazard from Falling Ice	6-21
6.4.4.4	Summary:	6-21
6.4.5	Other Issues	6-22
6.5	MITIGATION	6-22
6.5.1	General	6-22
6.5.2	Health & Safety	6-22
6.5.3	Electromagnetic Radiation	6-23
6.5.4	Structural Integrity of Turbines:	6-24
6.5.5	Hazards from Falling Ice	6-24
6.6	CONCLUSION	6-25
7	NOISE	7-1
7.1	INTRODUCTION	7-1
7.2	APPROACH AND METHODOLOGY	7-1
7.2.1	Background Noise and Wind Speed Monitoring	7-2
7.2.2	Turbine Noise Prediction Modelling	7-6
7.2.3	Corrections for Existing Wind Farm Noise	7-7
7.3	RECEIVING ENVIRONMENT	7-8
7.3.1	Summary background noise	7-10
7.4	IMPACT OF THE DEVELOPMENT	7-10
7.4.1	Sources of Noise	7-10
7.4.2	Construction Noise	7-13
7.4.3	Operational Noise Impact	7-16
7.4.3.1	Method of Assessment and Noise Limits	7-16
7.4.3.2	Predicted Noise	7-18
7.4.3.3	Predicted Operational Noise	7-19
7.4.3.4	Predicted Cumulative Impacts	7-20
7.4.3.5	Summary of noise impacts	7-21
7.5	CUMULATIVE IMPACTS	7-22
7.5.1	Cumulative Impact of Oweninny and Corvoderry	7-22
7.5.2	Cumulative Impact with other projects	7-23

7.5.3	Decommissioning Phase	7-25
7.6	MITIGATION	7-26
7.6.1	Construction phase	7-26
7.6.2	Operational phase	7-26
7.6.3	Decommissioning	7-27
7.7	CONCLUSIONS	7-27
7.8	GLOSSARY AND DEFINED TERMS	7-29
8	SHADOW FLICKER	8-1
8.1	INTRODUCTION	8-1
8.2	RECEIVING ENVIRONMENT	8-1
8.3	IMPACT OF THE DEVELOPMENT	8-2
8.3.1	Predicted Impact	8-2
8.3.2	Assessment	8-5
8.4	CUMULATIVE IMPACTS	8-6
8.5	MITIGATION	8-7
8.6	CONCLUSIONS	8-8
9	TERRESTRIAL ECOLOGY	9-1
9.1	INTRODUCTION	9-1
9.1.1	Locational and General Information	9-1
9.2	SURVEY METHODS AND DATA COLLATION	9-2
9.2.1	Habitats and Vegetation	9-2
9.2.2	Bird Surveys	9-3
9.2.2.1	Summer bird surveys	9-3
9.2.2.2	Winter bird surveys	9-8
9.2.2.3	Autumn bird surveys	9-10
9.2.3	Bat Survey	9-10
9.2.4	Otter Survey	9-10
9.2.4.1	Survey route distance & survey timing	9-11
9.2.5	Other Mammals, Amphibians and Reptiles	9-11
9.2.6	Criteria for Evaluation of Ecological Resources and Impact Assessment	9-12
9.3	RECEIVING ENVIRONMENT	9-13
9.3.1	Sites Designated for Nature Conservation	9-13

9.3.1.1	Special Areas of Conservation (SAC)	9-13
9.3.1.2	Special Protection Areas (SPA)	9-14
9.3.1.3	Natural Heritage Areas (NHA)	9-15
9.3.1.4	Proposed Natural Heritage Areas (pNHA)	9-15
9.3.1.5	Statutory Nature Reserves	9-15
9.3.1.6	National Parks	9-16
9.3.2	Habitats, Vegetation and Flora	9-16
9.3.2.1	Description of habitats on site	9-16
9.3.3	Vegetation descriptions at construction areas	9-37
9.3.3.1	Turbines and tracks	9-37
9.3.3.2	Sub-stations	9-38
9.3.3.3	Borrow pit and gravel storage area	9-38
9.3.3.4	Peat deposition area	9-38
9.3.3.5	Powerline routes	9-38
9.4	Otters and Other Terrestrial Mammals	9-40
9.4.1.1	Otters	9-40
9.4.1.2	Badger	9-41
9.4.1.3	Pine Marten	9-42
9.4.1.4	Irish Hare	9-42
9.4.1.5	Deer	9-42
9.4.1.6	Fox	9-42
9.4.1.7	Others	9-42
9.4.2	Bats	9-42
9.4.2.1	Desk study results	9-42
9.4.2.2	Bat field survey results	9-42
9.4.3	Amphibians and Reptiles	9-43
9.4.4	Birds	9-43
9.4.4.1	Breeding and summering birds	9-44
9.4.4.2	Wintering birds	9-47
9.4.4.3	Autumn birds	9-49
9.4.4.4	Birds of conservation importance	9-51
9.4.5	Evaluation Of Conservation Importance Of Site	9-67
9.4.5.1	Habitats and flora	9-67

9.4.5.2 Fauna	9-69
9.4.5.3 Birds	9-71
9.5 IMPACT ASSESSMENT	9-72
9.5.1 Characteristics of the Development	9-72
9.5.2 Loss of Habitats	9-73
9.5.3 Changes to Habitats as a Result of Works	9-74
9.5.3.1 Habitats affected directly by construction works	9-74
9.5.4 Changes to habitats during operation phase	9-74
9.5.5 Potential Hydrological Impacts on Flush Systems	9-75
9.5.6 Potential Pollution of Watercourses	9-75
9.5.7 Potential Impacts from Peat Slippage	9-76
9.5.8 Potential Impacts on Birds of Conservation Importance	9-78
9.5.8.1 Impacts on Annex I and/or Red Listed bird species	9-78
9.5.8.2 Impacts on Amber Listed species	9-81
9.5.9 Potential Impacts on Terrestrial Mammals	9-83
9.5.9.1 Otter	9-83
9.5.9.2 Badger	9-84
9.5.9.3 Other mammal species	9-84
9.5.10 Potential Impacts on Bats	9-84
9.5.10.1 Adjudged likely impact of the proposed development on bats	9-86
9.5.11 Potential Impacts on Amphibians and Reptiles	9-86
9.5.12 Potential Impacts on Sites Designated for Nature Conservation	9-86
9.5.12.1 European Sites	9-86
9.5.12.2 Other designated Sites	9-89
9.5.12.3 Proposed Natural Heritage Areas	9-89
9.5.12.4 Statutory Nature Reserves	9-90
9.5.12.5 National Parks	9-91
9.6 MITIGATION MEASURES	9-91

9.6.1	Habitat Avoidance	9-91
9.6.2	Sensitive Design to Maintain Habitat Integrity	9-91
9.6.3	Measures Specific for Protection of Bellacorick Iron Flush SAC	9-92
9.6.3.1	Access restrictions	9-92
9.6.3.2	Hydrological monitoring	9-92
9.6.3.3	Vegetation monitoring	9-92
9.6.4	Measures to Maintain Bog Remnants	9-93
9.6.5	Measures to Reduce and Prevent Water Pollution during Construction Works	9-93
9.6.6	Measures to Reduce and Prevent Water Pollution during Tree Felling	9-94
9.6.7	Measures to Maintain Peat Stability	9-96
9.6.7.1	Mitigation Measure for Areas of Insignificant Risk	9-96
9.6.7.2	Mitigation Measures for Areas of Significant Risk	9-96
	<i>Design mitigation measures</i>	9-96
	<i>Construction mitigation measures</i>	9-97
9.6.7.3	Construction control measures	9-98
9.6.7.4	Substantial Risk Mitigation Measures	9-98
	<i>Design mitigation measures</i>	9-98
9.6.7.5	Construction mitigation measures	9-99
9.6.7.6	Construction control measures	9-99
9.6.7.7	Peat Stability Risk Conclusions and Recommendations	9-100
9.6.8	Measures for Construction of Overhead Power Lines	9-101
9.6.8.1	Substation No. 1 line	9-101
9.6.8.2	Substation No. 2 line	9-101
9.6.9	Habitat Management and Enhancement	9-101
9.6.9.1	Re-establishment and promotion of wetland habitats	9-101

9.6.10	Removal of self-seeded conifers and Rhododendron	9-103
9.6.10.1	Removal of pine trees	9-104
9.6.10.2	Removal of Rhododendron	9-104
9.6.11	Measures for Sensitive Breeding Birds	9-105
9.6.12	Measures Applicable to All Breeding Birds	9-106
9.6.13	Monitoring for Birds during Operation Phase	9-106
9.6.14	Measures for Otters	9-107
9.6.15	Measures for Badgers	9-107
9.6.16	Measures for Bats	9-107
9.6.16.1	Trees	9-107
9.6.16.2	Lighting restrictions	9-107
9.6.16.3	Bridges	9-107
9.6.16.4	Vegetation-free buffer zone	9-108
9.6.17	Measures for Common Frog	9-108
9.6.18	Project Ecologist	9-108
9.7	Cumulative Impacts	9-110
9.7.1	Cumulative Impacts with Other Wind Farms	9-110
9.7.1.1	Cumulative impacts on habitats	9-112
9.7.1.2	Cumulative impacts on birds	9-112
9.7.2	Meteorological Mast	9-114
9.7.3	Power Line Projects	9-114
9.7.4	Substation Project	9-116
9.7.5	Power Plants	9-116
9.7.6	Renewable Energy Strategy (RES) for County Mayo, 2011-2020	9-117
9.7.7	Oweninny Cutaway Bog Rehabilitation Programme	9-117
9.7.8	Forestry	9-118
9.7.9	Peat Harvesting	9-119
9.7.10	Agriculture	9-119
9.7.11	Overview of In-combination Effects	9-120
9.8	CONCLUSION	9-121

10	WATER QUALITY, FISHERIES AND AQUATIC ECOLOGY	10-1
10.1	INTRODUCTION	10-1
10.1.1	Relevant legislation	10-3
10.1.2	Hydrology of the site	10-3
10.2	Approach and Methodology	10-4
10.2.1	Electrofishing	10-4
10.2.2	Stream Invertebrate Sampling	10-8
10.2.3	Biological Water Quality Assessment Criteria	10-9
10.3	RECEIVING ENVIRONMENT	10-10
10.3.1	General Catchment Information	10-10
10.3.2	Inland Fisheries Ireland – Oweninny Report 2012	10-10
10.3.3	Fishery Value	10-12
10.3.4	Electrofishing surveys	10-14
10.3.4.1	Inland Fisheries Ireland Surveys	10-14
10.3.4.2	Electrofishing survey	10-15
10.3.5	Electrofishing Summary	10-19
10.3.6	EPA Biological analyses.	10-20
10.3.7	Aquafact Biological analyses.	10-23
10.3.8	Ecological Importance and Designated areas	10-23
10.4	POTENTIAL IMPACT OF THE DEVELOPMENT	10-26
10.4.1	Construction Phase Impacts Pollution of Streams with Suspended Solids	10-27
10.4.2	Pollution with Nutrients Decomposition of Brash after Forestry Clearfelling	10-27
10.4.3	Construction - Pollution with Nutrients due to Ground Disturbance and Clearfelling Operations	10-31
10.4.3.1	Nutrients Adsorbed or Chemically Bound to Eroded Suspended Solids	10-31
10.4.4	Construction - Pollution with Other Substances	10-32
10.4.5	Potential Operational Impacts Long-Term Aquatic Effects	10-33
10.4.5.1	Pollution with Surface Runoff from Completed Development	10-33

10.4.5.2 Permanent Loss of Habitat and Obstruction to Upstream Movement of Aquatic Fauna Due to Culverting, Track Construction & Upgrading	10-33
10.4.6 Hydrological impacts	10-34
10.4.7 Decommissioning phase	10-34
10.5 MITIGATION	10-34
10.5.1 Construction Phase Mitigation - Reduction and Prevention of Suspended Solids Pollution	10-34
10.5.1.1 General Recommendations	10-34
10.5.2 Construction Phase Mitigation - Forestry Clearfelling	10-36
10.5.3 Construction Phase Mitigation - Pollution of Watercourses with Nutrients	10-37
10.5.4 Construction Phase Mitigation - Pollution of Watercourses with nutrient from Repository areas.	10-37
10.5.5 Construction Phase Mitigation - Turbine Foundations, Cable Trenches and Upgrade of Tracks	10-38
10.5.6 Construction Phase Mitigation – General Management of Pollution	10-38
10.5.7 Operational Phase Mitigation - Wastewater treatment system	10-39
10.5.8 Operational Phase Mitigation - Habitat Loss	10-39
10.5.9 Operational Phase Mitigation - Obstruction to Movement of Aquatic Fauna	10-39
10.5.10 Operational Phase Mitigation - Hydrological Impacts	10-41
10.5.11 Procedures, Monitoring and Maintenance	10-41
10.5.12 Residual Impacts post mitigation	10-42
10.6 CUMULATIVE IMPACTS	10-42
10.6.1 Wind Farms	10-42
10.6.1.1 Corvoderry Wind Farm Development	10-42
10.6.1.2 Dooleeg, Bellacorick Wind Farm	10-42
10.6.1.3 Tawnanasool Wind Farm	10-42

10.6.1.4 Potential future development of Oweninny Phase 3	10-43
10.6.2 Meteorological Mast	10-43
10.6.3 Overhead Power Lines	10-43
10.6.4 Substation Project	10-44
10.6.5 Power Plants	10-44
10.6.6 Grid 25/Grid West	10-45
10.6.7 Forestry	10-45
10.7 CONCLUSION	10-46
11 LANDSCAPE	11-1
11.1 BASIS OF VISUAL IMPACT ASSESSMENT	11-1
11.1.1 Introduction	11-1
11.2 METHODOLOGY	11-1
11.2.1 Introduction	11-1
11.2.2 Zone of Visual Influence	11-2
11.2.2.1 Visibility	11-2
11.2.3 Design Guidelines	11-3
11.2.4 Survey Methods	11-3
11.2.5 Definition of Visual Impact	11-4
11.2.6 Location of photomontages	11-6
11.2.7 Summary	11-7
11.3 RECEIVING ENVIRONMENT	11-7
11.3.1 Site Context	11-7
11.3.2 Landscape Character	11-7
11.3.3 Physical characteristics (Topography, Landform)	11-7
11.3.4 Social (Land use)	11-8
11.3.5 Experiential (Scale and exposure)	11-8
11.3.6 Visual	11-8
11.3.7 Planning Context (Refer to Figure 11.1)	11-9
11.3.8 Landscape Character County Mayo	11-9
11.3.9 Principle Policy Area:	11-9
11.3.10 Areas designated for ecological importance	11-11
11.3.11 Protected views and prospects	11-13

11.3.12 Walking routes	11-15
11.3.13 Cycling Routes	11-18
11.3.14 Céide Fields	11-19
11.3.15 Ballycroy National Park	11-19
11.3.16 Proposed Nephin Wild Project	11-19
11.3.17 Renewable Energy Development	11-19
11.4 CHARACTERISTICS OF THE PROPOSAL	11-20
11.4.1 The Proposal	11-20
11.4.2 Spatial Layout Characteristics	11-20
11.4.2.1 Relationship to Site, Topography and Landscape	11-20
11.5 IMPACT OF THE DEVELOPMENT	11-21
11.5.1 Introduction	11-21
11.5.2 Zones of Theoretical Visibility (Refer to Figures 11.4 & 11.5)	11-22
11.5.3 Principal Views (Refer to Figure 11.6)	11-22
11.5.4 Landscape and Visual Effects (Refer to Figure 11.7)	11-24
11.5.5 Cumulative effects	11-67
11.5.5.1 Wind Farms	11-67
11.5.5.2 Meteorological Mast	11-70
11.5.5.3 Substation development	11-71
11.5.5.4 Transmission line developments	11-71
11.5.5.5 Grid West	11-72
11.5.6 Cumulative effects – Conclusion	11-74
11.5.7 Effects of warning lights	11-76
11.5.8 Summary of Landscape and Visual Effects	11-76
11.5.9 Summary of effects on viewpoints	11-76
11.5.10 Visual Effects	11-77
11.5.11 Landscape Effects	11-78
11.5.12 Effects on Natural Heritage Areas and Natura 2000 sites	11-79
11.5.13 Effects on Scenic Routes and Protected Views	11-80

11.5.14	Effects on Walking Routes	11-84
11.5.15	Effects on Cycling Routes	11-86
11.5.16	Effects on Céide Fields	11-87
11.5.17	Effects on Ballycroy National Park	11-87
11.5.18	Effects on the proposed Nephin Wild Project	11-87
11.5.19	Summary of Effects on Designated Areas	11-88
11.5.20	Effects on Built-Up Areas	11-88
11.5.21	Effects on Roads within the study area	11-88
11.5.22	Connection to the National Grid	11-91
11.6	MITIGATION	11-91
11.6.1	Siting, Design and Layout	11-91
11.6.2	Comparison of alternative turbine heights	11-92
11.6.3	Design of Site Access Roads	11-92
11.6.4	Colour	11-92
11.6.5	Planting	11-93
11.6.6	Decommissioning	11-93
11.7	CONCLUSIONS	11-93
12	AIR QUALITY & CLIMATE	12-1
12.1	RECEIVING ENVIRONMENT	12-1
12.1.1	Air Quality	12-1
12.1.1.1	Legislative Context	12-1
12.1.1.2	Baseline Air Quality	12-2
12.1.2	Atmospheric Emissions	12-4
12.1.2.1	Legislative Context	12-4
12.1.2.2	Greenhouse Gas Emissions	12-5
12.1.2.3	Other Emissions	12-8
12.1.3	Local Emission Sources and Receptors	12-10
12.2	IMPACT OF THE DEVELOPMENT	12-10
12.2.1	Construction Phase impacts	12-10
12.2.1.1	Atmospheric Emissions	12-10
12.2.1.2	Air Quality	12-12
12.2.1.3	Impact of Air emissions on Protected Areas	12-13

12.2.2 Operational phase impacts	12-15
12.2.2.1 General	12-15
12.2.2.2 Loss of Forestry	12-15
12.3 MITIGATION	12-15
12.4 Cumulative Impacts	12-16
12.4.1 Wind Farms	12-16
12.4.1.1 Cumulative Benefits to greenhouse gas reduction from Wind Farm Developments	12-16
12.4.2 Cumulative impacts on air quality	12-17
12.4.2.1 Wind farms	12-17
12.4.2.2 Meteorological Mast	12-18
12.4.2.3 Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410)	12-18
12.4.2.4 Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45)	12-18
12.4.2.5 Uprate of the Existing Bellacorick to Bangor Erris 38 kV Overhead Line (planning reference PL15/611)	12-18
12.4.2.6 Substation Project	12-19
12.4.2.7 Power Plants	12-19
12.4.2.8 Grid 25/Grid West	12-19
12.5 CONCLUSION	12-20
13 SOILS & GEOLOGY	13-1
13.1 INTRODUCTION AND METHODOLOGY	13-1
13.2 RECEIVING ENVIRONMENT	13-1
13.2.1 Soils	13-1
13.2.2 Bedrock	13-3
13.2.3 Groundwater	13-3
13.2.4 Geological Heritage and Resources	13-5
13.2.5 Borrow Pit and Peat Repository	13-5
13.2.6 Ground Investigation and Slope Stability	13-6
13.2.6.1 Ground Investigation	13-6
13.2.6.2 Peat and Slope Stability	13-6

13.3 POTENTIAL IMPACT OF THE DEVELOPMENT	13-7
13.3.1 Construction Phase	13-7
13.3.1.1 General	13-7
13.3.2 Operational Phase	13-9
13.3.3 Decommissioning phase	13-9
13.4 MITIGATION OF POTENTIAL IMPACTS	13-10
13.4.1 Construction Mitigation	13-10
13.4.1.1 General	13-10
13.4.1.2 Soil Management	13-10
13.4.1.3 Materials and Fuels	13-11
13.4.1.4 Water and Effluents	13-12
13.4.1.5 Transmission Lines and HDD	13-13
13.4.1.6 Geoheritage	13-13
13.4.1.7 Slope Stability	13-13
13.4.2 Operational Mitigation	13-14
13.4.3 Decommissioning Mitigation	13-15
13.5 Cumulative Impacts	13-15
13.5.1 Wind Farms	13-15
13.5.1.1 Corvoderry Wind Farm	13-15
13.5.1.2 Dooleeg, Bellacorick Wind Farm	13-15
13.5.1.3 Tawnanasool Wind Farm	13-16
13.5.1.4 Potential future development of Oweninny Phase 3	13-16
13.5.2 Meteorological Mast	13-16
13.5.3 Uprate of the Existing Bellacorick to Castlebar 110 kV Overhead Line (planning reference P14/410)	13-16
13.5.4 Uprate of the Existing Bellacorick to Moy 110 kV Overhead Line (planning reference P15/45)	13-16
13.5.5 Substation Project	13-16
13.5.6 Power Plants	13-17
13.6 CONCLUSIONS	13-17
14 TRAFFIC & TRANSPORT	14-1
14.1 INTRODUCTION	14-1

14.2 TURBINE COMPONENT HAUL ROUTE ASSESSMENT	14-1
14.2.1 Methodology	14-2
14.2.2 Alternatives reviewed	14-3
14.2.3 Potential haul route options	14-3
14.2.4 Assessment of Potential Routes	14-5
14.3 TRAFFIC AND TRANSPORT ASSESSMENT	14-5
14.3.1 Methodology	14-5
14.3.2 Receiving Environment	14-6
14.3.3 Traffic Volumes	14-6
14.3.3.1 Traffic Counts	14-6
14.3.3.2 Annual Average Daily Traffic (AADT) Counter Mulranny	14-8
14.3.4 Project Appraisal Guidelines (AADT Estimation)	14-9
14.3.5 Existing Road Capacity	14-9
14.3.6 Public Transport	14-10
14.3.7 Accident Record	14-11
14.3.8 Proposed Site Access	14-11
14.3.8.1 Site Access Road Safety Audit	14-12
14.3.9 Trip Generation and Distribution	14-14
14.3.9.1 Construction Phase	14-14
14.4 IMPACT OF THE DEVELOPMENT	14-15
14.4.1 Future Background Traffic Flows	14-16
14.4.2 Project Construction	14-18
14.4.2.1 Miscellaneous Construction Vehicles	14-18
14.4.2.2 Concrete Foundations and Piles	14-18
14.4.2.3 Track Construction & Turbine Hardstands	14-19
14.4.2.4 Abnormal Loads	14-20
14.4.2.5 Electrical Equipment & Building Materials	14-20
14.4.2.6 Cranes	14-21
14.4.2.7 Worst Case Traffic Scenarios	14-21
14.4.3 Assessment of Potential Traffic Routes – Wind Turbine Components	14-27

14.4.4 Assessment of Construction Impacts (Extreme Worst Case Scenario)	14-28
14.4.5 Project Operation	14-34
14.4.5.1 Wind Farm Maintenance	14-34
14.4.5.2 Road Safety	14-35
14.4.5.3 Visitor Centre traffic	14-36
14.4.6 Project Decommissioning	14-36
14.5 MITIGATION OF POTENTIAL IMPACTS	14-37
14.5.1 Delivery of Wind Turbine Components	14-37
14.5.2 Maximising use of existing ground conditions and existing on site tracks	14-37
14.5.3 Potential Reduction in the traffic movements	14-38
14.5.3.1 On-site borrow pit	14-38
14.5.3.2 On site Concrete Batching Plant	14-38
14.5.4 General Construction Traffic	14-38
14.5.5 Traffic Management Plan	14-39
14.5.6 Landtake	14-39
14.5.7 Access points	14-40
14.6 CUMULATIVE IMPACTS	14-40
14.6.1 General	14-40
14.7 Wind Farm Developments	14-40
14.7.1.1 Potential future development of Oweninny Phase 3	14-43
14.7.2 110kV Overhead Line Upgrade	14-44
14.8 CONCLUSION	14-44
15 FORESTRY	15-1
15.1 INTRODUCTION	15-1
15.2 APPROACH AND METHODOLOGY	15-1
15.3 RECEIVING ENVIRONMENT	15-1
15.3.1 Forest Management Plans	15-1
15.3.2 Local Context	15-3
15.3.3 Sustainable Forest Management	15-4
15.3.4 Effect of Trees	15-5

15.3.5 Forest Management at Oweninny	15-5
15.3.5.1 Tree Felling Methodology	15-5
15.4 IMPACT OF THE DEVELOPMENT	15-8
15.4.1 Timber harvesting	15-8
15.4.2 Replanting	15-9
15.4.3 Potential Site Impacts	15-9
15.4.4 Change in Local Hydrology	15-9
15.4.5 Water quality - nutrient enrichment	15-10
15.4.6 Water quality - increase in suspended matter	15-10
15.4.7 Loss (or Change) of Habitat	15-10
15.4.8 Noise Disturbance During Felling	15-10
15.4.9 Increase of Extraction Road Traffic	15-11
15.5 CUMULATIVE IMPACTS	15-11
15.5.1 Wind Farms	15-11
15.5.1.1 Corvoderry Wind Farm	15-11
15.5.1.2 Dooleeg Wind turbine	15-11
15.5.1.3 Tawnanasool Wind Farm	15-11
15.5.1.4 Potential future development of Oweninny Phase 3	15-11
15.5.2 Overhead Line Projects	15-11
15.5.2.1 Bellacorick to Castlebar 110kV OHL Uprate	15-11
15.5.2.2 Bellacorick to Moy 110kV OHL Uprate	15-11
15.5.2.3 Bellacorick to Bangor Erris 38 kV OHL Uprate	15-12
15.5.3 Meteorological Mast at Sheskin	15-12
15.5.4 Grid West	15-12
15.6 MITIGATION	15-12
15.7 CONCLUSIONS	15-13
16 MATERIAL ASSETS	16-1
16.1 INTRODUCTION	16-1
16.2 TOURISM & AMENITY	16-1
16.2.1 Approach and methodology	16-1

16.2.2 Receiving Environment	16-1
16.2.2.1 General	16-1
16.2.2.2 Local	16-2
16.2.3 Impact of the Development	16-4
16.2.3.1 General	16-4
16.2.3.2 Cumulative Impacts	16-4
16.2.3.3 Local Interest	16-8
16.2.4 Mitigation	16-9
16.2.5 Conclusions	16-9
16.3 ENERGY SUPPLY	16-10
16.3.1 Receiving Environment	16-10
16.3.2 Impact of the Development	16-12
16.3.2.1 Cumulative impacts	16-13
16.3.2.2 Potential future development of Oweninny Phase 3	16-15
16.3.3 Mitigation	16-15
16.3.4 Conclusions	16-15
16.4 AIR NAVIGATION	16-15
16.4.1 Receiving Environment	16-15
16.4.2 Impact of the Development	16-15
16.4.3 Mitigation	16-16
16.4.4 Conclusions	16-16
16.5 TELEVISION and COMMUNICATIONS SIGNALS	16-16
16.5.1 Receiving Environment	16-16
16.5.2 Impact of the Development	16-17
16.5.3 Mitigation	16-17
16.5.3.1 Cumulative impacts	16-18
16.5.4 Conclusion	16-19
16.6 WIND FARMS AND PROPERTY PRICES	16-19
16.7 CONCLUSIONS	16-21
17 CULTURAL HERITAGE	17-1
17.1 INTRODUCTION	17-1
17.2 METHODOLOGY	17-1

17.2.1 Desk Study	17-1
17.2.2 Field Inspection	17-2
17.2.3 Assessment Methodology	17-2
17.3 RECEIVING ENVIRONMENT	17-3
17.3.1 Local History	17-3
17.3.2 Settlement History	17-9
17.3.3 Archaeology	17-10
17.3.4 Results from previous documented relevant archaeological reports	17-24
17.3.5 Reported archaeological artefacts	17-25
17.3.6 Summary of Archaeological Heritage	17-34
17.3.7 Architectural Heritage	17-35
17.4 IMPACTS OF THE DEVELOPMENT	17-45
17.4.1 Construction Phase	17-45
17.4.2 Operational Phase	17-49
17.4.3 ‘Do-Nothing’ Scenario	17-49
17.5 MITIGATION MEASURES	17-49
17.5.1 Construction Phase	17-49
17.5.2 Operational Phase	17-51
17.6 PREDICTED IMPACTS	17-51
17.6.1 Construction Phase	17-51
17.6.2 Operational Phase	17-51
17.6.3 ‘Worst Case’ scenario	17-51
17.7 CUMULATIVE IMPACTS	17-52
17.8 CONCLUSION	17-52
18 IRON FLUSH HYDROLOGICAL AND HYDROGEOLOGICAL ASSESSMENT	18-1
18.1 INTRODUCTION	18-1
18.2 APPROACH AND METHODOLOGY	18-2
18.2.1 NPWS and An Taisce consultation process	18-2
18.2.2 Sources of information	18-2
18.3 DESK STUDY REVIEW	18-3
18.3.1 Rainfall & evaporation	18-3

18.3.2 Regional and Local Hydrology	18-4
18.3.3 Geology	18-4
18.3.4 Hydrogeology	18-5
18.3.5 Review of previous investigation findings	18-7
18.4 IRON FLUSH HYDROGEOLOGICAL INVESTIGATION	18-7
18.4.1 Field Investigations	18-8
18.4.2 Vegetation survey	18-9
18.4.3 Drainage	18-9
18.4.4 Window Sampling, Peat Augering and Water Level Monitoring	18-11
18.4.5 Groundwater & peat water level monitoring installations	18-12
18.4.6 Water Levels	18-14
18.4.7 Hydrochemistry	18-17
18.5 RECEIVING ENVIRONMENT BELLACORICK IRON FLUSH	18-25
18.5.1 Introduction	18-25
18.5.2 Geology	18-25
18.5.3 Hydrology	18-27
18.5.4 Hydro-geology	18-28
18.5.5 Hydrochemistry	18-30
18.5.6 Surface Water Input (i.e. rainfall)	18-33
18.5.7 Shallow Ground Water (peat iron accumulation theory)	18-33
18.5.8 Discrete Deep Groundwater upwells (iron rich bedrock groundwater)	18-34
18.5.9 Flush Surface Water Catchment & Groundwater Recharge Area	18-35
18.5.10 Summary Hydro-geological Conceptual Model	18-37
18.6 IMPACT OF THE DEVELOPMENT - BELLACORICK IRON FLUSH	18-38
18.6.1 Introduction	18-38
18.6.2 Components of development which could impact on the iron flush	18-38

18.6.3 Description of Borrow Pit Area	18-40
18.6.4 Disruption of Groundwater Flow Paths Towards the Iron Flush	18-42
18.6.5 Reduction in Groundwater Recharge to the Iron Flush	18-43
18.6.6 Impact on Groundwater Levels in the Vicinity of the Iron Flush	18-44
18.6.7 Potential Release of Hydrocarbons & other Chemicals	18-44
18.6.8 Alteration of Surface Water Drainage in the Vicinity of the Iron Flush	18-44
18.6.9 Potential Hydrochemical Effects on the Flush due to Introducing Concrete Piles	18-45
18.7 MITIGATION MEASURES BELLACORICK IRON FLUSH	18-45
18.7.1 Disruption of Groundwater Flow Paths Towards the Iron Flush	18-45
18.7.2 Reduction in Groundwater Recharge to the Iron Flush	18-45
18.7.3 Impact on Groundwater Levels in the Vicinity of the Iron Flush	18-45
18.7.4 Potential Release of Hydrocarbons & other Chemicals	18-45
18.7.5 Alteration of Surface Water Drainage in the Vicinity of the Iron Flush	18-46
18.7.6 Potential Hydrochemical Effects on the Flush due to the Introducing Concrete Piles	18-46
18.8 CONCLUSIONS ON BELLACORICK IRON FLUSH	18-46
18.9 WIDER HYDROLOGICAL STUDY	18-46
18.9.1 Introduction	18-46
18.9.2 Schedule and methodology	18-47
18.10 WIDER AREA HYDROLOGY & HYDROGEOLOGY	18-47
18.10.1 Locations assessed	18-48
18.11 CONCLUSION ON WIDER AREA	18-51
18.12 Cumulative Impacts	18-52

19 HYDROLOGY & SEDIMENT	19-1
19.1 INTRODUCTION	19-1
19.2 RECEIVING ENVIRONMENT	19-2
19.2.1 Site Characterization	19-2
19.2.2 Water Balance	19-3
19.2.3 Flooding	19-4
19.2.4 Cutaway Bog Rehabilitation	19-5
19.2.5 Sensitive Receptors	19-6
19.3 POTENTIAL IMPACT OF THE DEVELOPMENT	19-7
19.3.1 Working in Cutaway Peatland	19-7
19.3.2 Windfarm Activities	19-7
19.4 MITIGATION	19-8
19.4.1 Approach	19-8
19.4.2 Water Quantity	19-9
19.4.3 Sediment Control	19-9
19.4.3.1 Settlement Lagoons and Ponds	19-10
19.4.3.2 Swales	19-12
19.4.3.3 Check Dams	19-12
19.4.4 Access Tracks	19-12
19.4.5 Turbines, Substations and Buildings Hardstanding	19-13
19.4.6 Borrow pit	19-14
19.4.7 Peat Repository	19-14
19.4.8 Batching plant	19-14
19.4.9 Tree Felling	19-15
19.4.10 Other Construction Settlement Control Measures	19-16
19.5 MONITORING AND MAINTENANCE DURING CONSTRUCTION	19-16
19.5.1 Monitoring	19-16
19.5.2 Operational Phase	19-17
19.5.3 Decommissioning Phase	19-17
19.6 CUMULATIVE IMPACTS	19-18

19.6.1	Wind Farms	19-18
19.6.1.1	Corvoderry Wind Farm Development	19-18
19.6.1.2	Dooleeg, Bellacorick Wind Farm	19-19
19.6.1.3	Tawnanasool Wind Farm	19-19
19.6.1.4	Potential future development of Oweninny Phase 3	19-19
19.6.2	Meteorological Mast	19-19
19.6.3	Overhead Power Lines	19-19
19.6.4	Substation Project	19-20
19.6.5	Power Plants	19-20
19.7	CONCLUSIONS	19-20
20	INDIRECT AND INTERACTION OF IMPACTS	20-1
20.1	INTRODUCTION	20-1
20.2	APPROACH AND METHODOLOGY	20-1
20.3	INDIRECT IMPACTS (Secondary Impacts)	20-1
20.3.1	Economic	20-2
20.3.2	Road Maintenance	20-2
20.3.3	Noise	20-3
20.3.4	Air and Climate	20-3
20.3.5	Indirect impact from mitigation	20-3
20.4	INTERACTIONS	20-4
20.4.1	Human Beings / Noise	20-6
20.4.2	Human Beings / Landscape	20-6
20.4.3	Human Beings / Roads & Traffic	20-6
20.4.4	Human Beings / Material Assets	20-7
20.4.5	Ecology / Landscape	20-7
20.4.6	Geology and Soils/Water	20-7
20.4.7	Geology and Soils/Ecology	20-8
20.4.8	Geology & Soils/Ecology	20-8
20.4.9	Aquatic Ecology / Water	20-8
20.4.10	Forestry /Ecology	20-9
20.4.11	Forestry /Water Quality	20-9
20.4.12	Forestry/Air and Climate	20-9

20.4.13 Landscape / Material Assets	20-9
20.4.14 Air & Climate / Roads & Traffic	20-10
20.4.15 Geology & Soils / Cultural Heritage	20-10
20.5 EPA GUIDANCE	20-10
20.6 Potential to connect to Grid West	20-11
20.7 CONCLUSIONS	20-12

Table of figures

Figure 1-1: Oweninny Site Location Map 1-9

Figure 2-1: Site Layout..... 2-29

Figure 2-2: Typical turbine components (*ESB Curryfree wind farm*)..... 2-30

Figure 2-3: Typical Wind Turbine Nacelle (Courtesy of Nordex) 2-31

Figure 2-4: Access locations to Oweninny site off the N59 2-32

Figure 2-5: Typical tower structure 2-33

Figure 2-6: Borrow pit and gravel storage area 2-34

Figure 2-7: Oweninny Visitor Centre- Site Plan 2-35

Figure 2-8: Oweninny Visitor Centre Elevation 2-36

Figure 2-9: Contractors typical site compound layout 2-37

Figure 2-10: Typical batching plant layout..... 2-38

Figure 2-11: Project indicative phasing 2-39

Figure 2-12: Location of other projects near Oweninny 2-40

Figure 4-1: Trend in Wind Turbine Sizes4.22

Figure 4-2: Growth of Wind Energy in Ireland4.22

Figure 4-3: Average wind velocity at hub height across the EU.4.23

Figure 4-4: Oweninny Initial Constraints Map.....4.24

Figure 4-5: Planning approved and proposed wind farm layout4.25

Figure 4-6: Proposed wind farm layout issued for Scoping Report4.26

Figure 4-7: Communication signal corridors with final proposed layout4.27

Figure 4-8: Final Constraints Map4.28

Figure 4-9: Alternative 110 kV Overhead Line Routes.....4.29

Figure 5-1: Greenhouse gas emissions (including international aviation and excluding LULUCF) trend, EU-28, 1990–2012 5-6

Figure 5-2: County Mayo Renewable Energy Wind Map – (*Reproduced from the County Mayo Renewable Energy Strategy*)..... 5-24

Figure 6-1: District Electoral Divisions at Oweninny6.27

Figure 6-2: Investment Contributions 6-28

Figure 6-3: Irish Wind Jobs by Category 6-29

Figure 6-4: Favourability to More Wind Farms 6-30

Figure 7-1: Wind Farm layout with Noise Sensitive Locations..... 7-33

Figure 7-2: Representative Noise Monitoring Locations 7-34

Figure 7-3: Predicted long term wind speed and direction at Mast 1 @ 50m .. 7-35

Figure 7-4: Predicted long term wind speed and direction at Mast 2 @ 50m .. 7-36

Figure 7-5: Predicted long term wind speed and direction at Mast 3 @ 50m .. 7-37

Figure 7-6: Predicted Noise Level Contour Map with Siemens SWT-3-101 wind turbines – Oweninny only..... 7-38

Figure 7-7: Predicted Noise Level Contour Map with Siemens SWT-3-101 wind turbines – Oweninny and Corvoderry..... 7-39

Figure 8-1: Potential Shadow Flicker Receptors at Oweninny for Turbines with 112 m Rotor Diameters8.10

Figure 8-2: Potential Shadow Flicker Receptors at Oweninny for Turbines with Rotor Diameters of 120 m.....8.11

Figure 9-1: Habitat and vegetation map..... 9.123

Figure 9-2: Bog Remnant locations 9.124

Figure 9-3: Bird survey transects..... 9.125

Figure 9-4: Bird survey vantage point locations 9.126

Figure 9-5: Otter survey routes..... 9.127

Figure 9-6: Designated and protected areas within 15 km..... 9.128

Figure 9-7: Distribution of selected breeding birds 9.129

Figure 9-8: Hen Harrier winter roost locations 9.130

Figure 9-9: Hen Harrier winter flight lines to winter roost..... 9.131

Figure 9-10: Hen Harrier departing flight lines from winter roost 9.132

Figure 10-1: Oweninny Rivers..... 10-47

Figure 10-2: A3 Oweninny site and main rivers..... 10-48

Figure 10-3: Electrofishing survey locations 10-49

Figure 10-4: EPA Biological Assessment Sites..... 10-50

Figure 10-5: Aquafact Water Monitoring sites 10-51

Figure 10-6: FPM Records on Deel river..... 10-52

Figure 10-7: Lough Dahybaun Catchment 10-53

Figure 11-1: Landscape designations..... 11-97

Figure 11-2: Landscape character..... 11-98

Figure 11-3: NHA 11-99

Figure 11-4: ZTV 120m..... 11-100

Figure 11-5: ZTV Blade Tip 176m	11-101
Figure 11-6: Visual Impact	11-102
Figure 11-7: Nature of Visibility Tip Height	11-103
Figure 12-1: Air quality Zones	12-21
Figure 12-2: Air quality monitoring locations	12-22
Figure 12-3: Greenhouse gas emissions in 2013 by Sector	12-23
Figure 12-4: Greenhouse Gas Emissions in Ireland 1990 – 2013	12-23
Figure 13-1: A3 Soil Formation	13-18
Figure 13-2: Ground water vulnerability	13-19
Figure 13-3: Bedrock Formation	13-20
Figure 13-4: Groundwater Resources	13-21
Figure 14-1: Oweninny County Roads	14-46
Figure 14-2: Oweninny Traffic Count Locations	14-47
Figure 14-3: Oweninny Site Access	14-48
Figure 14-4: Turbine Blade in transportation	14-49
Figure 15-1: Forest Plantations	15-14
Figure 15-2: Felling Areas	15-15
Figure 16-1: Fáilte Ireland Survey of tourist attitudes to wind farms	16-22
Figure 16-2: Fáilte Ireland Wind farm influence on decision to visit Ireland (Fáilte Ireland, Visitor Attitudes on the Environment - Wind Farms, 2008/ No 3)	16-23
Figure 16-3: Tourist Centres near Oweninny	16-24
Figure 16-4: Annual Energy Demand	16-25
Figure 16-5: Communication Links with original proposed layout	16-26
Figure 16-6: Communication Links with layout adjusted	16-27
Figure 17-1: Cultural Heritage Locations	17-53
Figure 18-1: Site Location Map	18-54
Figure 18-2: Regional Hydrology Map	18-55
Figure 18-3: Local Soils Map	18-56
Figure 18-4: Mapped Subsoils	18-57
Figure 18-5: Bellacorick Iron Flush Drainage and Vegetation Map	18-58
Figure 18-6: Bellacorick Iron Flush Local Drainage Map	18-59
Figure 18-7: Bellacorick Iron Flush Peat Depth Map	18-60
Figure 18-8: Bellacorick Iron Flush Site Investigation Network	18-61

Figure 18-9: Bellacorick Iron Flush Hydrochemistry Map	18-62
Figure 18-10: Bellacorick Iron Flush Durov Hydrochemistry Plot	18-63
Figure 18-11: Bellacorick Iron Flush Hydrogeological Cross Section A	18-64
Figure 18-12: Bellacorick Iron Flush Hydrogeological Cross Section B	18-65
Figure 18-13: Bellacorick Iron Flush Groundwater Contour Plot	18-66
Figure 18-14: Bellacorick Iron Flush Regional Groundwater Catchment ...	18-67
Figure 18-15: Bellacorick Iron Flush Groundwater Recharge Area	18-68
Figure 18-16: Spring Location Map Wider Hydrological Area	18-69
Figure 18-17: Eastern Flush Location Map	18-70
Figure 18-18: Formoyle Flush Catchment	18-71
Figure 19-1: Oweninny Site and Main River Catchments	19-22
Figure 19-2: Oweninny Shaded Relief Map	19-23
Figure 19-3: Water level recession curve	19-24
Figure 19-4: Sub Catchments Oweninny Wind Farm	19-25
Figure 19-5: Typical Local Drainage Layout	19-26
Figure 19-6: Lough Dahybaun Catchment	19-27
Figure 19-7: Freshwater Pearl Mussel Catchment	19-28
Figure 19-8: Peat Repository Area	19-29
Figure 19-9: Batching Plant Drainage Layout	19-30

Table of Tables

Table 1.1: Oweninny wind farm Phase 1 and Phase 2 project townlands	1-3
Table 2.1: Candidate Wind Turbines*	2-6
Table 2.2: Locations of Turbines	2-9
Table 2.3: Electrical Substation Locations (Centre point)	2-13
Table 2.4: Meteorological Mast	2-14
Table 2.5: Borrow Pit Location	2-19
Table 2.6: Estimates of material quantities	2-21
Table 3.1: Indicative Project Phasing	3-1
Table 3.2: Construction Schedule and Nominal Time Scales	3-2
Table 3.3: Estimated Typical Construction Plant and Equipment*	3-3

Table 3.4: Construction Waste and their Sources	3-23
Table 4.1: Global Deployment of Wind Power	4-3
Table 4.2: Fuel Mix for All-Ireland Electricity Generation 2014	4-5
Table 4.3: Planning Applications for Wind Farms – Republic of Ireland	4-10
Table 4.4: Wind Classification	4-11
Table 4.5: Wind turbine locations in Phase 1 and Phase 2 identified by IPCC as potential issues	4-17
Table 4.6: Suitability of 110 kV Overhead line route	4-19
Table 4.7: Evaluation of potential Line Routes from Substation 1 against Assessment Criteria	4-20
Table 4.8: Evaluation of potential Line Routes from Substation 2 against Assessment Criteria	4-20
Table 5.1: National Renewable Energy Targets	5-11
Table 5.2: National 2020 target and estimated trajectory of energy from renewable sources in heating and cooling, electricity and transport	5-14
Table 6.1: Population Change 2002-2011	6-3
Table 6.2: Number of Persons in Employment by Industry - Co. Mayo	6-4
Table 6.3: Distance of neighbouring houses to OHL and substation locations	6-19
Table 8.1: Potential Shadow Flicker Occurrence for turbines with Rotor Diameters of 112 m and Hub Heights of 120 m	8-4
Table 8.2: Potential Shadow Flicker Occurrence for Turbines with Rotor Diameters of 120 m and Hub Heights of 116 m	8-4
Table 9.1: Summer bird survey periods	9-4
Table 9.2: Vantage point locations	9-7
Table 9.3: Winter bird survey periods	9-8
Table 9.4: Autumn bird survey periods	9-10
Table 9.5: Approximate length of survey route for otter	9-11
Table 9.6: Impact significance criteria	9-12
Table 9.7: Summary of habitat types found on site. Classification is after Fossitt (2000). Where relevant, the corresponding Annex 1 habitat of the EU Habitats Directive is given	9-16
Table 9.8: Typical species list for grassland on old railway tracks	9-23
Table 9.9: Typical species list for dry heath habitat	9-24
Table 9.10: Substantial bog remnants	9-26
Table 9.11: Typical species list for lowland blanket bog habitat	9-28

<i>Table 9.12: Typical species list for cutover bog habitat.....</i>	9-32
<i>Table 9.13: Typical species list for rich fen habitat.....</i>	9-35
<i>Table 9.14: Distance from nearest bog remnants to construction area.....</i>	9-37
<i>Table 9.15: Details of bare peat cover and vegetation associated with powerline structures leading away from Substation No. 1.....</i>	9-39
<i>Table 9.16: Details of bare peat cover and vegetation associated with powerline structures leading away from Substation No. 2.....</i>	9-40
<i>Table 9.17: Adjudged local status of Irish bat species at Oweninny site.....</i>	9-43
<i>Table 9.18: Breeding status of species recorded within Oweninny wind farm during 2010, 2011 and 2012 breeding seasons. Red and Amber listed species (after Lynas et al. 2007) & Annex I species of the EU Birds Directive are highlighted.....</i>	9-45
<i>Table 9.19: Winter occurrences of species recorded on Transect sections 1-11 (7.3 km) within Oweninny wind farm during winters 2011/12 and 2012/13. Red and Amber listed species are highlighted (after Lynas et al. 2007).....</i>	9-48
<i>Table 9.20: Autumn occurrences of species recorded on Transect sections 1-11 (7.3 km) within Oweninny wind farm during October 2011 and August to October 2012. Red and Amber listed species are highlighted (after Lynas et al. 2007³).....</i>	9-50
<i>Table 9.21: Bird species of conservation importance recorded on site, 2010-2013.....</i>	9-51
<i>Table 9.22: Whooper Swan records.....</i>	9-52
<i>Table 9.23: Summary of Hen Harrier activity at roost, winters 2011/12 and 2012/13.....</i>	9-57
<i>Table 9.24: Hen Harrier arrival and departure routes at winter roost site, winters 2011/12 and 2012/13.....</i>	9-60
<i>Table 9.25: Record of Golden Plover.....</i>	9-63
<i>Table 9.26: Skylark Record.....</i>	9-66
<i>Table 9.27: Legal status of protected fauna encountered or considered likely to occur within the study area.....</i>	9-70
<i>Table 9.28: Distance from nearest bog remnants to construction area.....</i>	9-73
<i>Table 9.29: Peat Stability Risk Assessment Risk Rating.....</i>	9-77
<i>Table 9.30: Result of PSRA.....</i>	9-77
<i>Table 9.31: Survey target species.....</i>	9-105
<i>Table 10.1: Location co-ordinates semi quantitative electrofishing.....</i>	10-7
<i>Table 10.2: Duration of electrofishing times at each site studied.....</i>	10-7
<i>Table 10.3: Location co-ordinates for kick-sampling stations and water sampling site in Lough Dahybaun.....</i>	10-8

Table 10.4: Biotic Index of Water Quality	10-9
Table 10.5: Results of the electrofishing survey – Sheskin, Oweninny and Owenmore River.....	10-15
Table 10.6: Salmon capture rates, minimum density estimates and capture rates per m² per min, separate calculations for first run and second run fishings. 10-15	
Table 10.7: Length frequency distributions of salmon captured at each site (>0+ salmon highlighted in red).....	10-16
Table 10.8: Length frequency distribution of brown trout captured at all sites during the survey.	10-18
Table 10.9: EPA Biological Monitoring Data	10-21
Table 10.10: Q-value result for each station	10-23
Table 10.11. Results of analyses on a sample collected in L. Dahybaun, January, 2013. All values as mg/l.....	10-26
Table 11.1: Definition of magnitude / degrees of visual effects resulting from the proposal	11-5
Table 11.2: Criteria for the assessment of magnitude of effects on landscape character.....	11-5
Table 11.3 – List of Landscape Character Units (LCU) fully or partially contained within the study area	11-10
Table 11.4 – List of Principle Policy Areas (PPA) fully or partially contained within the study area.....	11-11
Table 11.5 – List of Natura 2000 (cSAC and SPA) sites within the 30km study area.....	11-12
Table 11.6 – List of Natural Heritage Areas within the 30km study area....	11-12
Table 11.7 County Mayo - List of Scenic Routes and Highly Scenic Views within the study area.....	11-14
Table 11.8 County Sligo - List of Scenic Routes within the study area.....	11-15
Table 11.9: Definitions to determine cumulative effects on landscape and visual effects.....	11-67
Table 11.10 – Summary of landscape, visual and cumulative effects as illustrated in Photomontages 1 – 27	11-76
Table 11.11: List of Scenic Routes within the study area	11-81
Table 11.12: List of Highly Scenic Views within the study area	11-84
Table 12.1: Summary of air quality assessment in Zone D.....	12-2
Table 12.2: EPA 2014 Air Quality Bulletin for monitoring stations in County Mayo.....	12-4

Table 12.3: Greenhouse Gas Emissions in Ireland (in Mt of CO₂ equivalent).	12-5
Table 12.4: Table 12.2: Annual Air Emissions	12-9
Table 12.5: Approximate Annual Equivalent Air Emissions	12-12
Table 13.1: Groundwater Vulnerability Classification	13-2
Table 13.2: Groundwater Resource Protection Matrix	13-5
Table 14.1: Potential Turbine Component Haul Routes	14-4
Table 14.2: Forecast N59 Future Year AADT	14-17
Table 14.3: Typical Wind Turbine Components*	14-20
Table 14.4: Forecast Traffic Generation Scenarios - All Vehicle Movements	14-21
Table 14.5: Peak Daily HGV Traffic Generation Scenarios (No Borrow Pit – No Concrete Batching Plant)	14-22
Table 14.6: Peak Daily HGV Traffic Generation Scenarios (Including Borrow Pit – Not Including Concrete Batching Plant)	14-23
Table 14.7: Traffic Distribution Potential (Excluding Borrow Pit)	14-25
Table 14.8: Traffic Distribution Potential (Including Borrow Pit)	14-25
Table 14.9: Forecast Capacity in AADT during construction period (Extreme Worst Case Scenario of Original EIS)	14-29
Table 14.10: Forecast Capacity in AADT West of Site During Construction Period (85th Percentile Scenario C with and without Borrow Pit)	14-31
Table 14.11: Forecast Capacity in AADT East of Site During Construction Period (85th Percentile Scenario C with and without Borrow Pit)	14-32
Table 14.12: Forecast Capacity in AADT West of Site During Construction Period (Average Scenario D with and without Borrow Pit)	14-32
Table 14.13: Forecast Capacity in AADT East of Site During Construction Period (Average Scenario D with and without Borrow Pit)	14-33
Table 14.14: Forecast Capacity in AADT West of Site During Construction Period (Average Scenario D with and without Borrow Pit)	14-42
Table 14.15: Forecast Capacity in AADT East of Site During Construction Period (Average Scenario D with and without Borrow Pit)	14-42
Table 15-1: Areas by Management Objectives for Shannetra Forest	15-2
Table 15-2: Planting year and area	15-3
Table 15-3: Coillte felling schedule	15-3
Table 16-1: Overseas Visits (Thousands) to Ireland	16-2
Table 16-2: Response to question as to whether wind farms spoil the look of the countryside	16-8

Table 16-3: Electricity System Records	16-11
Table 16-4: Transmission Demand Forecast (MW)	16-12
Table 17-1: Description of Potential impacts	17-2
Table 17-2: List of archaeological monuments within overall study area..	17-11
Table 17-3: Site CH-1	17-12
Table 17-4: Site CH-2	17-12
Table 17-5: Site CH- 3	17-15
Table 17-6: Site CH-4	17-17
Table 17-7: Site CH-5	17-17
Table 17-8: Site CH- 6	17-18
Table 17-9: CH - 7	17-18
Table 17-10: Site CH - 8	17-19
Table 17-11: Site CH - 9	17-20
Table 17-12: Reported Archaeological Artefacts	17-25
Table 17-13: Site CH - 11	17-36
Table 17-14: Site CH - 11	17-36
Table 17-15: Site CH - 12	17-37
Table 17-16: Site CH - 13	17-38
Table 17-17: Site CH - 14	17-38
Table 17-18: Site CH - 15	17-39
Table 17-19: Site CH - 16	17-39
Table 17-20:Site CH - 17	17-40
Table 17-21: Site CH - 18	17-40
Table 17-22: Site CH -19	17-41
Table 17-23: Site CH - 20	17-42
Table 17-24: Site C - 21	17-43
Table 17-25: Site 22	17-44
Table 17-26: Site 23	17-44
Table 17-27: Site 24	17-45
Table 18-1: Summary of Subsoil Water Level Monitoring Data (2003 – 2011).	18-6
Table 18-2: Results of Rising Head Tests (EDA, 2003).	18-6
Table 18-3: Summary of Site Investigation Methods.	18-8
Table 18-4: Total Flush Discharge Measurements from D4.	18-10

Table 18-5: Site investigation and related water monitoring locations 18-12

Table 18-6: Summary of Piezometer Network..... 18-13

Table 18-7: Summary of Permeability Analysis..... 18-14

Table 18-8: Water Level Data for Phreatic Piezometers. 18-15

Table 18-9: Water Level Data for Deep Peat/Subsoil Interface Piezometers.. 18-16

Table 18-10: Water Level Data for Mineral Subsoil Piezometers..... 18-16

Table 18-11: Water Level Data for Perimeter Boreholes..... 18-16

Table 18-12: Surface Water Field Hydrochemistry..... 18-17

Table 18-13: Phreatic Surface Field Hydrochemistry. 18-18

Table 18-14: Deep Peat Field Hydrochemistry..... 18-19

Table 18-15: Mineral Subsoil Field Hydrochemistry. 18-19

Table 18-16: Hydrochemical Results for Round 1 of Sampling..... 18-20

Table 18-17: Hydrochemical Results for Round 2 of Sampling..... 18-21

Table 18-18: Hydrochemical Results for Round 3 of Sampling..... 18-22

Table 18-19: Hydrochemical Results for Round 4 of Sampling (Part 1). 18-22

Table 18-20: Hydrochemical Results for Round 4 of Sampling (Part 2). 18-23

Table 18-21: Summary of Water Type Analysis..... 18-25

Table 18-22: Development Setback Distances from cSAC Boundary. 18-39

Table 18-23: Results of Wider Study Hydrochemical Analysis 18-51

Table 19-1: Catchments and Turbines 19-3

Table 19-2. River Risk and Design Rainfall Return Periods 19-11

Table 20-1: Potential interaction of effects 20-5

Table 20-2: Summary of Potential Interactions during the Construction stage 20-13