RWE

Clachaig Glen Wind Farm

Environmental Impact Assessment Report

Volume 2a

Main Report

# Chapter 18: Shadow Flicker

# 18 Shadow Flicker

## 18.1 Introduction

18.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) considers the potential for shadow flicker to occur at neighbouring properties due to the operation of the Proposed Development, as described in Chapter 3 of this EIAR: Project Description. The layout of the Proposed Development has been designed to avoid the potential for shadow flicker occurrence as far as practicable in light of other constraints.

18.1.2 The term ‘shadow flicker’ is given to the flickering effect created when a moving shadow of a rotating wind turbine rotor blade periodically casts a shadow across a constrained opening (such as a window or open door of a nearby property).

18.1.3 Shadow flicker on a property occurs when a particular combination of conditions coincides in specific locations at particular times of the day and year. It is most likely to occur when the sun is low in the sky and shines on a building from behind a turbine rotor. As the shadow from the turbine is most pronounced in these periods, this can cause the shadow of the turbine blades to be cast onto the building, which appears to flick on and off as the turbine blades rotate. When this flicking shadow is viewed through a narrow opening it is known as shadow flicker. The magnitude of the shadow flicker effect therefore varies spatially and temporally.

18.1.4 In the UK, the shadow flicker effect is only considered to affect properties within 10 rotor diameters of a turbine and within 130 degrees either side of north relative to a turbine (Department of Energy and Climate Change (DECC), 2011).

18.1.5 It is important to note that not all properties within the potentially affected area will experience shadow flicker. In order for it to occur, the weather must be sunny and the blades must also be rotating. The effect is also reduced if the turbine rotors are perpendicular to the location experiencing flicker, since the turbines turn to face into the wind when operating. Vegetation such as trees or hedgerows or intervening buildings, and indeed topography, may also have a screening effect.

18.1.6 It is possible to calculate the number of hours per year that shadow flicker may occur at a building from the relative position of the turbine to the building, the geometry of the wind turbine, the latitude of the wind farm site and the width of the windows potentially affected. The specialist computer software 'Wind Pro' has been used to quantify the levels of potential shadow flicker associated with the Proposed Development.

18.1.7 The turbines of the Proposed Development are expected to operate at around 6 to 14 revolutions per minute (rpm). Given each turbine will have three blades, the frequency at which a blade will pass a particular point will be in the order between 18 and 42 times per minute, which equates to between 0.3 and 0.7 flashes per second (hertz). This is significantly less than the 2.5 and 30 hertz frequency range generally thought to induce photosensitive epilepsy (National Society for Epilepsy, 2002). The issue of photosensitivity epilepsy to

potential users of the Development Site or nearby residents is not therefore considered further in this assessment, as there are unlikely to be any predicted adverse health effects.

18.1.8 The turbines are located approximately 1 km from the nearest core path / cycle route, named the Kintyre Way. As the Proposed Development's proposed blade tip height is a maximum of 200m, the turbines are therefore located well in excess of the 3 times blade tip height (600m) separation distance recommended by the British Horse Society (BHS) to avoid distress to horses from shadow flicker (BHS, 2014). The effect on pedestrians and horse riders has therefore not been considered further and is expected to be negligible.

18.1.9 There are no shadow flicker effects during the construction or decommissioning of a wind farm, as it only has potential to occur whilst the wind turbine blades are rotating.

## 18.2 Legislation, Policy and Guidance

18.2.1 There is no specific standard for the assessment of shadow flicker in the UK and no guidelines on acceptable levels of shadow flicker, however the Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014) states:

*'Under certain combinations of geographical position, time of day and time of year, the sun may pass behind the rotor and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as 'shadow flicker'. It occurs only within buildings where the flicker appears through a narrow window opening. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the potential site.*
*Where this could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem. However, there is scope to vary layout/reduce the height of turbines in extreme cases.'*

18.2.2 This is similar to advice from DECC, which considers that shadow flicker effects are only considered to affect properties within 10 rotor diameters of a turbine and within 130 degrees either side of north relative to a turbine (DECC, 2011).

18.2.3 While there are currently no UK guidelines which quantify what exposure levels of shadow flicker are acceptable, Predac, an EU sponsored organisation that promotes best practice in energy use and supply, suggests that a maximum of 30 hours of shadow flicker in any calendar year is acceptable for properties within 500 m of a turbine position (Predac, 2004).

18.2.4 The Argyll and Bute Local Development Plan (LDP) was adopted in 2015. The LDP sets out local planning policy for renewable energy. The following policy is relevant to wind farm infrastructure:

- Policy LDP 6 – Supporting the Sustainable Growth of Renewables - states that all wind energy developments will be assessed against a number of criteria, including impacts on communities and individual dwellings through shadow flicker.

18.2.5 Argyll and Bute Council is currently in the process of preparing their new Local Development Plan (LDP2). Consultation on this has ended and the next stage will be examination. The LDP2 was planned to be adopted in January 2022, based on an examination period spanning April to October 2021. However, it is understood that as examination has yet to commence, adoption of LDP2 will likely be delayed until January 2023. As LDP2 is still to be examined, the adopted LDP remains the primary policy consideration. Nevertheless, relevant proposed policy in LDP2 includes:

- Policy 30 – The Sustainable Growth of Renewables – this repeats Policy LDP 6 in regard to the assessment criteria of wind energy developments including impacts on communities and individual dwellings through shadow flicker.

## 18.3 Methodology

18.3.1 As the effects of shadow flicker can be calculated in a quantitative manner, it is not necessary to define sensitivity or magnitude of change as set out in the EIA methodology in Chapter 2 of this EIAR: Approach to Environmental Impact Assessment. Therefore, this methodology has not been followed in this chapter.

18.3.2 Specialist software 'Wind Pro' has been used to quantify the extent of shadow flicker that could occur within a study area of 10 times rotor diameter plus a 50m micro-siting allowance. This model accounts for the latitude and longitude of the Proposed Development and uses a model of the sun's position in the sky throughout the year to calculate shadow lengths, positions and times. A 5 metre (m) Digital Terrain Model (DTM) was also used in the assessment to take account of the topography between receptors and turbines. This assessment does not take into consideration the effects of any woodland screening therefore is considered worst case.

18.3.3 The assessment study area was defined as the area over which shadow flicker effects could impact residential properties (i.e. within 10 rotor diameters of each turbine). Given the parameters of the Proposed Development described in Chapter 3 of this EIAR: Project Description, a buffer radius of 1600m was applied to each turbine location to determine the overall study area, which is shown on Figure 18.1 (EIAR Volume 2b). This is based on a maximum 155m rotor diameter x10, plus an additional 50 m proposed micro-siting allowance.

18.3.4 Following the results of the calculations, and due to the lack of specific standards or guidelines for shadow flicker as referenced in Section 18.2, professional judgment is then applied in light of predictions as to the extent of any shadow flicker which is expected to arise.

18.3.5 An EIA Scoping Report was submitted to the Scottish Government's Energy Consents Unit (ECU) in July 2020 for comment on the proposed scope and methodology of the EIA. The Scoping Opinion issued by the ECU in response was received in October 2020. These documents can be found in Appendices 5.1: Scoping Report and 5.2: Scoping Opinion (EIAR Volume 3). Relevant responses from the consultees who contributed to the Scoping Opinion are summarised in Chapter 5 of this EIAR: Summary of Consultation. Within this response,

Argyll and Bute Council confirmed that they are satisfied with the proposed approach to the shadow flicker assessment.

# 18.4 Baseline Environment

## *Residential*

18.4.1 As shown on Figure 18.1 (EIAR Volume 2b), there is one residential dwelling, High Clachaig, within the shadow flicker study area. The minimum distance between the closest turbine, T14, and this dwelling is 1,178m. Details of this are shown in Table 18-1 Shadow Flicker Assessment Locations.

18.4.2 The orientation of a property and the position of the windows relative to the turbines will affect the impact shadow flicker has on the residents inside a property. A site visit was undertaken on 21 December 2015 to determine the location of windows at the High Clachaig residential property, which is situated adjacent to the Development Site boundary and within the study area. Details and site photographs are shown on Figure 18.2 (EIAR Volume 2b). It was confirmed that none of the windows of this property face the direction of the wind farm.

**Table 18-1 Shadow Flicker Assessment Locations**

| ID | Property Name | Easting (m) | Northing (m) |
|---|---|---|---|
| A | High Clachaig | 169985 | 640844 |

# 18.5 Embedded Mitigation

18.5.1 The evolution of the design of the Proposed Development has resulted in a significant reduction in the number of turbines proposed from those originally considered at the Development Site (see the Design Statement and Chapter 4 of the EIAR: Reasonable Alternatives). Through this reduction in the number of turbines and the layout of the final design, potentially significant effects on receptors have largely been avoided. This has resulted in a reduction in the number of properties potentially affected by shadow flicker.

# 18.6 Assessment of Effects

18.6.1 Figure 18.3 (EIAR Volume 2b) illustrates the predicted amount of shadow flicker occurrence at the affected property (High Clachaig), calculated using the Wind Pro Software. The theoretical maximum hours of shadow flicker occurrence which may arise from the operation of the Proposed Development is shown in Table 18-2 Shadow Flicker Occurrence. The detailed results from the model are shown in Appendix 18-1.

**Table 18-2 Shadow Flicker Occurrence**

| ID | Property Name | Theoretical maximum of shadow flicker occurrence (hours/year) | Likely average of shadow flicker occurrence* | Turbine ID contributing to the shadow flicker occurrence |
|---|---|---|---|---|
| A | High Clachaig | 42:32 | 13:11 | T11 & T14 |

** Based on historical Met Office data at Campbeltown Airport the number of sunshine hours are approximately 31% of all daylight hours averaged over a year (Met Office Average Climate Statistics, 2021).*

18.6.2 A worst case shadow flicker analysis has been undertaken for one property (High Clachaig) within the study area. It is predicted that this property should experience no more than 43 hours of shadow flicker per year. This would be distributed over 38 occurrences in the year (during end April to early June, and again in early July to mid-August), with no single event lasting more than 54 minutes. Any shadow flicker is also predicted to only occur in the early hours of the morning (within the time 05:45 to 07:00), when any occupants are unlikely to be awake or active to witness the event.

18.6.3 These results are worst case and the actual instances of shadow flicker should be less than those predicted by the model. Shadow flicker only occurs under specific conditions during the operation of a wind farm (i.e. when the rotor blades are turning, and when the sky is clear enough to cast shadows). It is important to take account of the following facts when considering this assessment:

- The model is based on an assumption that the windows of the property are facing the wind farm. As confirmed on the site visit, none of the windows of this property currently face the direction of the wind farm and therefore shadow flicker should not affect residents inside this property.
- Based on historical Met Office data at Campbeltown Airport the number of sunshine hours are approximately 31% of all daylight hours averaged over a year. While some shadow may still be cast under slightly overcast conditions, no shadow at all would be cast when heavy cloud cover prevails. Taking the expected number of sunshine hours into account, it is predicted that shadow flicker would only occur at this property for a maximum 13 hours per year.
- The turbines will not operate for 100% of daylight hours. During periods of very low speed wind or very high speed wind (or maintenance shut-downs), the rotors do not turn. During such periods shadow flicker would not occur.
- Objects such as trees or walls near to the receptors may obscure the view of the turbines and therefore reduce the occurrence of shadow flicker.
- During operation, the turbine rotors automatically orient themselves to face the prevailing wind direction. This means the turbine rotors may not be correctly aligned relative to the sun and property for shadow flicker to occur during the hours on sunshine. This is particularly the case when turbines are ‘side-on’ to affected properties and in such instances the occurrence of shadow flicker will be less than the worst case predictions. The met mast data from the site suggests that the vast majority of the wind comes from

a west and south-west direction, and then from a south and north-west direction. Taking this into consideration the frequency of blades being 'side-on' to High Clachaig is likely to be lower than the worst case predictions.

18.6.4 Consideration of the above factors leads to the conclusion that the level of shadow flicker will be significantly less than the results from the model. There are currently no UK guidelines which quantify what exposure levels of shadow flicker are acceptable however, Predac, an EU sponsored organisation that promotes best practice in energy use and supply, suggests that a maximum of 30 hours of shadow flicker in any calendar year is acceptable for properties within 500 m of a turbine position (Predac, 2004). The effect of shadow flicker on High Clachaig (the only property located within the study area) is therefore considered not significant in terms of the EIA Regulations.

## 18.7 Mitigation and Monitoring

18.7.1 No routine mitigation is proposed, this will however be kept under review during the operation of the Proposed Development in case particular combinations of circumstances arise that increase the potential for disturbance (particularly where rooms affected are in regular occupancy and the effect proves to be a frequent occurrence).

18.7.2 Where issues arise, mitigation measures such as standard shadow flicker controllers can be installed on turbines to shut them down when all parameters needed to cause shadow flicker are present, thereby eliminating the problem. Other options such as screening affected dwellings from turbines could also be implemented.

## 18.8 Residual Effects

18.8.1 There are no predicted residual effects. Shadow flicker occurrence will be kept under review during the operational stage of the Proposed Development and mitigation measures will be applied to remove the effects of any shadow flicker occurrence if necessary.

## 18.9 Cumulative Effects

18.9.1 There are no proposed wind farms that have a combined shadow flicker study area with the Proposed Development; therefore, there will be no cumulative effects from shadow flicker.

## 18.10 Summary of Assessment

18.10.1 A shadow flicker analysis has been undertaken for the one property (High Clachaig) present within the study area. It has been shown that for worst case conditions, the maximum occurrence of shadow flicker is predicted to be approximately 42.5 hours per year. Taking the expected number of sunshine hours into account, it is predicted that in a more realistic scenario shadow flicker would only occur at this property for a maximum 13 hours per year.

18.10.2 However, it should be noted that the actual amounts of shadow flicker is expected to be significantly less than the model has predicted, due to local screening effects, the fact that the blades may not be orientated in a direction that causes shadow flicker or may not be moving during the hours when there is potential for shadow flicker to occur (see section 18.6.3). It was also confirmed from a site visit that none of the windows of this property face the direction of the wind farm; therefore shadow flicker should not affect occupants in this property and no significant effects are predicted to occur.

18.10.3 It has been demonstrated that the frequency at which shadow flicker might occur at the High Clachaig property (up to 1 hertz) is significantly less than the frequency at which photosensitive epilepsy is usually triggered (between 2.5 and 30 hertz). While some people are sensitive at higher frequencies, it is uncommon to have photosensitivity below 2.5 hertz. It is therefore considered that shadow flicker from the Proposed Development will have no adverse health effects.

# 18.11 References


- British Horse Society: BHS. (2014). Advice on Wind Turbines and Horses – Guidance for Planners and Developers.
- Department of Energy and Climate Change. (2011). 'Update of UK Shadow Flicker Evidence Base.'
- Met Office Average Climate Statistics for Campbeltown Airport. [Online} Accessed on 05 August 2021 at: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcggqkdp5
- National Society for Epilepsy. (2002). Information on Epilepsy: Photosensitive Epilepsy.
- Predac (2004). Spatial Planning of Wind Turbines.
- Scottish Government Online Renewables Planning Advice: Onshore Wind Turbines (Scottish Government, 2014)

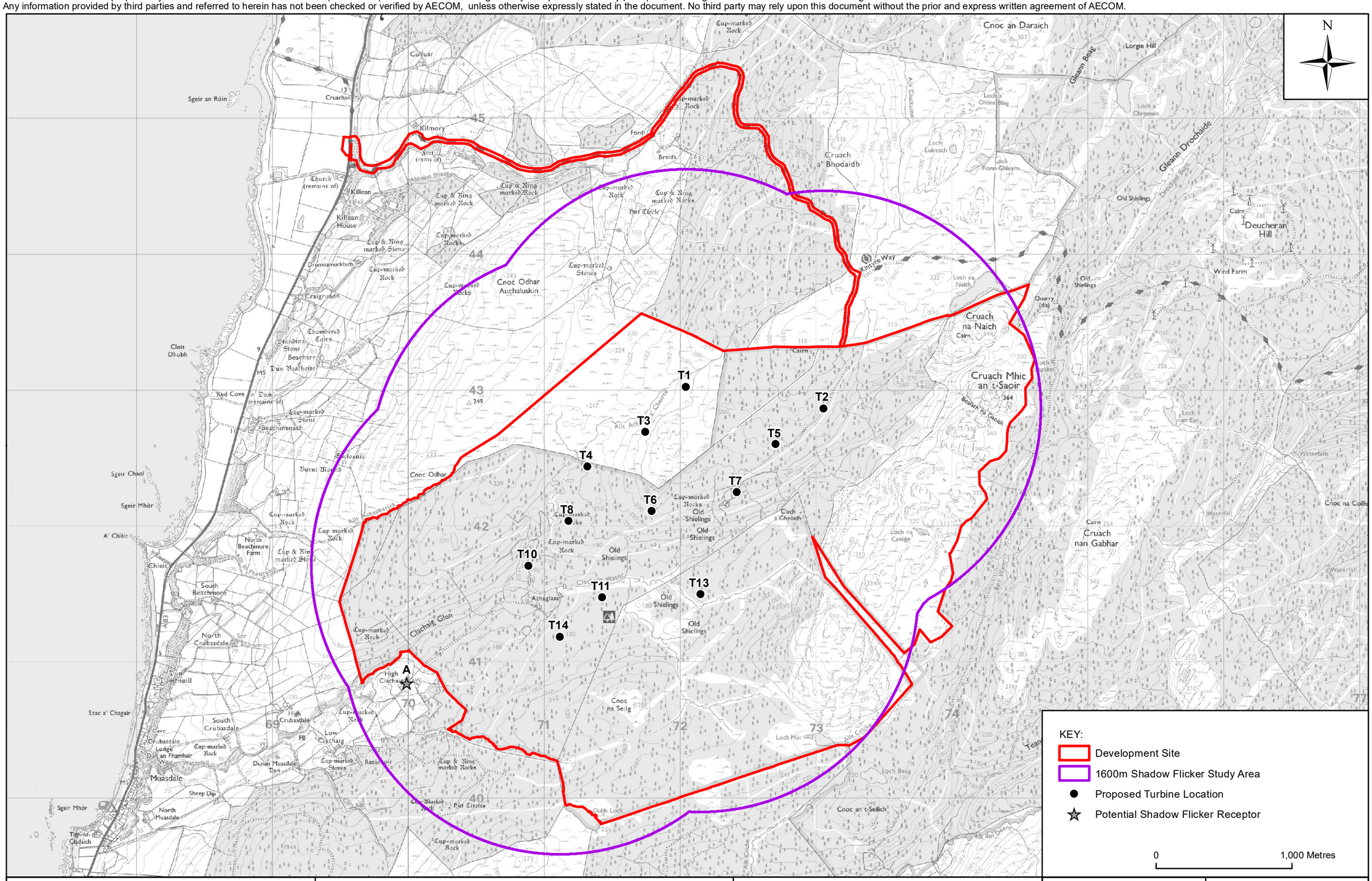
# Clachaig Glen Wind Farm

## Environmental Impact Assessment Report

## Volume 2b

## EIAR Figures

# Figures: 18.1; 18.2; 18.3

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|---|---|---|---|
| Client: RWE | Title: FIGURE 18.1 SHADOW FLICKER STUDY AREA | AECOM One Trinity Gardens Quayside Newcastle, NE1 2HF Tel +44 (0) 191 224 6500 Fax +44 (0) 191 224 6599 www.aecom.com | Drawn: LC / Checked: AR |
| Project: CLACHAIG GLEN WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT | | | Verified: RB / Approved: SW |
| | | | Date: JANUARY 2022 / Scale at A3: 1:25,000 |
| | | | Drawing Number: CG_220105_EIA18.1_v2 / A3 |

Photograph 3

Photograph 4

Photograph 2

Photograph 1




N

KEY:
- Development Site
- Window Location
- Site Photograph Location

0 — 100 Metres

| | | | |
|---|---|---|---|
| Client: RWE | Title: FIGURE 18.2 SITE PHOTOGRAPHS | Drawn: LC | Checked: AR |
| Project: CLACHAIG GLEN WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT | | Verified: RB | Approved: SW |
| | | Date: JANUARY 2022 | Scale at A3: 1:2,500 |
| | | Drawing Number: CG_220105_EIA18.2_v2 | A3 |

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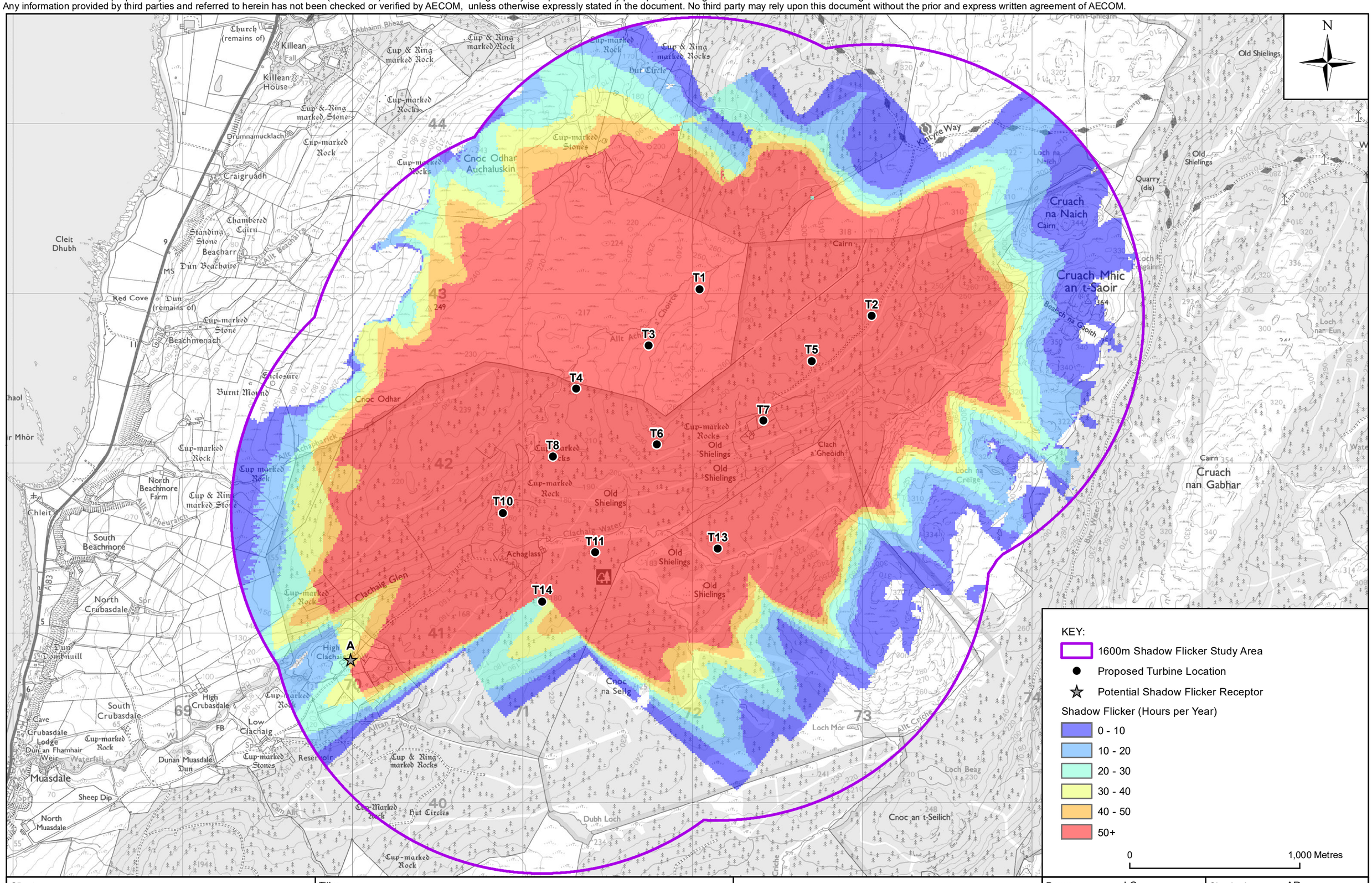


| | | | |
|---|---|---|---|
| Client: RWE | Title: FIGURE 18.3 OCCURRENCE OF POTENTIAL SHADOW FLICKER | AECOM One Trinity Gardens Quayside Newcastle, NE1 2HF Tel +44 (0) 191 224 6500 Fax +44 (0) 191 224 6599 www.aecom.com | Drawn: LC / Checked: AR |
| Project: CLACHAIG GLEN WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT | | | Verified: RB / Approved: SW |
| | | | Date: JANUARY 2022 / Scale at A3: 1:20,000 |
| | | | Drawing Number: CG_220105_EIA18.3_v2 / A3 |

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