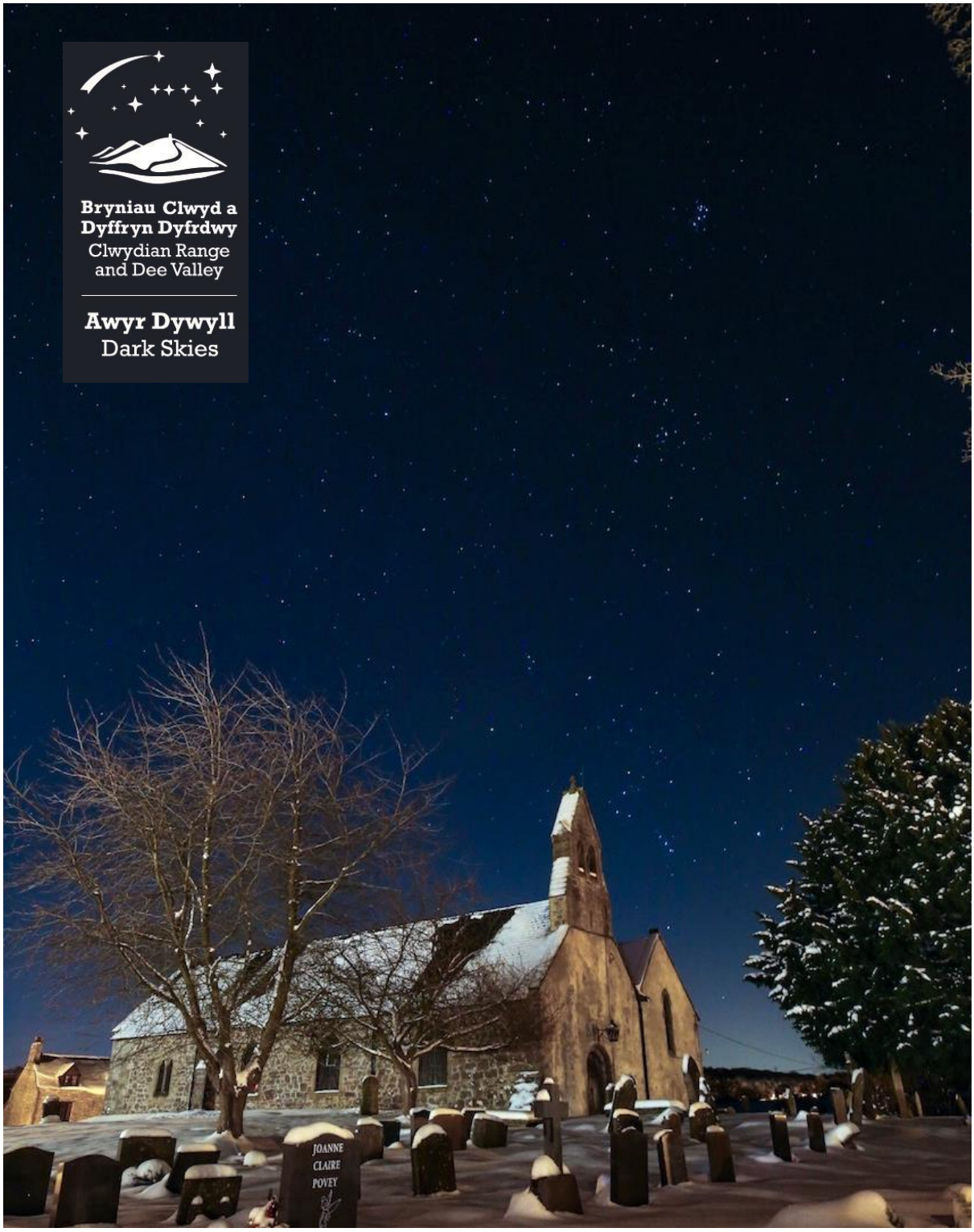

DARK SKIES SCOPING STUDY REPORT AND OUTLINE ACTION PLAN

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Report produced for
Clwydian Range and Dee Valley AONB
supported and funded by

Adroddiad gynhyrchwyd ar gyfer
AHNE Bryniau Clwyd a Dyffryn Dyfrdwy
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All study-specific mapping
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Cover image: Night skies over Llanarmon yn Iâl – Allan Trow, December 2017

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EXECUTIVE SUMMARY

In 2016, the Clwydian Range and Dee Valley AONB set about exploring the opportunities to improve the quality of its dark skies and attain appropriate designation by the International Dark Sky Association (IDA).

To progress this aim, with support from the Welsh Government Rural Communities – Rural Development Programme 2014-2020, which is funded by the European Agricultural Fund for Rural Development and Welsh Government, and the Sustainable Development Fund, Cadwyn Clwyd in January 2017 commissioned BRO and DSW to:

- Assess the current night sky quality within the AONB using IDA Guidelines
- Provide advice and guidance that could be used by communities and businesses in lighting schemes that will help to preserve the quality of the night sky whilst providing for lighting needs
- Engage communities and agencies to raise awareness of the importance of dark skies
- Explore the feasibility of Dark Sky Status and provide an outline Action Plan for pursuing the most appropriate IDA recognition

The study took place between February and December 2017.

MAIN STUDY OUTPUTS AND FINDINGS

- Addressing and reducing light pollution to improve the quality of the night skies in the AONB will result in significant positive social, environmental, and economic benefits.

- In addition to the benefits through enhanced tourism, formal IDA recognition would bring benefits in public health, biodiversity and energy efficiency.

- The Clwydian Range and Dee Valley AONB Management Plan (2014 – 2019) recognises the importance of dark night skies and, in particular, they tranquillity they offer. Formal Dark Sky recognition and designation is supported by a number of key, relevant AONB Management Plan policies: PolART1, PolCP3, PCO3, and LQCO4. The aims for Dark Sky recognition and designation are also supported by the Sustainable Tourism Strategy and Action Plan, including Objectives 2 and 3.

- Recent legislation supports the AONB's Dark Sky ambitions, especially the Wellbeing of Future Generations Act (WFGA), which seeks to improve the social, economic, environmental and cultural wellbeing of Wales.

- As highlighted by satellite-based desktop mapping undertaken in the study, the quality of the night skies on the eastern edges of the AONB is currently affected by light pollution from the towns of Mold and Wrexham as well as Deeside, Chester and Merseyside, with similar impacts in the north from the coastal towns. These have a significant effect upon tranquillity, particularly at night, spilling light onto the darker skies to the south and west in the AONB.

- Satellite-based desktop analysis indicated areas that appear to be little affected by light pollution, particularly the rural locations remote from centres of population. Conversely, the more built-up and urban areas are those where there is most light pollution which will affect the quality of the night skies and street lights and other public lighting are contributory factors to this.

- Combined data from the dark sky surveys undertaken in over 40 locations on two occasions by Dark Sky Wales, indicates the quality of dark skies is largely very good or excellent in large areas of the AONB with night sky brightness darker than 20 magnitudes per square arc second. These include popular areas such as the Horseshoe Pass and Moel Famau.

- The dark sky surveys showed that other locations closer to areas of populations do not enjoy such good quality skies, e.g. Pontcysyllte Aqueduct and Llangollen, which is seemingly due to light pollution. Resultantly, local people in those areas are currently deprived of the maximum benefits afforded by high-quality dark skies and they also impact on the tourism potential through Dark Skies in those areas.

- A key element in obtaining official IDA designation will be a commitment from the AONB to preserve (and improve) the night sky quality through the implementation and enforcement of quality lighting codes. Consultation with appropriate officers in the local authorities and the Trunk Road Agency indicated a mix of policy and practice amongst them together with a variety of future plans across them.

- A series of engagement events were held throughout the study with specific groups, as well as the general public, to raise awareness of the importance of dark skies and the AONB's aspirations. These are indicative of the type of the programme required in future to attain formal IDA designation

- We have produced an indicative Community Guidance Pack and Business Guidance and Toolkit. These can be amended accordingly by the AONB for a future education and engagement programme needed for formal IDA designation.

RECOMMENDATIONS

In light of the above, we propose a series of implementation recommendations to take an action plan forward to obtain formal IDA designation.

RECOMMENDATION 1

We propose that Dark Sky Community status is most appropriate if the AONB is considered on its own. We believe the best option moving forward is to apply for Dark Sky Community status with a view to establishing long-term partnerships with adjoining areas. A larger collaborative application to IDA for reserve status could then be considered in the future working in partnership with neighbouring areas. The AONB may wish to approach the IDA to see if another description of its own is more appropriate than 'community'.

RECOMMENDATION 2

To apply for Dark Sky Community (or Park) status, the AONB will need to establish a regular night sky monitoring programme, devise a progressive lighting plan that seeks to reduce and/or minimise light pollution, and establish education/training and community awareness plans.

RECOMMENDATION 3

The opportunity exists to designate specific locations within the AONB as Dark Sky Discovery Sites (DSDS). Such a route might still available formally, but if not, it could be done informally. In seeking to attain official designation as a Dark Sky Community (or Reserve) as a more ambitious approach, there is likely merit in this as an intermediate step, and as part of the wider process.

As such, the AONB might consider whether it is worth establishing a number of Dark Sky Discovery sites within the AONB for communities and visitors and promoting these through the AONB's website and other marketing routes.

RECOMMENDATION 4

The development of a separate dedicated lighting plan to be submitted as part of the IDA application. To develop this, further to the completion of this study, we propose a specific lighting working party be established to produce it, comprising the appropriate lighting and planning officers, and perhaps led by Tony Hughes from the AONB.

This should decide on whether Supplementary Planning Guidance (or another form of guidance) can be produced by the AONB. A defined discrete piece of work

undertaken by a lighting engineer based on the evidence provided here is likely to be necessary for the actual plan.

RECOMMENDATION 5

The AONB creates an ongoing series of Dark Sky awareness events and activities in coming years as part of its Dark Skies action plan and application, based on the experiences of the activities and events undertaken as part of this study.

RECOMMENDATION 6

The AONB uses the indicative community guidance produced and amends accordingly for future use to support its Dark Sky aspirations and application.

Together with an awareness events programme, this should be used as part of ongoing community engagement and involvement and to enlist letters of support needed from community organisations for the IDA application.

RECOMMENDATION 7

As necessary, the AONB amends the indicative Business Guidance and Toolkit we have produced to support the business and tourism elements and include it as part of its Dark Sky aspirations and formal application. This could also be used to enlist letters of support from business and local and regional tourism organisations for the IDA application.

RECOMMENDATION 8

In conjunction with the events and activities**,** the collection of supporting materials including letters of support is undertaken from a range of interested partners and community organisations as well as the appropriate statutory authorities. A letter of support from the Future Generations Commissioner might also be a good idea in light of the WFGA.

RECOMMENDATION 9

In light of challenges, especially around lighting, political champions, who are supporters of the ambitions and recognise the benefits of dark skies, are identified amongst the elected members of each of the three local authorities to act as advocates and help drive the action plan forward.

FUTURE ACTION PLAN COSTS

We consider there are two elements to this:

1. the implementation of lighting changes and associated costs
2. the costs incurred in delivering the action plan itself (printed materials, website, events, and surveys etc.)

Lighting Costs

It is not possible at this stage to provide accurate indicative figures since this will require an agreed plan amongst the AONB and the relevant partners to move towards the IDA-compliant lighting code. As such, this funding could potentially be largely outside the direct influence of the AONB, e.g. the Trunk Road Agency. Also, as indicated in section 5, procurement could be an issue in this regard. Nevertheless, it is clear that this is likely to costs hundreds of thousands of pounds. Some of this will fall within the existing budgets of local authorities for their lighting changes in the coming years but it should be borne in mind that some of it might require additional budgets outside that allocated.

Other Action Plan Costs

These costs are comparatively more modest, but, unlike the lighting costs, where budgets will be available for at least some of the work, in this case, the AONB will have to use its own resources or may well have to apply for additional funding from external sources.

In providing an indicative figure for specific events, DSW normally charges a daily rate of £800 (+VAT) for business events and £500 (+VAT) for community events. The Brecon Beacons NPA holds 6 events each year as part of its Dark Skies programme, so at DSW rates, the average cost is around £12,000. DSW surveys to monitor dark sky quality are priced at £2500 each, so two likely to be required each year, this will be between £7,500 and £15,000 over a three-year period. With associated elements we believe an indicative total cost over three years is likely to around £35-40,000 (+VAT).

1. INTRODUCTION

In 2016, the Clwydian Range and Dee Valley AONB set about exploring the opportunities to improve the quality of its dark skies and attain appropriate designation by the International Dark Sky Association (IDA).

Light pollution through inappropriate or excessive use of artificial light makes it increasingly difficult to observe the night skies; indeed, over 90% of the UK population now lives under highly light-polluted skies. As demonstrated elsewhere and set out in more detail in this document, reducing this pollution should bring significant social, environmental, and economic benefits for the area. Dark skies contribute significantly to human health and wellbeing with increasing evidence showing that sleep is often disturbed by a lack of proper darkness at night with adverse impacts for health. Light pollution also impacts adversely on around 60% of wildlife, which is most active at night. In addition, sympathetic and energy-efficient lighting in communities can satisfy community needs at lower cost whilst importantly reducing carbon emissions. Furthermore, dark skies are increasingly important for tourism through landscapes that offer unblemished views of the night sky.

To progress this aim, supported by the Welsh Government RDP and the Sustainable Development Fund, Cadwyn Clwyd commissioned BRO and DSW in 2017 to:

- Assess the current night sky quality within the AONB using IDA Guidelines
- Provide advice and guidance that could be used by communities and businesses in lighting schemes that will help to preserve the quality of the night sky whilst providing for lighting needs
- Engage communities and agencies to raise awareness of the importance of dark skies
- Explore the feasibility of Dark Sky Status and provide an outline Action Plan for pursuing the most appropriate IDA recognition

2. ABOUT THE CLWYDIAN RANGE AND DEE VALLEY AONB

The Clwydian Range and Dee Valley AONB encompasses some of the most wonderful landscapes in Wales and the UK. The Clwydian Range forms an unmistakeable chain of purple heather-clad summits, some topped by dramatically situated hillforts, and was designated as an Area of Outstanding Natural Beauty in July 1985. Further to work by the-then Countryside Council for Wales - now part of Natural Resources Wales (NRW) - and the three Local Authorities of Denbighshire, Flintshire and Wrexham, the AONB designation was extended in 2011 to include the Dee Valley, which is rich in cultural and industrial heritage and includes the historic towns of Llangollen and Corwen.

The power to designate an Area of Outstanding Natural Beauty emanates from the National Parks and Access to the Countryside Act, 1949, with their purposes, duties and management requirements laid down in the Countryside and Rights of Way Act, 2000. This establishes the primary purpose of AONB designation as the conservation and enhancement of natural beauty. The three authorities discharge their AONB functions by means of a Joint Committee, set up in 2014, whilst the AONB Partnership, established in 2015, supports the delivery of the AONB Management Plan through its members' political and professional expertise and experience.

The area covered by the Clwydian Range and Dee Valley AONB is 390 km^2 (Figure 1 – AONB shown in green), comprising hills, heather moorland, limestone crags and wooded valleys. Amongst its outstanding features are:

- The UNESCO Pontcysyllte Aqueduct and Canal World Heritage Site
- Imposing mountains crossed by the Horseshoe Pass and the Dee Valley, which winds its way through historic Llangollen, home to the world-famous International Eisteddfod

- The Offa's Dyke National Trail running along its spine, recalling the ancient margins of Wales, which links up the area's special places, and connects beyond with the southern Marches and the Wales Coast Path

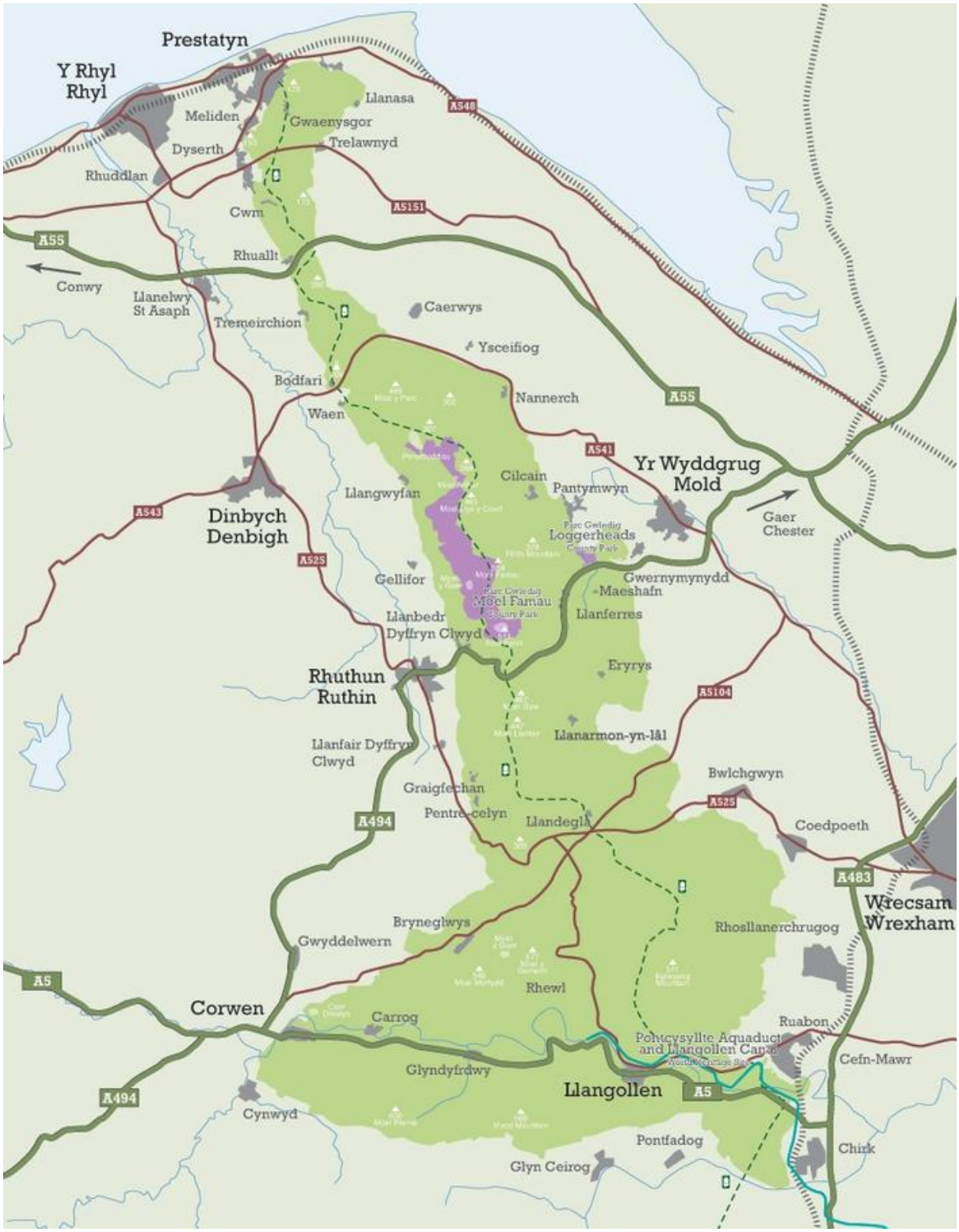


FIGURE 1 – THE CLWYDIAN RANGE AND DEE VALLEY AONB

3. AIMS AND BENEFITS OF DARK SKY DESIGNATION

The natural night sky is a common and universal heritage, yet its wonder is becoming lost and unknown to people, primarily through uncontrolled outdoor lighting which hides the stars and the galaxies visible to our ancestors, and changes awareness of the night and the night skies.

Aside from the simple wonder and the inspiration that the beauty of the night skies can instil, there are other important social, economic and cultural reasons that underlie the need to create environments conducive to seeing and experiencing the night skies in all their glory. At the recent European Dark Sky Places Conference, held at Gatehouse of Fleet, Scotland in September 2017[1], Dr Tom Davies (University of Exeter) expressed the view that environmental impacts of artificial light at night is a rapidly increasing field of global change science which will be a likely focus for research in the 21st century owing to the growing number of impacts being evidenced on human health, culture and biodiversity conservation.

Before looking specifically at the significant positive social, environmental, and economic benefits that Dark Skies can bring to the AONB, we address briefly some of those impacts more generally first.

The Need for Dark Skies: Adverse Impacts of Light Pollution

Health

The rhythms of the natural light-dark cycle of day and night are vital to good human health. Yet few people, especially those living in urban and peri-urban areas, rarely experience truly dark nights these days.

[1] http://eudarkskiesconference.com/presentations

Increasingly, research suggests that artificial night light can increase risks for obesity, depression, sleep disorders, diabetes, breast cancer amongst others. In particular, exposure to blue light at night is especially harmful, suppressing the secretion of the hormone melatonin which influences circadian rhythms or our daily body clocks[2] At the moment, this includes the light emitted from most outdoor lighting LEDs.

The International Dark Sky Association's 2010 paper, *Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting*[3] has detailed the threats associated with exposure to blue-rich white light sources. More recently, a 2016 report by the American Medical Association (AMA)[4] highlighted health concerns about the exposure to blue light from outdoor lighting.

To address this, the IDA advocates effectively shielded outdoor lighting, consideration of adaptive controls to dim or extinguish light, and limiting the correlated colour temperature (CCT) of outdoor lighting to 3000 Kelvin (K) or lower. As Figure 2 below shows, the colour temperature is a measure of the spectral content of light with higher CCT values indicating a greater amount of blue light that a fixture emits.

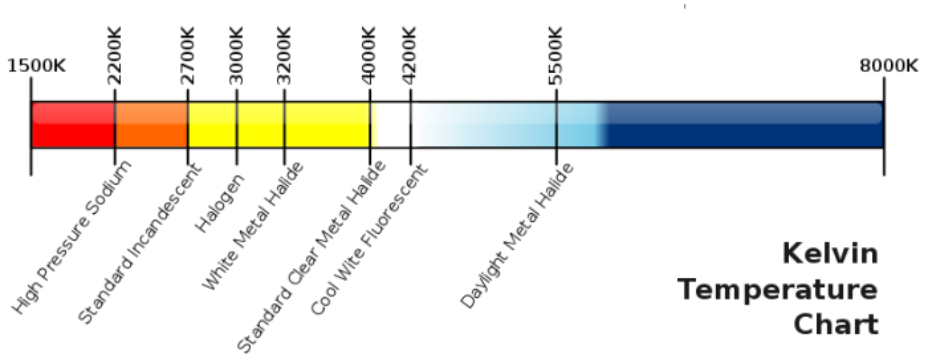


FIGURE 2 - KELVIN TEMPERATURE CHART AND LIGHTING
Source: http://commons.wikimedia.org/wiki/File:Kelvin_Temperature_Chart.svg

Adverse Impacts on Wildlife and Ecosystems

Increasingly, scientific evidence is indicating the harmful effects that artificial light at night has on many creatures including amphibians, birds, mammals, insects and plants. The 2016 AMA report, referred to above, indicated that the detrimental effects

[2] https://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side
[3] http://darksky.org/wp-content/uploads/bsk-pdf-manager/8_IDA-BLUE-RICH-LIGHT-WHITE-PAPER.PDF
[4] http://darksky.org/wp-content/uploads/bsk-pdf-manager/AMA_Report_2016_60.pdf

of blue-rich LED lighting are not limited to humans, but also other species which suffer disruption of their circadian rhythms.

New research in 2017 showed the impact LED lighting has on the behaviour of number of grassland species which has deleterious knock-on effects for food-webs.[5] The authors at the University of Exeter showed that it was possible to manage LED lighting to reduce its environmental impacts by, for example, changing their spectrum, and dimming them and switching them during the early hours.

Crime and Safety Considerations

Reducing outdoor lighting is sometimes cited as being responsible for increased crime, anti-social behaviour, and reduced road safety. However, whilst outdoor lighting at night is often meant to enhance safety and security, its overuse and/or poor management can in fact have the opposite effect, impacting adversely upon visibility. Thus, glare from bright, unshielded lights reduces safety by constricting pupils, so impacting on the ability to see and making it more difficult to adjust to low-light conditions.

In addition, a 2015 study in the Journal of Epidemiology and Community Health, looking at data for road traffic collisions and crime in 62 local authorities across England or Wales found little evidence of any harmful effects of switch-off, part-night lighting, dimming, or changes to white light/LEDs on road collisions or crime.

Energy Costs and Carbon Emissions

Poorly-designed or misdirected light, which shines into the sky rather than onto the ground or the object intended to be illuminated, contributes to 'sky glow', the orange haze many of us now see rather than dark skies and the stars. Not only does this have light pollution impacts, as indicated, affecting our ability to witness dark skies, but it is often wasteful energy-wise, thus raising costs unnecessarily, and also contributes to carbon emissions and hence global warming.

Additional Benefits of Dark Skies

Aside from mitigating the negative impacts of light pollution with the concomitant societal and environmental benefits, increasingly high-quality night skies have been viewed as boosting so-called astro-tourism, so providing an economic stimulus.

After its designation as Europe's largest Dark Sky Park, the tourism authority in Northumberland reported many of the hotels in and close to it witnessed increases in business with visitors especially from urban areas, wishing to see and experience the

[5] Davies, T.W., Bennie, J., Cruse, D., Blumgart, D., Inger, R. & Gaston, K.J. (2017) Multiple night-time LED lighting strategies impact grassland invertebrate assemblages. Global Change Biology, DOI:10.1111/gcb.13615

wonders of the night sky. This has also been reported in other areas globally where there are high-quality dark skies and areas in Wales like the Brecon Beacons, Anglesey and Gwynedd have been devising ways of boosting business through astro-tourism (example - Figure 3).

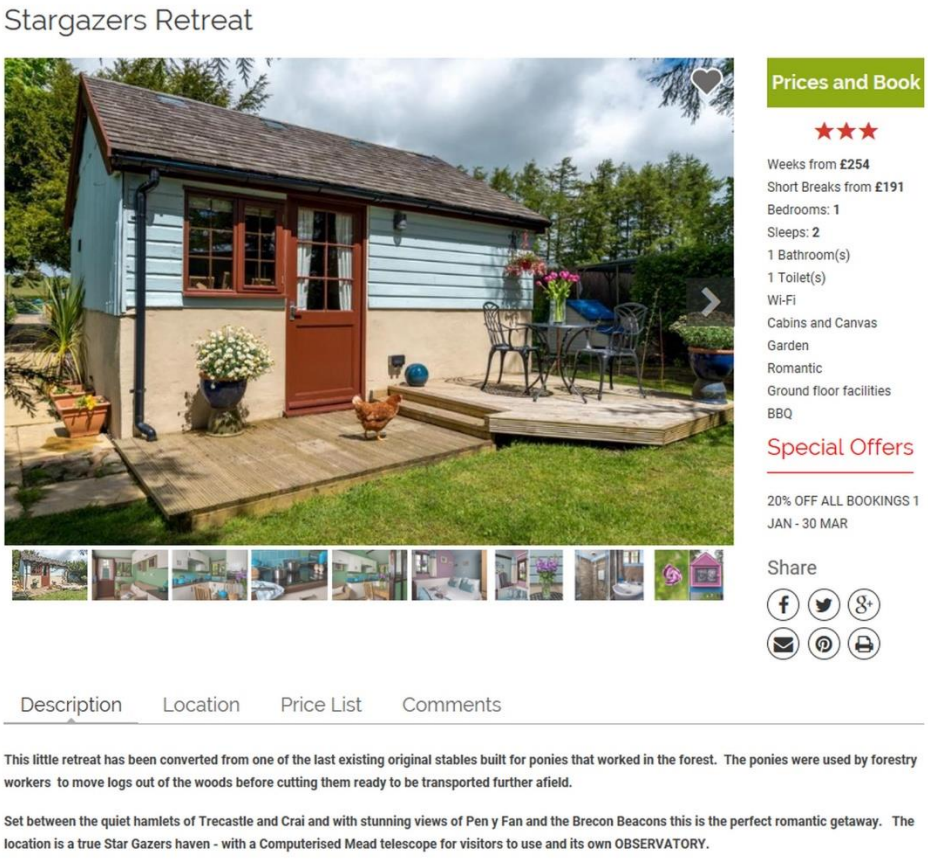


FIGURE 3 – STARGAZING ACCOMMODATION IN THE BRECON BEACONS
Source: https://www.breconcottages.com/cottages/brecon/stargazers-retreat

Policy and Legislative Support for AONB Dark Skies

As shown by the above, addressing and reducing light pollution and improving the quality of the night skies in the AONB will bring significant positive social, environmental, and economic benefits. The Clwydian Range and Dee Valley's Management Plan, 2014-2019 recognises the importance of dark night skies and, in particular, they tranquillity they offer. However, currently, the quality of the night sky on the eastern edges of the AONB is affected by light spillage from the towns of Mold and Wrexham as well as Deeside, Chester and Merseyside. There are similar impacts in the north from the coastal towns. These have a significant effect upon tranquillity, particularly at night, spilling light onto the darker skies to the south and west in the AONB.

Nevertheless, it is possible to seek to address these and, in particular, there are actions that can and should be taken within the AONB itself to reduce light pollution.

Seeking to attain formal Dark Sky recognition and designation should support these actions and aims, which are supported by a number of key, relevant AONB Management Plan policies:

- PolART1 – To promote the sustainable use and enjoyment and understanding of the landscape of the AONB in a way that contributes to local prosperity and social inclusiveness

- PolCP3 – Ensure that local businesses and communities feel a sense of ownership and responsibility for their surroundings

- PCO3 – Foster a sense of place and local pride to secure social well-being

- LQCO4 – Protect the tranquillity of the AONB and take steps where possible to reduce noise and light pollution

In addition to the AONB's Management Plan, the objectives of Dark Sky recognition and designation are supported and strengthened by the Sustainable Tourism Strategy and Action Plan, including:

- Objective 2 – To develop and enhance year-round visitor experiences and promotable offers based on appreciation, enjoyment and understanding of the area' special countryside and heritage assets, specifically:

  2i) Strengthen access to, and interpretation of, natural and cultural heritage sites and themes

  2j) Strengthen the range of visitor attractions available throughout the year

- Objective 3 – To encourage and assist tourism-related enterprises to develop and improve their performance, facilities, sustainability and relationship to the AONB

  3f) Encourage business to reach, maintain and promote high quality standards

  3g) Encourage and recognise good sustainability practice amongst businesses

Clearly, there are also legislation drivers that support the Dark Sky ambitions. In particular, the aims are in keeping with the 2015 Wellbeing of Future Generations Act (WFGA), which seeks to improve the social, economic, environmental and cultural wellbeing of Wales. To do this, the Act has set out seven Wellbeing Goals that should be achieved through five ways of working (Figure 4).

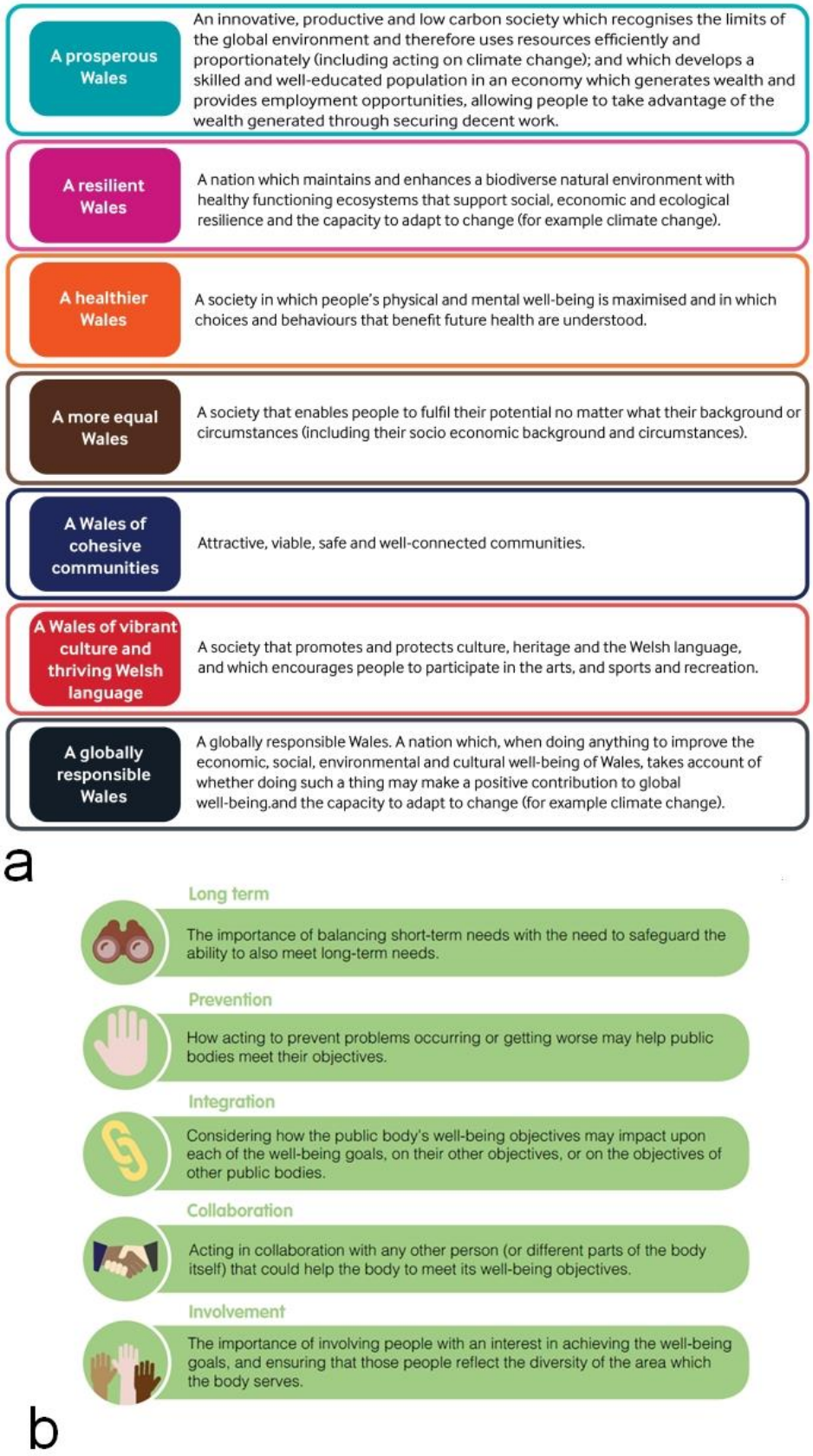


FIGURE 4 – WFGA GOALS (a) AND WAYS OF WORKING (b)

As shown by the examples in Table 1 below, improving the quality of the night skies in the AONB and achieving Dark Sky Designation meets with many of the goals set out by the WFGA.

A prosperous Wales	More efficient dark sky friendly lighting is environmentally responsible and will reduce carbon emissions thus helping to address climate change Dark skies can support sustainable tourism so generating and wealth and helping to create jobs and training opportunities in the local economy
A resilient Wales	In addition to the positive impacts in addressing climate change (above), reduced light pollution and better quality dark skies will produce beneficial impacts for wildlife and ecosystems, boosting their resilience
A healthier Wales	Reduced light pollution and better quality dark skies will produce beneficial impacts for the health of local people
A more equal Wales	Reducing light pollution and better quality dark skies across the AONB will allow people in all localities, rural and urban, to better enjoy the wonders and benefits of the night skies
A Wales of cohesive communities	Improved, more effective and efficient lighting can increase safety and security within communities and provide communal opportunities to enjoy the night skies
A Wales of vibrant culture and thriving Welsh language	The wonders of the night skies are part of our shared culture and heritage and improving opportunities to view them will enhance recreational opportunities
A globally responsible Wales	Reduced light pollution and better quality dark skies will contribute positively to economic, social, cultural, and environmental wellbeing, not just in Wales, but globally.

TABLE 1 – THE GOALS OF THE WELLBEING OF FUTURE GENERATIONS ACT AND AONB DARK SKIES AMBITIONS

In order to attain these ambitions, the AONB and its partners will have to adopt the five ways of working set out by the WFGA.

As indicated in this section, the aims and ambitions of the AONB to achieve Dark Sky Designation is underpinned and supported by key local and national policy and legislative drivers.

4. IDA DARK SKY DESIGNATION OPTIONS

Currently, there are five International Dark-Sky Association designations

- International Dark Sky Communities
- International Dark Sky Parks
- International Dark Sky Reserves
- International Dark Sky Sanctuaries
- Dark Sky Developments of Distinction

The following indicates main features of each of the designations according to the IDA (note the emphasis is largely on US definitions of areas and organisations)

Communities: Must have some type of legal organisation that is officially recognised by outside groups. This can be in the form of a town, city, municipality or other legally organised community (such as an urban neighbourhood or subdivisions).

Parks: Must be public or private land, accessible to the public in part or whole, that is legally protected for scientific, natural, educational, cultural, heritage and/or public enjoyment purposes. The core area must provide an exceptional dark sky resource, relative to the communities and cities that surround it, where the night sky brightness is routinely equal to or darker than 20 magnitudes per square arc second.

Reserves: Must be public or private land of at least 700 km², accessible to the public in part or whole that is legally protected for scientific, natural, educational, cultural, heritage and/or public enjoyment purposes. The core area must provide an exceptional dark sky resource, relative to the communities and cities that surround it, where the night sky brightness is routinely equal to or darker than 20 magnitudes per square arc second.

Sanctuaries: Must be a public or a private land, accessible to the public in part or whole, that is legally protected for scientific, natural, educational, cultural, heritage and/or public enjoyment purposes. The site must provide an exceptional dark sky resource where the night sky brightness is routinely equal to or darker than 21.5 magnitudes per square arc second.

Developments of Distinction: Developments of Distinction recognise subdivisions, master planned communities, and unincorporated neighbourhoods and townships whose planning actively promotes a more natural night sky but does not qualify them for the International Dark Sky Community designation.

Within the UK, a number of places are now recognised under these designations:

- Snowdonia Dark Sky Reserve
- Exmoor Dark Sky Reserve
- Brecon Beacons Dark Sky Reserve
- Galloway Forest Dark Sky Park
- Elan Valley Dark Sky Park
- Northumberland Dark Sky Park
- Sark Dark Sky Island (Community)
- Coll Dark Sky Island (Community)
- Moffat Dark Sky Community

There is no indication that any changes in designation categories were made at the first-ever international Dark Sky Park conference, which was held in the Galloway and Southern Ayrshire Biosphere, Scotland in September 2017.

Certification Process

The Dark Sky Places certification process is modelled on other conservation and environmental designation programmes, such as the UNESCO World Heritage Sites and Biosphere Reserves. Certifications are made on the basis of a written application with applicants working to gather the necessary evidence in support of the designation, which is submitted to a Dark Sky Places Committee whose members are themselves previous successful Dark Sky Places applicants.

The Committee judges the quality of the application and makes a recommendation to the IDA Board of Directors for final approval. If the Committee turns down an application, it's sent back to the applicants with a review identifying problem areas. A prior rejection does not harm the application's chances of reconsideration, if the applicants revise and resubmit the document. The entire process takes on average 1 - 2 years from initial inquiry to formal designation. There is no formal template for applications, but examples of applications are provided on the IDA website.

Initial Dark Sky Designation Assessment for the AONB

Early in this study, we conducted an initial exploration of the potential Dark Sky Status for the Clwydian Range and Dee Valley AONB using International Dark-Sky Association (IDA) quality standards. In doing so, we assessed the existing physical characteristics of the AONB against the International Dark-Sky Association designations and their criteria and provided examples of areas within each of them as indicators for how Dark Sky Status might develop over the coming years for the Clwydian Range and Dee Valley AONB.

A key factor in the designation is the actual area of the AONB which, at 390 km^2, restricts the available status, e.g. as indicated above, the minimum size requirement for Dark Sky Reserve Status is 700km^2. Based on the desk-top mapping and the actual survey data obtained in this study, we believe that the two possible options for AONB designation are Dark Sky Community and Dark Sky Park designations since the land area and ownership requirements rule out other designations, certainly at this stage.

Designation as a Dark Sky Park, which is principally governed by the quality of the night and requires a brightness routinely darker than 20 magnitudes per square arc second cannot be ruled out in future. Further data will be required on the quality of the skies over coming years. Below we provide a quick guide to how we currently view the opportunities for the designation for the AONB.

Community	possible
Park	possible
Reserve	Not possible (size constraint)
Sanctuary	Unlikely (requires exceptionally dark skies)
Development of Distinction	Not applicable

In July 2017, Bodmin Moor in Cornwall was officially designated an International Dark Sky Landscape. Cornwall Council's website indicates that the "Bodmin Moor International Dark Sky Designation covers the portion of the moor within the Cornwall Area of Outstanding Natural Beauty plus a two-mile buffer zone around it". As indicated above, there appears to be no official Dark Sky Landscape designation. Consequently, to ascertain whether this specific designation, as opposed to Community or Park, might be an available avenue for the Clwydian Range and Dee Valley AONB, we sought clarification directly from the IDA with regard to the Dark Sky Landscape designation. Their response indicates Bodmin Moor in Cornwall is actually officially designated as a Dark Sky Park, but "in their application, (Cornwall) described themselves as a landscape so that is where that word is coming from."

As indicated above, Coll and Sark both call themselves Dark Sky Islands, as opposed to communities, although their applications were on the basis of community status. This indicates that the IDA is open to applicants proposing their own

descriptions other than those officially designated although the actual process will be application for one of the official designations.

Future Actions for Dark Sky Designation Application

International Dark Sky Communities must have some type of legal organisation that is officially recognised by outside groups. This can be in the form of a town, city, municipality, or other legally organised community. In the case of the AONB, these criteria would appear to be met. IDA Dark Sky Communities must exhibit "exceptional dedication to the preservation of the night sky through the implementation and enforcement of quality lighting codes, dark sky education, and citizen support of dark skies." The full criteria for International Dark Sky Community status are provided in Appendix 1, whilst those for International Dark Sky Park status are shown in Appendix 2.

Consequently, a monitoring programme, coupled with a lighting plan and education/training and community awareness plans should be established and run throughout the AONB on a regular basis. This study document provides the basis for that moving forward with the next sections dealing with those elements.

The rest of this study report provides the basis for that moving forward with the next sections dealing with those elements.

5. AONB DARK SKIES QUALITY ANALYSIS

A fundamental element of this study was to provide an assessment of the current quality of the dark skies in the AONB.

We undertook this in two complementary ways:

- Desktop examination of current light pollution, performed by Angharad Owen, BRO Associate, of existing, available satellite and other relevant data for the AONB

- Dark Sky Quality surveys carried out by Dark Sky Wales at specific locations within the AONB on two occasions - August and December 2017

Once the data from each of these was gathered and analysed, we subsequently combined and mapped them with respect to some key locations and attractions within the AONB.

5.1 LIGHT POLLUTION EXAMINATION

Light pollution is the major factor affecting dark skies quality. To undertake the initial examination of this, we used data available from a variety of relevant sources including:

- Light Pollution Map Info (www.lightpollutionmap.info) – This is a mapping application that displays VIIRS[6]/DMSP[7]/World Atlas overlays and the user

[6] Visible Infrared Imaging Radiometer Suite (VIIRS) is a satellite scanning radiometer which collects visible and infrared imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans
[7] The Defense Meteorological Satellite Program (DMSP) satellites collect visible and infrared cloud imagery as well as monitoring the atmospheric, oceanographic, hydrologic, cryospheric and near-Earth space environments

measurements overlay over Microsoft Bing base layers (road and hybrid Bing maps). Its primary use is to show VIIRS/DMSP data in a friendly manner, but it also includes some other interesting overlays that deal with light pollution like SQM/SQC and World Atlas. We used the available 2016 data for this study

- Lle Geo-Portal (www.lle.gov.wales) - The Lle Geo-Portal, developed as a partnership between Welsh Government and Natural Resources Wales, serves as a hub for data and information covering a wide spectrum of topics, but primarily around the environment

- Denbighshire County Council data

- Ordnance Survey (OS) Open Data

The maps on the following pages show composites using combinations of these data to highlight the light pollution within the AONB, with attempts to identify its sources, which could inform future actions by the AONB with regard to its Dark Sky ambitions.

We did not include data in this study from Wrexham or Flintshire local authorities at this stage. This is primarily because the main intention is to highlight the types of lighting that are contributing to the pollution, rather than provide a detailed map now, and Denbighshire CC data is most relevant due to its larger geographic inclusion with the AONB. Nevertheless, this is something that could be done further to this study.

Figure 5 shows the radiance observed from space which indicates those areas of the AONB that were most and least affected by light pollution in 2016. As shown, there are clearly areas where this is minimal (radiance readings of <0.40 or even <0.25), especially in the south of the AONB and the spine of the Clwydian Range northwards. Within the AONB itself, most of the radiance (and light pollution), emanates from more-built-up areas such as Corwen, and in particular, the centre of Llangollen.

Figure 6 shows VIIRS light pollution data for the same area from 2013 through to 2016. This might appear to suggest that in some areas of the AONB, light pollution is decreasing, e.g. Llangollen, whilst other areas have worsened. However, as the Light Pollution Map info website warns, annual VIIRS comparisons “should be avoided as there are too many factors involved by just doing a direct comparison”. Accepting this important caveat, nevertheless, we include the maps showing the four years here simply to demonstrate that the same built-up areas are suffering most with light pollution whilst the unpopulated areas show little, and that the 2016 data (Figure 4) can be considered to be representative of the current position.

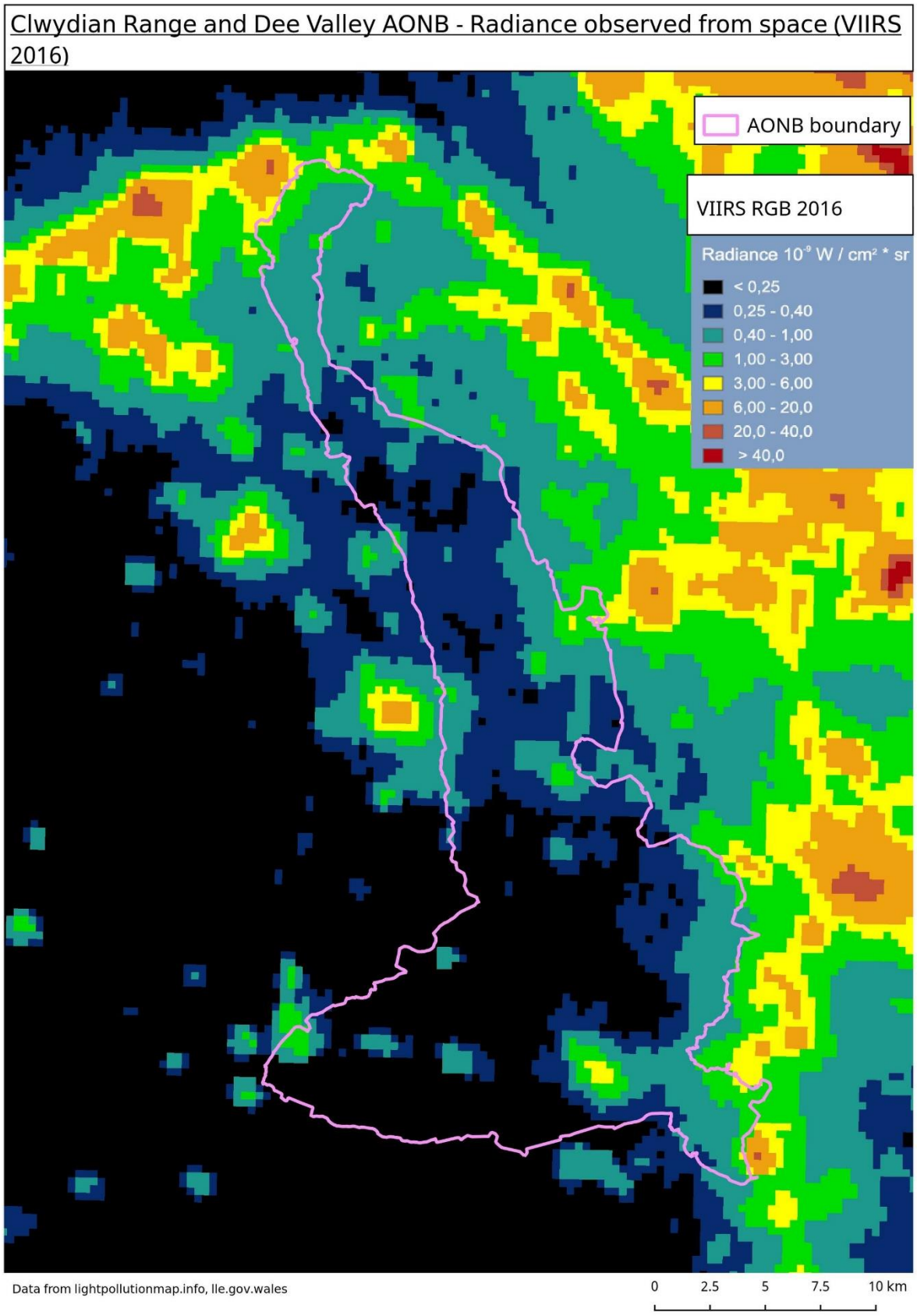


FIGURE 5 – NORTH-EAST WALES AND THE CLWYDIAN RANGE AND DEE VALLEY AONB SHOWING THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2016)

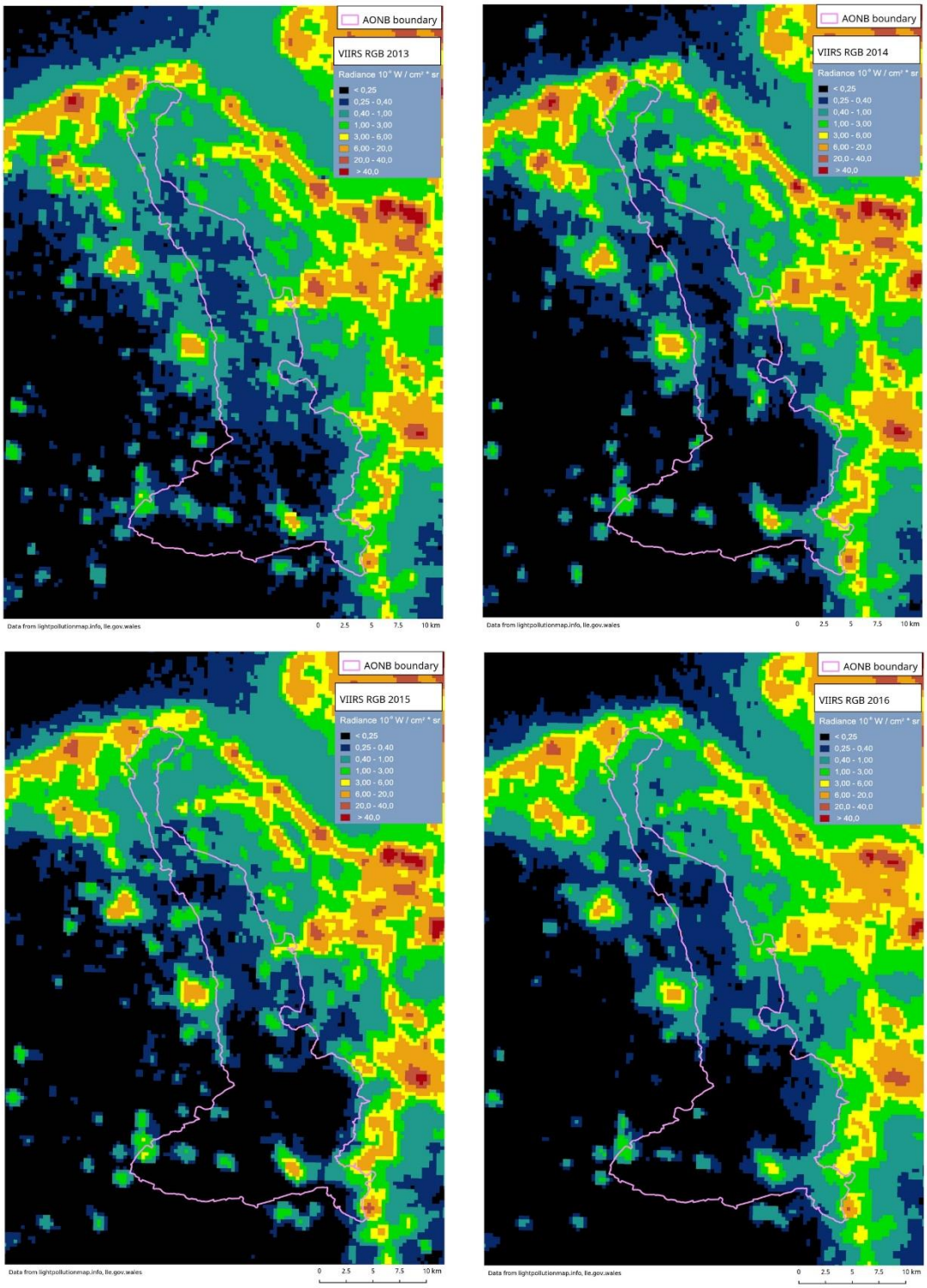


FIGURE 6 – NORTH-EAST WALES AND THE CLWYDIAN RANGE AND DEE VALLEY AONB SHOWING THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2013 - 2016)

Figures 7a - d look at potential correlations within the Denbighshire part of the AONB, the largest of the three constituent local authority areas geographically, between the light pollution (as measured by VIIRS) and point source public lighting in the form of street lights, illuminated signs, and illuminated bollards.

Figure 7a shows these together and, as expected, indicate strong overlaps between areas with concentrations of such lighting and those that have greater levels of light pollution. Unsurprisingly, these occur in the more built-up and urban areas.

Figures 7b - d show these split into street lights, illuminated signs, and illuminated bollards respectively. These maps show that street lights in particular contribute to the observed light pollution, and that improved local authority lighting will be key in improving the quality of dark skies in the AOB's towns and villages. Importantly, these do not take into account external private residential lighting, or that from businesses, which again are likely to be more concentrated in built-up areas and will also be contributory factors.

We emphasise that this initial desktop examination is clearly not exhaustive, owing to the time constraints of the study. Rather, it is primarily intended to give an indication, using currently available satellite data, of the present situation within the AONB concerning light pollution and potential sources that contribute to that. As indicated, there are some areas that appear to be little affected by light pollution, particularly the rural locations remote from centres of population. Conversely, the more built-up and urban areas are those where there is most light pollution which will affect the quality of the night skies and street lights and other public lighting are contributory factors to this.

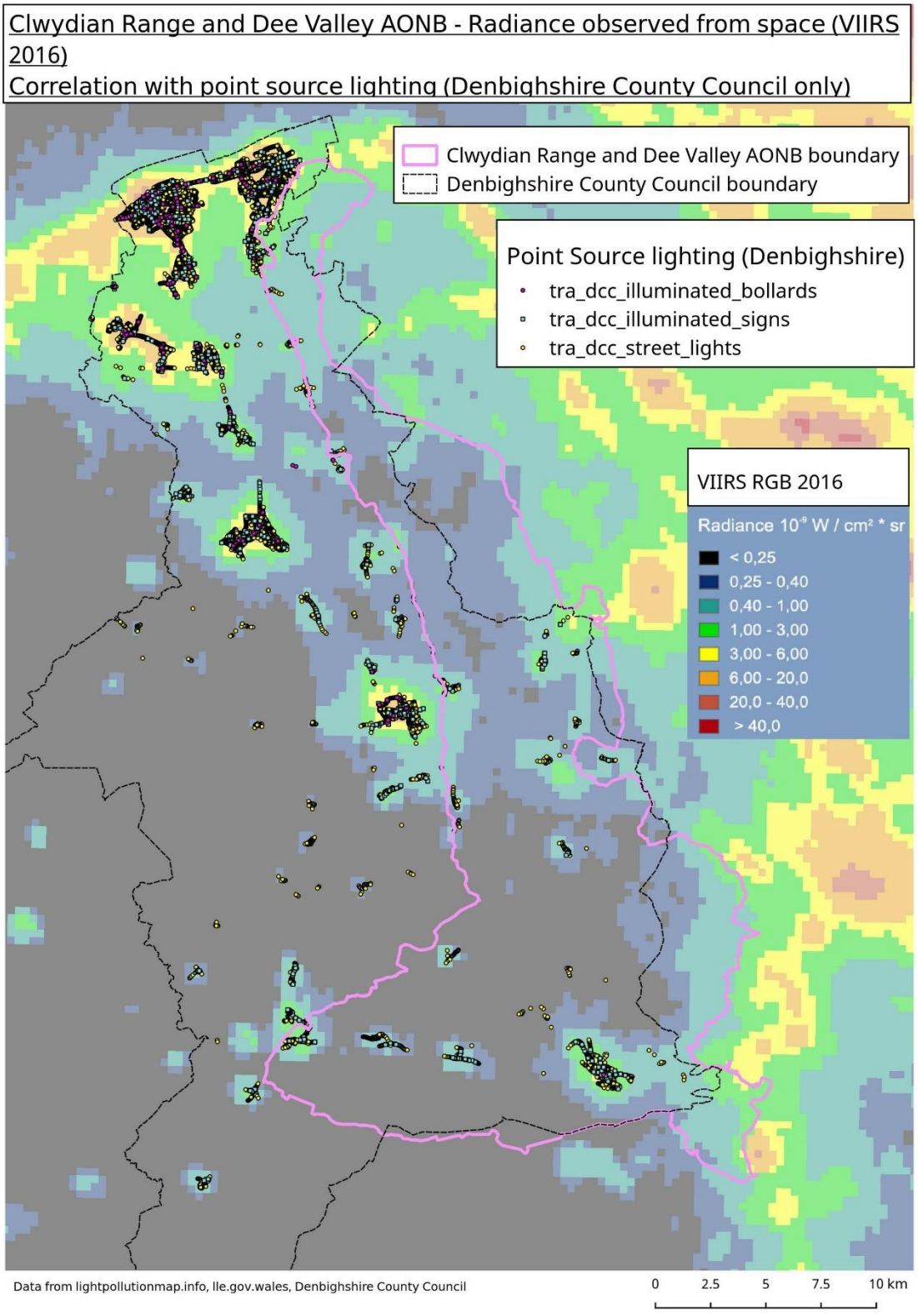


FIGURE 7a – PUBLIC POINT SOURCE LIGHTING IN DENBIGHSHIRE OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2016)

*note the actual colour key in the VIRRS RGB legend from the base maps varies to those in the map (c.f. figs 4/5)

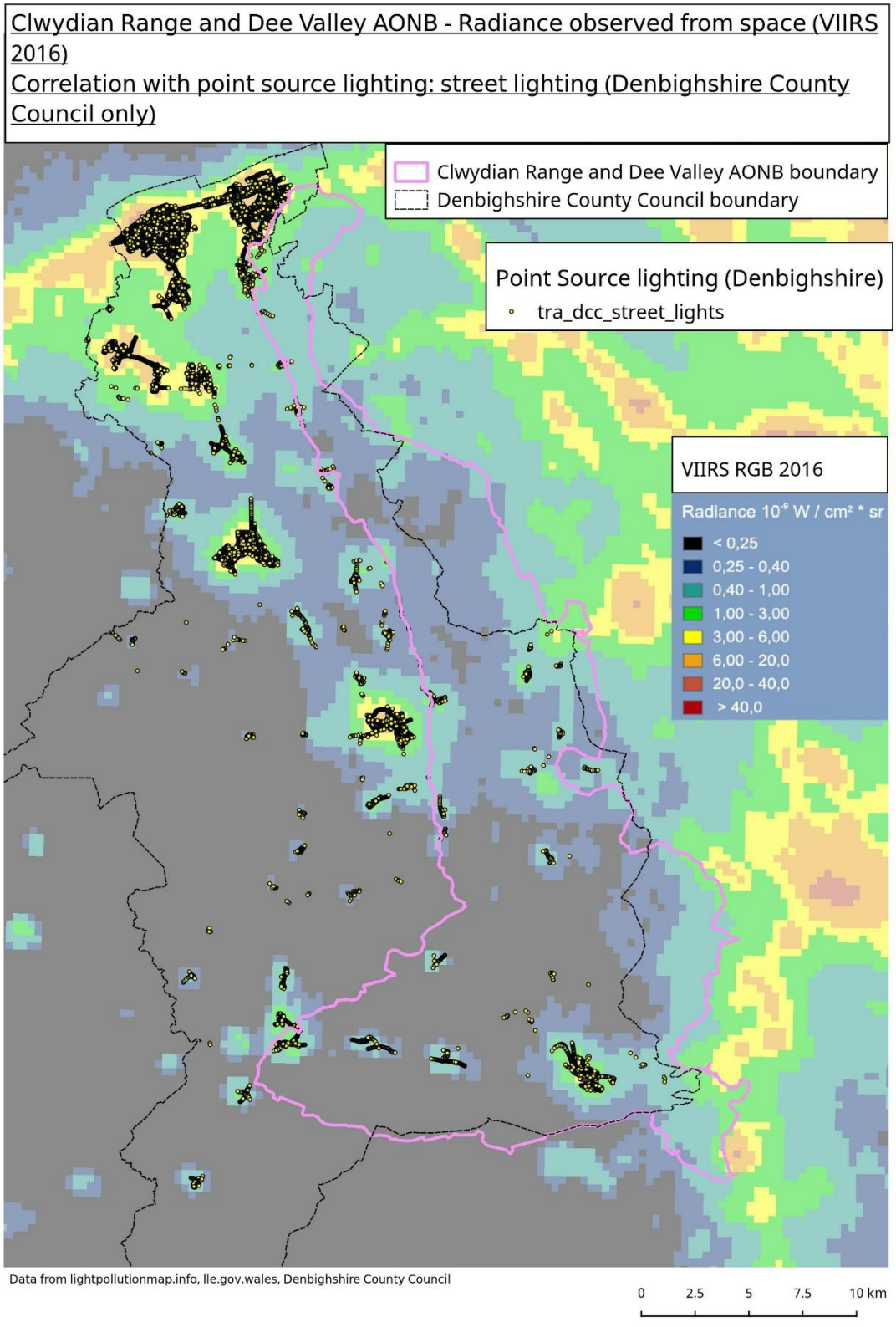


FIGURE 7b – PUBLIC STREET LIGHTS IN DENBIGHSHIRE OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2016)

*note the actual colour key in the VIRRS RGB legend from the base maps varies to those in the map (c.f. figs 4/5)

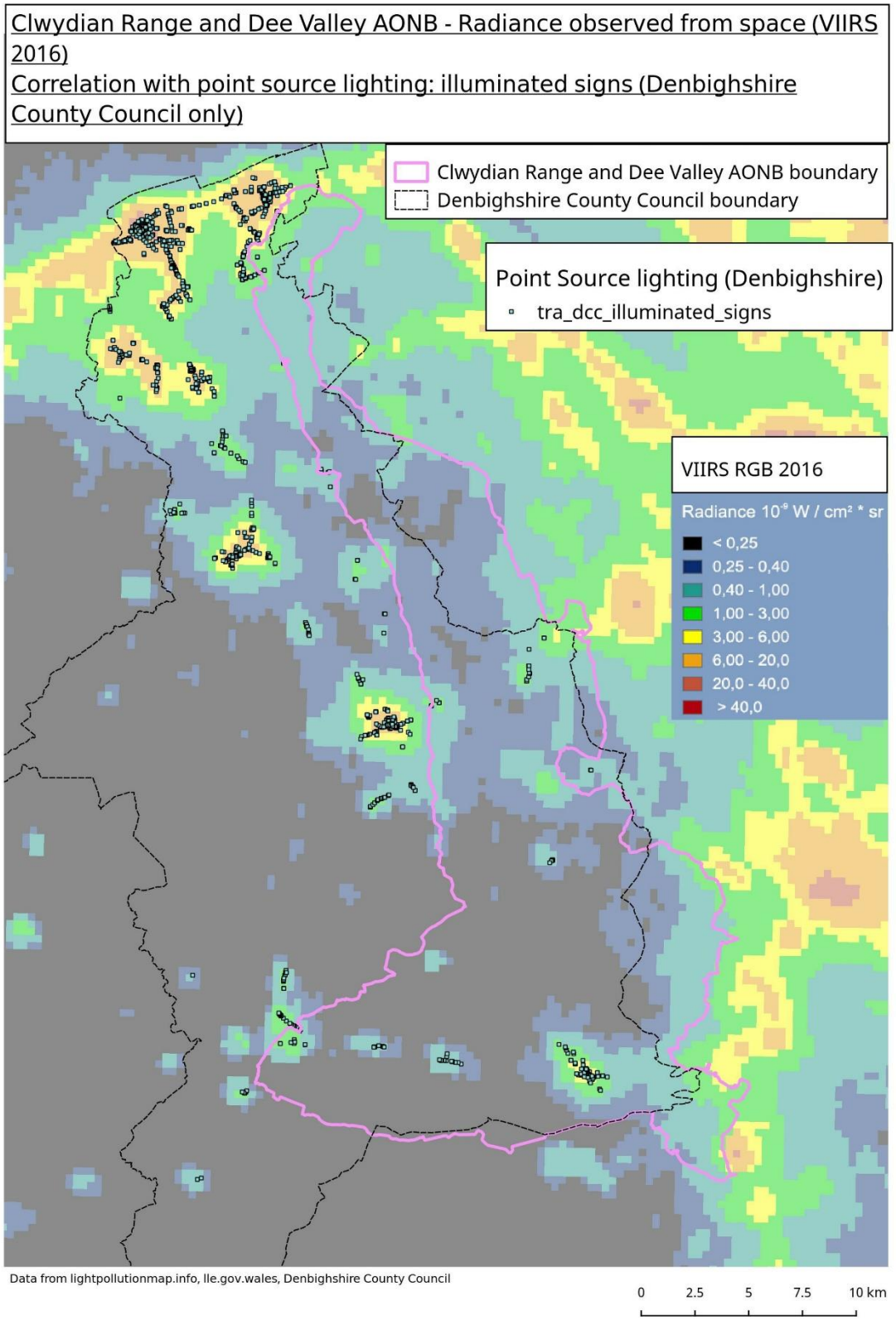


FIGURE 7c – ILLUMINATED SIGNS IN DENBIGHSHIRE OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2016)

*note the actual colour key in the VIRRS RGB legend from the base maps varies to those in the map (c.f. figs 3/4)

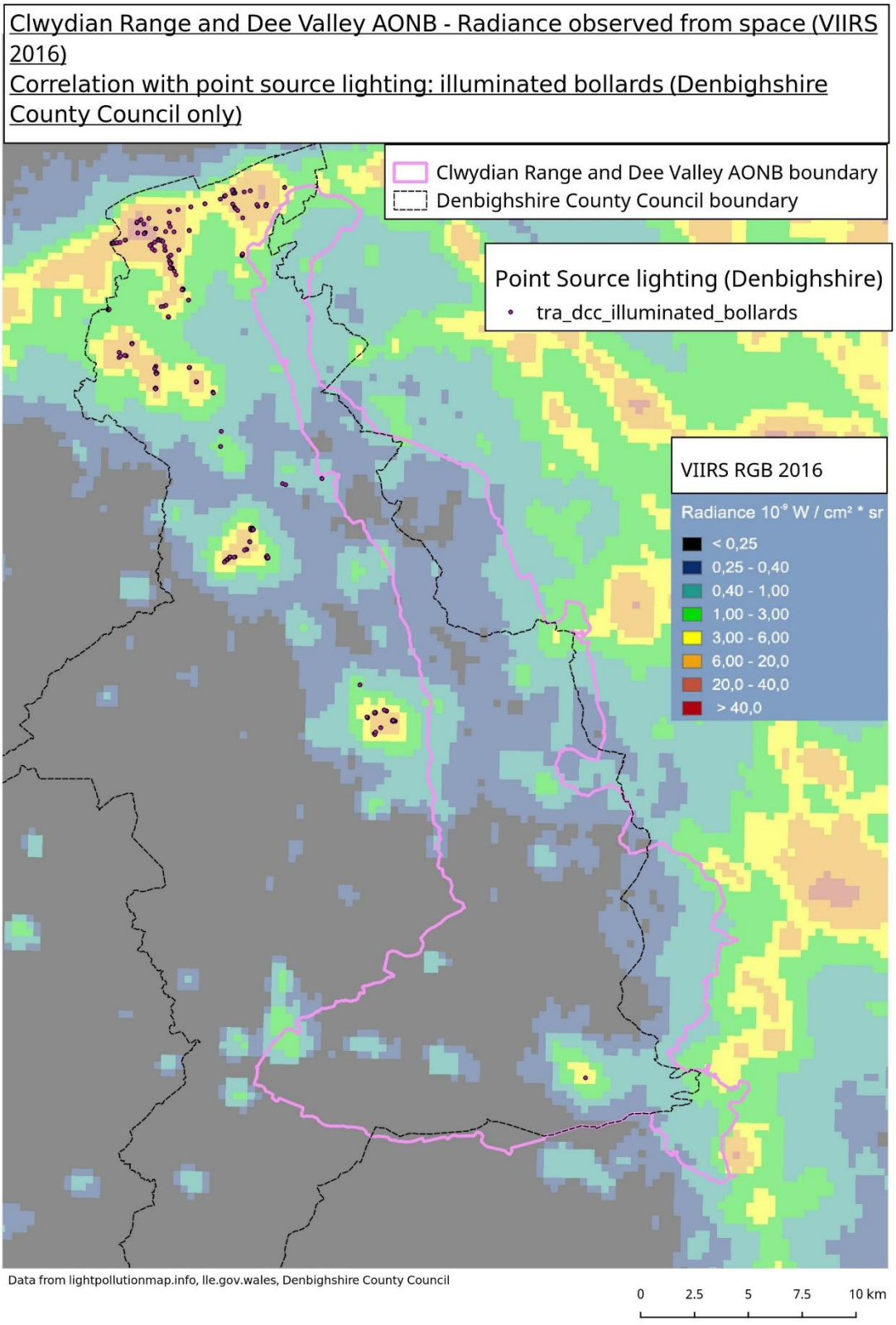


FIGURE 7d – ILLUMINATED BOLLARDS IN DENBIGHSHIRE OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS DATA (2016)

*note the actual colour key in the VIRRS RGB legend from the base maps varies to those in the map (c.f. figs 3/4)

4.2 DARK SKIES SURVEYS AND MAPPING

To supplement and augment information obtained from the desktop light pollution analysis above, Dark Sky Wales undertook field surveys carrying out dark sky quality measurements (SMQ) at various locations across the AONB. Importantly, these areas were not simply selected on the basis of being “dark” in the satellite light pollution analysis since any submission to the IDA will require that the whole area is representatively analysed. Consequently, survey locations were selected across the AONB using a grid system to provide a good representation of the area (Figure 8).

Because of the nature of the survey, locations were selected where there was mostly reasonable vehicular access to them, or they were accessible on foot close to roads. This was important from two aspects; first, safe access for the Dark Sky Wales team undertaking the survey, and, second, since such areas are likely to be those that will be accessed by local people and visitors to the area and used to view the night skies. As a result, in some cases, the actual survey locations were close to the AONB boundary and, possibly, in a small number just outside it.

As expected, undertaking the surveys often proved difficult due to the light nights in the summer months, weather conditions, and adverse phases of the moon, which precluded several attempts over the duration of the study. Nevertheless, in keeping with the study requirements, measurements were eventually obtained over three separate nights (27/28 August and 11 December 2017). Four separate SQM monitors were used to take readings (units - magnitudes per square arc second) at each location. For the first survey (27/28 August 2017), 41 locations were originally selected of which it was possible to obtain measurements at 33 of them (Table 2). For the second survey (11 December), at the request of the AONB, six additional locations were added to bring the total to 47, all of which provided measurements (Table 3). Consequently, in total, as shown in Table 4, 36 locations provided measurements for both surveys.

The actual data are shown for the two individual surveys in Tables 2 and 3 respectively. As shown, the SQM readings at each location were averaged and converted into NELM (Naked Eye Limiting Magnitude). This is the magnitude of the faintest star that an observer can distinguish under given sky conditions, the observer’s experience, and sharpness of vision. The human eye can perceive stars down to a NELM of 6, with areas above 5 generally considered as good.

In Figures 9 and 10 (a - c), we have overlaid and mapped the individual survey data from August and December respectively against proximity to centres of population (a), selected AONB attractions (b), and finally with respect to the light pollution data from the desktop examination.

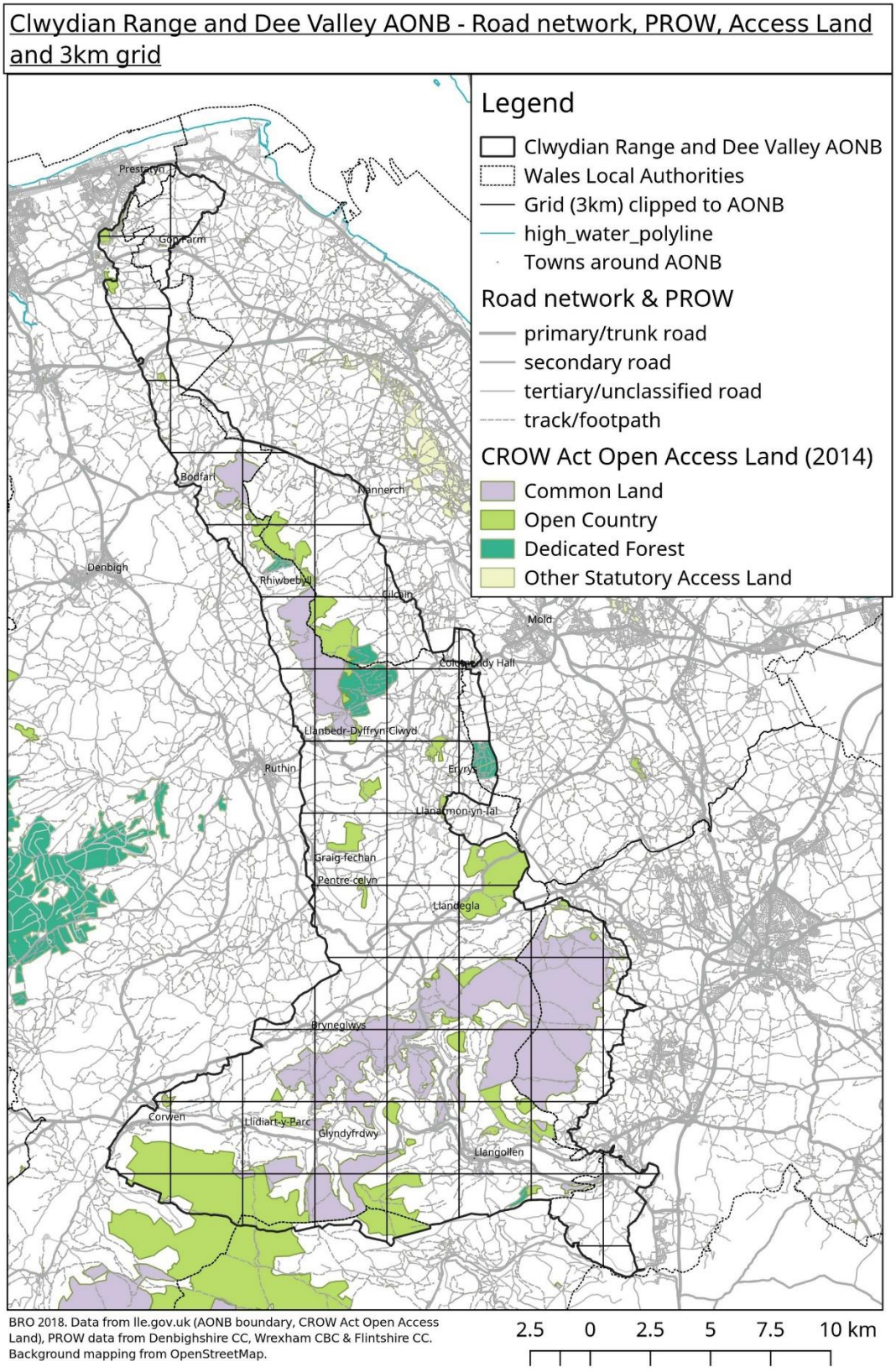


FIGURE 8 – THE GRID SYSTEM USED TO ASSIGN DARK SKY SURVEY LOCATIONS WITH REFERENCE TO THE ROAD NETWORK AND PUBLIC RIGHTS OF WAY

Dark Sky Survey: 27/28 August 2017 Moon Phase – Set								
Location	**GPS coordinates**		**Reading 1***	**Reading 2***	**Reading 3***	**Reading 4***	**Average**	**NELM**
Gronant	53.20.6	3.21.57	19.69	19.72	19.43	19.36	19.55	5.2
Gwespyr	53.20.17	3.20.18	19.63	19.49	19.53	18.96	19.40	5.1
Llanasa	53.19.20	3.20.36	20.06	19.94	19.94	19.78	19.93	5.4
Gwaenysgor	53.19.1	3.23.15	20.32	20.23	20.3	20.32	20.29	5.7
Gop Hill	53.18.40	3.21.45	20.14	20.08	20.06	20.10	20.20	5.6
Bron Heulog Hill	53.17.54	3.22.18	20.37	20.33	20.29	20.30	20.32	5.7
Marian Ffrith	53.17.30	3.23.08	20.29	20.23	20.24	20.19	20.23	5.7
Cwm	53.17.04	3.23.41	20.25	20.27	20.19	20.12	20.20	5.6
Rhuallt	53.15.52	3.23.19	20.39	20.36	20.02	19.87	20.16	5.6
Glan Y Llyn	53.16.29	3.21.27	20.36	20.40	20.30	20.30	20.34	5.7
Bryngwyn Mawr	53.15.54	3.22.04	20.47	20.56	20.48	20.50	20.50	5.8
Moel Meanefa	53.15.52	3.23.19	20.56	20.59	20.57	20.54	20.56	5.8
Tremeirchion	53.14.46	3.22.30	20.35	20.40	20.41	20.42	20.39	5.7
Bodfari	53.13.20	3.21.47	20.56	20.63	20.52	20.60	20.57	5.9
Afonwen	53.14.9	3.19.04	20.40	20.43	20.43	20.48	20.43	5.8
Nannerch	53.12.48	3.14.54	20.32	20.34	20.25	20.30	20.30	5.7
Bryn Golau	53.13.08	3.16.28	20.80	20.88	20.89	20.84	20.85	6.0
Coed Llangwyfan	53.11.30	3.17.25	20.41	20.36	20.31	20.35	20.35	5.7
Llangwyfan	53.10.54	3.18.54	20.32	20.39	20.32	20.39	20.45	5.8
Llandyrnog	53.09.38	3.18.54	19.17	19.20	18.42	18.46	18.81	4.6
Hendrerwydd	53.09.38	3.18.54	18.40	18.54	18.36	18.66	18.49	4.4
Moel Famau Country Park	53.09.37	3.17.50	20.62	20.68	20.54	20.59	20.60	5.9
Gellifor	53.09.14	3.18.40	20.51	20.52	20.44	20.48	20.48	5.8
Llanbedr Dyffryn Clwyd	53.07.34	3.16.59	18.64	18.59	18.18	17.88	18.32	4.3

Bwlch Uchaf	53.07.01	3.14.18	20.56	20.59	20.67	20.59	20.60	5.9
Llanferres	53.08.05	3.12.53	17.35	17.69	16.32	16.58	16.98	3.1
Loggerheads	53.09.12	3.12.08	20.39	20.32	20.42	20.44	20.39	5.7
Cilcain	53.10.38	3.13.56	19.77	19.67	19.65	19.67	19.69	5.3
Eryrys	n/d							
Llanarmon yn Iâl	n/d							
Llandegla	53.03.27	3.11.52	20.66	20.69	20.65	20.66	20.66	5.9
Pentre Celyn	n/d							
Graigfechan	n/d							
Tŷ Mawr	n/d							
Bryneglwys	n/d							
Carrog	n/d							
Glandyfrdwy	n/d							
Llangollen	52.58.11	3.10.13	13.69	13.17	13.25	13.73	13.46	-0.2
Horseshoe Pass	53.0.58	3.12.16	20.84	20.98	20.84	20.83	20.87	6.0
Pontcysyllte	52.57.49	3.05.12	17.03	17.00	16.44	16.60	16.76	2.9
Froncysyllte	52.57.49	3.05.12	17.03	17.10	16.34	16.60	16.76	2.9

TABLE 2 – CLWYDIAN RANGE AND DEE VALLEY AONB - DARK SKY SURVEY RESULTS (AUGUST 2017)

* The 4 SQM readings are given in magnitudes per square arc second with the average converted in the final column into NELM (naked eye limiting magnitude).

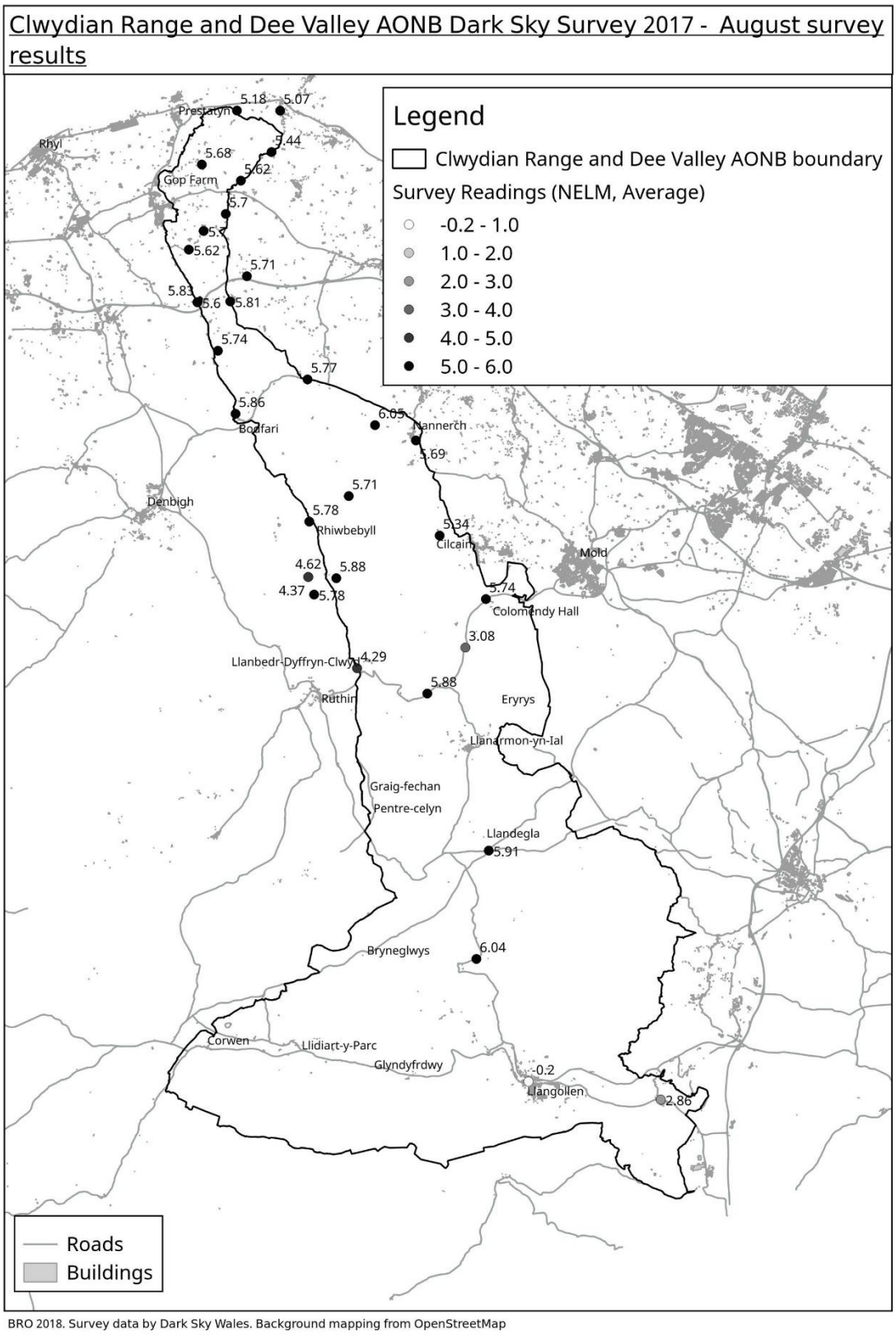
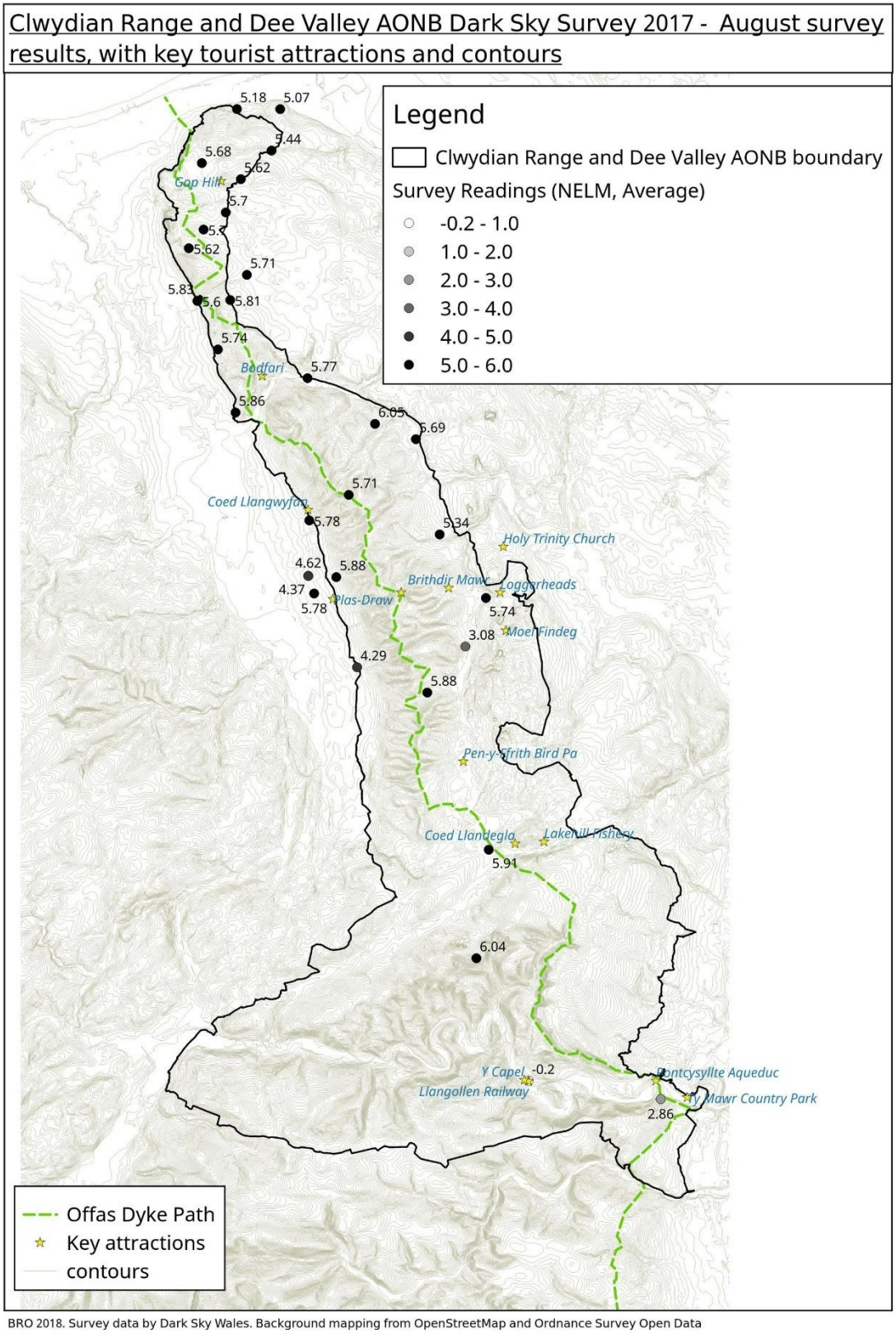


FIGURE 9a – DARK SKY QUALITY (NELM DATA) FOR SELECTED SURVEY LOCATIONS WITHIN THE AONB SHOWING PROXIMITY TO TOWNS AND VILLAGES (AUGUST 2017)



BRO 2018. Survey data by Dark Sky Wales. Background mapping from OpenStreetMap and Ordnance Survey Open Data

FIGURE 9b – DARK SKY QUALITY (NELM DATA) FOR SELECTED SURVEY LOCATIONS WITHIN THE AONB SHOWING PROXIMITY TO SELECTED ATTRACTIONS (AUGUST 2017)

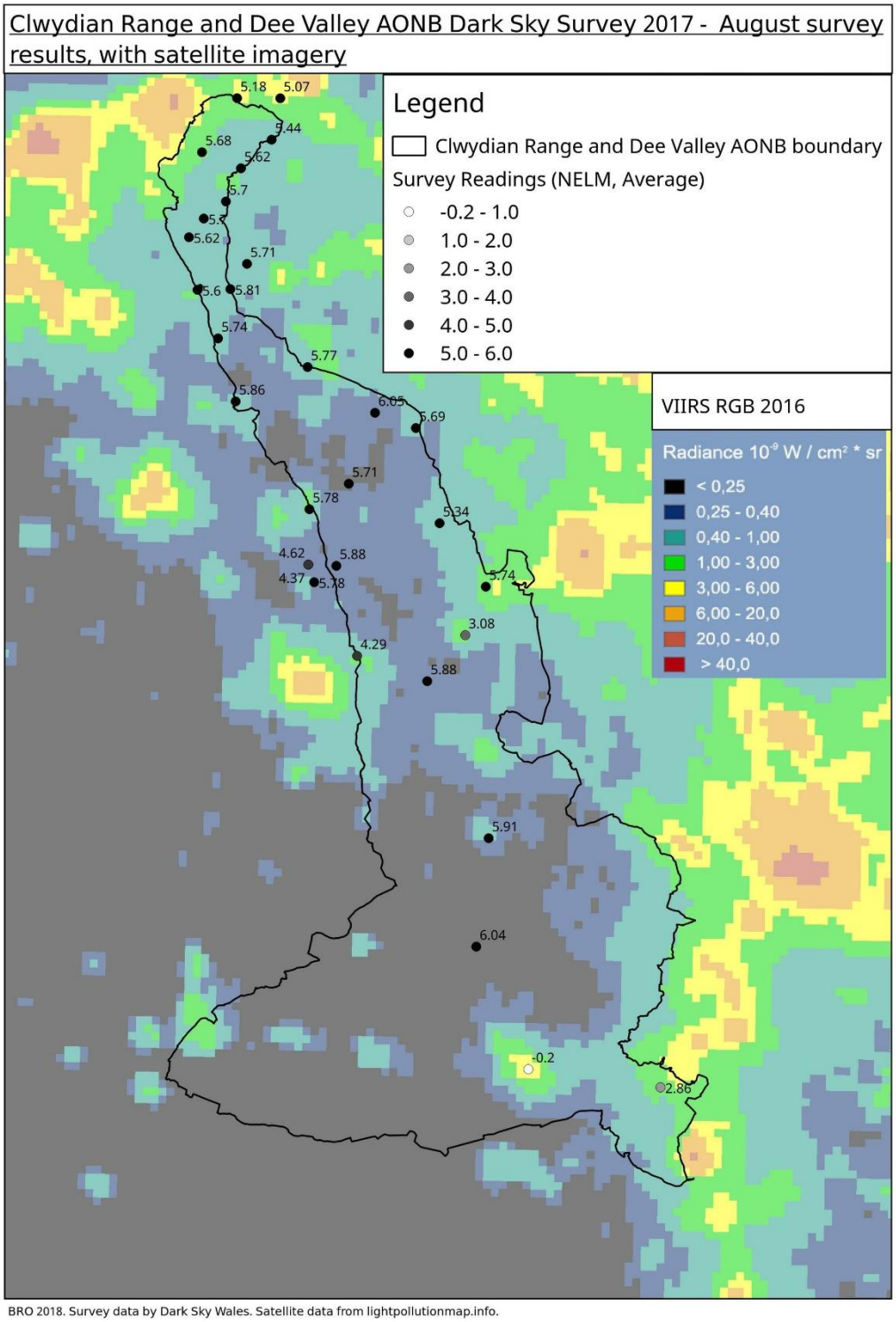


FIGURE 9c – DARK SKY QUALITY (NELM DATA) FOR SELECTED AONB SURVEY LOCATIONS OVERLAID ON VIIRS SATELLITE LIGHT POLLUTION DATA (AUGUST 2017)

Dark Sky Survey: 11 December 2017 Moon Phase – not applicable as Moon had not risen before dawn								
Location	**GPS coordinates**		**Reading 1***	**Reading 2***	**Reading 3***	**Reading 4***	**Average**	**NELM**
Gronant	53.20.16	3.21.57	19.75	19.72	19.83	19.82	19.78	5.3
Gwespyr	53.20.17	3.20.18	19.88	19.76	19.79	19.70	19.78	5.3
Llanasa	53.19.20	3.20.36	20.06	19.94	19.94	19.81	19.93	5.4
Gwaenysgor	53.19.1	3.23.15	20.32	20.23	20.30	20.32	20.29	5.7
Gop Hill	53.18.40	3.21.45	20.21	20.18	20.11	20.10	20.15	5.6
Bron Heulog Hill	53.17.54	3.22.18	20.37	20.33	20.29	20.33	20.32	5.7
Marian Ffrith	53.17.30	3.23.08	20.29	20.23	20.25	20.27	20.26	5.7
Cwm	53.17.04	3.23.41	20.25	20.27	20.24	20.18	20.23	5.6
Rhuallt	53.15.52	3.23.19	20.41	20.36	20.31	20.18	20.31	5.7
Glan Y Llyn	53.16.29	3.21.27	20.36	20.44	20.39	20.38	20.39	5.7
Bryngwyn Mawr	53.15.54	3.22.04	20.47	20.56	20.48	20.55	20.51	5.8
Moel Meanefa	53.15.52	3.23.19	20.59	20.59	20.57	20.54	20.57	5.8
Tremeirchion	53.14.46	3.22.30	20.44	20.46	20.41	20.42	20.43	5.8
Bodfari	53.13.20	3.21.47	20.56	20.63	20.59	20.60	20.58	5.8
Afonwen	53.14.9	3.19.04	20.48	20.43	20.51	20.48	20.47	5.8
Nannerch	53.12.48	3.14.54	20.40	20.36	20.28	20.31	20.33	5.7
Bryn Golau	53.13.08	3.16.28	20.87	20.88	20.89	20.91	20.88	6.1
Coed Llangwyfan	53.11.30	3.17.25	20.56	20.55	20.61	20.59	20.57	5.9
Llangwyfan	53.10.54	3.18.54	20.41	20.39	20.39	20.36	20.38	5.7
Llandyrnog	53.09.38	3.18.54	19.21	19.20	19.23	19.22	19.21	4.9
Hendrerwydd	53.09.38	3.18.54	18.34	18.56	18.44	18.66	18.50	4.4
Moel Famau Country Park	53.09.37	3.17.50	20.62	20.68	20.67	20.64	20.65	5.8
Gellifor	53.09.14	3.18.40	20.57	20.52	20.46	20.51	20.51	5.8
Llanbedr Dyffryn Clwyd	53.07.34	3.16.59	19.23	19.17	19.11	19.08	19.14	4.9

Bwlch Uchaf	53.07.01	3.14.18	20.61	20.59	20.67	20.63	20.62	5.8
Llanferres	53.08.05	3.12.53	17.95	18.01	17.99	17.93	17.97	3.9
Loggerheads	53.09.12	3.12.08	20.39	20.41	20.42	20.48	20.42	5.8
Cilcain	53.10.38	3.13.56	20.01	20.02	19.99	20.00	20.05	5.5
Eryrys	53.04.19	3.12.13	20.01	20.12	20.15	20.13	20.10	5.6
Llanarmon yn Iâl	53.05.48	3.12.37	19.81	19.87	19.79	19.84	19.82	5.4
Llandegla	53.03.27	3.11.52	20.34	20.28	20.31	20.34	20.31	5.7
Pentre Celyn	53.04.19	3.16.13	20.12	20.10	20.15	19.98	20.08	5.5
Graigfechan	53.05.15	3.16.37	20.16	20.19	20.18	19.85	20.12	5.6
Ty Mawr	53.01.44	3.14.33	19.98	20.25	20.23	20.28	20.18	5.6
Bryneglwys	53.01.08	3.16.07	19.88	19.89	19.74	19.21	19.68	5.3
Carrog	52.59.10	3.20.03	20.14	20.15	20.13	20.15	20.14	5.6
Corwen	52.59.10	3.22.01	17.24	17.30	17.32	17.28	17.28	3.3
Glandyfwrdwy	52.58.44	3.18.30	19.73	19.54	19.66	19.81	19.68	5.3
Llangollen	52.58.11	3.10.13	14.17	14.04	13.99	14.05	14.06	0.3
Eglwyseg	53.00.27	3.10.11	20.03	19.87	20.19	20.03	20.03	5.5
Gwter Siani	53.03.02	3.07.05	20.01.	20.00	19.98	19.94	19.98	5.5
New Brighton	53.03.12	3.05.21	19.78	19.81	19.74	19.78	19.77	5.4
Horseshoe Pass	53.0.58	3.12.16	20.77	20.86	20.84	20.83	20.82	6.0
Tai'rant	52.58.46	3.13.11	19.74	19.67	19.56	19.71	19.67	5.3
Garth	52.58.35	3.06.21	19.59	19.57	19.56	19.78	19.62	5.2
Pontcysyllte	52.57.49	3.05.12	17.30	17.23	17.20	17.02	17.18	3.3
Froncysyllte	52.57.49	3.05.12	17.03	17.21	17.23	17.18	17.16	3.3

TABLE 3 – CLWYDIAN RANGE AND DEE VALLEY AONB - DARK SKY SURVEY RESULTS (DECEMBER 2017)

* The 4 SQM readings are given in magnitudes per square arc second with the average converted in the final column into NELM (naked eye limiting magnitude).

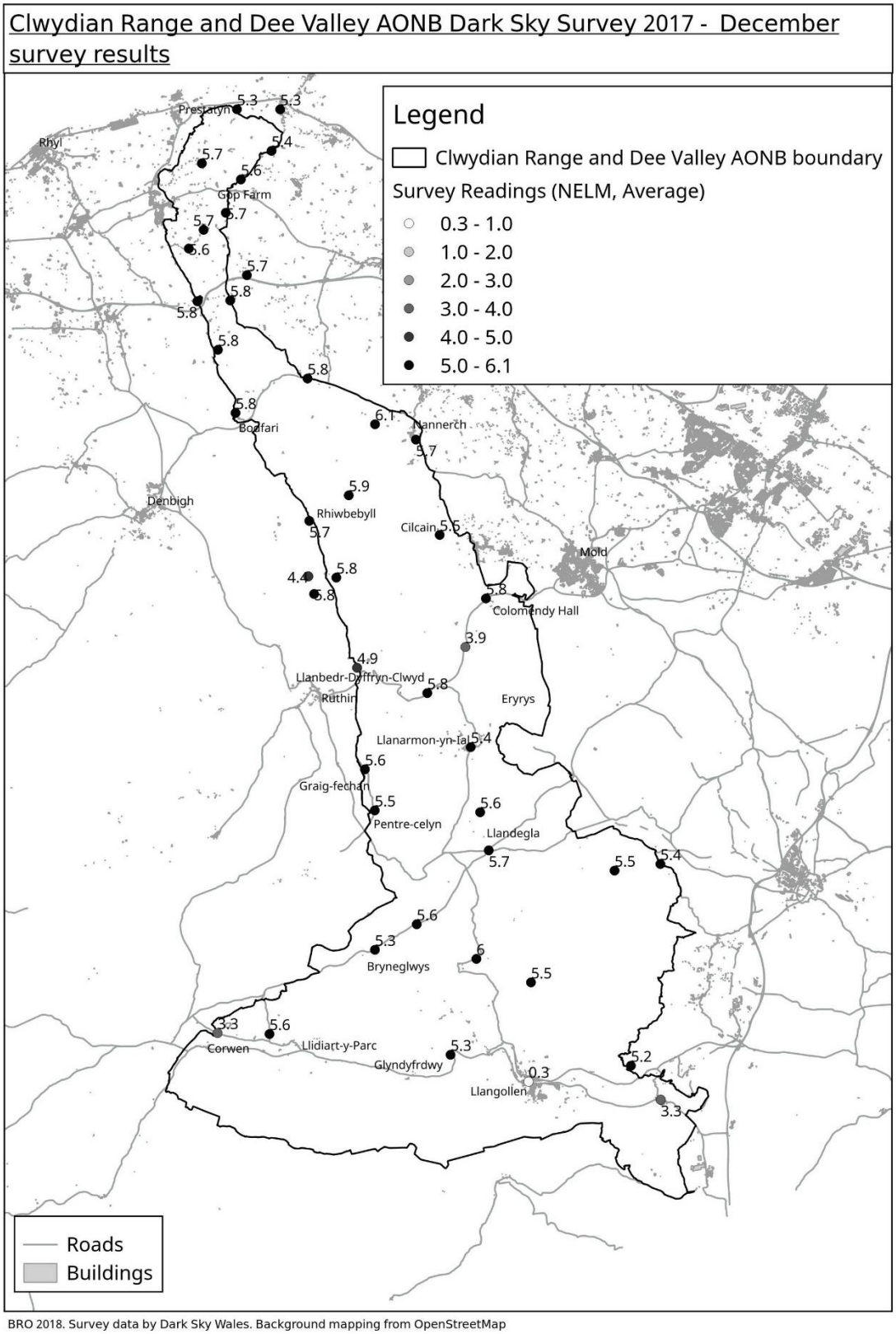


FIGURE 10a – DARK SKY QUALITY (NELM DATA) FOR SELECTED SURVEY LOCATIONS WITHIN THE AONB SHOWING PROXIMITY TO TOWNS AND VILLAGES (DECEMBER 2017)

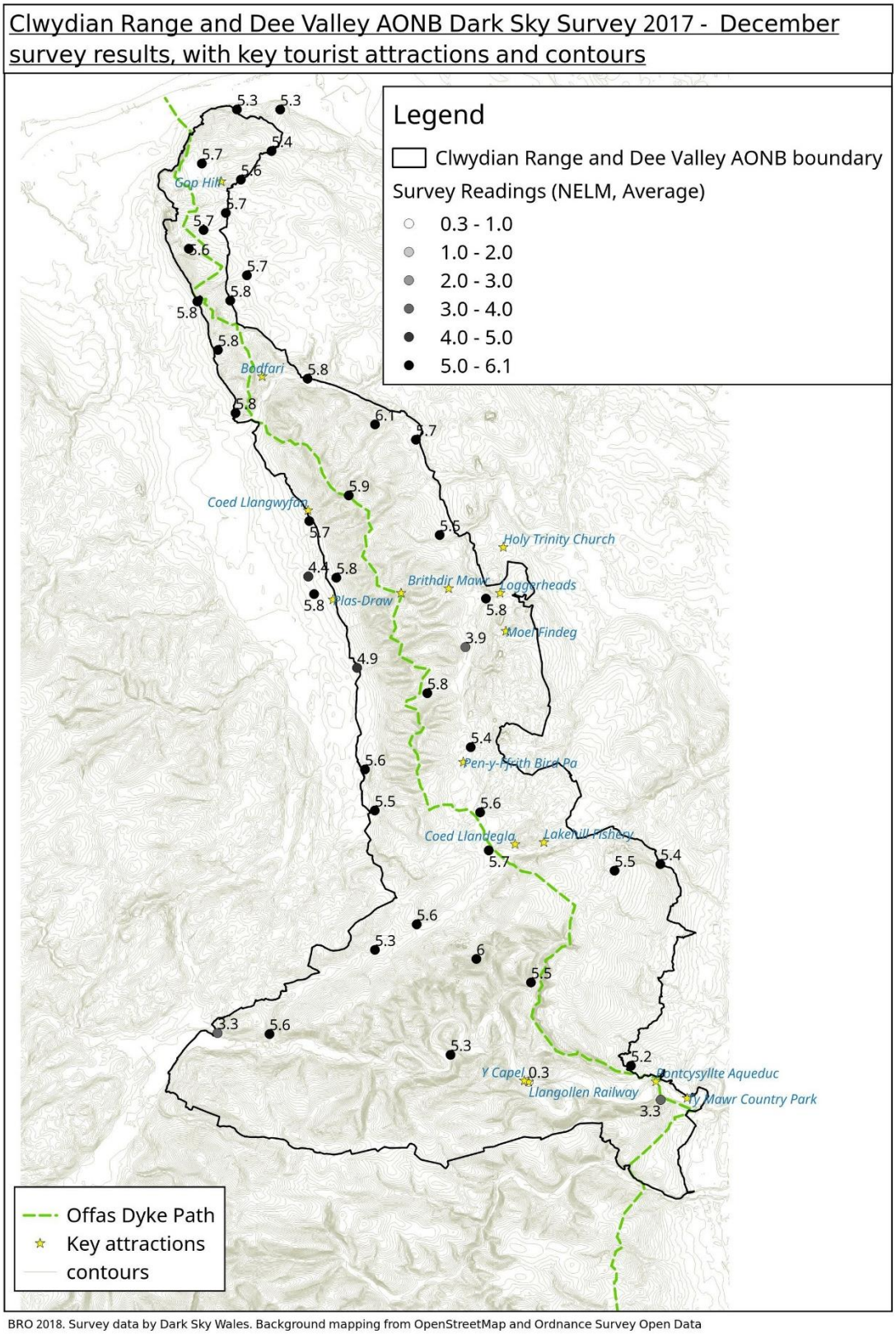


FIGURE 10b – DARK SKY QUALITY (NELM DATA) FOR SELECTED SURVEY LOCATIONS WITHIN THE AONB SHOWING PROXIMITY TO ATTRACTIONS (DECEMBER 2017)

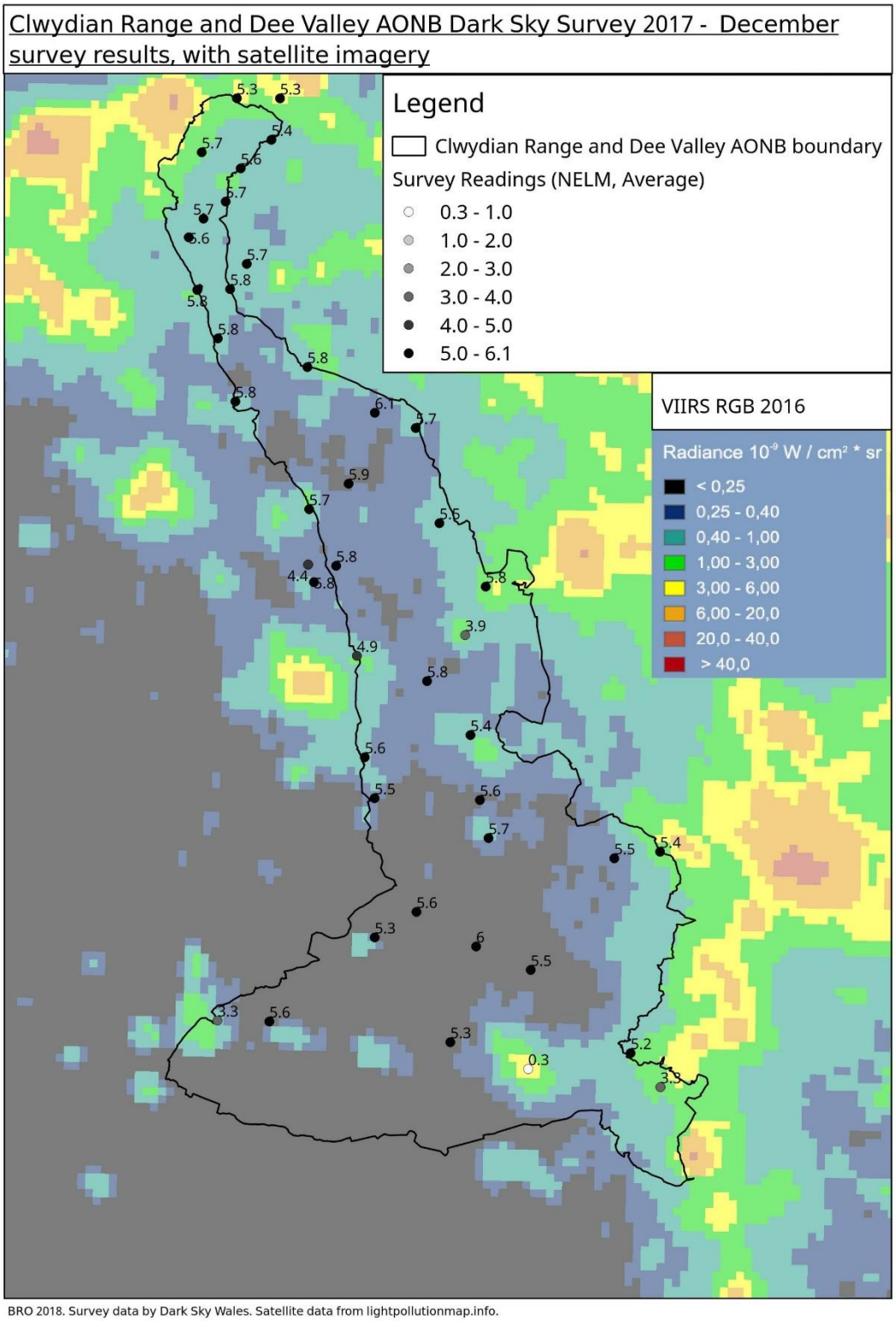


FIGURE 10c – DARK SKY QUALITY (NELM DATA) FOR SELECTED AONB SURVEY LOCATIONS OVERLAID ON VIIRS SATELLITE LIGHT POLLUTION DATA (DECEMBER 2017)

LOCATION		Averaged Survey Readings magnitude per square arc sec	Averaged Survey Readings NELM
1	**Gronant**	19.67	5.25
2	**Gwespyr**	19.59	5.20
3	**Llanasa**	19.93	5.40
4	**Gwaenysgor**	20.29	5.75
5	**Gop Hill**	20.18	5.60
6	**Bron Heulog Hill**	20.32	5.70
7	**Marian Ffrith**	20.25	5.70
8	**Cwm**	20.22	5.60
9	**Rhuallt**	20.24	5.65
10	**Glan Y Llyn**	20.37	5.70
11	**Bryngwyn Mawr**	20.51	5.80
12	**Moel Meanefa**	20.57	5.80
13	**Tremeirchion**	20.41	5.75
14	**Bodfari**	20.58	5.85
15	**Afonwen**	20.45	5.80
16	**Nannerch**	20.32	5.70
17	**Bryn Golau**	20.87	6.05
18	**Coed Llangwyfan**	20.46	5.80
19	**Llangwyfan**	20.42	5.75
20	**Llandyrnog**	19.01	4.75
21	**Hendrerwydd**	18.50	4.40
22	**Moel Famau Country Park**	20.63	5.85
23	**Gellifor**	20.50	5.80
24	**Llanbedr Dyffryn Clwyd**	18.73	4.60
25	**Bwlch Uchaf**	20.61	5.85
26	**Llanferres**	17.48	3.50
27	**Loggerheads**	20.41	5.75
28	**Cilcain**	19.87	5.40
29	**Eryrys**	20.10	5.60
30	**Llanarmon yn Iâl**	19.82	5.40
31	**Llandegla**	20.49	5.80
32	**Pentre Celyn**	20.08	5.50
33	**Graigfechan**	20.12	5.60
34	**Tŷ Mawr**	20.18	5.60
35	**Bryneglwys**	19.68	5.30
36	**Carrog**	20.14	5.60
37	**Corwen**	17.28	3.30
38	**Glandyfwrdwy**	19.68	5.30
39	**Llangollen**	13.76	-
40	**Eglwyseg**	20.03	5.50
41	**Gwter Siani**	19.98	5.50
42	**New Brighton**	19.77	5.40
43	**Horseshoe Pass**	20.85	6.00
44	**Tai'rant**	19.67	5.30
45	**Garth**	19.62	5.20
46	**Pontcysyllte**	16.97	3.10
47	**Froncysyllte**	16.96	3.10

TABLE 4 – CLWYDIAN RANGE AND DEE VALLEY AONB:
AVERAGED NELM READINGS FROM DARK SKY SURVEYS FOR EACH LOCATION

Rows shaded in grey indicate only one survey was undertaken at that location

Combining the survey data and mapping, it appears that dark sky quality at the majority of the AONB locations monitored is of a very good standard. As shown,

there are areas of higher light pollution that correspond to the more populated areas with the more rural locations showing better dark sky quality, as indicated in the original satellite data.

The combined data overview of the dark sky surveys shown in Table 4 above indicates the quality of dark skies is largely very good with night sky brightness darker than 20 magnitudes per square arc second in large areas of the AONB. If this were routinely the case, then it would meet the dark sky standards required for IDA Dark Sky Park or Reserve status (as shown earlier).

The overlaid mapping with point source lighting in Denbighshire shows that it is a key source of light pollution affecting the quality of the night skies. The SQM measurements at Llangollen (Tables 2 - 4) indicated that the quality is quite poor. As the close-up mapping in Figure 11 shows, there is a high incidence of public point source lighting in Llangollen as well as other possible sources of light which appears to be impacting on night sky quality, particularly in the centre of the town.

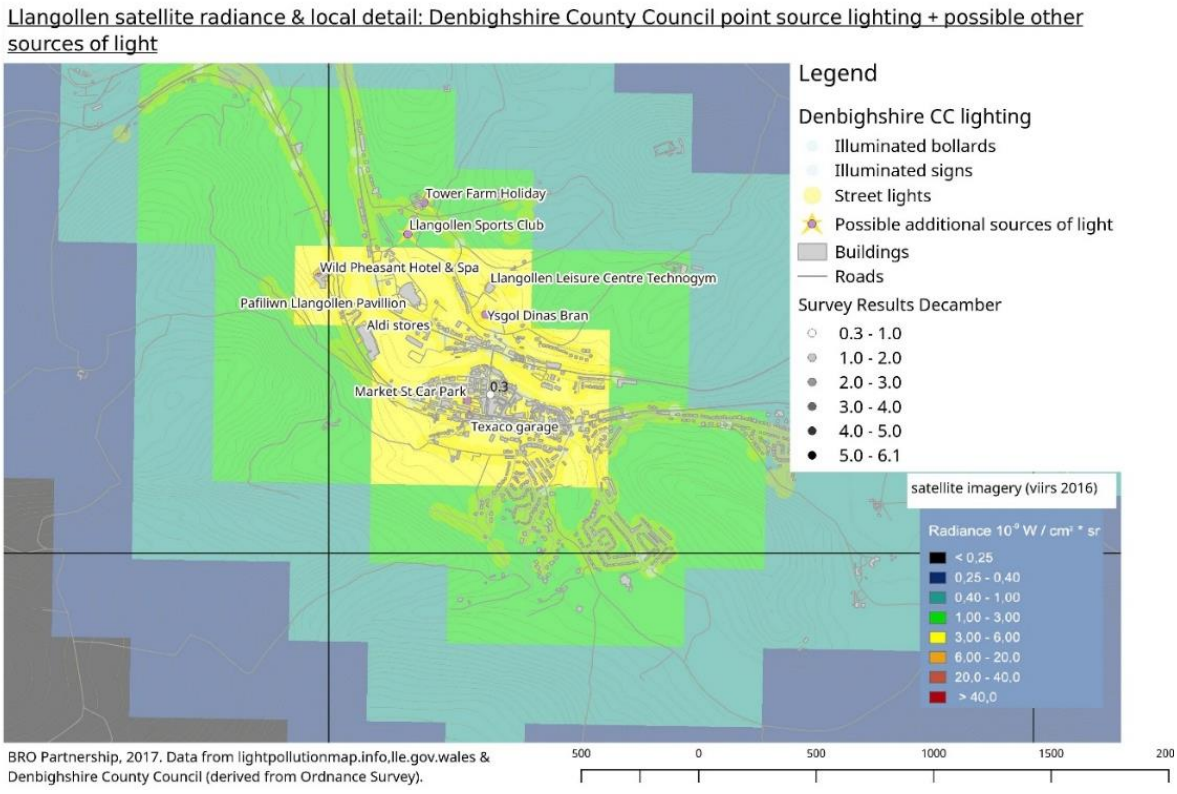


FIGURE 11 – LOCAL DETAIL FOR LLANGOLLEN SHOWING POINT SOURCE LIGHTING AND SQM MEASUREMENTS (AS NELM – DECEMBER 2017) OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS (2016) DATA

In contrast, the night skies above Llanarmon yn Iâl (Tables 2 - 4) are much better quality. As the close-up mapping in Figure 12 shows, unsurprisingly there is much less point source and other lighting in the area and as Figure 13 shows the quality of the dark skies above the village can be very good indeed.

It appears that the greatest source of light pollution in that area might be the holiday parks. This shows that private and residential lighting are also contributors to light pollution and so measures to address poor-quality lighting should take into account these as well as local authority and other statutory lighting, e.g. trunk roads.

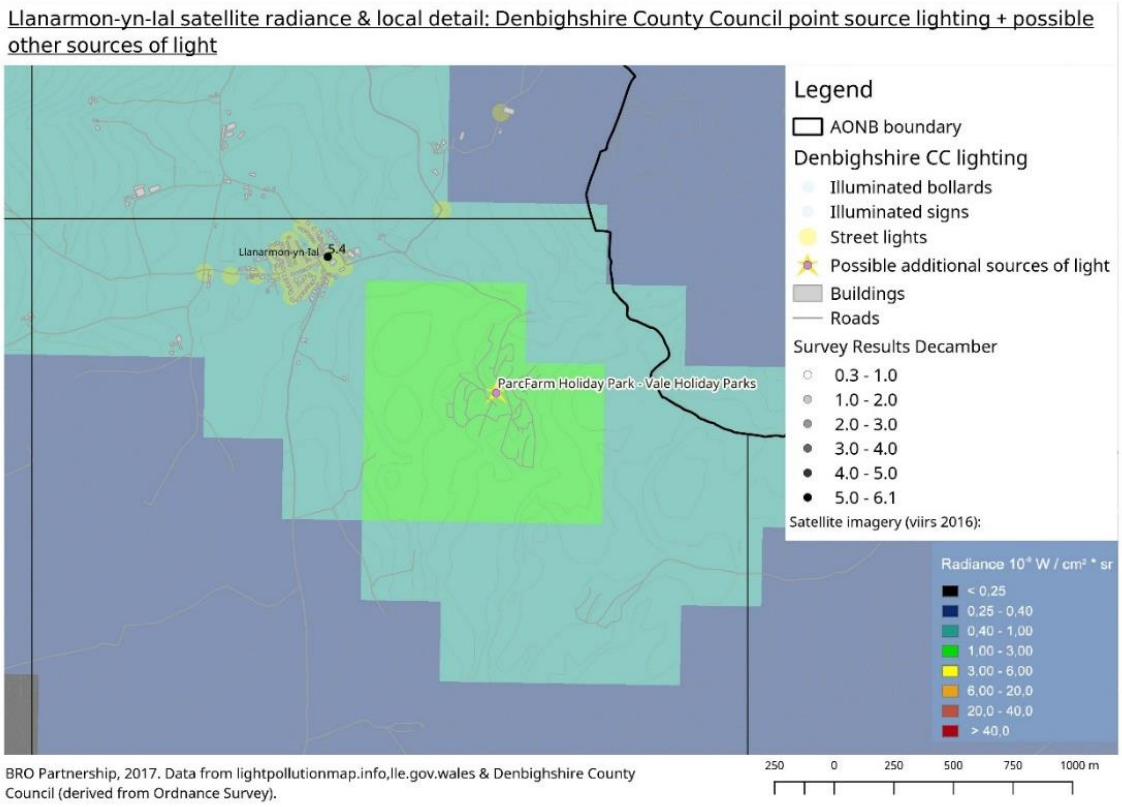


FIGURE 12 – LOCAL DETAIL FOR LLANARMON YN IÂL SHOWING POINT SOURCE LIGHTING AND SQM MEASUREMENTS (AS NELM – DECEMBER 2017) OVERLAID WITH THE RADIANCE OBSERVED FROM SPACE USING VIIRS (2016) DATA

In conclusion, the AONB appears to enjoy large areas where the night skies are of very good quality, including renowned tourist areas, e.g. the Horseshoe Pass and Moel Famau (Figure 14). This bodes well for attaining IDA designation. However, other locations closer to areas of populations do not enjoy such good quality skies, e.g. Pontcysyllte Aqueduct and Llangollen, which is seemingly due to light pollution. As such, local people in those areas are currently deprived of the maximum benefits afforded by high-quality dark skies. In the next section, we consider the Local Authority and Trunk Road Agency lighting survey undertaken in the study.

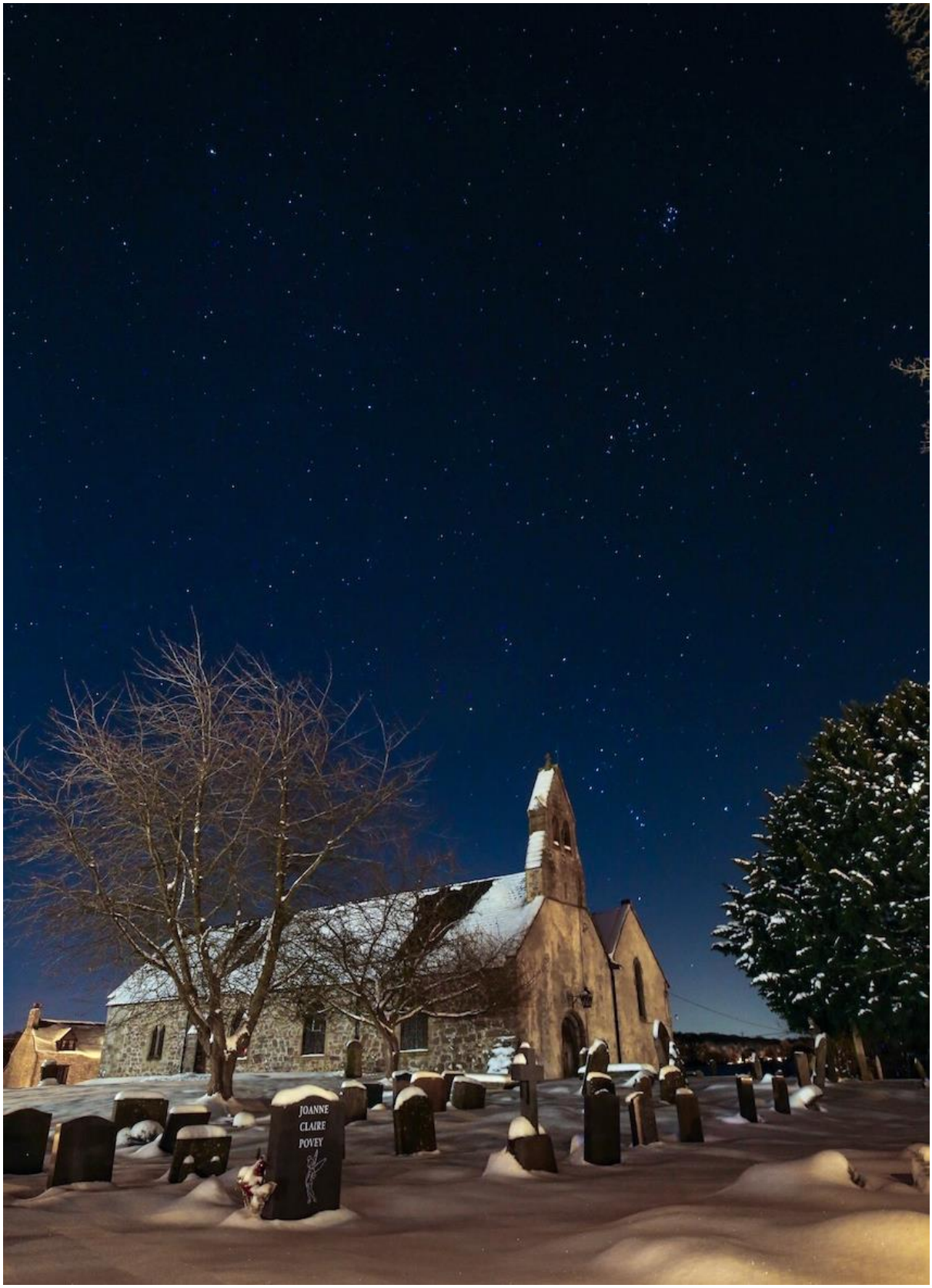


FIGURE 13 – NIGHT SKIES ABOVE THE CHURCH AT LLANARMON YN IÂL DECEMBER 2017)

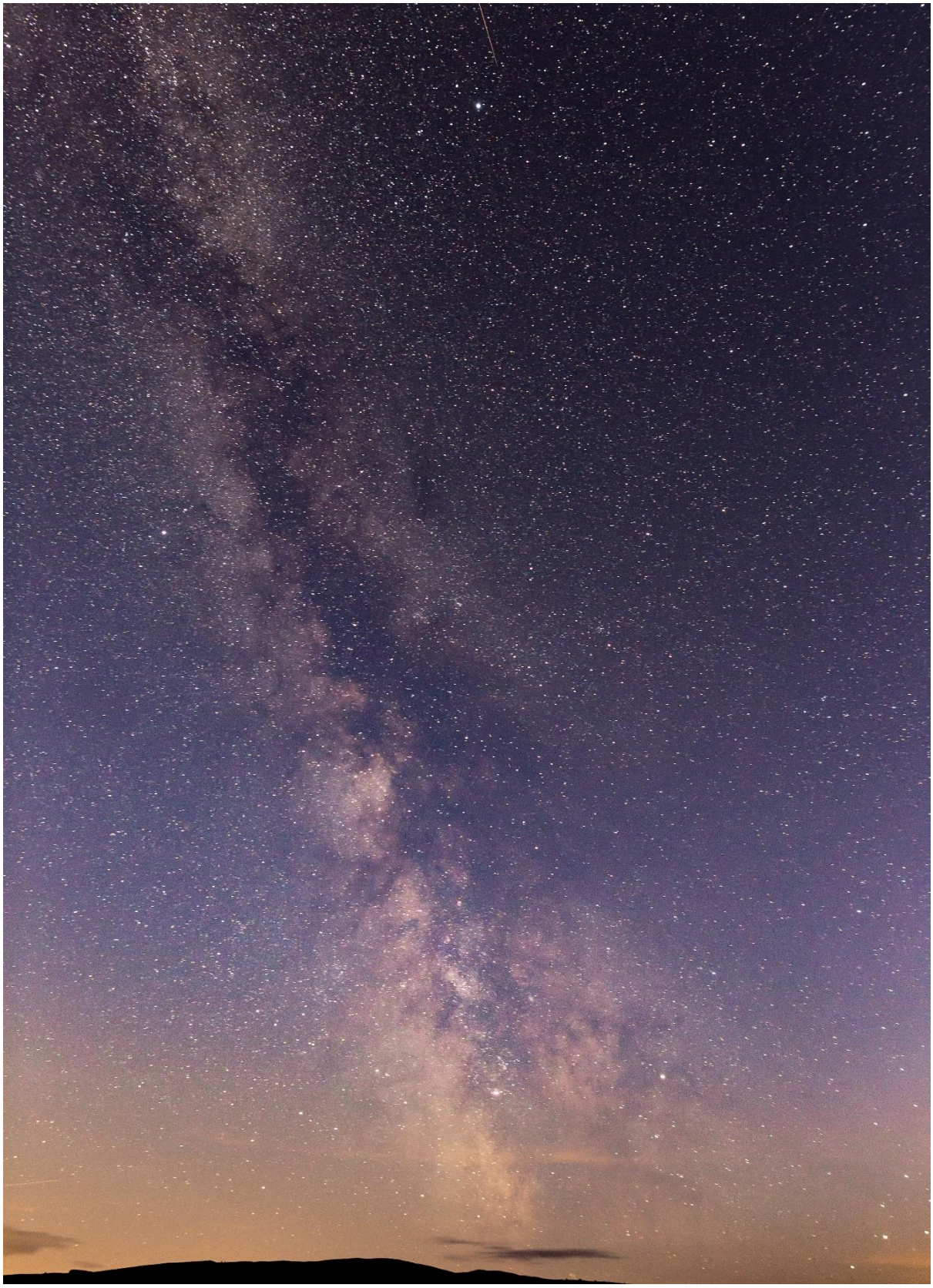


FIGURE 14 – NIGHT SKIES ABOVE MOEL FAMAU (DECEMBER 2017)

6. PUBLIC LIGHTING SURVEYS

As indicated previously, in keeping with the IDA Dark Sky designation criteria shown in appendices 1 and 2, the AONB will need to devise a progressive lighting code and plan that seeks to reduce and/or minimise light pollution.

A key aim of this study was to assess awareness of the importance of dark skies amongst local authority planners and lighting engineers and other relevant groups or individuals and capture current activity around public lighting schemes in the area.

Local Authority Lighting Policies and Plans

We worked with the AONB officers together with some of the lighting and planning officers in the three Local Authorities to seek to ascertain the current position concerning lighting in the AONB. A meeting was held a meeting with appropriate LA lighting and planning officers in Bodelwyddan in June 2017 to outline the plans for application for IDA status. The meeting notes are shown in Appendix 3.

Further to those discussions, a draft survey for wider distribution was circulated for agreement amongst the attendees and, further to that, this was sent out more widely in the summer of 2017. The survey's aim was to get an understanding of how AONB aspirations to meet IDA requirements to obtain Dark Sky Community status are consistent with and meet current and future lighting policies and implementation within the AONB and the three Local Authorities. The survey was sent to appropriate lighting and planning officers and sent also to officers at the North and Mid Wales Trunk Road Agency.

Appendix 4 provides a detailed composite overview of the responses to the survey from officers (mostly lighting engineers) in each of the local authorities. As these show, importantly, there is some variation in the lighting policies and practices across

the three Local Authority areas. Here, we provide a bulleted meta-analysis of the key questions and responses.

- **Dark Sky Designation Awareness**

Encouragingly, all of the officers in each authority were well aware of International Dark Sky (IDA) initiatives and lighting plans in designated areas in Wales, e.g. Snowdonia National Park and Brecon Beacons National Park. As a result of the Bodelwyddan meeting and subsequent conversations and email correspondence, they are also now aware, if they were not before, of the AONB's aspirations to apply for formal Dark Sky designation.

- **Current Lighting Policies and Implementation**

Each of the authorities currently employs a mix of traditional lighting technologies, such as Low- or High-Pressure Sodium, and LED, but are all moving towards exclusive use of LED lighting. For example, in the case of Flintshire, 12,000 units will be replaced in the next two years with zero upward waste light. Interestingly, Wrexham indicated this change is likely to be predicated upon funding.

- **How do current or proposed lighting plans fit with IDA criteria?**

Fully-shielded or full cut-off standard for all lighting fixtures over 1500 lumens initial lamp output (or equivalent wattages)

All proposed or future lighting replacement in all of the authorities will meet that requirement although it is not currently the case in Denbighshire.

The IDA criteria for Dark Sky Community status seek to establish a threshold of 3000 Kelvins for the allowable correlated colour temperature of all lighting fixtures

None of the lighting in any of the authorities currently meets with this threshold, e.g., in Flintshire, the lighting is currently between 3000K and 4000K. None of them suggest that their proposed or future lighting replacement regimes will meet this threshold, although Wrexham have suggested that they will give due consideration. Amongst the issues or challenges foreseen by Denbighshire and Flintshire are cost (funding) and possibly procurement issues.

Restrictions on total amount of unshielded lighting, such as a limit on lumens per acre or total site lumens in unshielded fixtures (or equivalent wattages)

There was a mixed response to this. Denbighshire has restrictions, Wrexham does not, whilst Flintshire's new lighting gives zero upward light.

A policy to address over-lighting, such as energy density caps, lumens/acre

caps, or maximum illuminance specifications

Wrexham has no such policy whilst there is some policy guidance in the Denbighshire LDP (Adopted 4/6/2013) – Policy RD1, criterion vi)[8]. In the case of Flintshire there is some guidance in its UDP (adopted 28/09/2011) – Policy EWP 13 (p. 146).[9] Flintshire and Wrexham are well advanced on preparing LDPs which will replace their out of date UDPs, but these have not yet been adopted. It should be noted that the responses concur with the details provided by Tony Hughes at the AONB, further to the meeting at Bodelwyddan.

A provision that clearly: (a) indicates where, when, and under what circumstances new public outdoor lighting (street lighting and lighting on other public property and rights-of-way) is warranted and will be permitted, and (b) requires that adaptive controls and curfews be employed in all future installations of public outdoor lighting.

None of these provisions apply in Wrexham or Denbighshire, although future provisions are to be considered in Wrexham. In Flintshire, they are already taken on board within their policy and specifications, but they also look on a site by site basis.

Obtaining a costed phased plan is likely to be an important element of the AONB's aspirations going forward

Flintshire did not provide a specific figure on this although they indicated that at current funding levels, they could be compliant within 5 years assuming that the K range is acceptable; importantly, it is unclear whether this means below 3000K. Wrexham did not provide a cost, whilst Denbighshire provided an indicative figure of £300K over a two-year period.

Community commitment to dark skies and quality lighting

Neither Wrexham or Denbighshire were aware any council or other information or support material that is available to make communities and businesses aware of Dark Sky benefits and good lighting practice. However, in Flintshire, it was indicated that some tenders and specifications do contain details. Of the authorities, only Flintshire reported specific examples of actions to achieve successes in light pollution control through elimination of upward waste light from standard lanterns and a policy that dims units by 30% from 2000 hrs until 0600 hrs.

In conclusion, there is no harmonisation between the three authorities currently as to lighting policies and plans. Importantly, in the context of Dark Sky aspirations, none of them suggest that their proposed or future lighting replacement regimes will meet this threshold, although Wrexham have suggested that due consideration will be

[8] http://www.denbighldp.co.uk/Webfiles/Adoption/Adopted%20LDP%20text%20english.pdf
[9] http://www.cartogold.co.uk/flintshire/text/english/00_contents.htm

given. Funding and procurement issues are likely to be challenges in achieving this, as is a consistent policy and ambition across all three authorities that meets with the AONB's aspirations.

Trunk Road Lighting Policies and Plans

To complement the above information, we sought to ascertain the details for the same questions from the North and Mid Wales Trunk Road Agency (NMWTRA) because three trunk roads, the A494, A5, and A55 go through the AONB. This proved difficult, owing to several reasons including staff leaving issues, but eventually we were given some relevant information from the appropriate officers in Welsh Government in response to four basic enquiries:

- **Type of lighting used?**
  A mixture of LED, SON and Metal Halide lighting is used across the area

- **What is their correlated colour temperature (CCT), e.g. 3000/4000 Kelvin etc. and are there plans to reduce this in the future?**
  LED specified as 4000K, SON would be around 2200K – 2700K and Metal Halide around 4000K

- **Are they effectively shielded with cut-offs?**
  Rear shields are used when required to limit light trespass. LED lanterns are specified as G4 glare rating.[10]

- **Are there any adaptive controls to dim or extinguish light at certain times at night?**
  Most street lighting is fitted with the Welsh Government street lighting (Telensa) central management system which gives us the ability to employ dimming and trimming as appropriate, providing these meet the necessary standards and criteria outlined within TD 34/07 – Design of Road Lighting for the Strategic Motorway and all-purpose trunk road network.[11]

This information appears to indicate that the LED lighting at 4000K currently would not conform to IDA criteria (< 3000K), but dimming and other opportunities should be discussed with the NMWTRA and Welsh Government officials to see what happens in current Dark Sky designated areas in Wales such as the Brecon Beacons and Snowdonia national parks.

Future Actions for Addressing Lighting and Producing a Plan

[10] https://blog.1000bulbs.com/home/how-is-a-bug-rating-calculated
[11] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol8/section3/td3407.pdf

One of the key elements in obtaining official IDA designation will be a commitment from the AONB to preserve (and improve) the night sky quality through the implementation and enforcement of quality lighting codes. As noted earlier, there is no set proposal document to be completed for the IDA application. Most contain separate lighting plans, e.g., for the Moffat Dark Sky Community application[12], the lighting plan covered public and private lighting.

The aim of this specific element of the overall study was to ascertain the position regarding the current public (Local Authority and Trunk Road Agency) lighting provision and policy in the AONB area and get indications of whether future plans meet with the AONB's aspirations.

As shown, there appears to be a mix of policy and practice amongst the different authorities and agencies along with a variety of future plans across them. One way of addressing this might be to produce specific Supplementary Planning Guidance (SPG) concerning lighting policy for the AONB. Snowdonia National Park Authority has developed SPG on the lighting of new developments whilst the Brecon Beacons NPA produced SPG on obtrusive lighting[13] and these could be raised with and considered by lighting engineers and planners in the three authorities.

Quite a few local authorities have SPG or other guidance notes, and good examples are those in from South Ayrshire[14] and Dumfries and Galloway.[15] Alternatively, the AONB, or its constituent authorities could adopt the Institute of Lighting Engineers guidance note[16] on the reduction in obtrusive lighting, which other authorities have done. Either could provide a useful guide for the AONB.

As an immediate action, we propose that the study findings are now considered again in detail with the planners and lighting engineers who contributed to get feedback and input with the aim of forming a specific group to produce any required SPG and a future plan as part of a IDA designation application.

[12] http://www.darksky.org/wp-content/uploads/2016/02/Moffat_LMP.pdf
[13] http://www.beacons-npa.gov.uk/wp-content/uploads/Obrusive-Lighting-SPG-.pdf
[14] https://www.south-ayrshire.gov.uk/documents/sg%20dark%20sky%20lighting.pdf
[15] http://egenda.dumgal.gov.uk/aksdumgal/images/att36338.pdf
[16] https://www.theilp.org.uk/documents/obtrusive-light/

7. DARK SKY AWARENESS AND INVOLVEMENT ACTIVITIES

A further key objective of the study was to work with AONB staff to arrange a series of engagement events and activities across the AONB, especially those that could enhance public awareness in conjunction with its annual programme of events.

Whilst these aimed at raising awareness of this particular study and dark skies in general amongst local residents and visitors, the series of events was also crucial in providing ideas and a framework for future awareness and education programmes that will need to be a key part of any application for IDA Dark Sky Designation as indicated earlier. For example, the Brecon Beacons National Park seeks to maintain and enhance its Dark Sky designation by running six public Dark Sky events each year to enhance people's understanding and enjoyment of the night sky.

7.1 EVENTS

Three of the events undertaken were specifically aimed at AONB partners and volunteers.

Llangollen Initial Awareness Event

The first of these was an initial awareness event was held in March at the Llangollen Pavilion to launch the study formally and provide over 30 delegates, from a range of backgrounds and interests, with a better understanding of the benefits of dark skies, the purpose and aims of the study, and to apprise them of the initial work carried out. It also provided an opportunity to hear about and learn from work going on in other areas in Wales related to dark skies, for example, the astro-tourism business pilot being conducted in Gwynedd with Llywelyn Rees of Menter Môn providing an overview of that. Delegates were treated to a Planetarium Show hosted by DSW to conclude the event.

Full notes on the event with details of the attendees and sessions are provided in Appendix 5. As shown, a breakout session was held focused on three different aspects of the AONB's dark skies ambitions and requirements; Tourism Opportunities, Technical Aspects (e.g. lighting plans) and Community Engagement. Each breakout group was tasked with considering key questions:

- Who needs to be involved?
- What do they need to do? e.g. organise events, monitor light readings
- Where do they need to do it? i.e. the geographical coverage
- How should it be done? e.g. through additional funding, regulations and controls, campaigns
- When are the actions required? i.e. the timescale

This provided useful background and information moving forward for development of the proposed future Action Plan. The event also generated useful publicity with radio and online coverage as illustrated in Figure 15.

FIGURE 15 – BBC NEW WEBSITE COVERAGE OF LLANGOLLEN EVENT (MARCH 2017)

Other Partner Events and Meetings

Aside from the specialist lighting engineers and planners meeting, these included a Volunteer Dark Sky Monitoring Training Event, held at Loggerheads Country Park in October 2017, and a DSW session at the Clwydian Range Tourism Group Autumn Meeting at Theatr Clwyd, Mold, also in October. BRO team members also apprised the AONB committee of the study at its autumn meeting at Llanarmon yn Iâl (Figure 16).

At the volunteer event, DSW provided a 2-hour session with planetarium talk and practice training using SQMs. Whilst future formal surveys for IDA designation will

need to be conducted professionally, nevertheless the involvement of volunteers will be crucial in informal monitoring of dark sky quality and will also serve to enhance community engagement and understanding. The Clwydian Range Tourism Group Meeting session was jointly held by DSW and the AONB, including a planetarium talk with Martin Griffiths (DSW) and an astro-tourism workshop with Allan Trow (DSW).

FIGURE 16 – BRO PRESENT THE DARK SKIES STUDY TO AONB COMMITTEE MEMBERS AT LLANARMON YN IÂL (OCTOBER 2017)

Public Events

BRO/DSW were also tasked with arranging for a touring planetarium dome to mimic the skies people are likely to experience in the AONB as well as stargazing events.

Through negotiation with the AONB, Dark Skies Wales provided a number of public events comprising a mix of star gazing sessions and planetarium shows and talks with a variety of audiences.

In August 2017, an event took place at Caer Drewyn Hillfort, Corwen as part of the 'Out and About' programme. In September, there was an event at Llangollen involving the High School, whilst two events took place in October, the first at Trelawnyd Village Hall (Figure 17) with a stargazing walk to Gop Cairn, and then a Planetarium show at Ty Mawr Country Park, Wrexham.

FIGURE 17 – PUBLIC EVENT AT TRELAWNYD VILLAGE HALL (OCTOBER 2017)

These events have provided a clear way forward for the type of public engagement events that the AONB will need to conduct and include as part of its formal application for IDA Dark Sky Designation.

7.2 INDICATIVE COMMUNITY GUIDANCE

In addition to community attendance at awareness events, a key element in future for any Dark Sky Designation will be involvement of the community in supporting the attainment of quality dark skies in the AONB.

This is vital for a number of reasons:

- It will help engender and develop community understanding and thus support for any future public lighting actions required AONB
- It will ensure that the residents can take their own steps in achieving and maintaining the quality of the dark skies
- It should help residents themselves to benefit directly from dark skies in their own properties and localities

To support the AONB going forward with a future application, in keeping with the study's aim of providing guidance to communities of public lighting schemes that meet IDA recommendations, we analysed the details of the initial awareness event (Appendix 5), together with conducting some best practice research from other areas

where community guidance had been produced, e.g. Northumberland National Park, and the experiences of Dark Sky Wales.

FIGURE 18 – COMMUNITY ENGAGEMENT BREAKOUT SESSION AT INITIAL AWARENESS EVENT, LLANGOLLEN (MARCH 2017)

As a result, we have produced an indicative Community Guidance Pack, which is included in Appendix 6. This is not intended to be prescriptive but rather provide a template for the AONB to take forward and amend accordingly in keeping with its other schemes and initiatives with the final glide being available online or in printed format. Moreover, it could be used to help enlist support from community organisations from which letters of support will be required for the IDA Dark Sky application.

7.3 INDICATIVE BUSINESS GUIDANCE AND TOOLKIT

Further to the presentations made at the initial awareness meeting in Llangollen in February 2017, and the Clwydian Range Tourism Group Autumn Meeting in later October 2017, where DSW gave an overview on how businesses can benefit from dark skies tourism, we conducted best practice research, coupled with the experience of Dark Sky Wales, to produce an indicative Business Guide and Toolkit Appendix 7)

As with the indicative Community Guidance, it is not intended to be prescriptive, but rather it can and should be amended to produce a scheme that fits with the aims of and existing initiatives within the AONB.

FIGURE 19 – ALLAN TROW (DSW) HIGHLIGHTS DARK SKIES OPPORTUNITIES FOR BUSINESS TO CLWYDIAN RANGE TOURISM GROUP MEETING (OCTOBER 2017)

Concluding Comments and Observations on Awareness and Engagement

In conclusion, a series of partner and public awareness events, meetings and activities were held throughout the study period across all three local authority areas in the AONB. These events enhanced awareness of the need and benefits of improving the dark skies quality across the AONB, helped engage key partners across different sectors, and provided a guide for taking forward these types of activities that will be required for applying for IDA Dark Sky Designation. There appears to be a great deal of enthusiasm for the ambitions and aspirations of the AONB across the board.

With respect to future engagement with and involvement of the business and specialist partners, e.g. astronomy and wildlife/biodiversity groups, as well the wider more general community (including community councils and organisations), we recommend that particular attention is paid to revisiting and considering some of the comments, ideas and suggestions derived at the initial awareness event (Appendix 5) including:

- Perceived impaired safety and security is likely to be one of the major factors in generating (or impacting upon) public support. There is a need to get the message out in an informed way to communities; use of social media as well as more traditional leaflets might be a productive way forward

- Do it now! No need to wait for the application

- There is a need to learn and adopt best practice where appropriate from elsewhere such as Dark Sky Gwynedd, Snowdonia etc.

- Links should be made with neighbouring areas

- Should a specifc steering group for the AONB with partners be set up take dark skies ambitions forward

- Opportunity to produce a series of toolkits and awards for businesses and communities

As part of this study, we have already some indicative Community and Business guidance with toolkits and awards. We are not proposing that the AONB adopts these in their entirety; rather, they are there to provide ideas for how the AONB might produce bespoke guidance (for website and print for example) as part of its future activities in seeking IDA Dark Sky Designation.

10. MAKING IT HAPPEN: OUTLINE ACTION PLAN - IMPLEMENTATION AND COSTS

Introduction

In order to apply for attaining the desired IDA Dark Designation, the AONB will essentially need to produce an action plan that comprises three elements: a Dark Sky Quality Survey and Monitoring regimen, a lighting plan to reduce light pollution within the AONB in the coming years, and an associated awareness/education programme.

CLWYDIAN RANGE & DEE VALLEY AONB ACTION PLAN
Annual Dark Skies Surveys regimen
A full lighting management plan
Establishment of an annual education/awareness programme

This plan will need to be accompanied by letters of support and endorsement from partners and community organisations.
As stated earlier, there is no set application form and the size and detail of applications to date have varied greatly, although almost all provided a separate detailed full lighting management plan. Accompanying a comprehensive lighting management plan, the Dark Sky Community application from Sark[17] for example was 39 pages comprising the following sections:

- Introduction
- About Sark
- Maps of Sark
- Sark Charter of Community Values
- Sark: A Dark Sky Community
- Sark: A Dark Sky Island
- Map of Sark showing SQM-L readings
- Dark Sky Community Status
- Commitments
- Letters of Support
- Copy of “Keeping Sark Dark Sky Friendly” leaflet
- Copy of “Property Self Audit Guidelines” leaflet

The application for Dark Sky Community designation by Moffat was 316 pages, which included an exterior lighting plan (covering Dumfries and Galloway) of more than 250 pages complied by James Patterson, a specialist lighting consultant (and

17 www.gov.sark.gg/Downloads/Press_Releases/2010_Press_Releases/1009_Sarks_dark_sky_community_application.pdf

Moffat resident) who also did the 126-page exterior lighting plan for the Northumberland National Park.

Along with the very detailed lighting plan, the Moffat application comprised the following:

- **International Dark Sky Community Letters of Support**
  - Letter from Dumfries and Galloway Council
  - Letter from Visit Scotland tourism agency
- **Moffat Dark Sky Community**
  - About Moffat
  - Moffat Dark Sky Town
  - The Bigger Picture: Dumfries and Galloway Dark Sky County
  - Meeting the Eligibility Criteria
- **Night Sky Monitoring**
  - Historical Conditions
  - Night Sky Monitoring NELM and Bortle
  - Night Sky Monitoring SQM-L Site Map
  - SQM-L Readings Pre-refit
  - SQM-L Readings Post-refit
  - Summary of Sky Brightness Reduction
  - Ongoing Monitoring
- **Lighting Management Plan**
  - Policy Statements
- **Light Pollution Mitigation**
  - Cost Saving and Carbon Reduction
  - Inventory of Street Lighting Refits
  - Technical Specification of New Street Lighting
  - Moffat Lighting Compliance Rates
- **Education and Outreach**
- **Other Letters of Support**

We recommend that the AONB explores these applications in detail to get an enhanced understanding of them and what is entailed. Importantly, this study has provided a strong basis with much of the initial material needed for putting an application together. We now provide greater detail on gathering the action plan together, with specific recommendations, along with some indicative costs.

Implementation

Recently, Dark Sky Wales has been working with Anglesey County Council/Cyngor Sir Ynys Môn to devise and implement a plan to establish Dark Sky recognition for the island. To this end, an all-sky survey was undertaken and repeated after a six-

month period to establish the overall quality of the night sky. Once this was established, an action plan was required to gather all the necessary information from the local authority, businesses, and the general public together with letters of support for the final application to the IDA. The following outlines some of the steps and the timeline with the indicative cost:

- Month 1 – Initial meeting with AONB staff
- Month 2 – All-Sky Survey begins
- Month 7 – Repeat All-Sky Survey
- Month 8 – Collection of supporting materials
- Month 9 – Establishment of education programme
- Month 15 – Compilation of Final Application
- Month 18 – Submission of Application

In light of the above, we propose a series of implementation recommendations to take the action plan forward.

RECOMMENDATION 1

We propose that Dark Sky Community status is most appropriate if the AONB is considered on its own. We believe the best option moving forward is to apply for Dark Sky Community status with a view to establishing long-term partnerships with adjoining areas. A larger collaborative application to IDA for reserve status could then be considered in the future working in partnership with neighbouring areas. The AONB may wish to approach the IDA to see if another description of its own is more appropriate than 'community'.

RECOMMENDATION 2

To apply for Dark Sky Community (or Park) status, the AONB will need to establish a regular night sky monitoring programme, devise a progressive lighting plan that seeks to reduce and/or minimise light pollution, and establish education/training and community awareness plans.

RECOMMENDATION 3

The opportunity exists to designate specific locations within the AONB as Dark Sky Discovery Sites (DSDS). Such a route might still available formally, but if not, it could be done informally. In seeking to attain official designation as a Dark Sky Community (or Reserve) as a more ambitious approach, there is likely merit in this as an intermediate step, and as part of the wider process. (we have included this idea as a separate Appendix - Appendix 9)

As such, the AONB might consider whether it is worth establishing a number of Dark Sky Discovery sites within the AONB for communities and visitors and promoting these through the AONB's website and other marketing routes.

RECOMMENDATION 4

The development of a separate dedicated lighting plan to be submitted as part of the IDA application. To develop this, further to the completion of this study, we propose a specific lighting working party be established to produce it, comprising the appropriate lighting and planning officers, and perhaps led by Tony Hughes from the AONB.

This should decide on whether Supplementary Planning Guidance (or another form of guidance) can be produced by the AONB. A defined discrete piece of work undertaken by a lighting engineer based on the evidence provided here is likely to be necessary for the actual plan.

RECOMMENDATION 5

The AONB creates an ongoing series of Dark Sky awareness events and activities in coming years as part of its Dark Skies action plan and application, based on the experiences of the activities and events undertaken as part of this study.

RECOMMENDATION 6

The AONB uses the indicative community guidance produced and amends accordingly for future use to support its Dark Sky aspirations and application.

Together with an awareness events programme, this should be used as part of ongoing community engagement and involvement and to enlist letters of support needed from community organisations for the IDA application.

RECOMMENDATION 7

As necessary, the AONB amends the indicative Business Guidance and toolkit we have produced to support the business and tourism elements and include it as part of its Dark Sky aspirations and formal application. This could also be used to enlist letters of support from business and local and regional tourism organisations for the IDA application.

RECOMMENDATION 8

In conjunction with the events and activities**,** the collection of supporting materials including letters of support is undertaken from a range of interested partners and community organisations as well as the appropriate statutory authorities. A letter of

support from the Future Generations Commissioner might also be a good idea in light of the WFGA.

RECOMMENDATION 9

In light of challenges, especially around lighting, political champions, who are supporters of the ambitions and recognise the benefits of dark skies, are identified amongst the elected members of each of the three local authorities to act as advocates and help drive the action plan forward.

Costs

We consider there are two elements to this:

3. the implementation of lighting changes and associated costs
4. the costs incurred in delivering the action plan itself (printed materials, website, events, and surveys etc.)

Lighting Costs

It is not possible at this stage to provide accurate indicative figures since this will require an agreed plan amongst the AONB and the relevant partners to move towards the IDA-compliant lighting code. As such, this funding could potentially be largely outside the direct influence of the AONB, e.g. the Trunk Road Agency. Also, as indicated in section 5, procurement could be an issue in this regard. Nevertheless, it is clear that this is likely to costs hundreds of thousands of pounds. Some of this will fall within the existing budgets of local authorities for their lighting changes in the coming years but it should be borne in mind that some of it might require additional budgets outside that allocated.

Other Action Plan Costs

These costs are comparatively more modest, but, unlike the lighting costs, where budgets will be available for at least some of the work, in this case, the AONB will have to use its own resources or may well have to apply for additional funding from external sources.

In providing an indicative figure for specific events, DSW normally charges a daily rate of £800 (+VAT) for business events and £500 (+VAT) for community events. The Brecon Beacons NPA holds 6 events each year as part of its Dark Skies programme, so at DSW rates, the average cost is around £12,000. DSW surveys to monitor dark sky quality are priced at £2500 each, so two likely to be required each year, this will be between £7,500 and £15,000 over a three-year period. With associated elements we believe an indicative total cost over three years is likely to around £35 - 40,000 (+VAT).

We must add the caveat that other suppliers of the above services are available whose costs might be significantly different.

APPENDICES

APPENDIX 1

MINIMUM REQUIREMENTS FOR DARK SKY COMMUNITIES

A) A quality comprehensive lighting code like the IDA/IES Model Lighting Ordinance (MLO) with the following minimum standards for permanent lighting installations (more on developing a lighting code and guidelines may be found on our website http://www.darksky.org/outdoorlighting/mlo):

i) Fully-shielded or full cut-off standard for all lighting fixtures over 1500 lumens initial lamp output (or equivalent wattages)
AND

ii) Establishes a threshold of 3000 Kelvins for the allowable correlated colour temperature of all lighting fixtures
AND

iii) Restrictions on total amount of unshielded lighting, such as a limit on lumens per acre or total site lumens in unshielded fixtures (or equivalent wattages)
AND

iv) A policy to address over-lighting, such as energy density caps, lumens/acre caps, or maximum illuminance specifications
AND

v) A provision that clearly: (1) indicates where, when, and under what circumstances new public outdoor lighting (street lighting and lighting on other public property and rights-of-way) is warranted and will be permitted, and (2) requires that adaptive controls and curfews be employed in all future installations of public outdoor lighting.

B) Community commitment to dark skies and quality lighting as shown by:

i) City owned lighting conforming with, or committed to conforming with, the lighting code (if the latter, a published plan with a timeline for completion in no more than 5 years)
AND

ii) Municipal support of dark skies and good lighting as indicated through city publications, flyers, public service announcements, funding of lighting upgrades, etc.

C) Broad Support for dark skies from a wide range of community organisations such as:

- Chamber of Commerce
- Local electrical utility
- Local IDA Chapter
- Lighting retailers
- Home Owners Association
- Business Improvement Associations
- Others

D) Community commitment to dark skies and education as shown by at least one of the following:

i) Planning and execution of at least two community dark sky awareness events per year. This may be organised through a local astronomy club, municipality, school etc.
AND/OR

ii) Inclusion of dark sky awareness documents (IDA brochures or community-created brochures) with other community informational documents for residents and visitors
AND/OR

iii) Inclusion of dark sky education in community schools and curriculum

E) Success in light pollution control. At least one of the following conditions must be demonstrated:

i) Examples of a minimum of ten projects built under the lighting code, demonstrating effective application of the local lighting code
AND/OR

ii) Alternative demonstration of success in light pollution control, to be discussed with IDA for compliance

F) A sky brightness measurement program must be maintained either by the Community or by another public or private organization (university, research centre, IDA chapter, astronomy club etc.) to follow the evolution of light pollution in the DSC.

G) Designation is permanent but is subject to regular review by IDA and possible revocation if minimum requirements are not maintained. More details may be found in the “Reassessment of DSC designation” section.

H) Periodic checks, through the submission of the annual report due October 1st, will be performed to ensure that minimum standards and objectives of

the program are being upheld and adequate progress is being made. This report is a short 1 to 2-page synopsis of the Community's activities and initiatives throughout the last year.

PROVISIONAL STATUS

In some cases, a Community interested in the program may lack all of the resources required to achieve a designation outright. If resource unavailability otherwise hinders the progress of a Community's application, that Community may apply for and be granted Provisional status at the discretion of the IDA Board of Directors.

Provisional status recognises the Community's ongoing work to become an IDA Dark Sky Community and is intended as a leverage point to successfully enable actions such as lighting upgrades/retrofits and policy changes.

Provisional status expires after three (3) years. At any time before the end of this period, a Community may reapply for full status. Material submitted for the removal of provisional status may be an addendum to the initial application as long as the material includes a current assessment of the goals, outreach efforts, and lighting policy listed in the original application and clearly demonstrates that any program requirements left unmet at receipt of the Provisional status have been satisfied.

To be considered for a provisional status, send a nomination package that includes the following information:

- Documented intent to create and support an IDA Dark Sky Community
- A description of the circumstances that currently prevent the Community from meeting the minimum Dark Sky Community requirements
- An action plan describing steps the aspiring Community will take to meet all programme requirements in the specified Provisional status period

APPENDIX 2

MINIMUM REQUIREMENTS FOR DARK SKY PARKS

A) A quality comprehensive Lightscape Management Plan (LMP) with the following minimum standards (see “Lightscape Management Plan Guidelines” section for more details):

i. New, current, and retrofitted lighting must meet the Park’s LMP (which must meet the “Lightscape Management Plan Guidelines” included in this document). The RASC/IDA Guidelines for Outdoor Lighting (GOL) should be consulted in creating the Park’s LMP. These guidelines may be found on IDA’s website (http://bit.ly/1NYjY9D)
AND

ii. Included policy for determining whether an area should or should not be lighted, at what times an area should or should not be lighted, and appropriate illumination levels
AND

iii. Fully shielded fixtures are standard throughout the Park. Any lighting fixtures above 500 initial lumens are required to use fully shielded fixtures emitting no light at or above the horizontal. When unshielded fixtures are used, impacts to the lightscape must be minimised with the use of timers and/or curfews
AND

iv. Methods for determining the appropriate type of lamp (colour, efficiency, technology) and fixture that should be used with goals to maximize energy efficiency and minimise impact to human vision dark adaptation/recovery time, wildlife, and the nocturnal ecology. The correlated colour temperature (CCT) of lamps installed in the Park shall not exceed 3000 K, and a CCT of 2000 K or less is recommended to minimise the impact on most wildlife
AND

v. The LMP should conform to or surpass applicable policy in the appropriate local jurisdiction concerning lighting and dark sky protection as well as other applicable guidance and laws (e.g. environmental leadership programs, agency orders, wilderness act, energy management guidelines)

B) The Park’s commitment to dark skies and lightscape management, as shown by:

i. The Park recognizes dark skies as an important natural, cultural, and/or scientific resource value as demonstrated by inclusion in approved

management documents (e.g. General Management Plan, Resource Management Plan, Facility Development Plan)
AND

ii. At least two-thirds (67%) of existing outdoor lighting fixtures within Park boundaries conform to the Park's LMP at the time of IDA DSP application (or an alternative fraction approved by the IDA Dark Sky Places Committee (DSPC)
AND

iii. Lighting Inventory and a plan to bring 90% of outdoor lighting into compliance with the Park's LMP within five (5) years of receiving an IDA designation, as well as a written commitment to bring the Sanctuary into 100% compliance within ten (10) years of designation
AND

iv. A measurement program must be maintained either by the Park, private landowner(s), or by another public or private organization (university, research centre, IDA chapter, astronomy club etc.) to follow the evolution of light pollution in the DSP and assert that the night sky quality does not degrade
AND

v. The Park has set a leadership example in the restoration of dark skies by implementing at least one of the following:

(1) Producing at least one "night sky friendly" lighting project that is publicly visible and interpreted
OR

(2) Involving at least two external partners in dark sky restoration efforts (e.g. chamber of commerce, power utility, university research, tribal nations, environmental groups, conservation groups, natural history association)
OR

(3) Cooperation with at least two nearby municipalities that results in adoption of lighting codes that improve sky conditions in the Park, **OR**

(4) Inventorying and monitoring night sky quality and using results to educate the public
OR

(5) A combination of the above or an alternative restoration project may be suggested

C) The Park's commitment to public education.

i. The importance of dark skies/natural darkness and the benefits of good lighting should be part of Park interpretation/outreach programs. (Dark skies education refers not only to astronomy education but also education about wildlife, energy efficiency, safety, and human health.) If Park typically provides interpretive programs, then dark skies must be one of the central themes communicated through on-site interpretation. If interpretative programmes are not typically offered, then extensive publications, flyers, press releases, media, social media, or other outreach are appropriate substitutes
AND

ii. Dedicated programming must occur at least four times per year, however, more events are preferable. These events may highlight the dark night sky in any appropriate way (e.g. cultural or historic value, importance to wildlife, astronomical or stargazing events, and a portion of the event must include dark sky awareness or preservation specifically including reference to the IDA and what it means to be an DSP).

D) IDA reserves the right to request stronger or alternative requirements if deemed appropriate and deny DSP status if these requirements are not met. Any requests by IDA will be made through direct contact and communication with the Park.

E) Once established, the Park must erect and maintain a sign indicating the IDA Dark Sky Park designation along a roadway entrance, along a footpath entrance if no roadway exists, or a visitor contact centre. Sign must include DSP text and logo. With Dark Sky Places Committee (DSPC) approval, an alternative wording may be used, such as Dark Sky Wilderness, Night Sky Refuge, or similar. The Park may include the awarded tier if desired. Once the sign is erected a picture documenting this sign must be taken and sent to IDA for records along with a description of its location.

F) A DSP designation is subject to regular review by IDA and possible revocation if minimum requirements are not maintained. More details may be found in the "Reassessment of IDA DSP designation" section.

G) The Park will submit an annual report to IDA by 1 October of each year detailing activities and progress towards fulfilling IDA DSP goals during the previous year. The reports also serve to document that Parks continue to meet minimum programme requirements, are sustaining partnership, outreach, and interpretive efforts, and are making adequate progress toward at least 90% compliance with LMPs. The report should include dates and brief descriptions of interpretive events, lighting retrofit projects, community

outreach, etc. It should also provide information on any new lands acquired since designation and/or the most recent prior report, as well as any potential future sale of land that may result in reassessment of DSP status (see “Sale or Transfer of Land Ownership,” below). Samples of printed materials and press articles should also be included. The annual report should not require a lot of time to produce, as it should be a compilation of information generated during the previous year. A form will be provided to aid in the compilation of these details. Electronic submission of these documents is required in MS Word or PDF format. If the annual report is not sent in a timely fashion, IDA may suspend the IDA DSP’s status until the annual reporting requirements have been met.

H) Sky Quality Tiers

i. Once the minimum requirements have been met, an IDA DSP is designated by IDA at one of three levels – Gold, Silver, or Bronze indicating the estimated sky quality of the site.

ii. Gold corresponds to natural, non-polluted or near-natural night.

iii. Silver corresponds to night-time environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and has exemplary night-time lightscapes.

iv. Bronze corresponds to areas not meeting the requirements of Silver, yet still offering people, plants, and animals a respite from an otherwise degraded nocturnal environment.

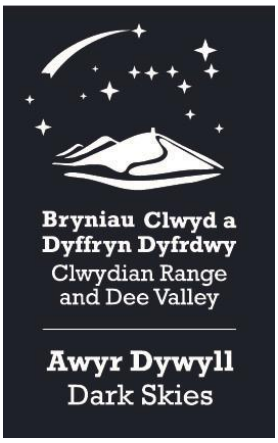
v. The determination of whether the minimum sky quality standard has been met and what tier will be awarded will be decided by IDA based on submitted information.

vi. For a breakdown of requirements for each tier designation, see the table on the next page

Indicator	Gold	Silver	Bronze
Philosophy	Night-time environments that have negligible to minor impacts from light pollution and other artificial light disturbance, yet still display outstanding quality night skies and have superior nighttime lightscapes.	Night-time environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and have exemplary nighttime lightscapes.	Areas not meeting the requirements of *Silver*, yet still offering people, plants, and animals a respite from a degraded nocturnal environment and suitable for communicating the issue of light pollution and connecting people with the many aspects of the night sky.
Artificial Light and Skyglow	Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.	Point light sources and glary lights do not dominate nighttime scene. Light domes present around horizon but do not stretch to zenith.	Areas with greater artificial light and skyglow than *Silver*, but where aspects of the natural sky are still visible.
Observable Sky Phenomena	The full array of visible sky phenomena can be viewed, e.g. aurora, airglow, Milky Way, zodiacal light, and faint meteors.	Brighter sky phenomena can be regularly viewed, with fainter ones sometimes visible. Milky Way is visible in summer and winter.	Many sky phenomena cannot be seen. Milky Way is seen when pointed out to the average person, as is the Andromeda Galaxy.
Nocturnal Environment	Area is devoid of obvious lights that can cause wildlife disorientation. Artificial light levels are thought to be below the threshold for plant and animal impact. Ecological processes related to nocturnality are unaltered. No lighting atop towers or buildings within Park boundary.	Areas that have minor to moderate ground illumination from artificial skyglow. Lights that may cause disorientation to wildlife are distant. Disruption of ecological processes is minor with no impairment to plants or wildlife.	Areas with greater nocturnal impact than *Silver*, but where ecosystems are still functional.
Visual Limiting Magnitude	Equal or greater than 6.8 under clear skies and good seeing conditions	6.0 to 6.7 under clear skies and good conditions	5.0 to 5.9 under clear skies and good seeing conditions
Bortle Sky Class	1-3	3-5	5-6
Unihedron Sky Quality Meter	> 21.75	21.74-21.00	20.99-20.00

APPENDIX 3

Notes from Bodelwyddan Lighting Meeting



Lighting Discussion Meeting
Action Notes

Cofnodion Gweithredu
Cyfarfod Trafod Goleuo

15 June 2017 - 15 Mehefin 2017
Bodelwyddan

ATTENDEES

David Shiel (AONB) - chair;
Tony Hughes (AONB); Ceri Lloyd (AONB); Howard Sutcliffe (AONB)
David Llewellyn (BRO); Rob Owen (BRO)
Allan Trow (DSW)
Karsten Brußk (Denbighshire - Planning Officer)
Craig Wilson (Denbighshire - Lighting Engineer)
Vicky Weale (Flintshire - Planning)

Apologies:
Martin Griffiths (DSW)
Darell Jones (Flintshire - Lighting Manager)
Sarah Jones (Cadwyn Clwyd)
Daniel Davies (Wrexham - Planning Officer)

Also notified/invited:
*Andy Clark (*Denbighshire Works Unit and Streetscene Manager)
Nicola Corbishley (Wrexham – Planning Policy Manager)
Angela Loftus (Denbighshire – Strategic Planning & Housing Manager)
Adrian Walters (Flintshire – Planning)

AGENDA

1. Brief Introductions
2. Setting the scene:
   - AONB aspirations and objectives for Dark Sky Status (AONB)
   - Brief update on study progress (BRO) – Action Plan
   - IDA Dark Sky Designations and lighting (Dark Sky Wales)

3. Open Discussion: *Questions? e.g.*
   - How does it fit with the authorities lighting and planning aspirations and actions moving forward?
   - Who else within the LA's should be involved?
   - Are any community councils or similar bodies involved in lighting control?
   - Involvement in IDA Designation Action Plan
   - Follow up meeting(s) in early autumn to develop a costed plan?
4. Next Steps (meeting date?)

AIM OF MEETING

To commence discussions on the opportunities and challenges with lighting and planning experts from Local Authorities in the AONB in devising and implementing a lighting policy that meets with IDA standards. A discussion paper was distributed in advance of the meeting (see Annex)

ACTION NOTES

BRIEF INTRODUCTIONS

Noted that others were invited; Wrexham has staffing issues at present with leave and work on the LDP. We will keep all in the loop and invite to future meetings.

SETTING THE SCENE

David Shiel (DS) briefly set out the AONB's aspirations and objectives for Dark Sky Status and the background to those.

Allan Trow (AT) and David Llewellyn (DLL) set out the options available for achieving IDA Dark Sky Designations as per discussion paper (annex) with Dark Sky Community status the most likely option for the AONB in the foreseeable future.

Moffat is Scotland was highlighted as a good example – see Annex and *Moffat Dark Sky Community External Lighting Master Plan* at:

- http://www.darksky.org/wp-content/uploads/2016/02/Moffat_LMP.pdf

AT emphasised the possibilities of linking with adjacent areas in future to create larger geographic opportunities. It was also noted that an option could be to apply for community status in a particular area of the AONB, especially the southern part where the skies are notably darker.

More will become apparent from the study's ongoing Dark Sky Survey, but satellite imaging maps collected and collated by BRO to date were shown indicating the light pollution in the area over the past 4 years and current point source lighting in Denbighshire.

- http://www.bro.cymru/docs/clwydianrange&deevalleyAONB/mapping/observedlightpollution.pdf

- http://www.bro.cymru/docs/clwydianrange&deevalleyAONB/mapping/pointsourcelighting.pdf

DLL gave a brief update on study progress; **the major points pertinent to this meeting is that the main element of the Action Plan is a Lighting Plan that sets out an achievable ambition to meet IDA requirements and that should be**

accompanied by an awareness/education plan for communities, businesses and the public sector in the AONB.

AT noted that the wording of the IDA code is oriented towards a US audience but that the AONB plan will obviously be UK/Wales focused.

Open Discussion

There was a discussion of current plans and implementation of lighting changes and possible fit with IDA requirements.

Craig Wilson (CW) - Lighting changes in Denbighshire to LED, driven by finance and energy considerations. LED at 4000 Kelvin is the norm at present; 4000K fitted recently at Corwen Business Park? Very little difference in cost between 3000K and 4000K LEDs? Dimming does not affect Kelvin.

For non-experts, a reasonable explanation can be found at:

- http://www.westinghouselighting.com/color-temperature.aspx

Purchase of lighting in Denbighshire has been supported through SALIX loans. These have payback periods of up to 8 years and have to pay for themselves through energy efficiency savings.

- https://www.salixfinance.co.uk/loans/welsh-loans

There are also procurement issues. Darell Jones in Flintshire is also involved in local procurement agreements?

AT - IDA designation stipulates 3000K lighting; less harsh on the eye with reduced glare and reflection. He also pointed out the issues that Welsh Government installation of lighting at 4000K had caused for the Brecon Beacons and its IDA status with a threat to it being withdrawn.

David Shiel (DS) and Howard Sutcliffe (HS) pointed out the need and desire for Dark Skies in the AONB to produce benefits for wildlife and health, in addition to economic and stargazing benefits. In this respect, importantly, the American Medical Association has recently produced health guidance, highlighting problems with high Kelvin street lights.

- https://www.ama-assn.org/ama-adopts-guidance-reduce-harm-high-intensity-street-lights
- http://theconversation.com/american-medical-association-warns-of-health-and-safety-problems-from-white-led-streetlights-61191

Note the case study of Davis, California where residents have complained about their public-lighting retrofit:

- http://volt.org/lessons-learned-davis-ca-led-streetlight-retrofit/

CW - Denbighshire uses pre-programmed lighting which can be dimmed between say 10 pm to 6 am. It is possible to reduce to 40% of full output. All public (highway) lighting in Denbighshire is LA controlled (no community lighting). Is that true for Wrexham and Flintshire?

AT - RCT in the south switches off 1/3 lights in some areas. CW highlighted that they would not wish to do that to avoid potential adverse strobe effects for drivers.

The issue of traffic calming measures and lighting was raised and is a consideration, i.e. often areas where such measures are introduced have commensurate increased lighting.

AT – Pembrokeshire is a good example of street lighting in Wales (*the linked story below is quite old but shows the approach

- http://www.bbc.co.uk/news/uk-wales-south-west-wales-12773153

Note this did cause some controversy amongst local members and highlights need to get local councillors and other key players informed and involved.

Vicky Weale (VW) noted that there are training sessions for members and officers in Flintshire and suggested these could be used for raising awareness and informing both about the benefits and opportunities through Dark Skies. Trunk Road officers should be involved. Community and business involvement also seen as key.

Tony Hughes (TH) raised the potential issue of “inadequate” outside domestic and business lighting. This highlights the need for getting good community/business lighting guidance within the AONB. This could be an opportunity for involvement of schools. It was suggested that an approach could be working with 1 village/school at a time across the AONB?

It was also suggested that local champions and good ‘political buy-in’ could help do this, particularly in view of the potential for perceived contradictions between economic growth and lighting issues, which might be the case in north Denbighshire as highlighted by Karsten Brußk (KS). One possibility is Ken Skates, AM for Clwyd South and WG Cabinet Secretary for Economy and Infrastructure. (Q – he would need to be approached?). The Dark Sky events throughout the summer offer opportunities to get key members and officers on board. Rob Owen (RO) suggested whether a specific session could be held for them?

A discussion then ensued on planning and planning guidance with respect to lighting. There were discussions on whether lighting was including in LDPs and/or whether there was a requirement for Supplementary Planning guidance, e.g. Snowdonia National Park is expected to produce SPG in the near future:

- http://www.eryri-npa.gov.uk/looking-after/dark-skies

TH has sent current LDP/UDP planning policies related to lighting:

Denbighshire LDP (Adopted 4/6/2013) – Policy RD1, criterion vi)

- http://www.denbighldp.co.uk/Webfiles/Adoption/Adopted%20LDP%20text%20english.pdf

Flintshire UDP (adopted 28/09/2011) – Policy EWP 13 (p. 146)

- http://www.cartogold.co.uk/flintshire/text/english/00_contents.htm

Wrexham UDP (Adopted 02/2005) - No policy specifically mentions controlling light pollution

Both Flintshire and Wrexham are well advanced on preparing LDPs to replace their out of date UD's, but these have not yet been adopted.

The Northumberland International Dark Sky Park has produced a Good Practice Guide for Outside Lighting in Northumberland International Dark Sky Park for residents and those seeking permission to develop within the area.

- http://www.northumberlandnationalpark.org.uk/wp-content/uploads/2016/03/NNP-outside-lighting-guide.pdf

AT emphasised that the IDA Dark Sky Community status requirements are primarily to produce a plan with a clear intention and commitment to achieve the standards over a fixed (e.g. 5 year) period that can be monitored for progress. So, direction of travel will be key.

APPENDIX 4

Overview of Lighting Surveys

Question	Wrexham	Denbighshire	Flintshire
DARK SKY AWARENESS			
Are you aware of the International Dark Sky (IDA) initiatives?	Yes	Yes	Yes
Are you aware of or familiar with Dark Sky lighting plans in designated areas in the UK, e.g. Snowdonia National Park, Brecon Beacons National Park, Moffat Dark Sky Community?	Yes	Yes	Yes
CURRENT LIGHTING POLICIES AND IMPLEMENTATION			
The IDA sets out a quality lighting code the following minimum standards for permanent lighting installations (lighting code development and guidelines are available on its website http://www.darksky.org/outdoorlighting/mlo)			
What is the existing lighting technology you are using?	Mixture of traditional lighting technologies and LED	LED and HID	Mixed (Son / Sox / CPO / LED)
Is there an existing commitment to changing lighting, for example from Low Pressure Sodium (SOX) or High-Pressure Sodium (SON) lighting to	To meet energy, carbon and maintenance savings we will, subject to funding, be phasing out the traditional	We are changing everything to LED	Yes - moving towards LED with zero upward waste light. 12,000 units in the next 2

LED, reducing lighting costs, and/or carbon emissions with your current policy and practice?	street lighting and replacing all lighting assets with LED		years
IDA CODE ASPIRATIONS **How do current or proposed lighting plans fit with IDA criteria?**			
Fully-shielded or full cut-off standard for all lighting fixtures over 1500 lumens initial lamp output (or equivalent wattages)			
Does your current lighting meet with that?	All LED lanterns being installed will be full cut-off	No	Yes – targeted area illumination.
Will proposed or future lighting replacement meet that?	Yes	Yes	Yes
Are there any specific locations that do not fit with this, or are unlikely to meet this, in the near future to your knowledge?	None	All areas will meet this within 4 years	Going forward we will hopefully be fully compliant
The IDA criteria for Dark Sky Community status seek to establish a threshold of 3000 Kelvins for the allowable correlated colour temperature of all lighting fixtures			
Does your current lighting meet with that?	No	No	No - Currently use between 3000K and 4000K
Will your proposed or future lighting replacement regime meet that?	Due consideration will be given to introducing this threshold	No	As above.
What issues or challenges might you	None	This could cause	Cost and reduced

foresee in attaining this?		procurement issues and will also affect efficiency, which could affect funding	illumination spread. Please note that our lanterns are G6 rated (dark sky friendly)
Restrictions on total amount of unshielded lighting, such as a limit on lumens per acre or total site lumens in unshielded fixtures (or equivalent wattages)			
Does the above apply (to your knowledge?)	No	Yes	Not really as our new lanterns give zero upward waste light and a class 6
A policy to address over-lighting, such as energy density caps, lumens/acre caps, or maximum illuminance specifications			
Are there existing formal or informal policies that address this?	No	The Denbighshire Local Development Plan 2006 – 2021 contains local policy RD 1 aiming at achieving good standard design in new development. Policy criteria vi) contains reference to light pollution but does not set specific standards regarding temperature, energy levels, etc	Yes, we can install shields if required. ND caps wouldn't really work for our requirement of illumination nor for the target areas
If not, is it possible that future policy can address this?	It is possible that a policy could be introduced in some areas to address the issue of over lighting	It is highly likely that the forthcoming LDP will contain a similar policy to the currently adopted RD 1. Specific details such as,	Yes.

		energy density caps and light temperature, should however be subject of a Supplementary Planning Guidance (SPG) note and not local policy. It would assist the local planning authority to be provided with further background information / evidence before producing such a document	
A provision that clearly: (a) indicates where, when, and under what circumstances new public outdoor lighting (street lighting and lighting on other public property and rights-of-way) is warranted and will be permitted, and (b) requires that adaptive controls and curfews be employed in all future installations of public outdoor lighting.			
Do any of the above provisions apply currently or are likely to in the foreseeable future?	No current provisions Future provisions to be considered	No	We already take on board this within our policy and specifications but also look on a site by site basis
Obtaining a costed phased plan is likely to be an important element of the AONB's aspirations going forward			
Could you provide a rough estimate at this time of what you think it would cost to bring the lighting to a standard that meets IDA requirements		£300K	Assuming that the K range is acceptable and current funding levels hold we could be compliant within 5 years.
Over what time period might that be		2 years	5 years

achieved?			
Community commitment to dark skies and quality lighting			
Are you aware of any council or other information or support material that is available to make communities and businesses aware of Dark Sky benefits and good lighting practice?	No	No	Yes, they tended to be included within specifications and tenders from various sources within differing Councils dependent upon their approach to illumination and cost savings
Success in light pollution control			
Have you any specific examples of current or proposed actions to achieve successes in light pollution control?	None	No	We aim to eliminate upward waste light from standard lanterns. Our policy dims units by 30% from 2000 hrs until 0600 hrs.
ANY OTHER COMMENTS OR SUGGESTIONS			
			We aim to eliminate upward waste light from standard lanterns. Our policy dims units by 30% from 2000 hrs until 0600 hrs.

APPENDIX 5

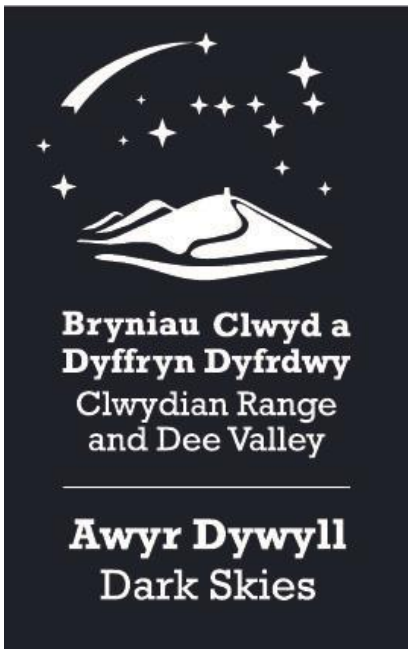
Initial Awareness Event Report

DIGWYDDIAD YMWYBYDDIAETH AWYR TYWYLL

PAFILIWN LLANGOLLEN

Dydd Llun 20fed Mawrth, 2017

ADRODDIAD ADBORTH



DARK SKIES AWARENESS EVENT

LLANGOLLEN PAVILION

Monday 20th March 2017

FEEDBACK REPORT

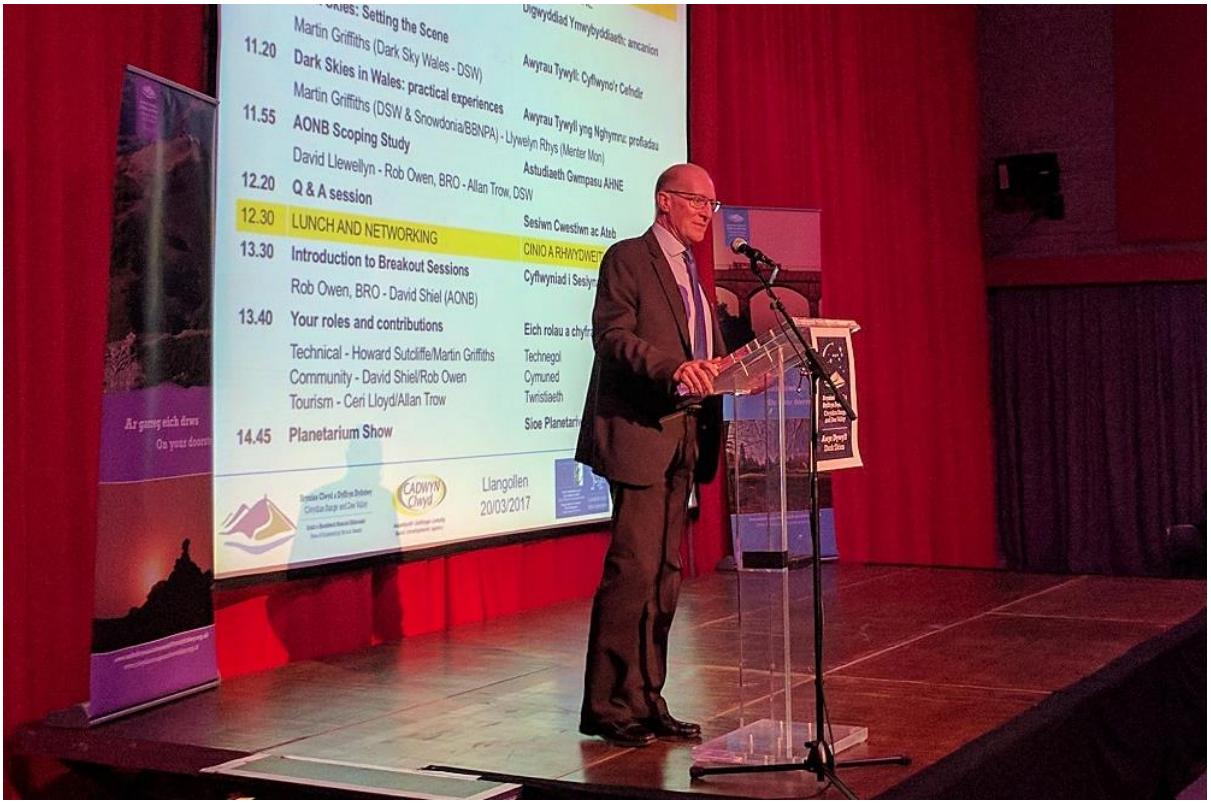
Partneriaeth BRO Partnership

Dark Sky Wales

PROGRAMME - RHAGLEN

10.30	**Welcome**	**Croeso**
	Andy Worthington, Partnership Chair AONB, Cadair Partneriaeth AHNE	
10.40	**Awareness Event: aims**	**Digwyddiad Ymwybyddiaeth: amcanion**
	Rob Owen (BRO)	
10.50	**Dark Skies: Setting the Scene**	**Awyrau Tywyll: Cyflwyno'r Cefndir**
	Allan Trow (Dark Sky Wales - DSW)	
11.20	**Dark Skies in Wales: practical experiences**	**Awyrau Tywyll yng Nghymru: profiadau**
	Martin Griffiths (DSW & Snowdonia/BBNPA) - Llywelyn Rhys (Menter Môn)	
11.55	**AONB Scoping Study**	**Astudiaeth Gwmpasu AHNE**
	David Llewellyn - Rob Owen, BRO - Allan Trow, DSW	
12.20	**Q & A session**	**Sesiwn Cwestiwn ac Ateb**
12.30	**LUNCH AND NETWORKING**	**CINIO A RHWYDWEITHIO**
13.30	**Introduction to Breakout Sessions**	**Cyflwyniad i Sesiynau Grŵp**
	Rob Owen, BRO - David Shiel (AONB)	
13.40	**Your roles and contributions**	**Eich rolau a chyfraniadau**
	Technical - Howard Sutcliffe/Martin Griffiths Community - David Shiel/Rob Owen Tourism - Ceri Lloyd/Allan Trow	Technegol - Howard Sutcliffe/Martin Griffiths Cymuned - David Shiel/Rob Owen Twristiaeth - Ceri Lloyd/Allan Trow
14.20	**Feedback and Summary**	**Adborth a Chrynodeb**
	Rob Owen, BRO - David Shiel (AONB)	
14.45	**Planetarium Show**	**Sioe Planetariwm**

MORNING SESSION



Above – Andy Worthington AONB Partnership Chair welcoming delegates

The morning session was dedicated to getting partners of the AONB to understand the concept of Dark Skies, its value and benefits, and how the study intended to proceed.

- Further to the introduction by Andy Worthington, Partnership Chair of the AONB, the session focused initially on the background to the concept of Dark Skies.

- Martin Griffiths set the scene regarding the background to Dark Skies before discussing developments in the Brecon Beacons and Elan Valley.

- Llywelyn Rhys of Menter Môn presented on the development work being done with Dark Sky Gwynedd to make tourism accommodation providers Dark Sky Friendly through a pilot scheme to provide simple equipment.

- The BRO team with DSW Wales then gave an overview of the AONB study and progress to date.

Questions from attendees were taken throughout the session relating to the opportunities afforded, particularly for businesses and tourism in general in the AONB.

Presentations will be available at www.bro.cymru/clwydianrange-deevalley.html. BRO will develop and maintain this to keep delegates up to date with the study.

Above - Martin Griffiths (DSW) presenting Dark Skies developments in Wales

Above - Llywelyn Rhys (Menter Môn) discusses the Dark Sky Gwynedd pilots

BREAKOUT SESSIONS

Introduction

In the afternoon a breakout session was held. Delegates were divided into three groups – Tourism, Technical and Community. The groups were evenly split with around ten in each group.

Each group were tasked with considering key questions:

- **Who** needs to be involved?
- **What** do they need to do? e.g. organise events, monitor light readings
- **Where** do they need to do it? i.e. the geographical coverage
- **How** should it be done? e.g. through additional funding, regulations and controls, campaigns
- **When** are the actions required? i.e. the timescale

These were not meant to be tackled in any particular order, rather they were intended to be a framework for capturing ideas that might eventually be included in the Action Plan.

TOURISM GROUP - Facilitators: Ceri Lloyd (AONB) and Allan Trow (DSW)

Who

- North Wales Economic Ambition Board
- Local Authorities
- Communities within the AONB

- Trunk Road Agency
- North Wales Regional Tourism Forum
- Clwydian Range Tourism Group (CRTG) / Flintshire Tourism Association (FTA)
- Ponstcysyllte Aqueduct and World Heritage Site
- Cadw
- Destination Management Partnerships including
- Tourism Ambassadors
- Shropshire LA (Shropshire Hills AONB)

Obtaining letters of support from some of these organisations would strengthen the application.

What

- Event at CRTG meetings, linked to advice and how to get involved guides
- Providing written info, including case studies showing the benefits. These should be easy to digest
- Capturing the Learning Journey as the initiative progresses. This could be done via Cadwyn Clwyd's Learning Journeys
- Organising Talks and Walks
- A link could be developed to 'Mythology Festival' through TAF
- Attend Tourism forums to raise awareness
- Organising weekend Dark Skies events and other packages
- Developing marketing and promotional materials, including the use of social media within a wider Comms Strategy
- There will be a need to develop a toolkit for the trade. This could be started now. This should give them the confidence to promote Dark Skies as a tourism product.

How

- Developing a grant scheme on the same lines as Snowdonia National Park
- The Dark Skies application should run alongside a programme of events to keep momentum and support
- Engaging with AONB staff
- Funding through Cadwyn Clwyd RDP, but further funding could be obtained from: Friends of the CRDV AONB, HLF, Visit Wales. The more partners that can be involved, the better.

Where

Possible locations include:

- Berwyn
- Corwen
- Caer Drewyn, Corwen
- Llandegla

There are less visitors to these areas compared to Moel Famau and Loggerheads.

Promoted sites will need to be based on: adequate facilities, car parking and access. These are not necessarily IDA issues, rather they are fundamental aspects relating to the management of the AONB.

When

Initial light surveys will be completed by Nov 2017 with view to starting application process after securing of funding. Application to be submitted for consideration at end of 2018. The IDA board meets every 2 months. A possible launch date would therefore be March 2019. From this point, it will be important to keep up the momentum.

TECHNICAL GROUP - Facilitators: Howard Sutcliffe (AONB) and Martin Griffiths (DSW)

Who

- Highways Lighting and Road Safety Engineers, individually and within professional bodies e.g. society of engineers
- Trunk Road Agency Officers
- Astronomical Societies
- The public, educational and outreach role
- Managers of sports fields and parks

- Industry
- Planners especially in terms of using Supplementary Planning Guidance

Where

Most of the light pollution comes from the North and the East, whilst adjoining areas, notably Berwyn and Hiraethog have dark skies.

What

- There needs to be a balance between the cost of reducing light pollution and the available funding, but this needs to include consideration of spending to eventually reduce costs.
- More guidance from Welsh Government on road lighting would be beneficial.
- More could be done to reduce the impact of security lighting through more appropriate technical solutions.

How

- Organising events
- Developing fact sheets
- Possible funding through the Single Use Carrier Bag levy
- The use of the Section 85 duty would encourage organisations to support the AONBs efforts
- Flintshire Business week could be a good opportunity to engage
- Building on the experience of others e.g. Northumberland NP and the leaflets they have produced
- Providing info on the Llangollen Notice Board
- Discussions with Network Rail
- Key businesses e.g. Llandegwyn Hall, One Planet Adventure, Ponderosa

COMMUNITY GROUP - Facilitators: David Shiel (AONB) and Rob Owen (BRO)

Who

The group felt it was important to set out why this work was important, and this built on some of the presentations given during the morning.

- Opportunities to experience the landscape at night, which is a natural resource. This reflects aspects of our quality of life and connection to the natural world
- There will be a need to show how reducing light pollution will not impact on security and safety
- The links to legislation, notably the Well-Being of Future Generations and Environment Acts. Under the latter the definition of natural resources is left fairly open, so there is an opportunity to present a case that dark skies should be included. This could then impact on the Area Statements being produced by NRW
- Tourism Economy, but based on sustainable principles and promoting out of seasons events
- Educational and learning opportunities

Where

Before identifying key actors and actions the group spent some time exploring the geographical limits of the possible designation.

- Should the whole of the AONB be included, or only the parts with darker skies?

- What should the buffer zone be?
- Where are the key locations e.g. Moel Famau? These could be promoted as core areas with the darkest skies.

The Community Designation is about continuous improvement, so this could (and should) include some areas of light pollution.

There could be merit in extending the area beyond the AONB, particularly into the Berwyn and Hiraethog mountains.

Who and What

This could be grouped under:

Beneficiaries

- Schools
- Special colleges
- Young Rangers
- Health Care Groups
- Older people
- Mental Health Groups
- Astronomy Groups
- Environmental Groups

These groups could be involved in light monitoring and capturing data. They would also be audiences to attend events. The promotional activities of some groups e.g. wildlife societies could be extended to include star gazing events and promotion.

Influencers

- Local Authorities (Flintshire, Denbighshire and Wrexham)
- Community Councils
- Potential funders
- Cadwyn Clwyd, LEADER funding
- Landowners
- Biodiversity Groups

Snowdonia National Park Authority have developed SPG on the lighting of new developments and this could be raised with planners in the three authorities.

The cost savings associated with street lighting schemes should also be raised with highway and lighting engineers.

Funding will need to cover both the promotion of events and the longer-term replacement programme of street and other lighting schemes.

For landowners and some local residents there will be a need to dispel any fears regarding possible negative effects of reducing light pollution.

More could be done to link dark skies to wildlife interests.

How

- Additional funding e.g. Dark Skies Officer
- Establishing a steering group
- Build on existing relationships
- Once designation is achieved it will be important to maximise the benefits of the status to businesses
- Organising community engagement events possibly linked to the AONB Forum
- Developing links with wider communities e.g. in Merseyside and Chester
- Planetarium events can be a big draw
- Possibility of organising trips to Jodrell Bank Observatory
- It will be important to involve the right groups from the beginning

GENERAL CROSS-CUTTING COMMENTS AND FEEDBACK

- There appeared to be a great deal of enthusiasm for the ambitions and aspirations of the AONB.
- Questions were well considered in the morning session and there was lively and informed debate in the breakout session.
- A common theme across groups was that perceived impaired safety and security would be one of the major factors in generating (or impacting upon) public support. There is a need to get the message out in an informed way to communities. Use of social media as well as more traditional leaflets might be a productive way forward. Note that Dumfries and Galloway Council adopted in August 2015, Dark Sky Park Friendly Lighting as SPG for their LDP.
- Doing it now! No need to wait for the application. There is a need to get started now in conjunction with the study, not just the awareness events but also other actions.
- There is a need to learn from elsewhere such as Dark Sky Gwynedd, Snowdonia.
- Links should be made with neighbouring areas.
- Opportunity to produce a series of toolkits and awards for businesses and communities
- Should a specifc steering group for the AONB with partners be set up take this forward.

	DELEGATES					
	Technical		**Community**		**Tourism**	
Staff	Howard Sutcliffe	AONB Officer	David Shiel	AONB Officer	Ceri Lloyd	Sustainable Development Officer
			Ros Stockdale	Community Partnership Officer	Karen Holthofer	Communications Officer
	Fiona Gale	County Archaeologist	Rachel Jones	Community Partnership Officer		
Delegates	Amy Green	Wildlife Trust	John Roberts	Friends of CRDV	Richard Jones	Flintshire Tourism
	Emma Broad	Wrexham Bio	Mike Skuse	Friends of CRDV	Joe Bickerton	Wrexham Tourism
	Sarah Slater	Flintshire Bio	Andy Worthington	AONB Partnership Chair	Ian Lebbon	Denbighshire DMP Chair
	Anna Irwin	Wrexham	Martyn Holland	DCC Councillor	Marilyn Jeffrey and Dave Jones	Clwydian Range Tourism Group
	R S Moore	Friends of the AONB			Nicola Lewis-Smith	Canal and River Trust
	Gethin Davies	NRW / SNPA	Liz Carding	Wrexham Countryside	Sarah Jones	Cadwyn Clwyd
			Mark Kelly	North Wales Astronomy	Dewi Davies	AONB
	Jonathan David Harty	North Wales Astro and Mid-Cheshire Astro	Dawn Roberts	WHS	Fiona Dolben	Denbighshire Tourism
					Roger Williams	AONB Guide
					Sarah Jones	Wales Blue Badge Guide

APPENDIX 6

Indicative Community Guidance

Bryniau Clwyd a Dyffryn Dyfrdwy
Clwydian Range and Dee Valley
Awyr Dywyll
Dark Skies

Dark Skies in the Clwydian Range and Dee Valley AONB
A Community Guide

As you may know from your own experience, the Clwydian Range and Dee Valley AONB offers wonderful opportunities for local communities and visitors to enjoy and wonder at the marvels of the night skies. And now there are plans afoot to try to improve those experiences for all by achieving International Dark-Sky Association (IDA) Designation for the AONB to be recognised amongst the best places in Wales,

the UK and indeed globally to view the marvels of the night skies.

What can you see?

Within the AONB, there are many areas that provide wonderfully dark skies where observers can view a host of stars, constellations ranging from well-known ones such as Orion and Ursa Major (the Plough) to perhaps less well-known ones, for example Cygnus, and galaxies including indeed our own Milky Way galaxy. The AONB will be producing a guide to indicate these locations in the near-future, which will help you enjoy the wonders of the night skies.

What other benefits are there, especially for communities?

Importantly, protecting our dark skies is about much more than simply being able to view the wonders of the universe above us although that will help improve the quality of life in our communities and attract more visitors which will help boost the local economy.

Light pollution from poorly-designed and implemented lighting impairs our ability to enjoy the night skies. Encouraging the use of high-quality eco-friendly lighting reduces light pollution and carbon emissions too so helping to combat climate change. Moreover, there is increasing evidence which is highlighting the crucial beneficial effects that safeguarding the night-time environment has for nature and wildlife, and very importantly too, for our own health and wellbeing. Despite the often-common misconception that 'reduced' lighting can adversely affect safety and contribute to crime and anti-social behaviour, studies have shown well-directed lighting actually improves our ability to see in the dark and can help combat crime and improve safety.

What can you as communities and individuals do to play your part and be involved in supporting the AONB?

Communities and individuals can play a vital part in helping to create an environment that supports dark skies. You can become dark sky friendly with your own outside lighting and, in doing so, help the AONB become one of the best places in Wales and the UK to view the wonders of the night sky. There are some common misconceptions around lighting to support Dark Skies including:

- **Everyone will need to turn their outdoor lights off**

This is not true. It's about getting exterior lighting, both public and private, being directed where it belongs and where it is more effective, and not into the sky and into neighbours' premises.

- **More lights will decrease crime**

Evidence for the UK and beyond suggests there is no direct link between higher

levels of lighting and lower crime levels.

- **Light pollution is inevitable in towns and cities**

Again, this is a fallacy. Why waste energy and money on producing light that never hits the ground?

- **The problem of light pollution is too big for us to make a difference**

Everyone can play their part. It is not a problem that can be solved overnight but we can all make a difference.

People in communities around the world are now taking action to reduce and eradicate light pollution from Moffat in Scotland to Harmony, Florida in the United States and beyond. As they show, we all need effective outside lighting. So, we are seeking to encourage 'good' exterior lighting that is directed effectively and not into the sky. There is no compulsion for you as a resident to fit cut-off fixtures etc. but you are encouraged to confine the light spill from your external lighting as shown above.

What about street lights?

Whilst moves are underway to try to improve road and street lights in the AONB, more needs to be done - you could ask your councillors or local authority street lighting departments to support you, your neighbours and your community.

FIVE TOP TIPS FOR CREATING AND MAINTAINING DARK SKIES

1. Keep it warm

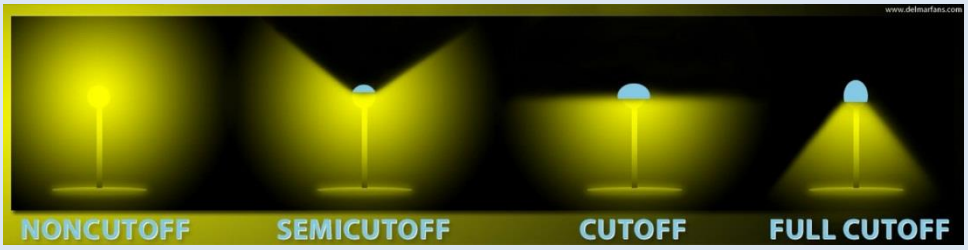
Use 'warm' light sources for outdoor lighting, i.e. lighting with lower colour temperatures, which has less blue in its spectrum. Many LED lights emit a blue short wavelength light that scatters easily into the atmosphere causing eyestrain, impairing night vision and adding to light pollution. So, use LED bulbs that produce warm white lighting.

2. Shield It

Choose outdoor light fixtures that are shielded, i.e. a solid cap above the bulb to prevent light from being emitted directly to the sky. Existing fixtures by buying and installing reasonably priced shades.

3. Cut It Off

Select exterior light fixtures with cut-off angles, preferably full cut-off as shown below, that prevent light from escaping and polluting the skies, and improving the effectiveness of your lighting.



4. Sensor It

Install motion sensors on outdoor light fixtures so they only come on when needed and turn off after a short time.

5. Turn It Off

Turn off unnecessary outdoor lights when you are home for the night or before going to bed to prevent wasteful dusk to dawn lighting.

APPENDIX 7

Indicative Business Guide and Toolkit

Dark Skies in the Clwydian Range and Dee Valley AONB Business Guide and Toolkit

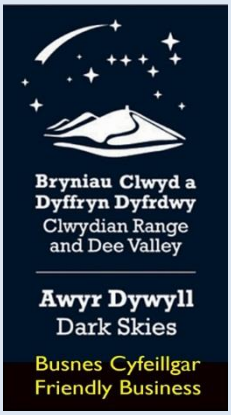
The Clwydian Range and Dee Valley AONB offers wonderful opportunities for local communities and visitors to enjoy and wonder at the marvels of the night skies and there are plans afoot to try to improve those experiences for all to become amongst the best places in Wales and the UK to view the night skies.

The attractions of dark skies have been successful in helping to boost business and tourism offers elsewhere globally, the UK and in Wales, e.g. in the Brecon Beacons and Snowdonia.

The AONB is keen to work with business partners to help them improve their dark skies offer to visitors. To do this, the AONB has developed a number of criteria to support the dark skies opportunities in the AONB and to support you to help your visitors understand the sort of dark skies experience they can expect when they visit or stay with you.

1. **Dark Skies Business Champion**
2. **Dark Skies Friendly Business**
3. **Dark Skies 'Visit and View' Business**

Dark Skies Friendly Business



Dark Skies Friendly Business accreditation is aimed at accommodation providers in the AONB, although pubs, restaurants and other attractions might also apply. Owners or appropriate staff of Dark Skies Friendly Businesses will be expected to have received training as Dark Skies Business Champions.

In addition, you should:

- Take measures to reduce light pollution on or close to the premises (the business and community guide provides detailed advice on this)
- Provide visitors with relevant information on how to enjoy the night skies in the AONB, including details of equipment that they might bring with them
- Provide information on site through leaflets or fact sheets, relevant maps, basic star charts, popular stargazing books etc.
- Provide relevant information on their website (if applicable) using the Dark Skies Friendly Business logo
- Promote star gazing activities and events in the AONB through their literature and social media outlets on websites
- Be flexible and amenable to visitors that have come to view the night skies and/or attend specific stargazing events and activities

You might also provide some basic equipment for loan such as binoculars, more advanced star charts, appropriately adapted torches.

Dark Skies 'Visit and View' Business

Dark Skies 'Visit and View' Businesses are those that can offer opportunities to stay and view the night skies on their premise,

You will need to satisfy the criteria for Dark Skies Friendly Businesses, but you should also provide a designated, safe (with appropriate lighting) viewing site for visitors that is not impacted upon adversely by indoor or other lighting.

You should offer equipment such as binoculars and telescopes for visitors to view the night skies – the owners or appropriate staff should be trained to support less experienced visitors in using these.

You could offer specific events or link with events within the AONB to provide additional offers for visitors.

APPENDIX 8

Dark Sky Discovery Sites Opportunity

There is a *UK Dark Sky Discovery Partnership* - www.darkskydiscovery.org.uk – which a network of national and local astronomy and environmental organisations. It aims to:

- Engage people from diverse backgrounds with the night sky
- Encourage positive attitudes towards science and technology
- Support the development of dark sky places, awareness and tourism
- Develop a national network of dark sky communicators
- Create long-lasting organisational partnerships in this area

A particularly good example of this from an AONB perspective is the North Pennines AONB where small sites, e.g. Cow Green Reservoir.[18]

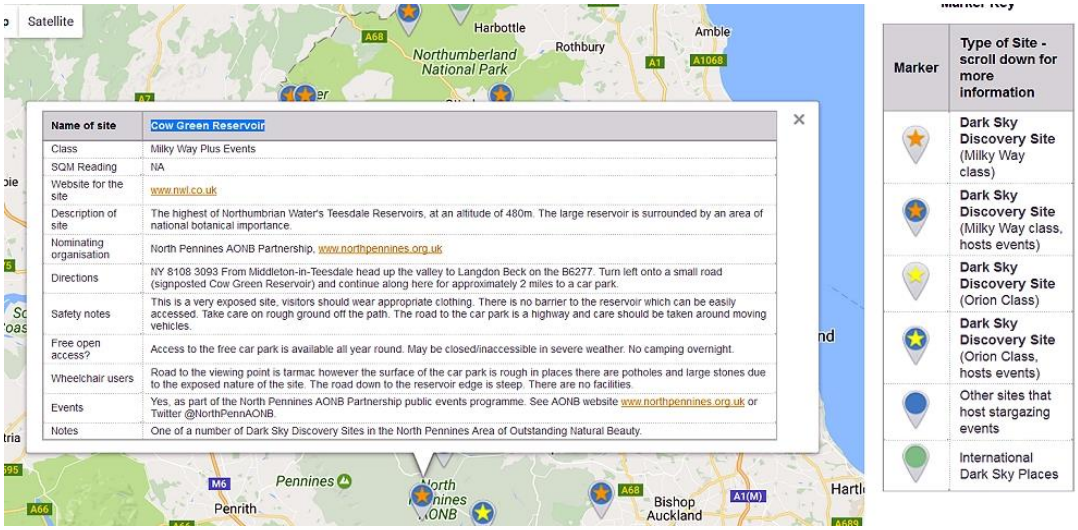


FIGURE 11 – COW GREEN RESERVOIR DARK SKY DISCOVERY SITE (NORTH PENNINES AONB)

These can also be coupled with the other attractions at a site such that the sites provide a wider offer for communities and visitors. Again, a good example of this is within the North Pennines AONB with the Derwent Reservoir site combining stargazing with walks, rides and wildlife.

Further to discussion, the AONB suggested, we explore the following sites for potential consideration:

- Moel Arthur Car Park
- Coed Llangwyfan Car Park
- Moel Famau – Pen Barras
- Llantysilio Green Car Park and View Point
- Caer Drewyn Corwen
- Coed Pen y Pigyn View Point

[18] More details at http://www.explorenorthpennines.org.uk/recreation-opportunity/stargazing

- Gop Hill – Trelawnyd

Our analysis suggests that based on their dark sky quality, these would gain recognition as Milky Way DSDS status - sites where the Milky Way is visible to the naked eye, usually darker sites found only in more rural areas. However, access is important for such formal designation, particularly disabled access, the last three do not meet access requirements currently as indicated in this report in Appendix 3, which shows the criteria and an example of the nomination form.

However, it is not clear whether this form of designation is still available formally. Nevertheless, some areas such as the south Wales valleys have done this informally in some cases.[19]

[19] http://www.thevalleys.co.uk/explore/maps/star-trail.aspx

APPENDIX 9

Dark Sky Discovery Sites Criteria

Dark Sky Discovery Sites
Criteria for Sites

These notes explain the criteria that are met by the places that are officially recognised as Dark Sky Discovery Sites (DSDS). We are not currently seeking nominations for further DSDS except through the programmes being led by the DSD Lead Partners in the English regions and in Scotland, Wales and Northern Ireland. Please see those Partners' contact details on our website if you wish to find out more about their programmes. - www.darkskydiscovery.org.uk .We hope to open up nominations more widely in the future.

What is a Dark Sky Discovery Site?

Every community has its best local place for seeing the stars on a clear night. In an urban area, this could be a park, a playing field or some other open space. In a rural area, it might be somewhere that is a short walk or drive from village. A Dark Sky Discovery Site is a place chosen by a local organisation to encourage local people, visitors, schools and groups to enjoy the night sky.

The Sites are publicised on the website www.darkskydiscovery.org.uk and as the list of nominations grows a network of good local stargazing sites will take shape.

Criteria for Dark Sky Discovery Sites

A Dark Sky Discovery Site must meet all the following criteria:

1. Size. The Site should be 100m² (10mx10m) in area. This is small enough to be defined clearly by an 8 figure Grid Reference and large enough to be used by a visiting group of 30 people. In many cases, the Site will be part of a wider park or open space which has other locations which don't match the other criteria (e.g. darkness, sightlines, access, safety) in the same way as the core Site. For example, they may have better sightlines but not have wheelchair access. If so, you can

explain this briefly in the Other Comments section of the form.

2. Darkness rating. The site must meet one of these levels:

- One Star Site: The seven main stars in Orion are visible to the naked eye. Typically, this means away from, or shielded from, bright lights such as street lights, security lights or approaching car headlights.

- Two Star Site: The Milky Way is visible to the naked eye. This will be a much darker site only found in more rural areas.

Ideally, please ask a local astronomy organisation such as a local club or university to confirm this rating.

Local clubs in the UK can be found here www.fedastro.org.uk/fas/. If you are able to take a Sky Quality Measurement for the site, please include tell us the figure. Here are some guidelines on how to do this

- Sightlines. The site should provide relatively good sightlines of the horizon in all directions. Typically, this means away from tall building, trees and high ground. There is no absolute measure required here and you and you may find it helpful for a local astronomy group to help with this judgement.

- Public access. Ideally, the site will be freely open to the public. However, it may be necessary for people to make special arrangements to visit. For example, it may be necessary for visitors to contact the managers of the site in advance because the site is part of an operation such as an outdoor learning centre. If so, you should explain this in the Form.

- Wheelchair access. The Site must be accessible to a wheelchair user. As explained above, the Site might be a short walk from other observing locations that do not meet these criteria.

- Safety. The site must have been Risk Assessed by the nominating organisation.

Please use your own Risk Assessment form. In Risk Assessing your site, hazards to be considered should include:

- Uneven or wet ground.
- Open water/steep drops.
- Traffic.
- Anti-social behaviour.

Check the website for the Site (linked from the google map) for the latest access information. Follow the countryside code for England, Scotland, Wales or North Ireland. A Site for which the Risk Assessment identifies the need for hard measures such as installation of a fence or steps, will not meet these criteria.
Whilst the Science and Technology Facilities Council will recommend the site as a good place to see the stars, we do not accept any responsibility for any harm, injury, damage, loss or prosecution as a result of people visiting these sites.

3. The nomination must be supported in writing by the landowner and local authority. For the local authority, the Parks and Open Spaces Department is likely to be the appropriate Department to approach for this support.

Example Nomination Form

Name of site	**Joppa Quarry Park**
Darkness rating	One Star
SQM reading	
Short description (20 words)	A public park in north east Edinburgh that is not directly overlooked by any streetlights.
Access routes	Access is via paths from xx road, yy road and zzz roads.
OS Grid Ref (6-8 figure)	xxxx xxxx
Free, open access?	Yes, no restrictions
Wheelchair	There are hard surface paths leading to the edge of the park but not across the park.
Stargazing events	None
Nominating organization + URL (optional)	Portobello Primary School
Contact for site	http://www.edinburgh.gov.uk/directory_record/10861/joppa_quarry_park
Safety notes (20 words)	There is a 3m slope running east to west across the middle of the park.
Other comments (20 words)	The levelled upper playing field gives a good vantage point in all directions.

Dark Skies Scoping Study
Astudiaeth Gwmpasu Awyrau Tywyll

Partneriaeth BRO Partnership
Dark Sky Wales