

**REPORT OF THE CONSERVATION POLICY OFFICER**

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**SUBJECT: NIGHT SKY QUALITY SURVEY, 2015- FINAL DRAFT**

Purpose of Report

To introduce a survey of Night Sky Quality in the National Park, and to propose next steps, for Members' endorsement.

Background

Dark Sky Reserve status is administered by the International Dark Sky Association, an American not-for-profit organisation, under its Dark Sky Places programme. The purpose of the programme is to recognise areas with dark skies and commit the relevant authorities to maintaining and improving them.

Brecon Beacons National Park has become a designated Dark Sky Reserve and Snowdonia National Park is working towards becoming one, through the 'Seeing Stars' campaign.

Pembrokeshire Coast National Park does not particularly lend itself to being a Dark Sky Reserve or Dark Sky Park because it is relatively small, ribbon-like, and is affected by significant light sources on the Milford Haven. These factors would make Dark Sky Reserve and Dark Sky Park requirements very difficult to meet, and the associated improvement commitments onerous to maintain.

Instead, officers have sought to identify a series of potential Dark Sky Discovery Sites across the National Park. Dark Sky Discovery Sites are small, accessible observation sites with good night sky quality. Proposals for Dark Sky Discovery sites are submitted to and decided by the UK Dark Sky Discovery partnership, which is made up of national and local astronomy and environmental organisations.

There is currently only one Dark Sky Discovery site in the National Park: the National Trust's car park at Broad Haven South. A spread of Dark Sky Discovery Sites across the National Park could help raise the profile of the Park, not only for stargazers and photographers but as part of more general "Park-at-night" type experiences (wildlife observation, John Muir/Duke of Edinburgh tasks, navigation, bushcraft and so on), potentially out of the main visitor season.

In planning terms, having Dark Sky Discovery Sites could provide the NPA with more information and leverage to address light pollution through, for example, householder awareness and voluntary codes, or through supplementary planning guidance on light pollution.

TACP Consultants successfully bid for the work and were tasked with identifying a shortlist of ten potential Dark Sky Discovery sites within the National Park, and with

providing some recommendations on protection and promotion of these sites, as well as of dark skies more generally in the National Park.

TACP Consultants worked with the Pembrokeshire Astronomy Group and Pembroke 21C Community Interest Company to survey a longlist of around thirty sites in the Park. The consultants' search focussed on land in the public realm, and most of the sites surveyed are owned or leased by the NPA, or owned by Pembrokeshire County Council or the National Trust. Accessibility and safety have been key considerations in site selection.

A key purpose of the Survey was to identify possible Dark Sky Discovery sites, and it provides the necessary evidence for submission of a site for Dark Sky Discovery site status. Members will be interested to note that some of the photos taken of the night sky at the potential sites feature the tint of the Aurora Borealis.

A further suite of sites is identified in the Survey; while these do not fulfil all the Dark Sky Discovery site criteria they may in fact be as good or better astronomically, have other advantages, or simply be good 'also-rans' in areas of the Park where there was a better alternative.

Subject to Members' endorsement of the Survey, it is proposed that it is circulated to, and discussed with, relevant land ownerships and interested parties by officers. This will allow partners to agree whether Dark Sky Discovery status should be applied for each site, and, if so, how each site will be promoted in a coherent way as part of the wider National Park recreational and visitor offer.

#### Financial considerations

The study was funded by the NPA.

#### Legal, sustainability and equalities considerations

None identified.

#### **Recommendation:**

**That Members ENDORSE the Sky Quality Survey as a basis for discussion between PCNPA and partner organisations on putting forward Dark Sky Discovery Sites for designation.**

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#### Background Documents

*Sky Quality Survey in the National Park, 2015*



Job Number 60710

TACP



SKY QUALITY SURVEY IN THE PEMBROKESHIRE  
COAST NATIONAL PARK

*PEMBROKESHIRE COAST NATIONAL PARK AUTHORITY*

*APRIL 2015*



Pembrokeshire Coast National Park Authority

*SKY QUALITY SURVEY IN THE PEMBROKESHIRE COAST NATIONAL PARK*

*09 April 2015*

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Project Number: **60710**

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## EXECUTIVE SUMMARY

TACP were commissioned by the Pembrokeshire Coast National Park Authority in February 2015 to undertake a survey of the night sky quality across a number of locations within the National Park and to produce a report recommending ten of these locations as suitable for Dark Sky Discovery (DSD) Site status.

The process began with an initial analysis of available information (OS mapping, light pollution data etc.) to produce a list of potential sites that might meet the DSD requirements in terms of access and size. This list was then refined following consultation with the Pembrokeshire Coast National Park Authority (several of the National Parks wheelchair walks were added for consideration at this point) and the Preseli Astronomy Group. These sites were then all visited in daylight hours to assess their suitability (size, surface, ease of access, parking provision, other safety issues etc.). Following daytime surveys, all those sites that were still considered to meet the DSD Site criteria, were visited at night, outside the hours of astronomical twilight (once the sun is far enough below the horizon to have no significant impact on darkness). During the night-time surveys a series of readings were taken at each of these sites using a Sky Quality Meter, which measures sky darkness, to give average values for each site. These readings all had to be taken on a clear, moonless night, so available windows were somewhat restricted, but this was all achieved within the available time.

Once all the readings were available they were used to rank the sites, and this darkness ranking was used, in combination with other information such as the geographic spread of the sites across the National Park, and how well they represented the different areas. From this a list of the ten recommended sites was agreed and, to support any future application process, 180 fisheye photographs were taken of the night sky at each location (these indicate visibility of stars, any obstructions and also the direction and nature of any sources of light pollution). As well as the photographs, a Bortle Scale assessment was undertaken at each of these locations. The Bortle Scale assessment is a recognised method of assessing how dark and clear the sky is, by observing increasingly dim stars with the naked eye, until they can no longer be seen. This requires significant experience and thorough knowledge of the night sky, so was undertaken by members of the Preseli Astronomy group, and their supporting site notes have been appended to the report, with key information included in the main body against each site. Although these two measures are not strictly required for all DSD Site applications they form an essential part of the process for making an application to the International Dark-Sky Association (who awarded the Brecon Beacons National Park with International Dark Sky Reserve status in 2013 and are currently processing an application from Snowdonia National Park).

In addition to the ten sites that are recommended for DSD Site nomination, a further six are also detailed in the report that were judged to meet the required DSD Site criteria, although they didn't make the final ten, often due to being close to other sites that were slightly superior. In many cases they offer unique or interesting experiences or interest to visitors in their own right, and could all be promoted on that basis, even without accreditation.

The final part of the report is a discussion of the issues relating to promoting dark skies, and how this could be achieved. This initially focusses on promoting the sites themselves, Dark Sky Discovery Site nomination and publicity around any award of the status, generating local support and the potential benefits that it could bring to the area. It also discusses measures to reduce current light pollution (at specific locations and more generally) and how to avoid future light pollution, both through the planning system and voluntary initiatives.



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The key recommendations from this discussion are given below:

- Develop a co-ordinated approach, and some sort of brand to be used as promotional tool.
  - Publicise the progress of any application and help get local people and business involved in advance of the application so they can become involved and take a degree of ownership of the initiative.
  - Work with other National Parks (especially in Wales) and organisations such as the National Trust– may be good opportunities to share resources as well as knowledge. Consider an approach to developing Wales as a dark-sky nation.
  - Ensure the local tourism industry is on board – there is potential to boost trade, particularly at quieter times of year.
  - Use a variety of methods for publicity – people respond far better on hearing/seeing things several times rather than just once.
  - Emphasise the diversity of the National Park (weather in one place may be totally different from another) and that parts of Pembrokeshire have the lowest cloud cover in all of Wales.
  - Consider developing a standalone website or pages on PCNPA site promoting dark skies, the individual sites and use for updates and linking to useful information (such as weather and road closures due to live firing in certain areas).
  - Emphasis other benefits of dark skies, such as to wildlife and health.
  - Consider nominating more than the ten sites (the other six detailed in the report probably all meet the requirements.
- 
- Promote general measures to reduce light pollution as part of any wider campaign, stressing additional benefits such as cost savings.
  - Consider longer term approaches, such as careful choice of replacement street-lighting and ensure focus is on light pollution as well as a combination of running costs and brightness.
  - Consider Supplementary Planning Guidance to make new developments dark sky friendly. The Brecon Beacons National Park have already developed SPG on Obtrusive Lighting.
  - Produce advice on measures local businesses and residents can take, and consider schemes such as the BBNP’s Dark Sky Ambassador Scheme.
  - Develop local support through educational initiatives, such as use of mobile planetariums and supporting cubs/brownies/scouts/guides in achieving astronomy/stargazing badges.
  - Encourage local businesses to support the initiative through making/selling branded products and organising or attending events.
  - Target tourism businesses such as campsites/caravan parks and B+B’s, emphasising benefits to them including increased low season trade – ensure they have the information available to pass on to visitors and understand the importance of making changes themselves.
  - Consider benefits to the economy – in Galloway Forest Park a study of 35 local businesses showed a return £1.93 for every £1.00 spent on the International Dark-Sky Park application process and associated publicity, and the actual total return is thought to be much higher.

Further details of all this are provided in the report itself, along with a detailed description of each of the recommended sites, including night sky photography and Bortle Scale assessments for the top ten sites.



## 1 INTRODUCTION

TACP were commissioned by the Pembrokeshire Coast National Park Authority in February 2015 to undertake a survey of the night sky quality across a number of locations within the National Park and to produce a report recommending ten of these locations as suitable for Dark Sky Discovery Site status. This report also outlines issues relating to the survey findings and recommendations for conserving and sensitively promoting dark skies.

### 1.1 Background

Tranquillity and peace are identified as special qualities of the Pembrokeshire Coast National Park (PCNP). A view of the stars on a cloudless, moonless night is important to many people, including residents, visitors, photographers and researchers. However, light pollution in the UK is generally increasing and it is estimated by the British Astronomical Society that 90% of the UK population live under a heavily polluted sky and as such do not have a clear view of the stars.

The Pembrokeshire Coast National Park Management Plan 2015-19 contains a policy (L4) “*to protect and promote dark night skies*”. Pembrokeshire Coast National Park Authority (PCNPA) wishes to explore the potential for promoting and conserving a series of Dark Sky Discovery sites/areas with partners.

PCNPA are seeking to conserve and extend this series over time, as part of a wider effort to create, expand, link up and promote dark areas across the National Park.

### 1.2 The Report

The first part of the report is designed to introduce the issues, then set out the survey methodology and process for interpreting the data.

The second part outlines the ten sites setting out the reasons for their selection and also provides a second list of sites that also offer good potential but did not make the final selection.

The final part of the report describes the issues faced and makes suggestions for promoting dark skies in the Pembrokeshire Coast National Park.

## 2 DARK SKY DISCOVERY STATUS

### 2.1 Dark Sky Discovery Background

The UK Dark Sky Discovery Partnership is a network of national and local astronomy and environmental organisations. They aim 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

The Partnership run a website that contains information about dark skies in the UK and an interactive map showing the accredited Dark Sky Discovery sites around the UK as well further information on viewing night skies, what to look for, activities and information for teachers.

Further details can be found on the website: <http://www.darkskydiscovery.org.uk/>

In order to qualify for Dark Sky Discovery (DSD) Site status, the proposed locations need to meet a number of criteria that make them safe and accessible as well as having suitably dark skies, in order to fully support the above aims. Dark Sky Discovery Sites are places that:

- are away from the worst of any local light pollution
- provide good sightlines of the sky
- have good public access, including firm ground for wheelchairs. The sites are generally freely accessible at all times

The website sets out two clear categories of Dark Sky Discovery sites. The two darkness ratings are:

"Orion" sites. At these sites, the seven main stars in the winter constellation 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 lights.

"Milky Way" sites. At these sites the Milky Way is visible to the naked eye. They are much darker sites found only in more rural areas.

For the purposes of this report, and given the nature and character of the Pembrokeshire Coast National Park, the focus is on the darker "Milky Way" sites. Due to the location of the National Park at the South West tip of Wales, it is well situated to avoid much of the light pollution that blights considerable amounts of the UK, and offer significantly darker skies than many areas. Being a National Park, with the associated tourist infrastructure and car parks in remote places, a number of potentially suitable locations exist.

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## 2.2 Dark Sky Discovery Site Requirements

To qualify as a DSD “Milky Way” Site, it must meet the following specific criteria and evidence of these points is needed with the application:

- Size. The Site should be 100m<sup>2</sup>
- The Milky Way is visible to the naked eye
- Sightlines. The site should provide relatively good sightlines of the horizon in all directions
- Public access. The site must be freely open to the public for significant periods of darkness during the year
- Wheelchair access. The Site must be accessible to a wheelchair user
- Safety. The site must have been Risk Assessed by the nominating organisation
- The nomination must be supported in writing by the landowner and local authority

The full guidance notes for nominating a site as a Dark Sky Discovery Site can be downloaded from the Dark Sky Discovery website: <http://www.darkskydiscovery.org.uk/dark-sky-discovery-sites/20130913-guidance-notes-for-nominating-dsds.pdf>

The application form is available from the Dark Sky Discovery website:

<http://www.darkskydiscovery.org.uk/dark-sky-discovery-sites/Nomination%20form%20for%20Dark%20Sky%20Discovery%20Site%202014.doc>

The pro-formas used in the data collection for the survey component of this commission were designed to collect all the information required for an organisation wishing to nominate a site, with the exception of Landowner/Local Authority support.

## 2.3 Other sites in the Area

The National Trust has already successfully applied for Dark Sky Discovery “Milky Way” Site status for Broadhaven car park at Stackpole. At the time of writing it is the only the site within the National Park that has been accredited. Further afield the National Trust have also recently been awarded the same status for **Llanerchaeron** and **Penbryn**, Ceredigion, as has the **National Botanical Garden of Wales** in Carmarthenshire.

## 2.4 Alternative Accreditation

As well as the UK based Dark Sky Discovery Site status, the International Dark-Sky Association has a number of possible designations. The Brecon Beacons National Park have International Dark Sky Reserve status, and Snowdonia are working on a bid for the same status. They also offer International Dark Sky Park and International Dark Sky Community accreditation. Further details of the requirements can be found here: <http://www.darksky.org/international-dark-sky-places/about-ids-places>

It is worth noting that the application process for these is more involved than is required for Dark Sky Discovery site status and requires a set of specialised lighting guidelines and planning policy to enforce the status.

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## 3 METHODOLOGY

### 3.1 Desk Study

The initial component of this study was to identify potential locations across the National Park and then assess their suitability. Due to the public accessibility requirements of Dark Sky Discovery Sites, the search focussed on identifying public car parks or publicly accessible open space near to suitable parking areas. As viewing of the night sky obviously needs to take place at night, public transport was not considered an important factor in accessibility of such sites, as very few services operate into the night, especially in the more remote areas that are likely to have the darkest skies.

#### 3.1.1 Published Light Pollution Data

An initial filtering process applied GIS data on light levels published by NASA to the search area to help identify the darkest/lightest places, along with a comparison of the OS data and the light pollution information found on the French Avex astronomy website here:

<http://www.avex-asso.org/dossiers/pl/uk/index.html> (further information on the data here and how to use it can be found here - <http://www.avex-asso.org/dossiers/pl/allemande/index.html#anglais> )

Careful examination of all the OS 1:25,000 scale mapping of the National Park identified a list of parking areas (or beaches and other public attractions etc). Of these locations the ones which were in the darker areas (see above) were then examined using aerial photography and Google Streetview to ensure that indicated parking was appropriate (area sufficiently large and a distinct from the road itself, especially if a through road) or in the case of other open spaces that there was suitable parking close by. The Google Streetview process also allowed for a preliminary check for potential sources of nearby light pollution and to identify the presence of street lighting etc. It is to be noted though, that in many parts of Pembrokeshire the streets lights are turned off after midnight.

#### 3.1.2 The Shortlist of Potential sites

This process generated a list of approximately 40 sites which were initially proposed for further investigation. Following initial consultation with Pembrokeshire Coast National Park Authority and members of the Preseli Astronomy Group around key requirements and issues a small number of changes were made to this list, and their locations pinpointed using Google Maps. (A full table of the sites and all the data collected on them and associated notes is supplied separately, in electronic form with this report).

The shortlisted sites were then all visited in daylight to assess their potential suitability, access, safety etc, and to rank them in terms of potential, in case the combination of timescales for undertaking the work and weather conditions did not allow for them all to be fully surveyed.

### 3.2 Daytime Surveys

All the remaining sites on the shortlist (shown below – **Table 3.1**) were visited during daylight hours to assess their suitability in terms of access, safety, general degree of visibility and current conditions etc.

| Site Name  | Grid Reference |
|--|----------------|
| Bwlch Gwvnt Car Park                             | SN0750332193   |
| Rhos Fach Common                                 | SN1652933079   |
| Car Park south of Carn Sian,                     | SN1353130343   |
| Poppit Sands                                     | SN1520648566   |
| Crugiau Cemmaes                                  | SN1254841471   |
| Newport sands                                    | SN0546540532   |
| Pen y Fan, Dinas Head                            | SN0057041124   |
| Bedd Morris                                      | SN0382936509   |
| Dinas Cross                                      | SN0103938266   |
| Car park, N-edge of Tycanol Woods                | SN0927338341   |
| Car park east of Pontfaen, Gwaun Valley          | SN0244733979   |
| Car park Sychpant, Gwaun Valley                  | SN0457034982   |
| Garn Fawr, Strumble Head                         | SM8990938835   |
| Strumble Head Lighthouse                         | SM8945041199   |
| St Justinian's Car Park                          | SM7249725241   |
| Porth Clais Bay Car Park                         | SM7399224259   |
| Whitesands Bay                                   | SM7344227174   |
| Abereiddi Bay                                    | SM7974831288   |
| Caerfai Bay                                      | SM7592024379   |
| Newgale Sands                                    | SM8505321745   |
| Abermawr   | SM8839634802   |
| St Brides  | SM8030710901   |
| Martin's Haven National Trust Car Park           | SM7619308981   |
| Car Park at Marloes Sands                        | SM7795808190   |
| Kete National Trust Car Park (at St Ann's Head)  | SM8032604298   |
| Dale Fort Field Studies Centre                   | SM8230905211   |
| 'Pickleridge', North of Dale                     | SM8085006619   |
| Dale Airfield                                    | SM7990406066   |
| Car Parks at Freshwater West Beach               | SM8844400462   |
| West Angle Bay                                   | SM8539203173   |
| St Govans Head                                   | SR9666093062   |
| Stack Rocks NPA Car Park (Green Bridge of Wales) | SR9254894667   |
| Broad Haven South Car Park                       | SR9758693785   |
| Picton Castle                                    | SN0076913490   |
| Carew Castle/Mill                                | SN0418403873   |
| Skrinkle Haven NPA Car Park                      | SS0833797509   |
| Lvdstep Village                                  | SS0879397771   |
| Freshwater East                                  | SS0240698380   |
| Saundersfoot                                     | SN1394905376   |
| Wisemans Bridge                                  | SN1433405745   |
| Amroth   | SN1627907080   |
| Colby Woodland Garden                            | SN1581108109   |

A photographic record was made of each site, paying particular attention to any important features (such as beach access if the proposal was to use a beach instead of a car park for example). Generally a panoramic photograph showing the views in all key directions was also taken to provide a record of any key features and to demonstrate the potential view of the sky from that location, including any obvious features which blocked parts of it out (such as landform, vegetation, buildings etc. See example below from Skrinkle Haven, Figures 3.1 – 3.3). These photographs were partly for use in the site selection process and can also be used to support any future application for the ten proposed sites.



**Figure 3.1**



**Figure 3.2**



**Figure 3.3**

The information was recorded using the pro-forma shown (**Figure 3.4**). It was designed to record all the information required for a Dark Sky Discovery Site application, as well as supplementary information to be used to compare the sites and assist with the selection process to choose which the preferred ten sites would be. Certain sections were designed to be completed during the night time surveys, such as the SQM-L readings.

Following initial discussions with both the Pembrokeshire Coast National Park Authority and the local Astronomy Group (the Preseli Astronomy Group) the original process was refined so that information such as the Bortle Scale class would only be assessed on the ten selected sites.

All the data collected through the site survey process is available in electronic format in a Microsoft Office Excel spreadsheet, supplied separately – the data for the ten proposed sites is included directly within this report.



**NIGHT SKY QUALITY SURVEY PRO-FORMA**

|   |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
|---|-------------------------------------|--------------------|----------------------|----------------------|----------------------|--------------------|----------------------|----------|----------------------|----------|--|
| <b>Site Name</b>  |                                     | <b>Grid Ref</b>    |                      |                      |                      | <b>Survey Date</b> |                      |          |                      |          |  |
|   |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Landowner</b>  |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Permissions Received</b>                               |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
|   |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Time</b>   |                                     | <b>Temperature</b> |                      | <b>Cloud Cover %</b> |                      |                    |                      |          |                      |          |  |
| <b>Name of Surveyor</b>                                   |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Access to the Site</b>                                 |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Bortle Scale Assessments (Please circle)</b>           |                                     | <b>1</b>           | <b>2</b>             | <b>3</b>             | <b>4</b>             | <b>5</b>           | <b>6</b>             | <b>7</b> | <b>8</b>             | <b>9</b> |  |
| <b>Approx Site Area (m<sup>2</sup>)</b>                   |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Wheelchair Access</b>                                  |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Other Facilities (eg: toilets &amp; opening times)</b> |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Car Parking Charges</b>                                |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Short Description</b>                                  |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Safety Notes</b>                                       |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Other Comments</b>                                     |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>Photos taken</b>                                       |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>DSD star rating</b>                                    |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| <b>SQM Readings</b>                                       |                                     |                    |                      |                      |                      |                    |                      |          |                      |          |  |
| 1.  | <input type="text" value="ignore"/> | 2.                 | <input type="text"/> | 3.                   | <input type="text"/> | 4.                 | <input type="text"/> | 5.       | <input type="text"/> |          |  |
| 6.  | <input type="text"/>                | 7.                 | <input type="text"/> | 8.                   | <input type="text"/> | 9.                 | <input type="text"/> | 10.      | <input type="text"/> |          |  |

**Figure 3.4**

### 3.3 SQM-L Readings

Following the daytime surveys, readings were taken at night, measuring the darkness of the night sky overhead. In accordance with procedures suggested by the International Dark-Sky Association for undertaking sky quality surveys readings were taken using a Sky Quality Meter, made by Unihedron. Readings are given in the recognised unit of *Magnitudes per square arc-second*. Although the initial brief suggested that the meter should allow a “a cone of view greater than 80 degrees” it was subsequently agreed that, in line with the suggestions from the IDA it would be more appropriate to use a more focussed meter, which concentrates its measurement across a narrower segment on the sky above. This led to use of Unihedron’s SQM-L model (**Figure 3.5**), instead of the SQM.



**Figure 3.5**

The significance of this is that it is likely to give a more accurate measurement of the darkness directly overhead, and be less influenced by any peripheral sources of light pollution (or conversely any physical features which might restrict light from certain angles).

To ensure accurate results readings were taken when there was no moon, outside the hours of astronomical twilight, when the cloud cover was less than 20%. As the meters can be affected by their operating temperature, the first reading often shows a higher value than it should, so although these were recorded and can be found in the raw data, all subsequent analysis is based on the other readings. Small differences such as a passing car can impact on the result so in order to discount the effect of such incidences a note was made of the darkest reading (excluding the first one) and the mean of the darkest four readings for each site.

### 3.4 Bortle Scale Assessment

In accordance with International Dark-Sky Association recommendations, a Bortle Scale Assessment was undertaken on the ten sites recommended for nomination as Dark Sky Discovery Sites. Although not strictly necessary for DSD status, should an application be made to the IDA, then the Bortle Scale Assessment would be required.

Due to the highly skilled nature of this task it has been carried out by experienced members of the Preseli Astronomy Group, who have sufficient knowledge of the night sky to successfully undertake the task and make the required judgements. As a note, due to the time of year, some of the objects listed on the Bortle Scale were too low in the sky to determine whether or not they would be visible so a process of ‘limiting magnitude’ has been used. A flow chart outlining the process is shown below (Figure 3.3).

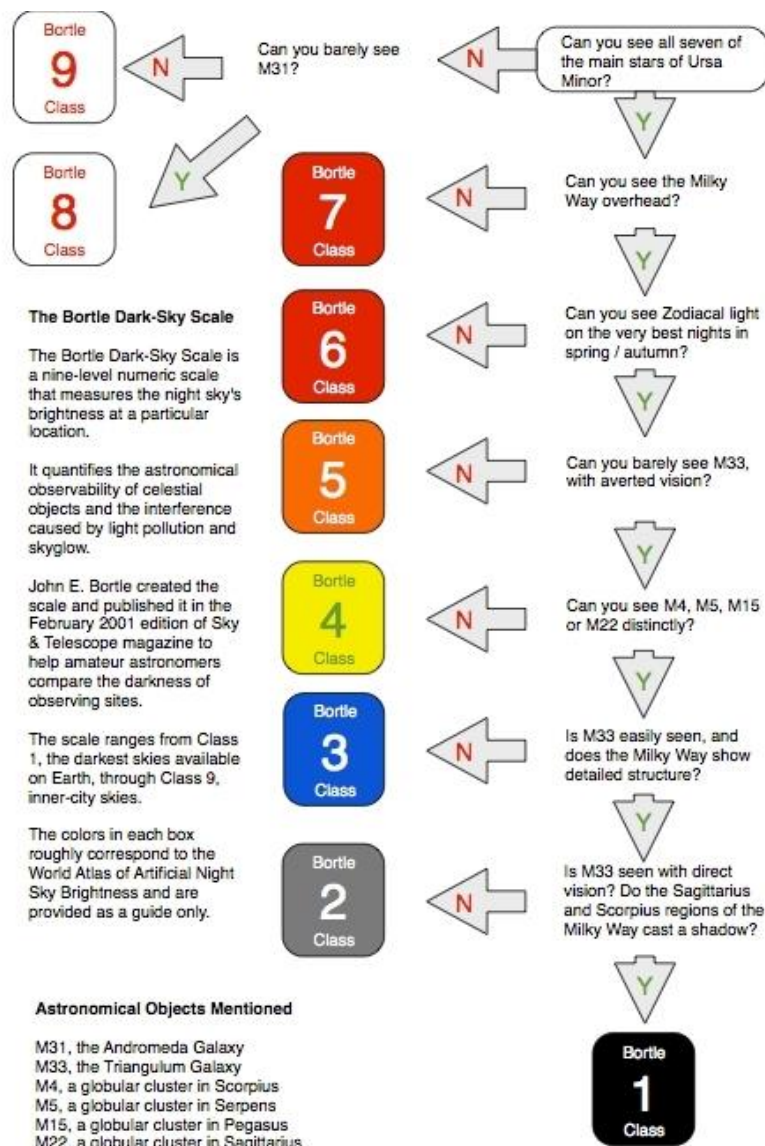
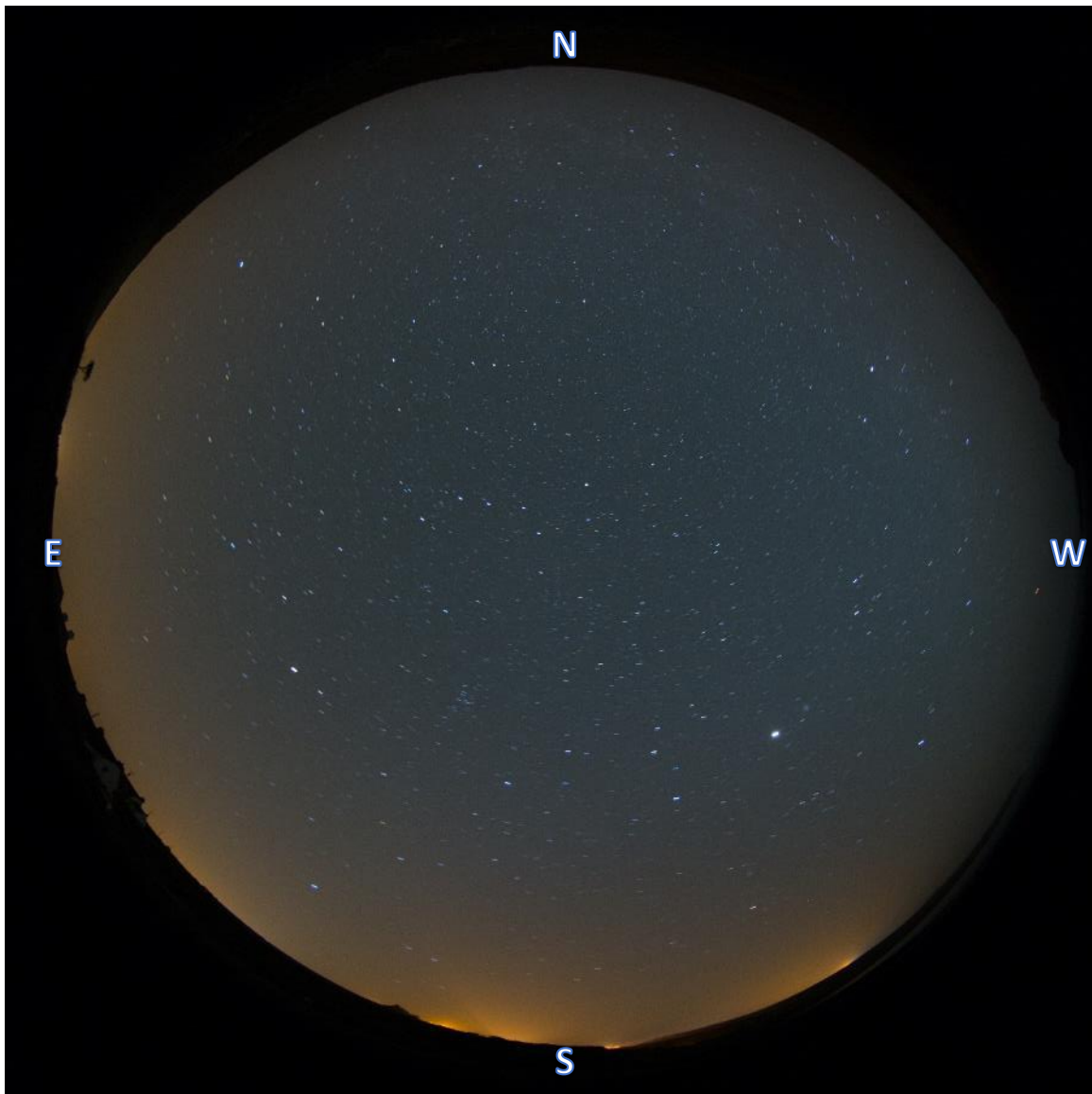


Figure 3.6 (Steve Owens - <https://darkskydiary.wordpress.com/2012/01/19/the-bortle-scale-a-flow-chart/>)

### 3.5 Photography

As well as the daytime photography to illustrate the site characteristics, night time shots were taken using a 180 degree fisheye lens and 180 second exposures. As with the Bortle Scale Assessments, this is a requirement for IDA dark sky applications rather than strictly being necessary for Dark Sky Discovery Site status, but it not only shows the range of stars visible in that location but also gives a good indication of peripheral sources of light pollution.

Again, as with the Bortle Assessments a specialist was used for this element of the process – in this case Owen Howells, a Pembrokeshire based professional photographer. Due to limited time and resources available the 180 degree fisheye photographs were only taken on the ten proposed sites. Also, while the SQM-L readings could be taken reliably when there was a degree of peripheral cloud, the Photography required much clearer conditions to be worthwhile, severely limiting the number of suitable nights available. An example is shown below (**Figure 3.7**).



**Figure 3.7**

## 4 INTERPRETING THE DATA

### 4.1 Post Day-Time Survey Filtering

Following the daytime surveys an initial filtering process was carried out and a few sites from the initial list were discounted due to being considered inappropriate or inadequate because of the physical characteristics of the site. The Following were omitted due to lack of parking provision at the site that would meet the Dark Sky Discovery Site Criteria (or where there was a lack of suitable access between the site and available parking.

|   |   |                      |
|---|---|----------------------|
| 5 | Crugiau Cemmaes                                     | 52.039863, -4.734537 |
| 2 | Car Park on road north of Mynachlog Ddu, nr Crymych | 51.965826, -4.672063 |

Several others were omitted because visibility from the site was considered too poor to consider proposing as a DSD Site, due to vegetation, landform or other physical features.

|    |  |                      |
|----|--|----------------------|
| 10 | E Newport, car park, N-edge of Tycanol Woods | 52.010642, -4.780477 |
| 11 | Car park east of Pontfaen, Gwaun Valley      | 51.969087, -4.877303 |
| 16 | Porth Clais Bay Car Park                     | 51.870991, -5.284452 |

The following sites were omitted as they were all in private ownership. While they may have potential for organised events in collaboration with the owners, it was decided that they did not meet the Dark Sky Discovery Criteria so would not be included at this point.

|    |                                |                      |
|----|--------------------------------|----------------------|
| 25 | Dale Fort Field Studies Centre | 51.703304, -5.151888 |
| 31 | Picton Castle                  | 51.784508, -4.889856 |
| 33 | Colby Woodland Garden          | 51.741335, -4.669190 |

As several of the suggested sites were in close proximity to each other, where one site was clearly less appropriate than a nearby one it was also omitted – these are shown below:

|    |                           |                      |
|----|---------------------------|----------------------|
| 23 | Car Park at Marloes Sands | 51.728343, -5.216658 |
| 34 | Lydstep                   | 51.646136, -4.765051 |

The Pembrokeshire Coast National Park Authority publish a series of ‘Wheelchair Walks’ – several of these were considered as potential sites, but the following were ruled out after site visits, due largely to insufficient space of provision of non-disabled parking.

|    |                   |                      |
|----|-------------------|----------------------|
| 37 | Aberfelin, Trefin | 51.948079, -5.152254 |
| 39 | Dinas Island      | 52.022004, -4.901196 |
| 41 | Haroldston Chins  | 51.804886, -5.100957 |

---

## 4.2 Post Night-Time Surveys

The remaining sites were then all visited at night and a number of SQM-L readings were recorded at each one and notes made about key observations such as key sources of light pollution etc.

As described in section 3.3, a number of readings were taken at each site, and most cases showed a degree of variation. To reduce the chance of anomalous results impacting unfairly on the decision making process, an average of the four darkest readings was taken, and the single darkest figure was noted – these two figures were compared across the sites and used to inform the decision-making.

The first reading was always discounted as it can be easily affected by the temperature of the meter, and often shows a higher figure (darker sky) than it should. In some there was one reading which stood out as significantly darker than the others, and this often seemed to coincide with a longer period of having the meter switched off, so where this was the case these results were omitted from the analysis.

In order to select the ten sites for nomination a number of factors were considered and weighed up against each other. These key considerations are listed below:

- Suitability of the site (access, size etc.)
- Field of view and obstructions
- Darkness (based on SQM-L readings)
- Geographical spread around the National Park

While the SQM-L results showed all the darkest sites to be in the north, around the Preseli Hills, it was considered more appropriate to suggest a number of slightly less dark sites around the south and west coastlines as well, partly in terms of accessibility to a wide range of people and partly as the visibility of the sky in different directions varies with position around the area. Due to the coastal nature of much of the National Park, the darkest skies are generally over the sea, and as such the best visibility changes from place to place, so a site on the south coast may offer better visibility of certain constellations or stars than one to the north, even if the darkness rating is slightly lower.

The night time surveys proved that the main sources of light pollution around the area come from Milford Haven/Pembroke Dock and the settlements of Haverfordwest, Tenby, Saundersfoot and to a lesser extent St Davids. The greatest concentration is around the Milford Haven waterway, with the large petro-chemical works having a strong influence, both in terms of light intensity and also its height making it visible from a wide area. The key significance of this is that in the north of the National Park the best views of the sky are to the north and west, and in the southern parts of the National Park they are more to the south. This means that potentially the best views of southern skies may be from the southern sites even though the northern ones are generally darker.

It was also apparent that some sites that have slightly more restricted visibility offer better general views of the sky than more open sites, as they shield bright lights (especially of the petro-chemical works). Due to how the human eye adjusts to different light levels, an absence of bright point sources of light is important as well as just darkness rating of the sky directly overhead.

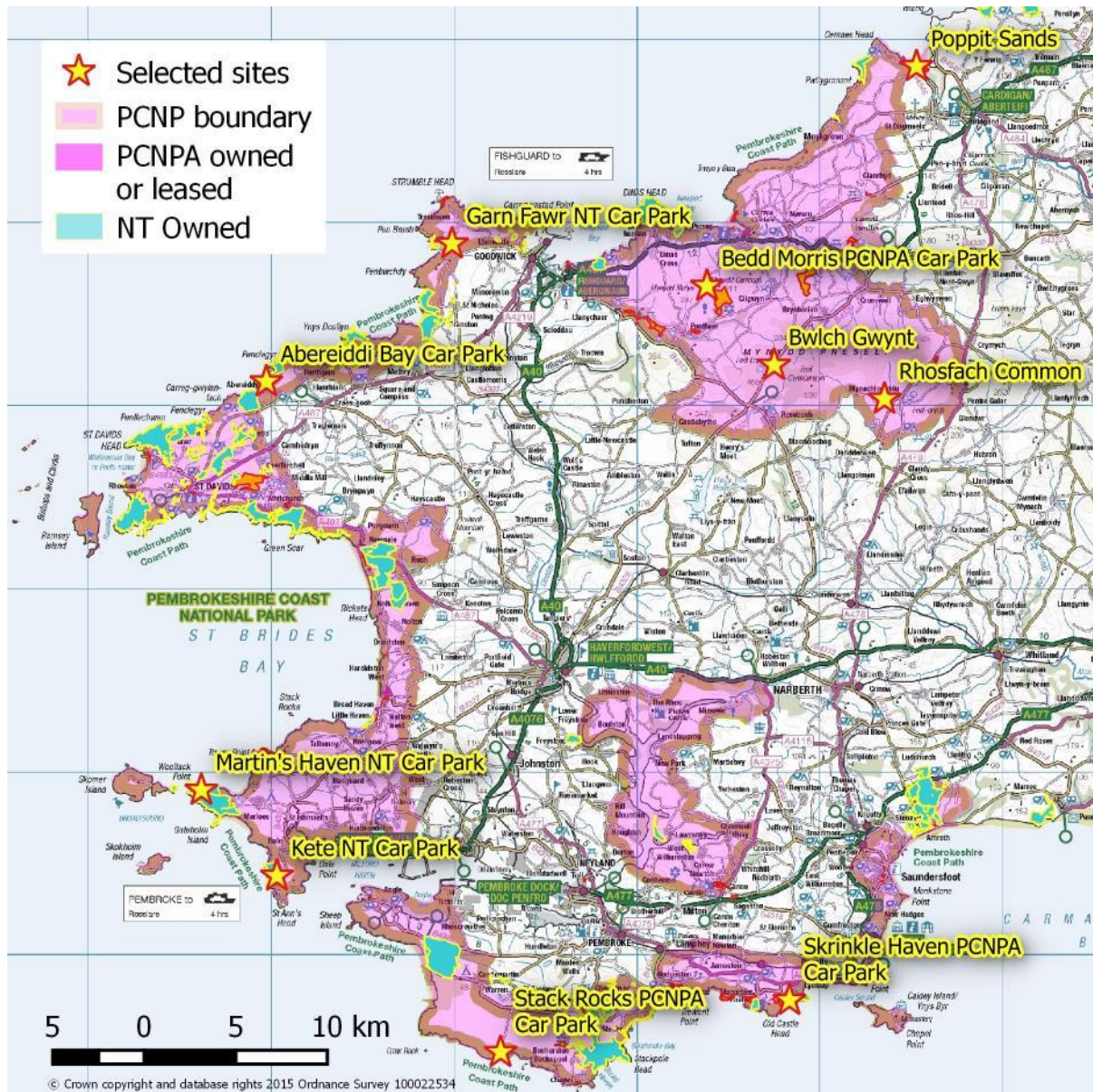
These factors were all considered in the process of selecting a representative sample of ten sites.



## 5 RECOMMENDATION FOR TEN DARK SKY DISCOVERY SITES

### 5.1 The Ten Recommended Sites

The following ten sites (**Figure 5.1**) are recommended as being suitable for nomination for Dark Sky Discovery Site status, and they offer a good spatial range of locations around the Pembrokeshire Coast National Park.



**Figure 5.1 – The Ten Recommended Sites**

The coastline around Tenby and eastward does not include any recommended sites, as the skies are noticeably less dark, and the whole Cleddau area, although showing as darker on the satellite data, did not appear to offer any particularly suitable sites (due partly to its wooded character, and the access requirements of DSD sites). This should not be taken to mean that views of the night sky are

all poor within this area. In addition to the ten recommended sites, a number of others also offered good opportunities (including two from the areas above) – these are shown in section 5.2.

The following pages give details of the ten sites that have been selected, and the reasons for their inclusion.

A map showing each recommended site is provided, along with a brief summary description of its physical qualities followed by the SQM-L readings, to give an indication of how dark the skies were when surveyed.

The second page includes a 180 degree fisheye photograph from each location, indicating the sky quality visually and peripheral sources of light pollution. These were taken using a 180 second exposure followed by a description of the visibility of the night sky and comments from the Preseli Astronomy Group, on their observations of the site, along with their Bortle Scale Assessments. The full notes are included in Appendix A.

The diagram below, developed by H. Spoelstra, shows an approximation of how the values compare on different scales. An urban area, with streetlighting is expected to give in the region of 16 mag/arcsec<sup>2</sup>.

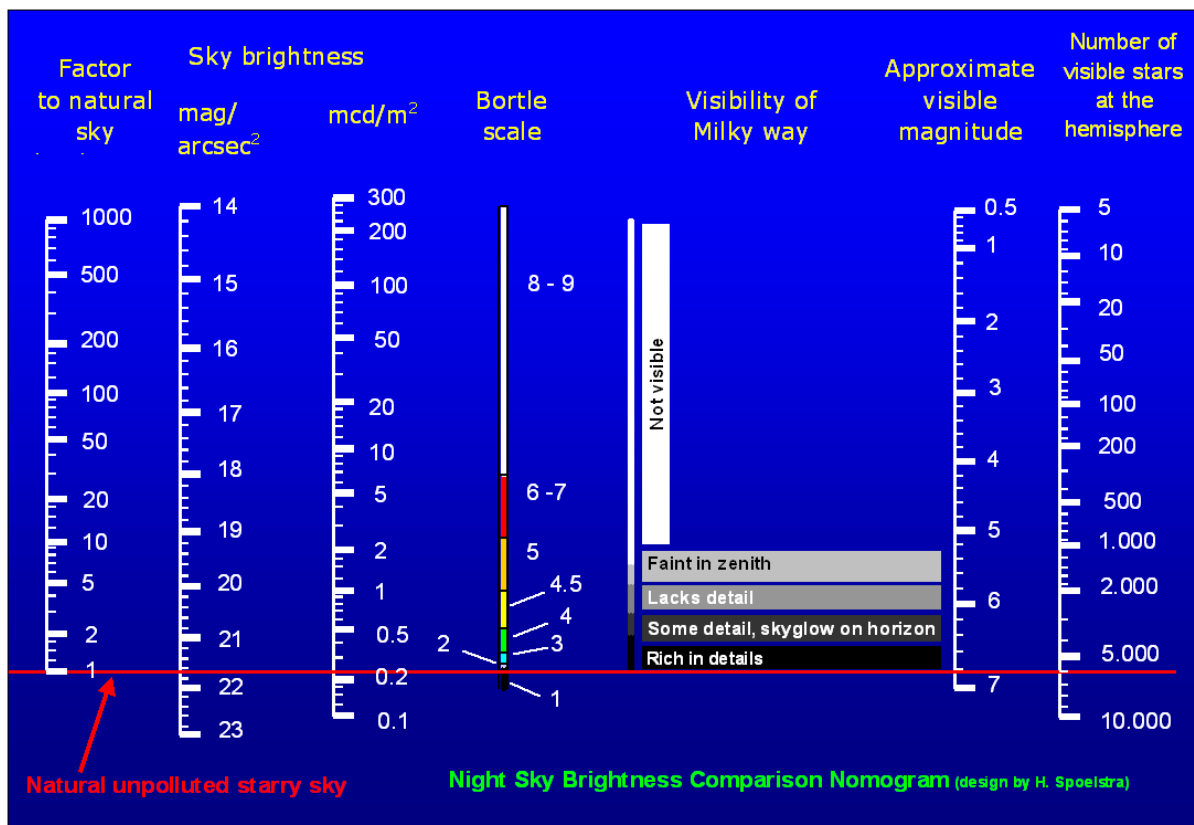
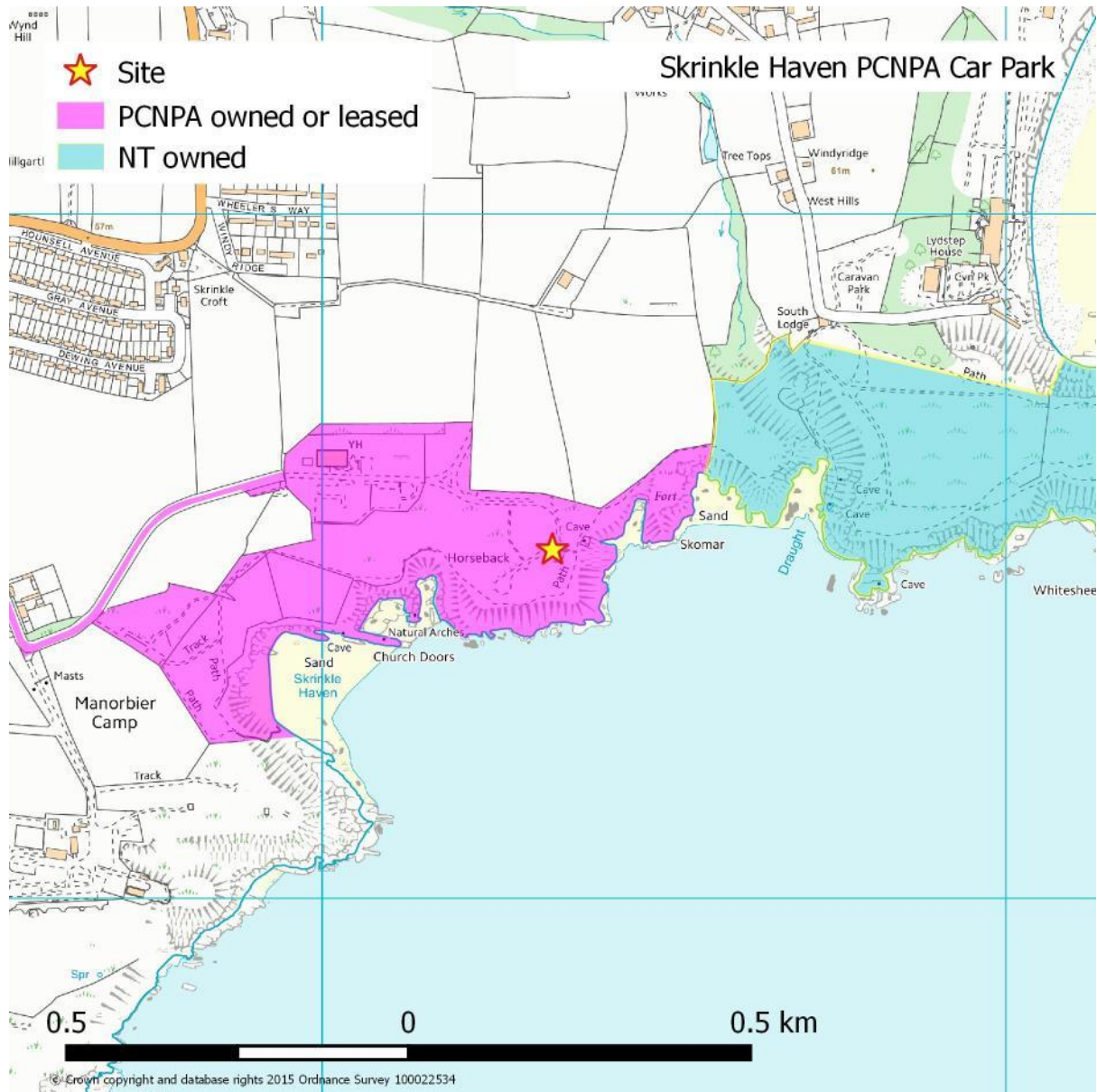


Figure 5.2 – Night Sky Brightness Comparison <http://www.darkskiesawareness.org/nomogram.php>



5.1.1 Skrinkle Haven National Park Authority Car Park



**Summary:**

The National Park car park at Skrinkle Haven is set within a wide, open grass area with very good visibility in all directions. Skies appear especially good to the south as there is less diffuse light pollution due to being over the sea, well away from built up urban areas. It is well suited to setting up a telescope, with large, firm, relatively level concrete areas set adjacent to the access road. The middle of the three is best positioned to avoid nearby light sources. There is a Youth Hostel in the immediate vicinity and optional walks along coast path.

**SQM-L Readings:** Mean of Darkest 4: **21.04** Darkest Individual Reading: **21.05**

Skrinkle Haven



Figure 5.3



Figure 5.4



Figure 5.5

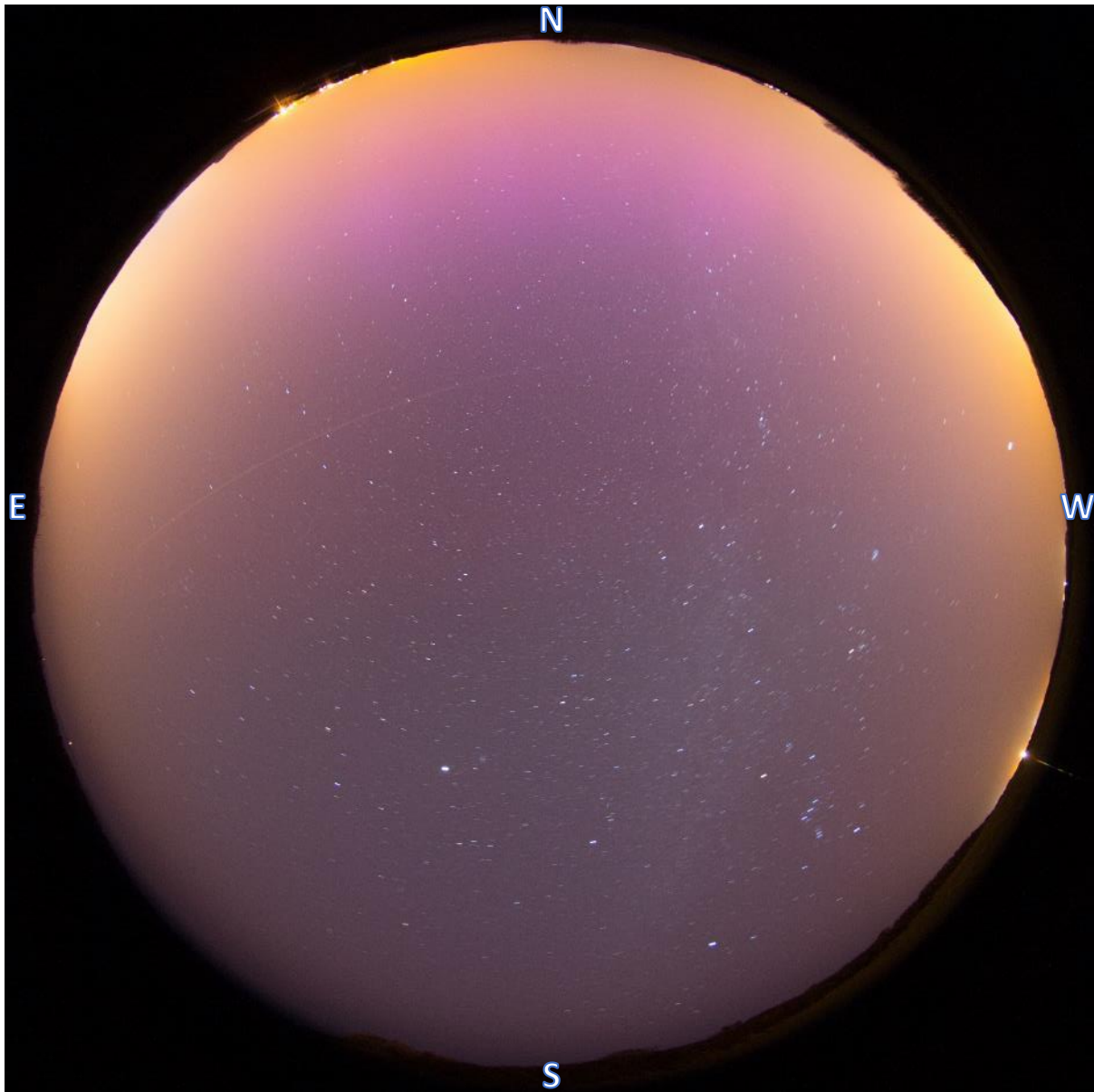


Figure 5.6 - Approaching the viewing area

Safety Notes:

- Beware of unprotected cliffs if venturing beyond the hard surfaced area.

## Skrinkle Haven



(Please note purple glow is the the presence of the northern lights)

The image shows the obvious sources of light visible, including a general orange sky-glow to the north generally, with much darker skies to the south, over the sea. Some direct light visible in on the horizon to the middle distance from Lydstep to the north-east and Manorbier Camp the the south-west.

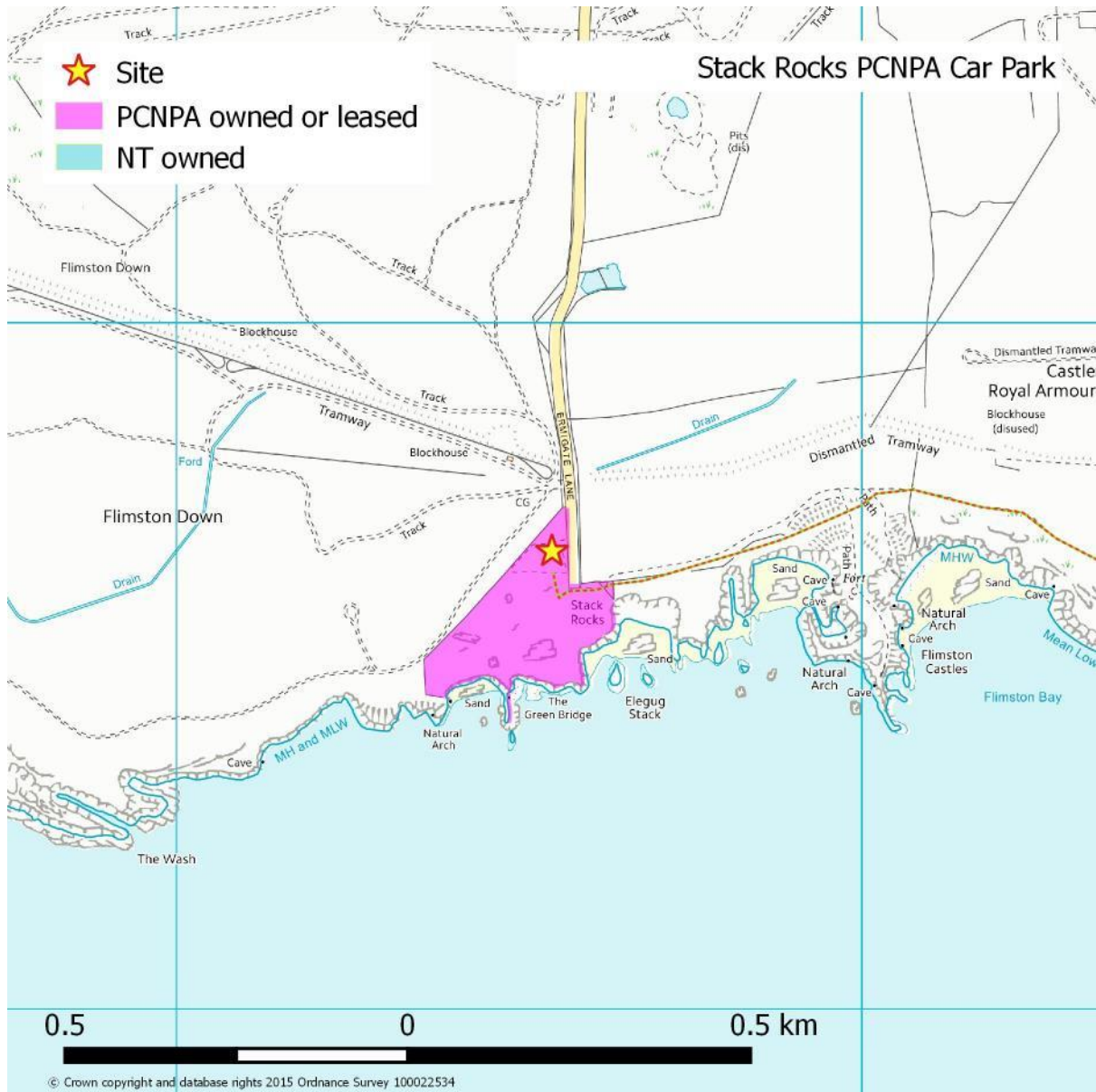
Preseli Astronomy Group notes:

A good site for viewing the southern or northern sky, allowing for difficult objects to be seen in such constellations as Sagittarius and Scorpio during the summer and Autumn months.

**Bortle class 5** as this site, despite the 6.2 LM does not fulfill the other criteria necessary for class 4.



5.1.2 Stack Rocks Pembrokeshire Coast National Park Authority car park  
(or St Govan’s Head if closed due to military firing)



**Summary:**

A large, open, grassy car parking area with good visibility in all directions, although especially good to the south as there is less diffuse light pollution. Access to the site may be restricted due to the road leading to it crossing a military firing range. Details of closures are available to download from here: [http://data.gov.uk/dataset/castlemartin\\_firing\\_programme\\_mod](http://data.gov.uk/dataset/castlemartin_firing_programme_mod)

When closed, similar views area available just along the coast at St Govan’s Head (with the chapel again offering impressive photo opportunities) although access here is also sometime restricted.

**SQM-L Readings:** Mean Darkest 4: 21.09 Darkest Individual Reading: 21.19

St Govan's Head PCNPA car park



Figure 5.7



Figure 5.8



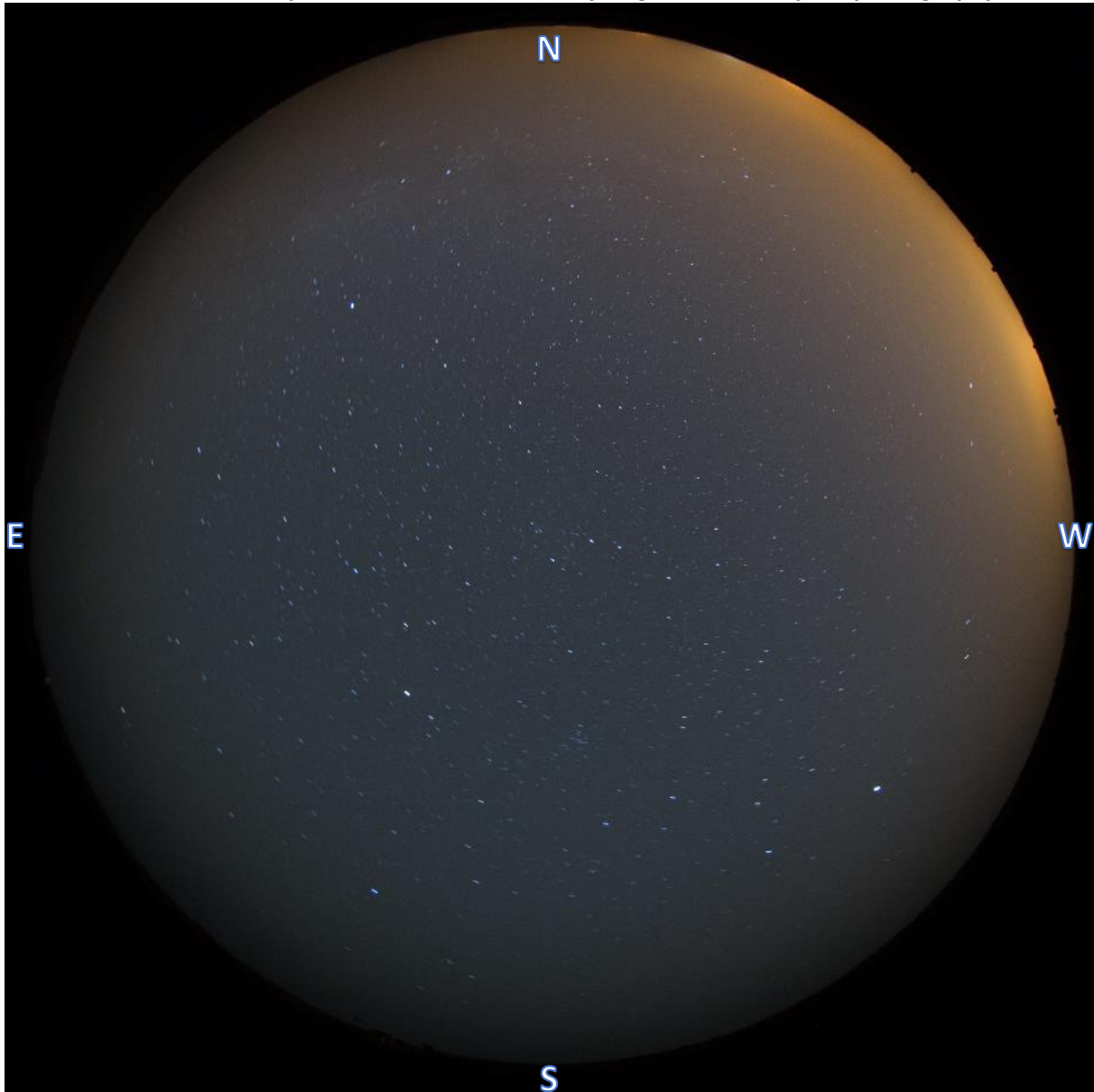
Figure 5.9

Safety Notes:

Beware of unprotected cliffs if venturing beyond the car park.

Stack Rocks PCNPA car park

**Please note that the photograph below is actually taken nearby from St Govans Head – the access to Stack Rocks PCNPA car park was closed due to live firing at the time of the photography.**



A definite sky-glow is visible to the north and north-west, but generally it is less dominant than in some other locations. There are no visible direct light sources in view and skies to the south and south east are especially dark.

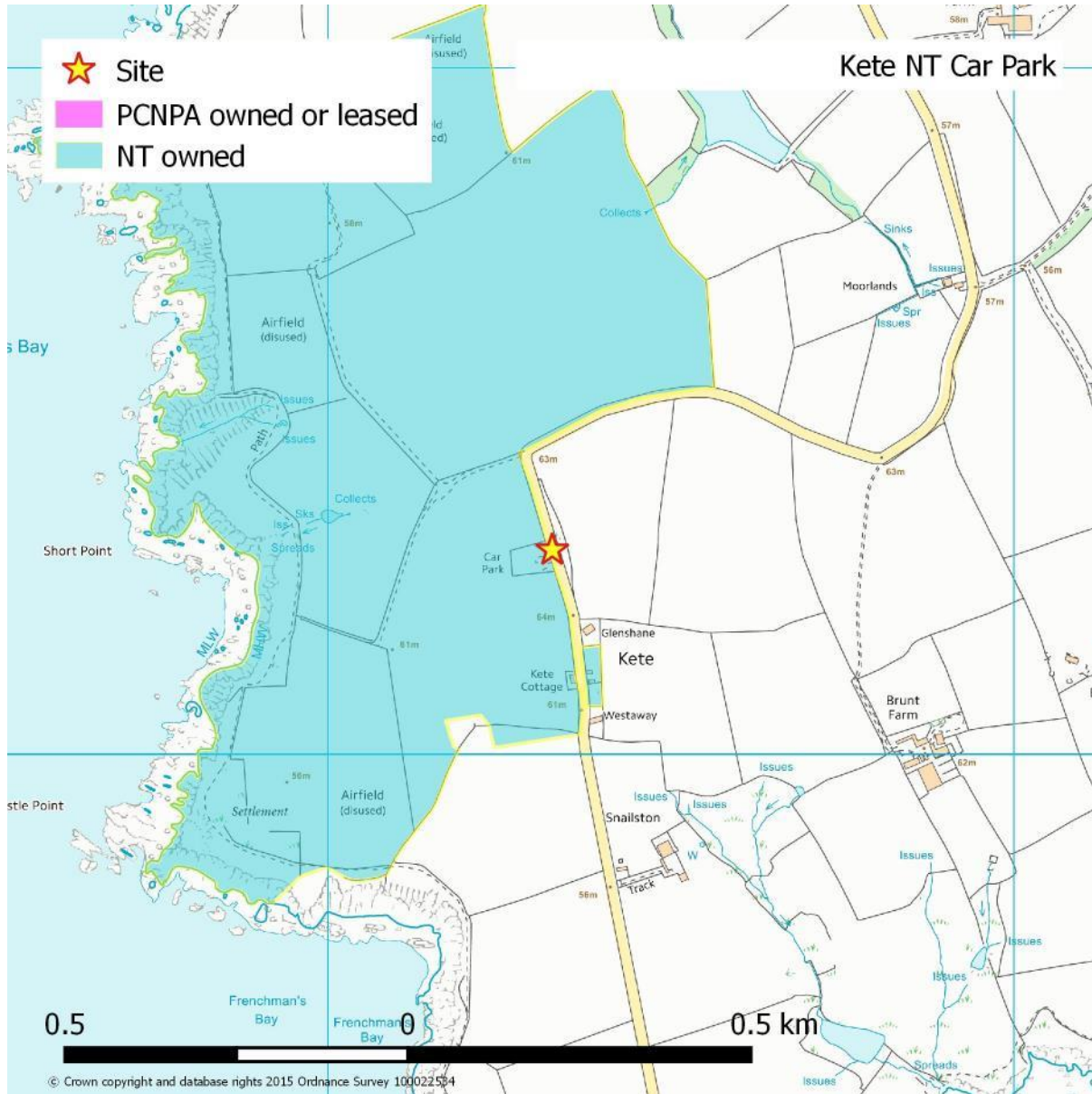
Preseli Astronomy Group notes: (assessment taken at Broadhaven South, as both Green Bridge of Wales and St Govans were closed)

The sky to the N and NNW had considerable light pollution from Pembroke, Milford Haven and the refinery complex, a lesser skyglow could be seen to the East from Tenby etc, but this was only to about 20° but either side of that fully round to the S the sky was very dark and free of any real glow, excellent views from ESE to WNW with the sea as horizon makes this an excellent site for observing.

**Bortle Class: 3**



5.1.3 Kete National Trust car park



**Summary**

A large National Trust car park with a firm surface to the main area and good visibility in all directions, although especially good to the west and south-west as these directions look out to sea and suffer less from the diffuse light pollution of built up areas. Flashes from the lighthouse to the south just visible although this does not cause a significant problem. There are no facilities other than an information board on the areas historical context.

It is easy to drive past the car park at night – visitors should look out for the sign saying ‘no turning place beyond this point’ which is immediately after the car park entrance.

**SQM-L Readings:**      Mean Darkest 4:      21.46      Darkest Individual Reading:      21.39

Kete National Trust Car Park



Figure 5.10



Figure 5.11

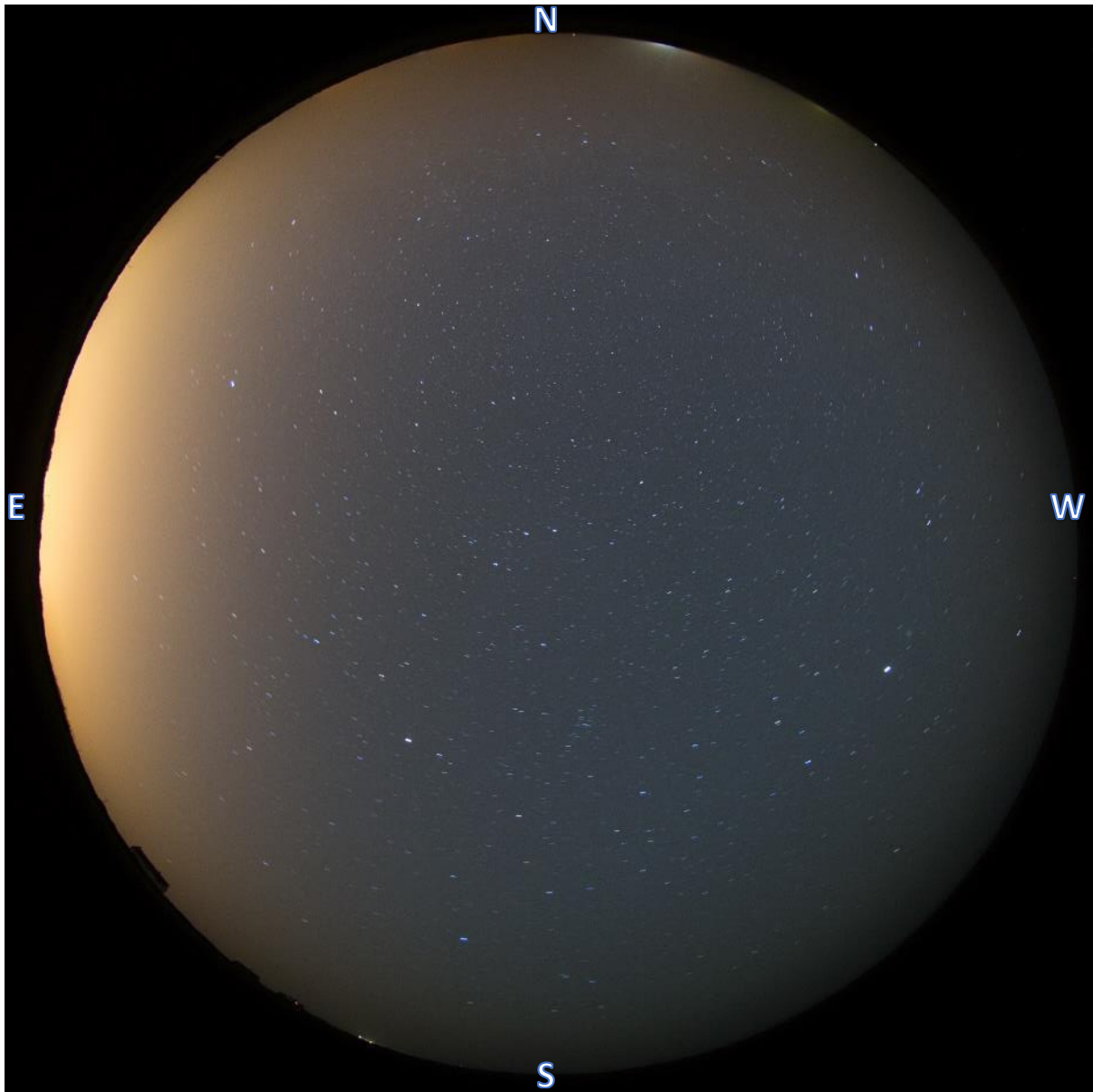


Figure 5.12

Car park provides firm ground and good views in all directions



Kete National Trust car park



The photograph shows a very prominent sky-glow coming from the east, (Milford Haven area). Views to the south and west are very clear with slight evidence of light pollution impacting on what can be seen to the north, especially at lower angles. There are a few distant light sources directly visible on the horizon.

Preseli Astronomy Group notes:

To the East the inevitable large dome of skyglow from Milford and Pembroke extends to 50°, but that is more than compensated for by the excellent view of the rest of the sky, superb views to the South, West and North completely free from any obstructions or skyglow making this a premier site, both for access and observations.

**Bortle Class: 3**

5.1.4 Martin's Haven National Trust Car Park



**Summary:**

A large car park with good visibility in all directions, although slightly restricted to the east, due to the slope of the land. Due to its elevated position and remote location on a headland skies are very dark here, with little in the way of local light pollution, although sometimes ships nearby can be a source. There is also the option of walking out onto Wooltack Point, although this does not seem to give noticeably darker sky readings. It would provide an interesting location for night time long-exposure photography though.

**SQM-L Readings:**      Mean Darkest 4:      21.46      Darkest Individual Reading:      21.65

## Martin's Haven National Trust car park



**Figure 5.13 – Looking west, from within car park**



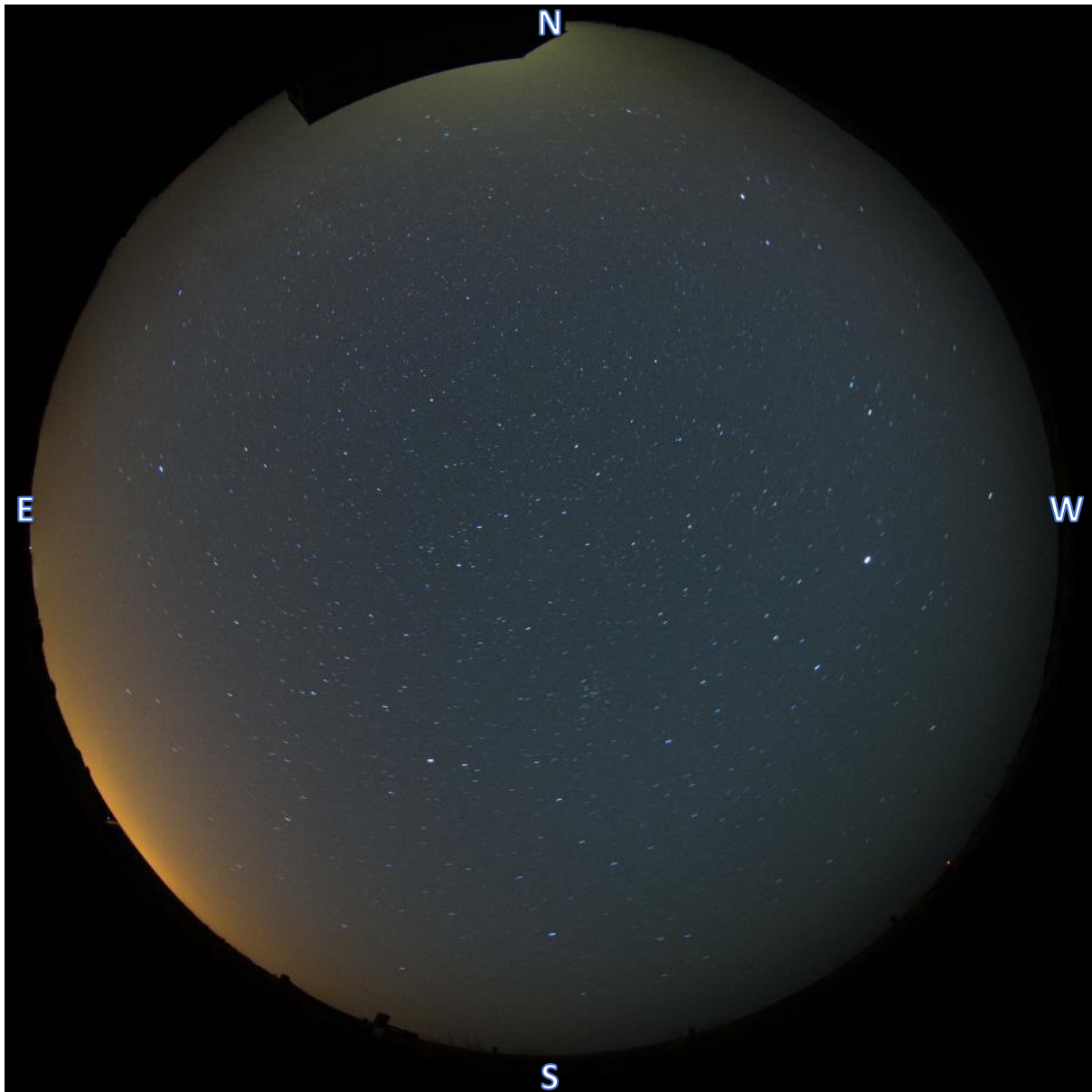
**Figure 5.14 – Looking east, across car park**

**Safety Notes:**

Care should be taken if venturing onto Wooltack point as paths are unsurfaced and the area is grazed by cattle.



Martin's Haven National Trust car park



The sky-glow from the Milford Haven/Haverfordwest/Pembroke area is visible to the south east from here although it exerts a less dominant influence on the sky than in some other locations. Skies appear darkest to the west, as might be expected. Dependent on position the car park attendant's hut is visible in the near horizon to the north (becoming more east as the viewer moves further down). Some distant red lights are just visible on the horizon out to sea and there is one distant light source to the east.

Preseli Astronomy Group Notes:

Site is easily accessed, even if a little remote. The carpark, which gently slopes from E to W (~5o), is gravel/stone/grass underfoot. There is good, unobstructed viewing in every direction. There is an obvious skyglow to the NE and S. The sodium street-lighting of Broadhaven, Brawdy and St David's sits far off to the N. A light cone from lighthouse in St David's Bay can be seen sweeping across to the N.

**Bortle Class: 4**

5.1.5 Abereididi Bay



**Summary:**

A secluded bay with car parking available directly on the beach. Although views north and south are slightly restricted by surrounding cliffs its sheltered position means it is also well shielded from any major sources of light pollution. There are a few cottages visible, but when surveyed there was no light visible from them. There is the possibility to head further down the beach at low tide which will open up views to the east slightly more, but will only have limited impact on sky quality. The spectacular cliffs and rock formations would offer good photography opportunities, although care should be taken as some of the rocks are very slippery.

**SQM-L Readings:** Mean Darkest 4: 21.12 Darkest Individual Reading: 21.17

Abereiddi Bay



Figure 5.15



Figure 5.16



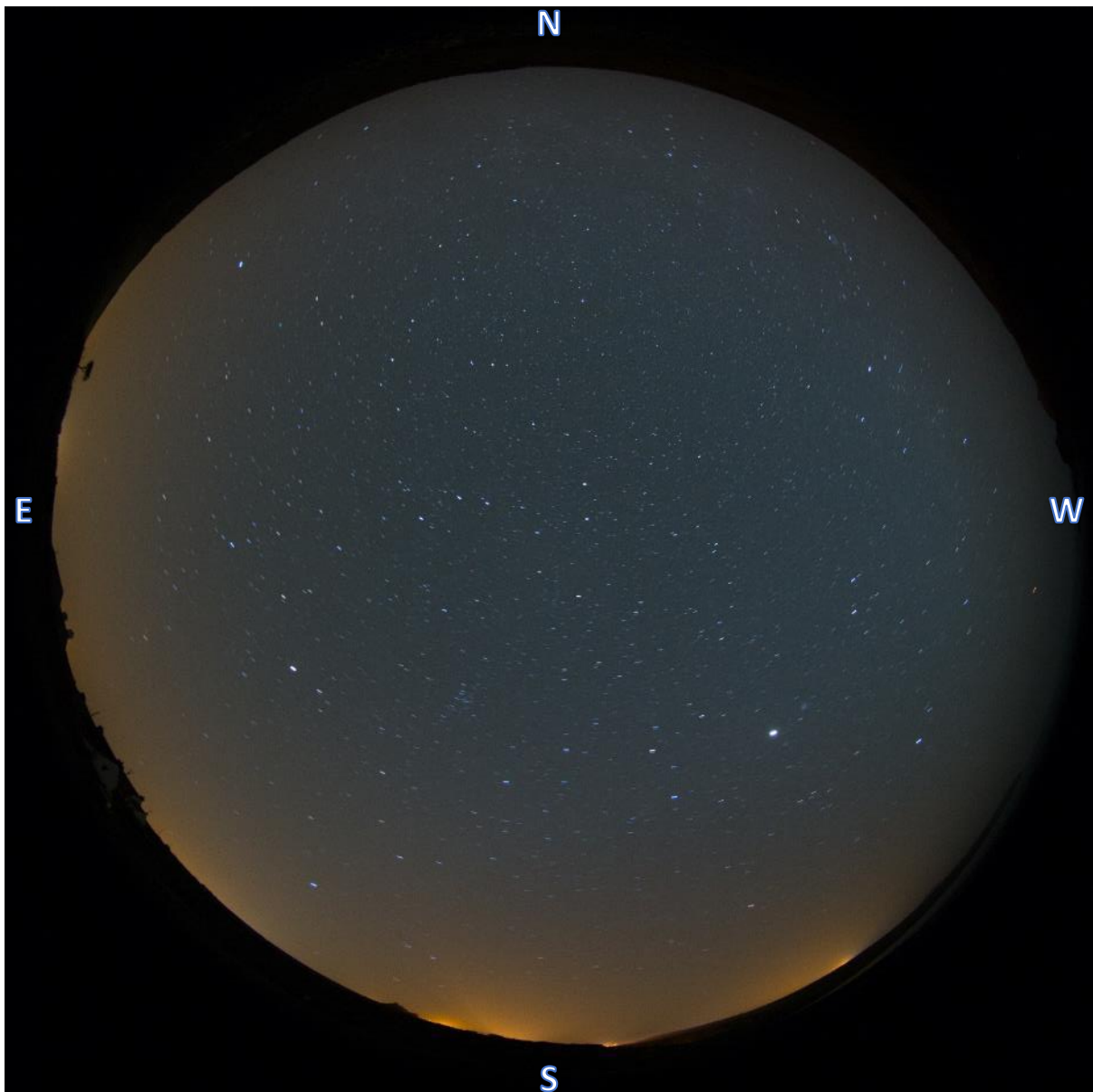
Figures 5.17 and 5.17

Safety Notes:

Some of the rocks on beach can be extremely slippery when wet.  
Surrounding cliffs are subject to erosion – beware loose or falling rock.



## Abereiddi Bay



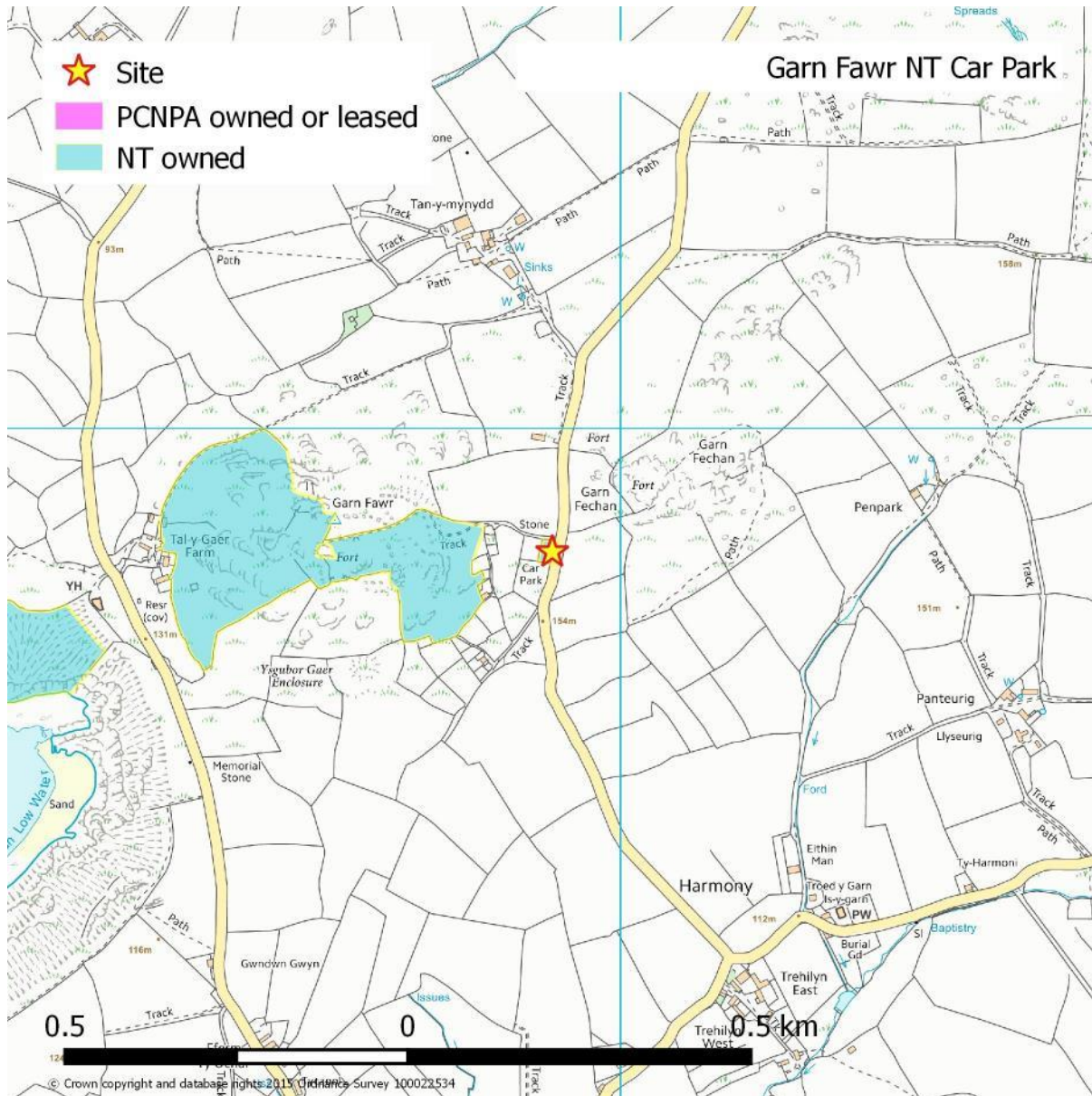
The main sources of sky-glow come from the south and east, as would be expected from the location on a north west facing coastline, with the brightest glow coming from the Milford Haven/Haverfordwest direction. To the east light coming from Fishguard is also just about discernible too as a faint orange-yellow glow.

Preseli Astronomy Group Notes:

This location is stunning in the dark and gave a SQML reading of 21.8. This car park fronts onto the Irish Sea. The carpark is large and relatively flat, composing of stone, gravel and dirt. Excellent viewing to the W, over the sea. N and S restricted by hills that obscure about 150. To the E there are 2 dwellings that are holiday lets and currently empty. Many faint magnitude 6+ stars clearly visible.

**Bortle Class: 3**

5.1.6 Garn Fawr National Trust Car Park



**Summary:**

A small car park with good visibility south, although slightly restricted to the north and slightly more to the east and west. Optional walk to Garn Fawr Summit for views in all directions, but may be difficult at night. Being located near the summit of the road between Garn Fawr and Garn Fechan the elevated position and remote location gives good views of sky, with little local light pollution. The parking area, although slightly sloping is of sufficient size for DSD status and is well surfaced. The nearby hills offer an interesting backdrop even if they do reduce overall visibility in certain directions.

**SQM-L Readings:**      Mean Darkest 4:      21.50      Darkest Individual Reading:      21.52



Garn Fawr NT car park



Figure 5.18

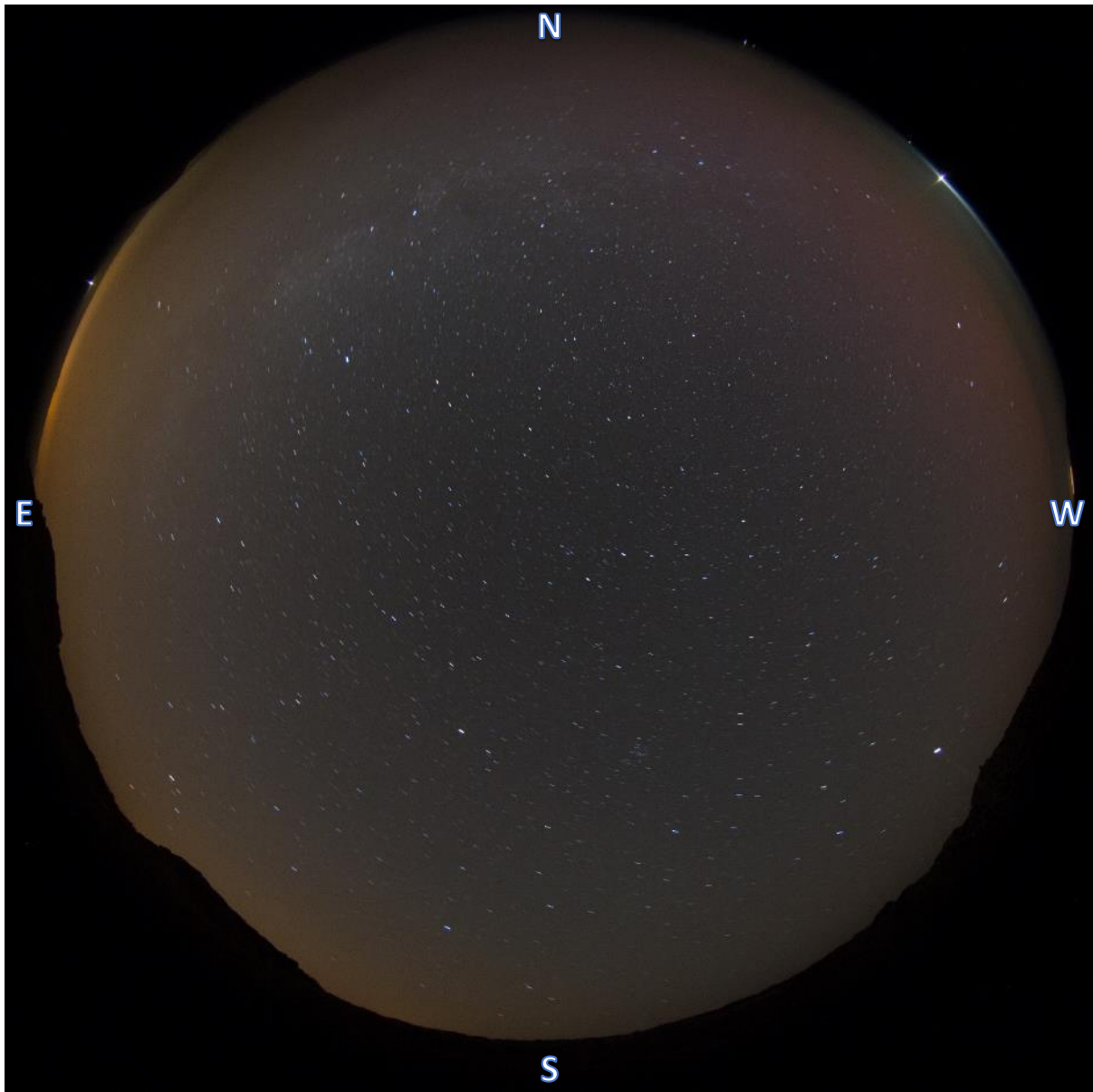


Figure 5.19

Safety Notes:

Care should be taken if venturing beyond car park due to ground conditions

## Garn Fawr NT car park



The point source from the nearby Strumble Head lighthouse is clearly visible to the north-north-west, (although it doesn't appear to dominate much of the view) as is the sky-glow over Fishgaurd. At this northerly location the glow from the Milford Haven area is far less pronounced to the south. Skies overhead are very clear and dark. The Milky Way is very clearly visible.

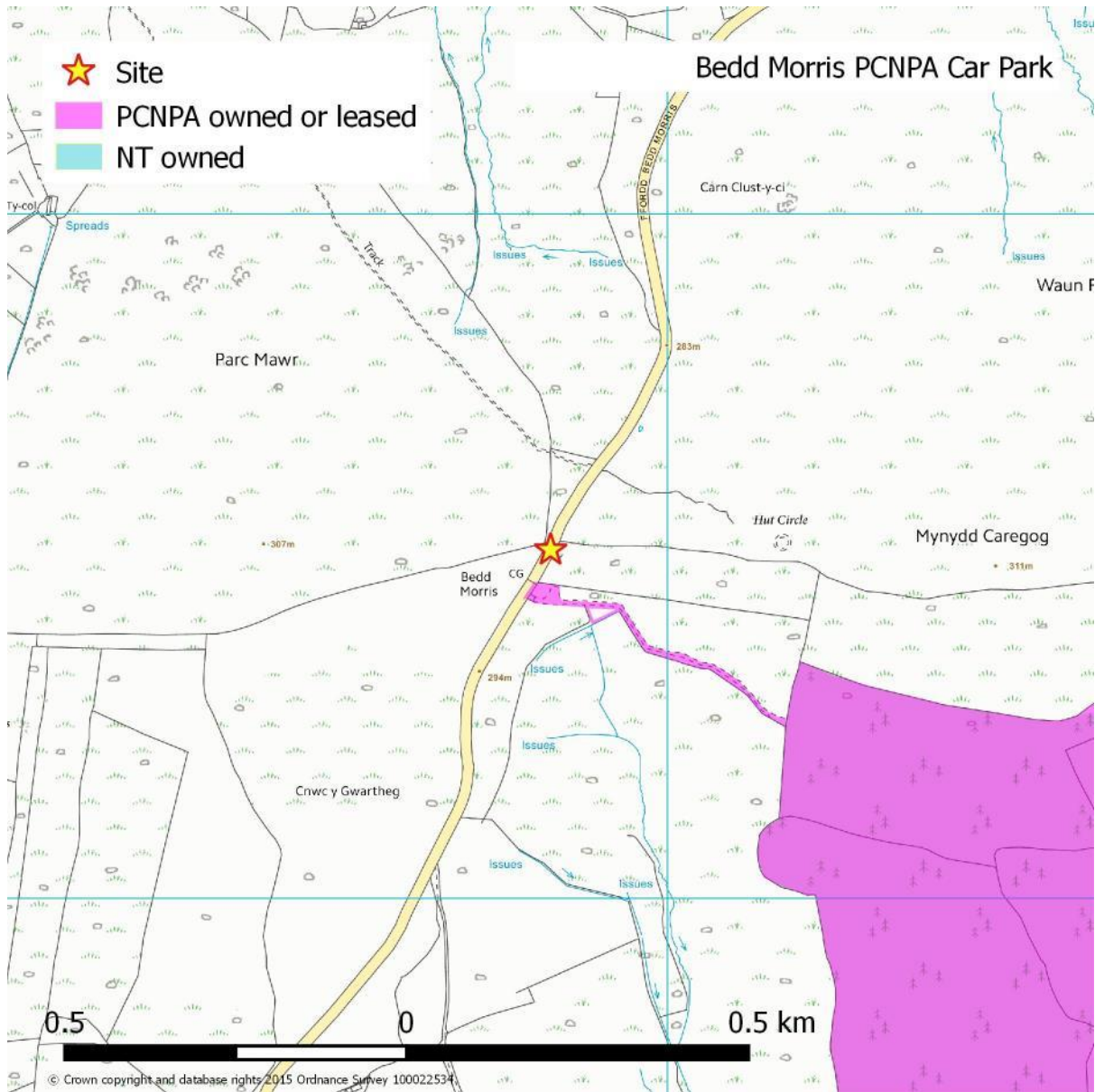
Preseli Astronomy Group notes:

As a gravel/dirt carpark it's good underfoot but probably on a 10/15 degree slope. Excellent viewing to the south, as far as the eye could see (between ESE and WSW). Distant lights are visible but have little impact. Two large TV transmitter are visible in the distance, offering opportunities to align finder scopes.

Viewing to the N, E and W limited by the landscape (to the north by Garn Fawr itself). North is also affected by the sweeping light cone of the Strumble head light house.

**Bortle Class: 3**

5.1.7 Bedd Morris



**Summary:**

Situated off the road leading into the Preseli Hills above Dinas Cross, the reasonably large car park offers good visibility in all directions, with optional walks leading directly from it onto surrounding hills. Being situated away from development means its skies are free from local sources of light pollution.

**SQM-L Readings:**      Mean Darkest 4:      21.37      Darkest Individual Reading:      21.39



Bedd Morris



Figure 5.20



Figure 5.21

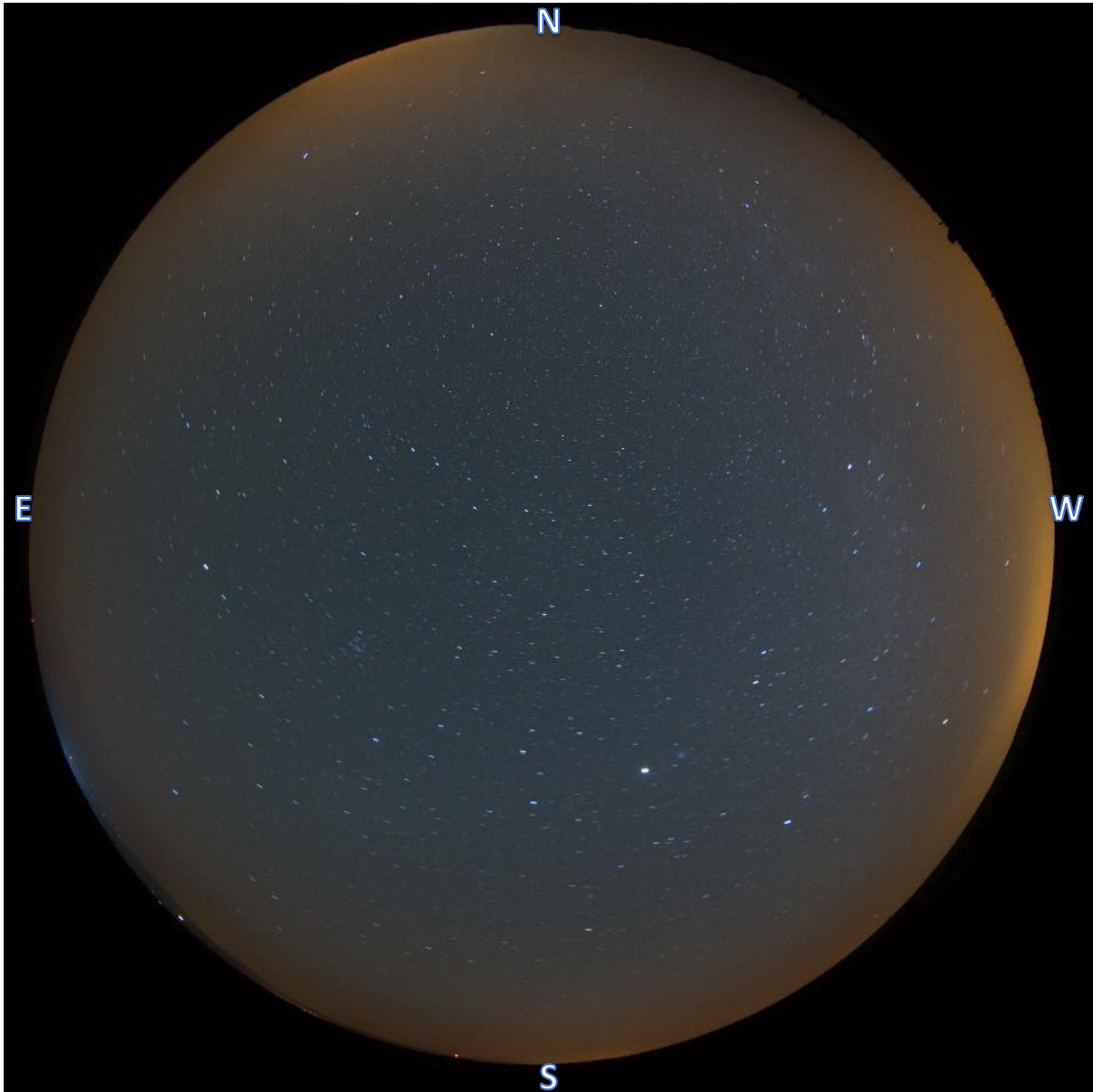


Figures 5.22 and 5.22

Safety Notes:

Care should be taken if venturing beyond car park due to ground conditions

Bedd Morris



There are good views of the sky in all directions although being at an elevated position means that many distant light sources are visible on the horizon. The Milky Way is also very clearly visible from here.

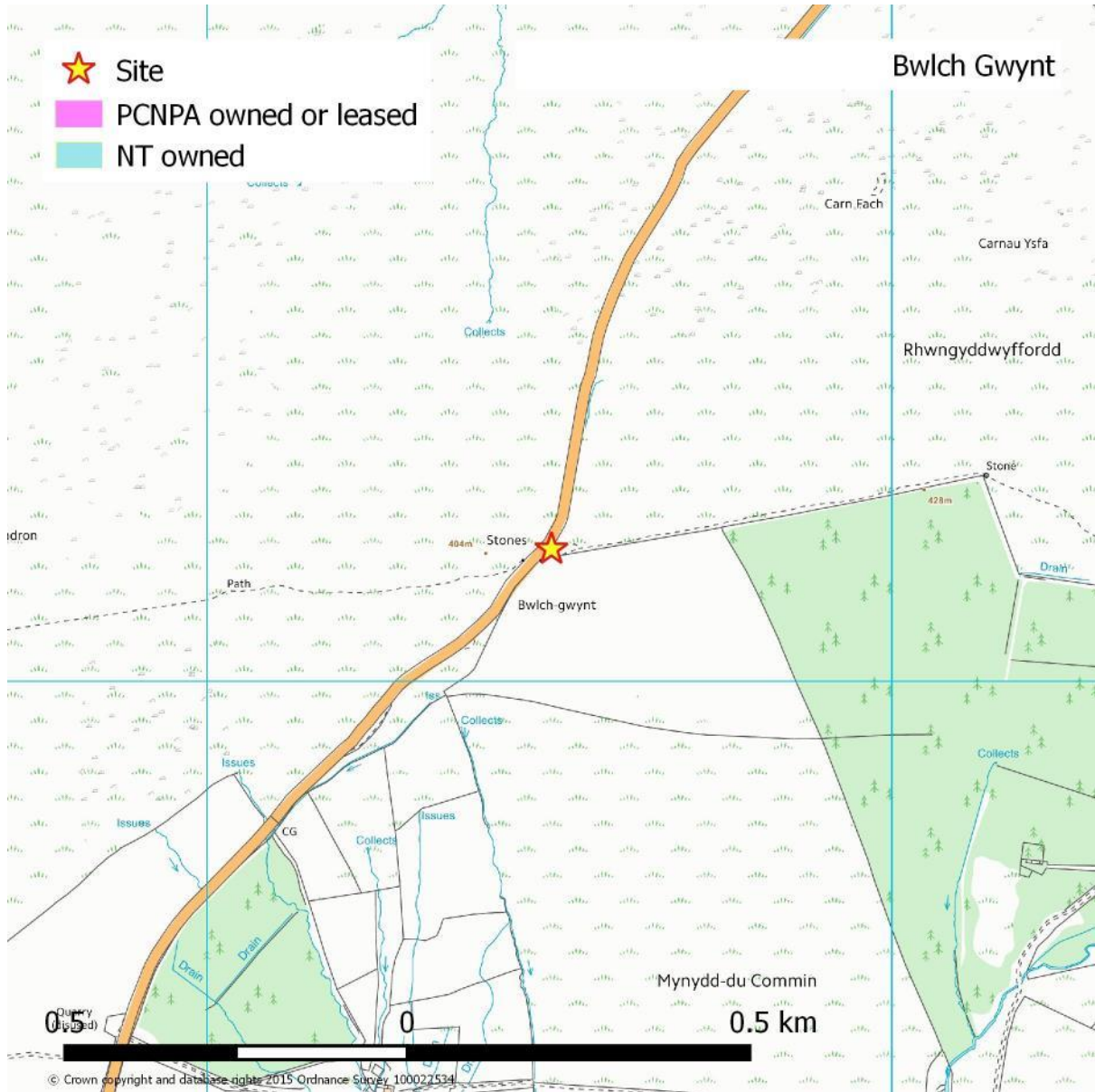
Preseli Astronomy Group Notes:

Good all round view to all points of the compass. A faint glow of Haverfordwest and Milford seen to the SE.

Site is an easily accessible, flat, gravel/dirt car park but a road alongside makes it unsuitable for 'deep sky' observations as light from passing vehicles interfere with observations.

**Bortle Class: 3**

5.1.8 Bwlch Gwynt



**Summary:**

This medium size car park is situated at a high altitude in the Preseli Hills and has good visibility in all directions and is far from any obvious major sources of light pollution. There are optional walks onto surrounding hills from here although little is to be gained in terms of visibility of the night sky. It offers excellent potential for an unspoilt view of the night sky and is reasonably well surfaced across much of the area, allowing for setting up a telescope.

**SQM-L Readings:** Mean Darkest 4: 21.52 Darkest Individual Reading: 21.54



Bwlch Gwynt



**Figure 5.23**

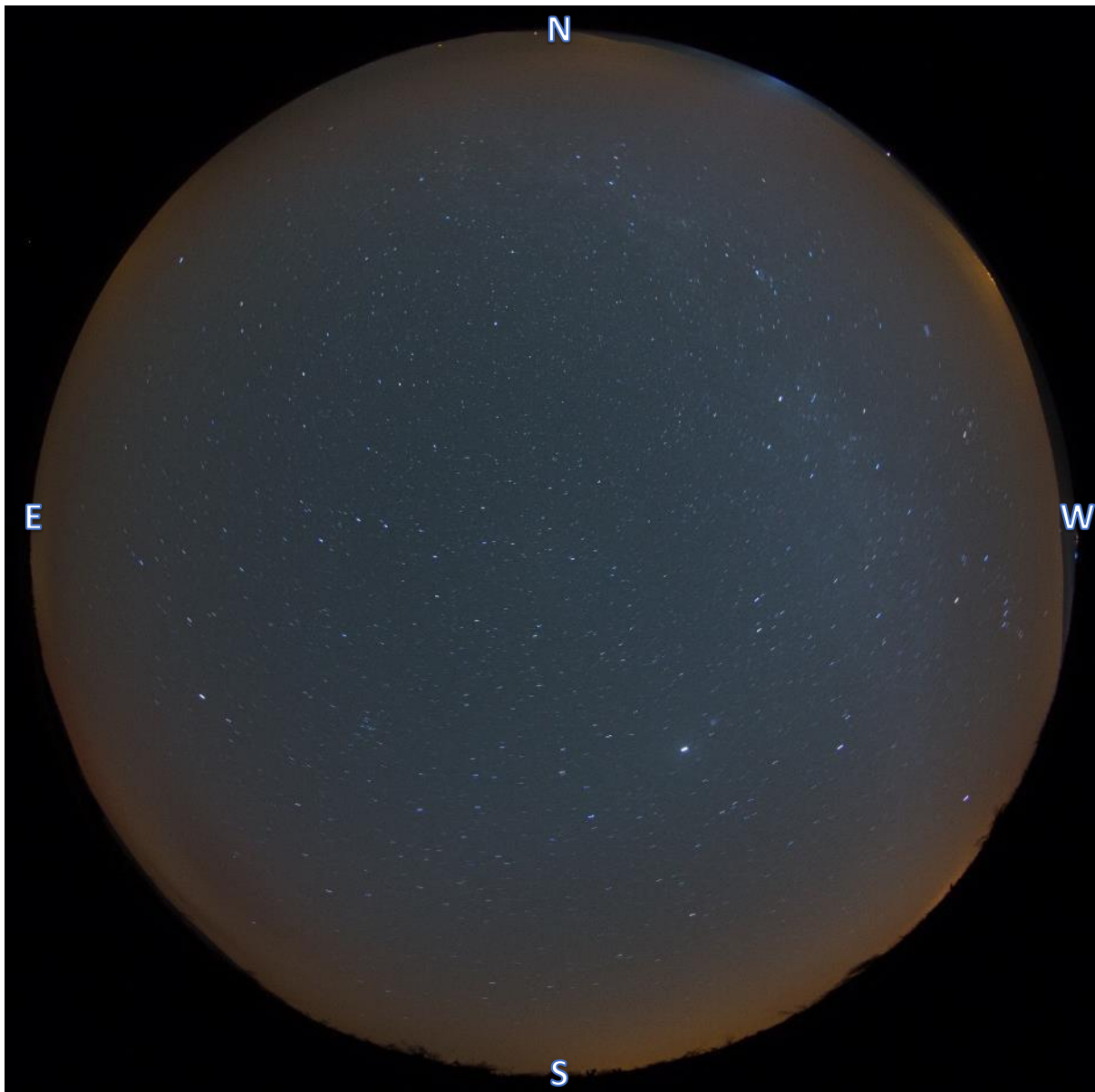


**Figure 5.24**

Safety Notes:

Care should be taken if venturing beyond car park due to ground conditions

## Bwlch Gwynt



There are excellent views of the night sky in all directions with only a very faint sky-glow coming from the distant towns. The Milky Way is clearly visible.

#### Preseli Astronomy Group Notes

Good access to site and easy parking. Excellent all round visibility with superb views to the north and south, slightly limited to the West by Cerig Llandron and a little more so to the east southeast by Foel Cwmceryn.

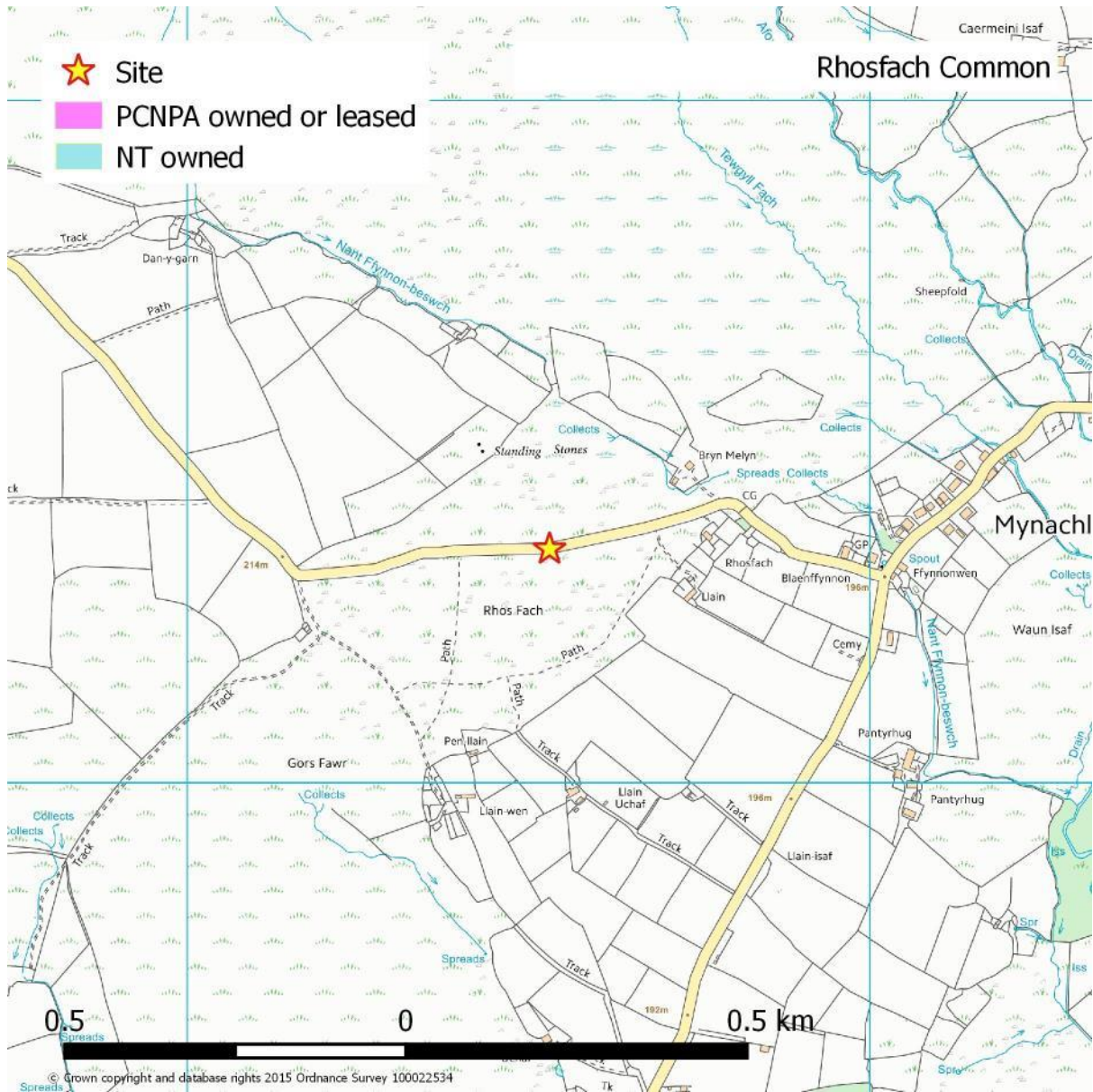
To the south a great number of distant lights are visible, but have little impact due to the distance, also the skyglow does not extend more than 10° above the horizon. To the north good dark sky to within a few degrees of the horizon.

Although the site has good potential, it also has a major drawback - there is a regular passage of traffic, occasionally these also utilise the car park, meaning that it would disturb any dark adapted vision acquired.

#### **Bortle Class: 3**



5.1.9 Rhos Fach Common



**Summary:**

This medium size car park in the Preseli Hills offers good visibility in all directions and very dark skies. Its remote location away from any large settlements means there is little in the way of direct light pollution and there are optional walks onto surrounding hills. It is well surfaced and relatively flat.

There are two prominent monument stones here – one to local poet William Waldo, and a more recent ‘pillar’ marking the use of locally quarried ‘Bluestone’ for the standing stones at Stonehenge.

**SQM-L Readings:**      Mean Darkest 4:      21.49      Darkest Individual Reading:      21.53

Rhos Fach Common



Figure 5.25



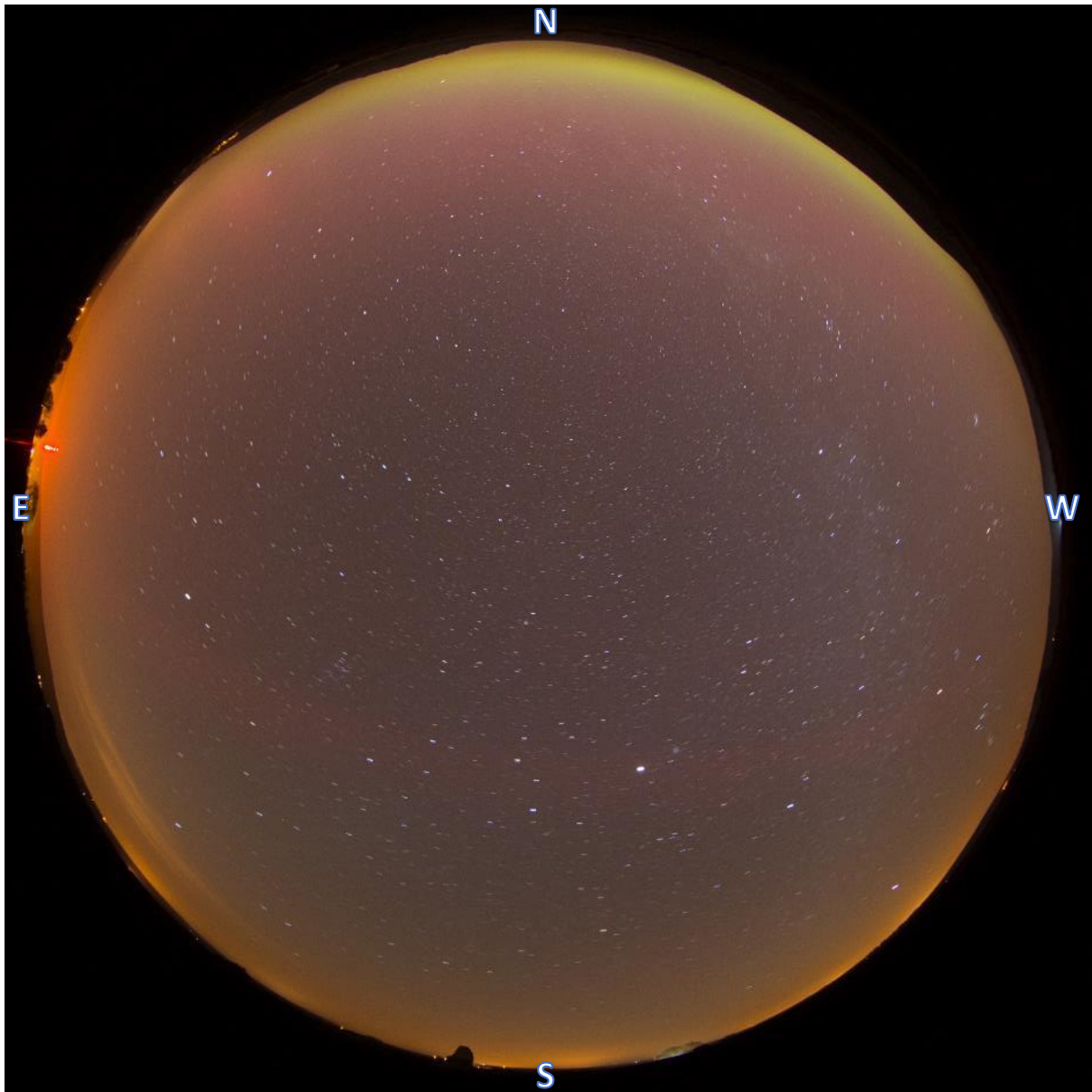
Figure 5.26



Figure 5.27



## Rhos Fach Common



There are excellent views of the night sky from here although in the photograph above they are influenced heavily by the presence of the northern lights, visible as a green and purple glow to the north (left). The red lights of the Preseli TV transmitting station are also clearly in view approximately 4km to the east. Despite these the Milky Way can clearly still be seen above.

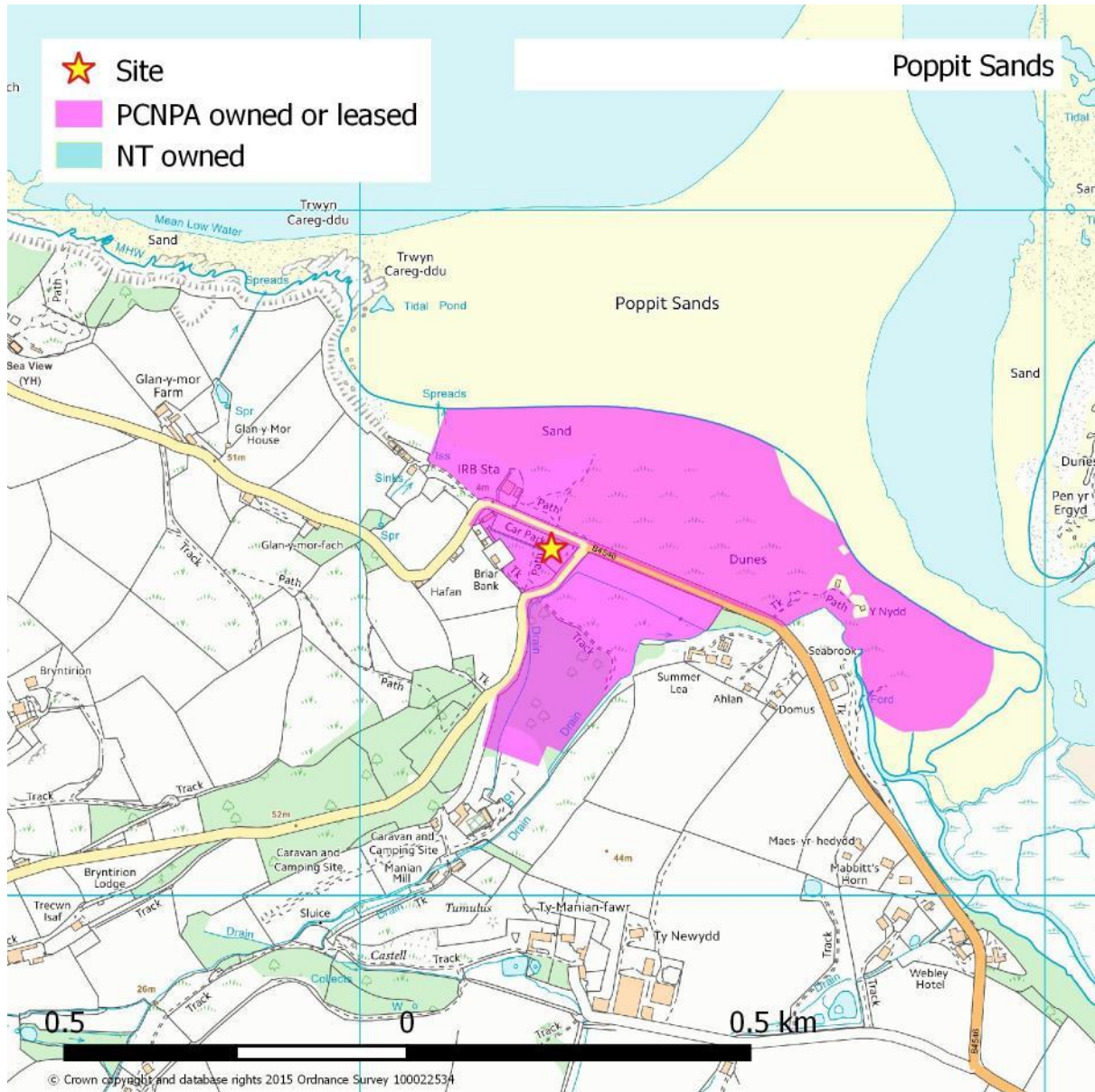
**Preseli Astronomy Group Notes:**

Another excellent site with good access, though the road is narrow in parts. Excellent all round visibility and far enough from the surrounding hills to see to within 5° of the horizon to the North and East, and right to the horizon to the South and West.

Very little traffic here with even less chance of disturbance, a first class location for astronomical observations.

**Bortle Class: 4**

5.1.10 Poppit Sands (Beach)



**Summary:**

The least restricted views of the sky from Poppit Sands are from the beach, accessed by crossing a quiet road and passing at the side of the lifeboat station. There is some light pollution from the lifeboat stations and café, and although moving further out onto the sand may reduce the impact of this it can increase visibility of lighting from across the bay. Its proximity to Cardigan and easy accessibility means it offers potential to attract visitors who might not wish to travel to the more remote locations or happen to be staying in the area.

**SQM-L Readings:** Mean Darkest 4: 21.27 Darkest Individual Reading: 21.37

Poppit Sands



Figure 5.28



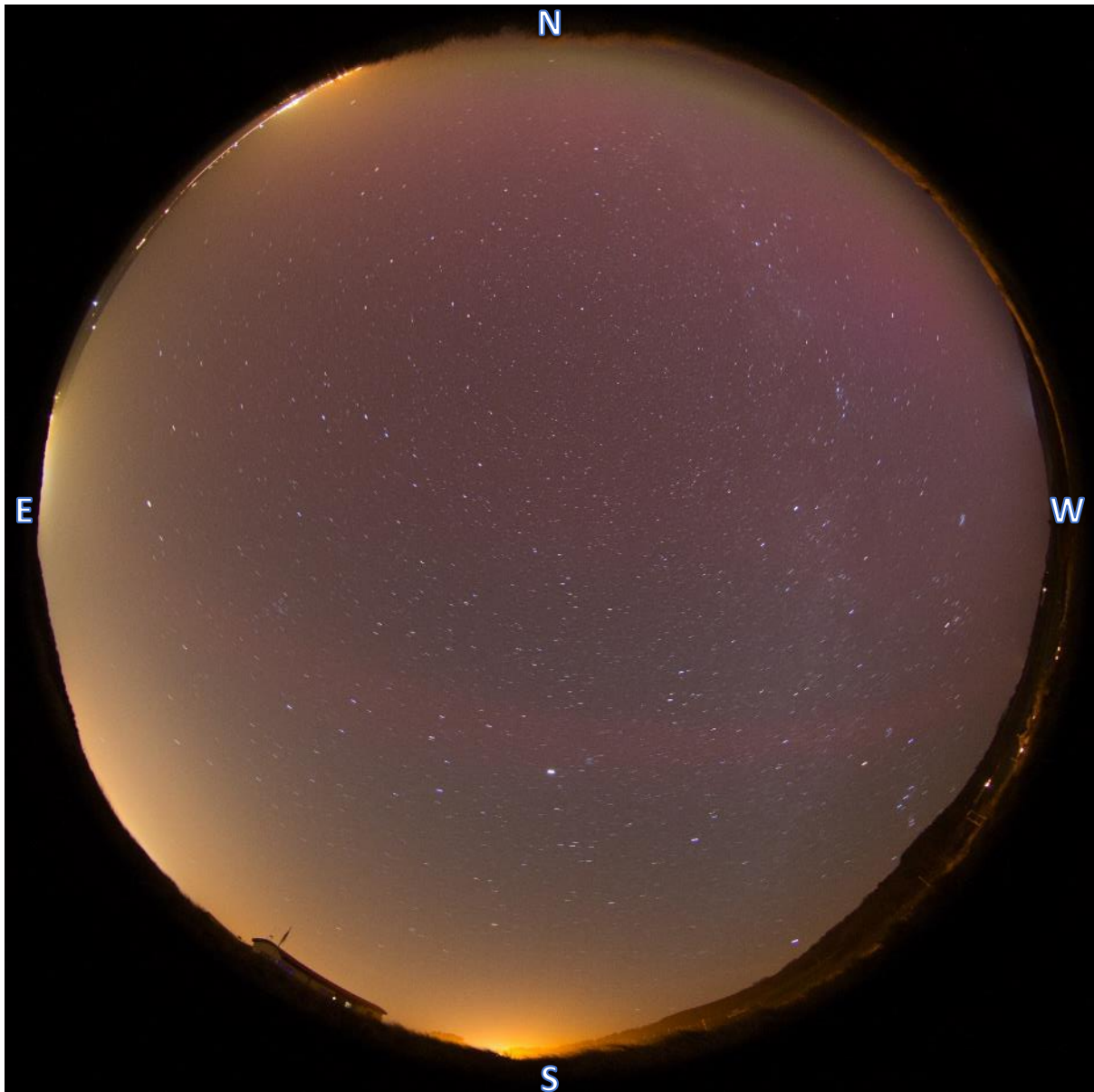
Figure 5.29



Figure 5.30



## Poppit Sands



Despite a considerable amount of visible light on the horizon in several directions, and its proximity to Cardigan, the skies here are surprisingly good, and the visibility in all directions is only restricted at the lowest angles. While there is clearly some sky-glow visible, the Milky Way is still clear in the image above, despite the purple glow of the Northern Lights visible in this image.

Preseli Astronomy Group Notes:

Large easily accessible site with ample space on a flat, dirt/gravel surface. SQM reading of 21.27 (temp 5°C). Views to south slightly limited by as landscape rises and the odd large tree. Excellent viewing in all other directions. Glow of Cardigan evident to the NE and the hotel to the north. Several nearby dwellings may add to background when residents are present.

**Bortle Class: 4**



## 5.2 Other Potential sites

Despite not making the recommended ten sites, the following sites all offered good potential for viewing dark skies, and would probably still meet all the required criteria for Dark Sky Discovery sites. In some cases they were only omitted due to being close to other sites that were slightly superior, and in many cases they offer unique or interesting experiences or interest to visitors.

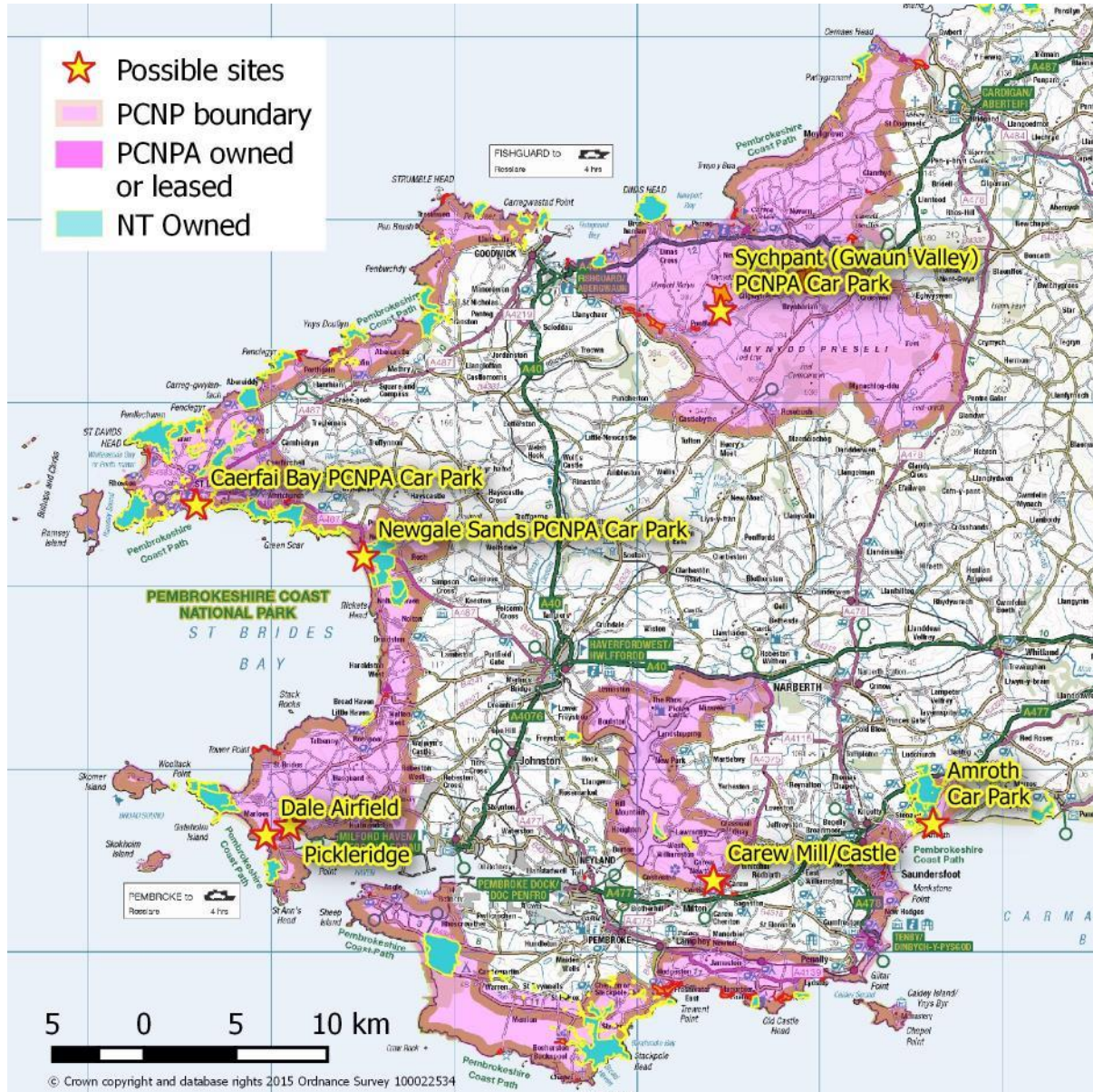


Figure 5.2

The following pages show the location of each of these sites in more detail and give a brief summary and the reasons why they failed to make the recommended ten.

5.2.1 Amroth



**Summary:**

The best views of the night sky here are from the beach (limited parking available at the western end of the seafront, near the public toilets). A slipway provides good access to the beach, although it is quite steep and may have rocks and pebbles washed across it. At low tide the sandy beach below is easily accessible. Views of the night sky here are particularly good to the south, and were significantly less affected by skyglow than at the nearby Wiseman’s Bridge and Saundersfoot locations. Lower angle views in a more northerly direction are restricted by landform. Heading further down the beach than the start of the sand fails to offer improvements as Saundersfoot itself and the associated light pollution become more visible.

There is noticeable light pollution coming from sea-front cafes/shops/properties – reducing this would offer improvements to the visibility of the night sky in this location. (See section 7.2).

**SQM-L Readings:**      Mean of darkest 4:      **20.90**      Darkest Individual:      **20.98**



Amroth Beach



Figure 5.31

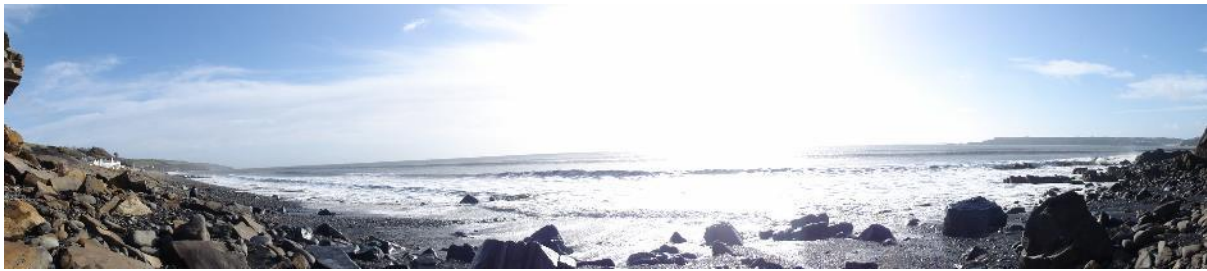


Figure 5.32

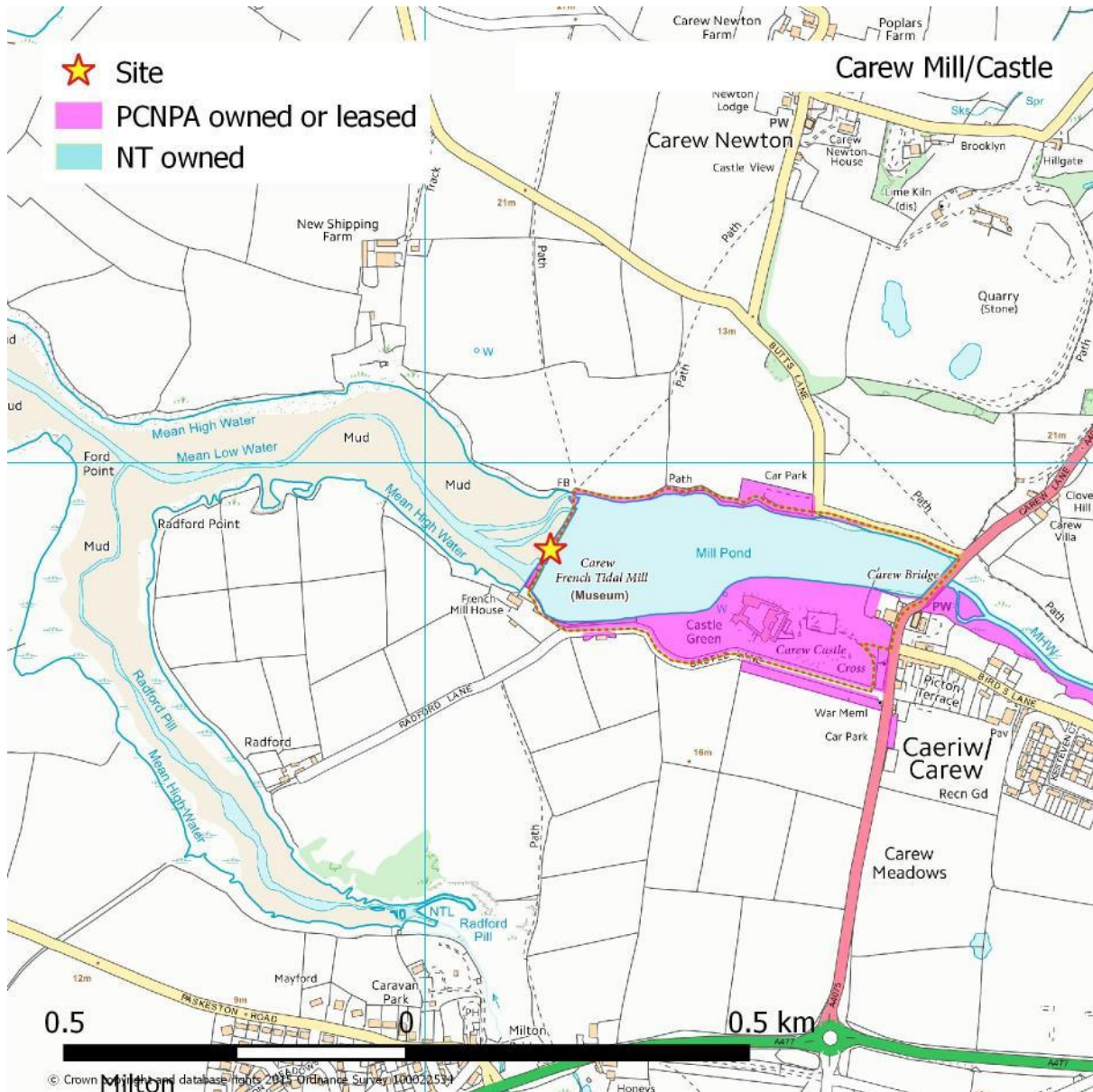


Figure 5.33

Safety Notes:

Care should be taken due to loose pebbles on beach and slipway.

5.2.2 Carew Mill



**Summary:**

The suggested viewing area for this site is from the middle of the dam, just past the mill building itself. There is a large, well surfaced car park for the castle accessed directly from the A4075, from where a short walk along Castle Lane leads to the mill (which is unlit). Although not the darkest of the sites, visibility is good in all directions, with any visible light sources being distant. The view of the stars and the silhouette of the Castle reflected in the water can be spectacular.

This would make a particularly good site for those wanting to take interesting night-time photographs, rather than purely hoping for the clearest views of the faintest astronomical objects.

**SQM-L Readings:**      Mean of darkest 4:      **20.76**      Darkest Individual:      **20.79**



Carew Mill



Figure 5.34 – View west



Figure 5.35 – View east towards Castle



Figure 5.36



Figure 5.37

Safety Notes: Care to be taken on dam due to unprotected open water.

5.2.3 Pickleridge



**Summary:**

Parking at Pickleridge is on a large gravel triangle at the side of the road, but best night sky views are obtained by walking along the causeway between the beach and the saltwater lagoon. By about halfway the refinery disappears behind the headland to the north when looking out to sea, and the vegetation which initially lined the path is far enough away to provide an excellent view in all directions, except at the very lowest angles. The flat, calm water of the lagoon allows clear reflections of the stars to the north-west on a still night and makes for spectacular photography opportunities. Care should be taken due to the presence of unprotected open water adjacent to the path, and note that it seems well used by dog walkers during the day.

The viewing position on the causeway may not fully meet DSD site criteria for size.

**SQM-L Readings:** Mean of darkest 4: **21.15** Darkest Individual: **21.29**



Pickleridge



**Figure 5.38 – Looking NE along causeway**



**Figure 5.39 – Looking SW along causeway, towards car park**

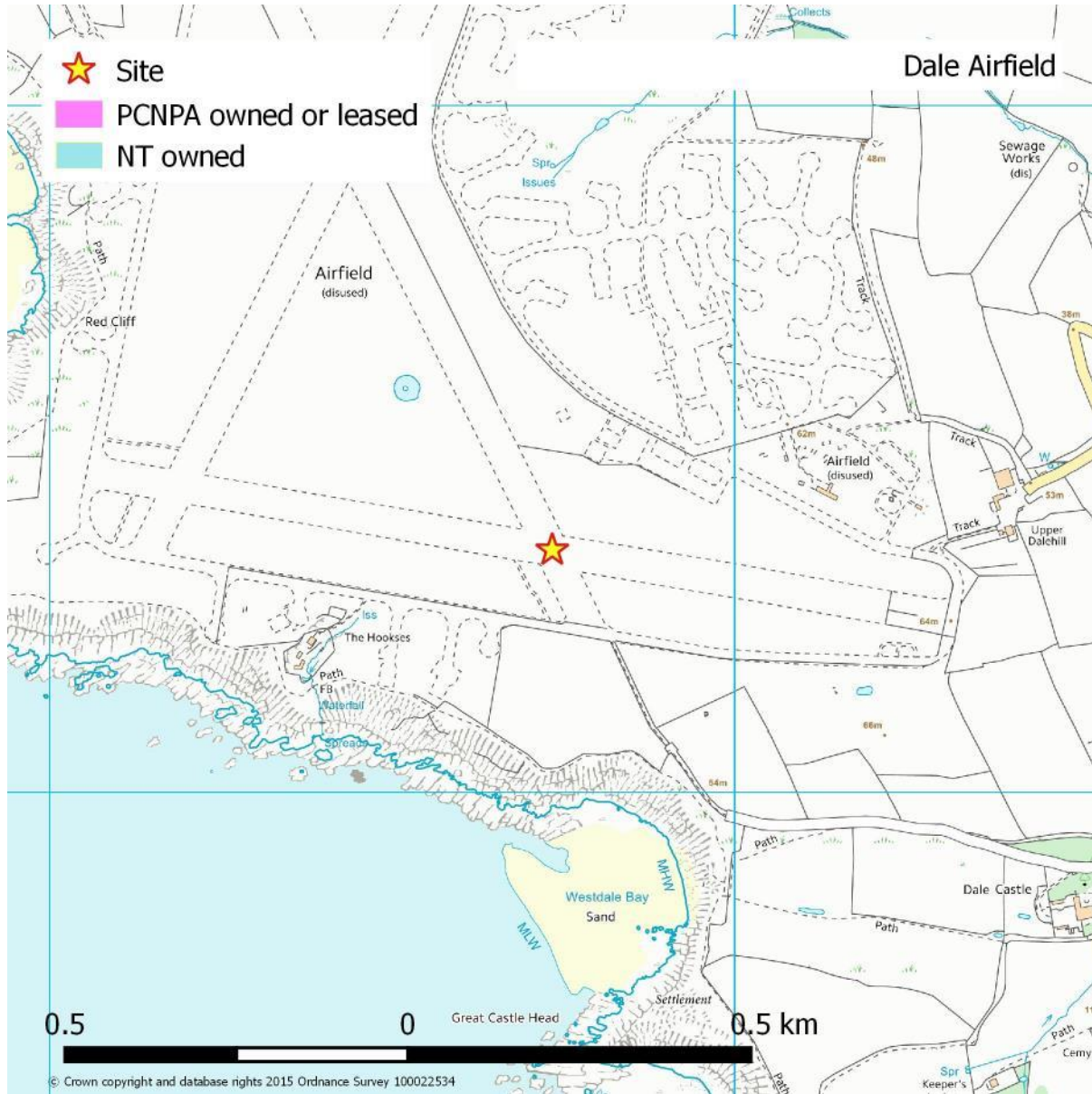


**Figure 5.40 – Car parking area**

Safety notes:

Care to be taken on Causeway due to proximity to open water  
The path along the causeways is slightly uneven

5.2.4 Dale Airfield



**Summary:**

The disused airfield to the north-west of Dale offers excellent views in all directions, due to its elevated position and flat topography of the surrounding area. There is a small car park immediately before a gate across the road, but best views are obtained by going through the gate and approx. 300m further, onto the old runway. The derelict remains of the old airfield may be of great interest to some but also create an atmosphere that can feel somewhat unwelcoming, especially at night. The single track access road is very steep and narrow.

While the views of the sky are excellent, other sites in the area are equally good or better in terms of visibility, with better access.

**SQM-L Readings:** Mean of darkest 4: **21.27** Darkest Individual: **21.31**

Dale Airfield



Figure 5.41



Figure 5.42



Figure 5.43



Figure 5.44 – Gate through which to access the site

Safety Notes:

Access road is very steep and narrow single-track.



5.2.5 Newgale Sands



**Summary:**

Newgale Sands is a long west-south-west facing beach with several parking areas along it. The recommended location is off the middle car park, on the beach (visibility is better, especially to the east by moving down the beach as the hillside obscures less of the sky). The larger car park to the north is closer to the lights of Newgale itself. Views are good in all directions with overall a clear unobstructed view much of the sky, away from major sources of skyglow, but there are a few visible light sources in direct sight.

Overall a good site, but no standout qualities. Probably not worth a special trip, unless you are in the area anyway.

**SQM-L Readings:**      Mean of darkest 4:      **21.08**      Darkest Individual:      **21.11**

Newgale Sands



Figure 5.45



Figure 5.46



Figure 5.47



5.2.6 Caerfai Bay



**Summary:**

Caerfai Bay offers a medium size gravel surfaced car park in a remote clifftop location. Excellent views south across the sea, and relatively good in all directions. A slight glow is visible inland, from St David’s, and lights are visible along the coast. Although not especially dark when compared to some of the other locations, it is a welcoming and interesting site that offers good views and has a campsite and a caravan park close by, as well as a small picnic area with wooden tables just below the parking (which may offer some shelter from a north-west wind) although it is accessed via steps.

**SQM-L Readings:**      Mean of darkest 4:      **21.09**      Darkest Individual:      **21.11**

Caerfai Bay



Figure 5.48



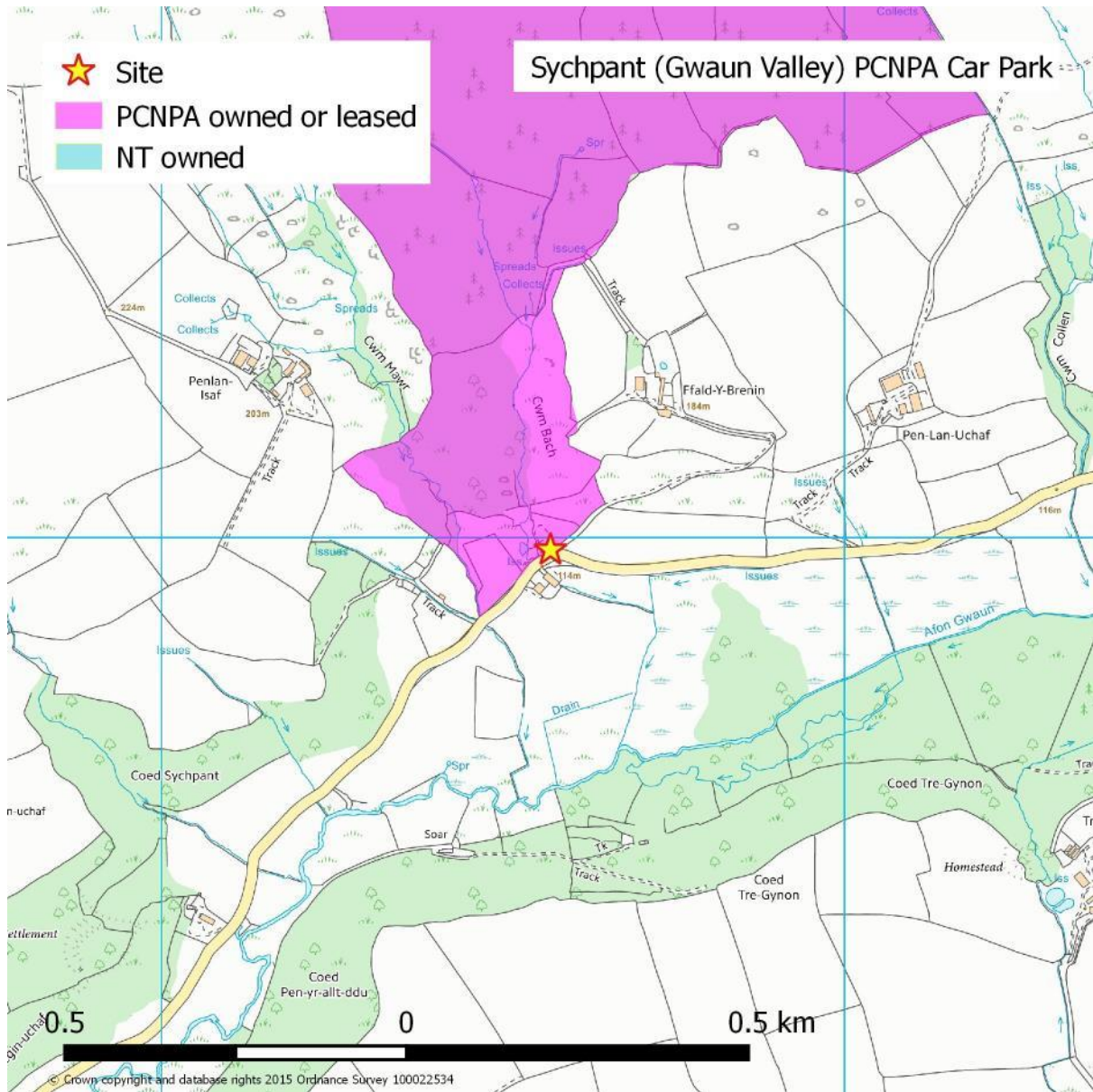
Figure 5.49



Figure 5.50



5.2.7 Sychpant, Gwaun Valley



**Summary:**

The Pembrokeshire Coast National Park car park and picnic area at Sychbant (or Sychpant) offers a unique opportunity within the Gwaun Valley, in terms of offering a publicly accessible space which meets the size and access criteria of a Dark Sky Discovery Site. With its valley floor location, views to the north and south are restricted by landform at lower angles, but looking along the valley to the east from the main car park is relatively good. By crossing the footbridge over the stream views to the south-west are dramatically improved as the line of tree is then on the other side. Faint sky-glow is visible to the south, and lights visible from one farm, but only a minor influence.

This site offers very good dark skies with little light pollution; the biggest issue is how much of the view is restricted – although this is only really at low angles, where visibility is reduced anyway to a combination of distant sky glow and atmospheric distortion.

**SQM-L Readings:** Mean of darkest 4: **21.40** Darkest Individual: **21.43**



Sychpant



Figure 5.51



Figure 5.52



Figure 5.53



Figure 5.54



## 6 DISCUSSION OF ISSUES

A number of issues were apparent at the start of the process and others arose during the site surveys.

From the outset, it was clear that all night time survey work would need suitable weather conditions to coincide with appropriate moon phases and rising/setting times – this limited the number of opportunities to undertake the work, although in the end there were sufficient clear, dark nights to take the SQM-L readings.

Actual visibility of the sky is dependent on not just overall percentage cloud cover but also the transparency of the atmosphere (hazy conditions will blur out the fainter stars and other objects, especially if these are low in the sky). This will have an impact on the photography and also complicate the process of undertaking Bortle Scale Assessments, as these rely on determining the faintest objects visible to the naked eye. The Preseli Astronomy Group reported having to use the process of ‘limiting magnitude’ – and looking for alternative objects instead of some of those listed to determine whether or not they would be visible.

On one of the two nights that the photographer was out in suitably clear conditions, the Aurora Borealis was visible and a faint green or purple glow is visible in some of the photographs. This is obviously far from ideal in terms of showing the stars that should be visible, but the images could be re-shot if required (probably only necessary if applying for International Dark-Sky Association accreditation), and may well be useful for publicity, as the fact they were visible demonstrates the quality of the skies in the area.

Both the Green Bridge of Wales and nearby St Govans are situated adjacent to a military firing range. Access is often restricted and this has hindered the survey process. SQM-L readings were taken at both sites, but the photographer was unable to access the Green Bridge of Wales. As a result, the photograph was taken from St Govans. While this clearly is an issue at certain times, it is felt that they should still be considered as DSD Sites, as they offer good views of the sky from that area in combination with iconic local landscape features.

The lighthouse at Strumble Head is extremely bright and highly visible from a long distance – it was clearly visible from a number of sites. Between the flashes, the car park immediately adjacent to the lighthouse actually gave some of the darkest sky readings of all. Because of the intensity though, especially when close to it, it may prevent the human eye from properly adjusting to the darkness and has a very strong influence on the long exposure photograph.

Another issue faced was during the long exposures moisture would begin to collect on the camera lens. This was very apparent at one site in particular, which was re-shot the following night, with better results.

Many of the sites that have not been proposed suffer from light pollution from street lighting. Many of these lights are switched off between Midnight and 05:30, so between these hours they may offer better sky quality than earlier in the night.

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## 7 GENERAL RECOMMENDATIONS

### 7.1 Promoting the sites

Gaining a recognised status for dark skies not only proves quality, rarity and value, but also creates a defined talking point for the NPA and working towards this can be a focus for early publicity. Future promotion of the dark skies over the Pembrokeshire Coast National Park will be a vital part of their protection as well as an important aspect of bringing more visitors into the area to enjoy them. Many of the area's other special features already enjoy statutory protection, such as landscape, wildlife etc., but dark skies do not, so gaining some sort of recognition of their quality will add weight to the argument that they should be protected.

Developing local support and recognition of their importance and quality will help to offer protection in the future and bring other benefits to the area.

A co-ordinated approach and the creation of some sort of brand, including a logo etc. that can be used by local businesses and organisations is strongly recommended. Publicising the progress of any application process among local people will help to raise the profile of the issue and having a clear identity will help people to become part of the process and take ownership of it.

Wales generally has some of the best dark skies in the UK and in fact much of Europe, with the Brecon Beacons National Park already accredited by the International Dark-Sky Association as a Dark Sky Reserve, and Snowdonia is in the process of applying for the same status. Further details of the process and requirements of this status can be found at <http://www.darksky.org/>

Much work has already been carried out promoting dark skies in the Brecon Beacons National Park, and staff there are keen to share information and good practice with other authorities pursuing similar aims. Significant opportunities exist to produce joint resources (star charts etc.) and for future collaborative working with both the Brecon Beacons and Snowdonia, helping develop Wales' status as a dark sky nation.

Recognised Dark Sky status can bring economic benefits, particularly by bringing in extra tourists at normally quiet times of year as winter obviously lends itself to viewing the stars, with longer periods of true darkness (outside of astronomical twilight) and at less antisocial hours. In order for this benefit to be fully realised though it is important to ensure that local businesses are aware of the campaign, and able to pass on information to visitors. Publicising the application process as well as any subsequent award allows for more opportunities to catch people's attention and doing this through a variety of media creates the best opportunity to do so.

People often remember information far better when they have seen/heard/read it in more than one place, so using a combination of local press, TV, radio, social media, websites, leaflets and organising specific events will have a greater cumulative effect than focussing on any one route for dissemination.

A co-ordinated strategy should focus initially on raising the profile locally within the National Park and immediate surroundings (and with partner organisations such as Pembrokeshire County Council) then following this up with wider marketing aimed at bringing in tourism. In terms of offering something unique, it is worth noting that parts of Pembrokeshire have the least amount of cloud of all Wales, which obviously has benefits for seeing the stars; and the diversity of character and location of the proposed sites means that in many cases even if the Preseli Hills are shrouded in fog or low cloud, better views may be available from a coastal peninsular.

Developing a standalone website, or pages within the National Park site, could offer opportunities to access details of the suggested sites as well as more general information such as star charts, contact details and safety checklists. It could also easily link to information on live firing on the Castlemartin ranges ([http://data.gov.uk/dataset/castlemartin\\_firing\\_programme\\_mod](http://data.gov.uk/dataset/castlemartin_firing_programme_mod)) and associated access issues, and to weather reports for the area. During survey work for this report the Weather Underground website (<http://www.wunderground.com/global/stations/03604.html>) was particularly useful and allows the user to select data from individual weather stations shown on a pop-up map, as well as having the option to display percentage cloud cover in graph format as well as various other information.

It is worth noting a number of other benefits to dark skies and reducing light pollution, such as the impact on wildlife. A number of species that are active at night are adversely affected by light pollution and the Pembrokeshire Biodiversity Partnership are keen to be involved in promoting dark skies for this reason. They also manage an active and popular Facebook page which could help promote key events or news items, as well as generally promoting partnership working and have two mailing lists – one for professional organisations and one for public volunteers. The contact is the Biodiversity Implementation Officer, based at County Hall in Haverfordwest.

It has recently been widely reported that there are also significant health benefits to experiencing dark nights, and a suggested link between too much artificial light/lack of darkness and cancer. There is actually a significant number of reports published over the last fifteen years or more, many of which can be found on the Campaign for Dark Skies website, here: <http://www.britastro.org/dark-skies/health.html?70>

## 7.2 [Dark Sky Discovery Site Nomination](#)

The ten sites recommended in this report are considered to all meet the published criteria for Dark Sky Discovery Site status and could be nominated as such. As well as the ten recommended sites, the other six sites suggested here may also stand a good chance of being accepted, and the PCNPA might wish to consider proposing all or some of them as well.

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## 7.3 Reducing current light pollution

### 7.3.1 Generally

A number of relatively simple opportunities exist to reduce the impact of light pollution and others require greater capital or resource investment. The simplest opportunities include encouraging people to:

- turn lights off
- draw curtains or close blinds
- alter settings on security lights (timings and direction)

This will bring them other benefits such as reduced fuel bills (and reduce heat losses as well). Any public campaign to promote dark skies could also highlight these issues.

The next stage is to consider using lower power, more energy efficient lighting units generally and perhaps just as importantly to consider shielding or directional lighting to ensure they only light the areas that are required. The Campaign for Dark Skies have a host of information on their website that is readily available and aimed at a variety of users. <http://www.britastro.org/dark-skies/index.html>

Pembrokeshire County Council already switch off many streetlights between midnight and 05:30 – but a further, long term option is to consider the upgrading of the lights to modern, directional LED models. While there is an upfront cost to doing this on a large scale the operating costs are far lower, so financially the investment pays over time and with well designed, directional lamp units the sky-glow they cause can be greatly reduced. LED technology has improved greatly in recent years and costs are falling, so while maybe not an immediate action, in the medium to long term it should be considered. It would be very important though to ensure that any specification for new lighting focusses on the directional qualities of any proposed replacements, and how this can minimise light pollution, rather than just on a combination of cost and brightness along – many of these new lights are very powerful, and need to be used with care.

### 7.3.2 At key locations

Most of the recommended sites do not suffer from immediate local sources of light pollution – the one that shows the most obvious example is Poppit Sands, with the Lifeboat station and adjacent café being well lit (although the café was closed) at the time of survey. Immediate benefits could be realised by agreeing with operators of these facilities to turn off or down their lighting at night, or for taking other measures to reduce its impact.

More generally there was a strong glow from the Milford Haven area, and its associated petrochemical works, visible from virtually every site (Being central to the National Park though, it was affecting different sectors of the sky in different locations). Although clearly not viable to eliminate this, if it was possible to negotiate any sort of long term reduction in light emissions here it could have significant impact on the wider area.

Similarly general reductions in emissions from street-lighting, through the measures mentioned above could begin to have a significant cumulative effect across the National Park over time.



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## 7.4 Avoiding future Light pollution

### 7.4.1 Planning guidance

The Brecon Beacons National Park Authority has produced Supplementary Planning Guidance (SPG) on Obtrusive Lighting. This SPG provides guidance on how new developments should address the issue of lighting and ensures that any new development proposals can be considered in terms of the impact of their lighting, while providing information to developers. The Pembrokeshire Coast National Park Authority could develop similar guidance or with suitable agreements use this document. Rather than emphasising the restrictions, focussing on the document as 'guidance for making new developments dark sky friendly' could be better received by the public.

### 7.4.2 Voluntary initiatives

A publicity campaign should include advice on what individuals and businesses can do. This should be readily available ideally in paper format as well as online and could be promoted through social media. The Brecon Beacons have organised a Dark Sky Ambassador Scheme for their tourism businesses – so they know what is special about their skies, how to promote them and attract stargazers. This also comes with a dark sky guide.

Supplying information on the wider benefits beyond the intrinsic value of having a sky which offers good views of the stars is also helpful. These include effects such as health benefits, increased tourism and the positive benefits for nature, and ensuring people are aware of this helps demonstrate the wider importance and can help them see how they may get a more direct return.

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## 7.5 Generating local support

As well as publicising a campaign directly through the PCNPA, gaining the support of other local organisations helps people to take more ownership of the whole idea. A series of events aimed at a mixture of interested beginners and more experienced astronomers allows people to meet up with others who have a similar interest as well as generally spreading information.

Cubs/Scouts/Brownies/Guides all have astronomy/stargazing badges and using education staff to give assemblies in local schools can help raise the profile among children and young people. It is understood that the Preseli Astronomy Group have worked with a number of Cubs/Scouts/Brownies groups, so there may scope for a co-ordinated approach. Several organisations, including Pembrokeshire County Council (through a scheme led by Robert Woodman) have mobile planetariums (that can be put up in school halls etc. or at other events) and offer training and educational events.

The Preseli Astronomy Group are always keen to welcome new and interested members and could be approached about giving talks or hosting specific events. They hold regular monthly meetings and welcome members of all levels of experience. Further details can be found on their website: <http://www.pasgroup.org.uk/>

Ideas mentioned earlier such as the creation of a brand, logo etc. create opportunities for local businesses to become more involved in the promotion of the Pembrokeshire Coast National Park's dark skies. In other areas local breweries have produced special runs of dark sky themed real ales and released them at launch events etc. Selling various branded products provides another opportunity for local businesses to benefit while also helping raise the profile.

Specifically targeting campsites, B+B's, caravan parks etc. helps them by potentially attracting more visitors (especially at a quiet time of year), and ensuring they have access to leaflets and accurate information helps them to spread knowledge to visitors. By ensuring that information is available during busy summer months (even if the skies are not so visible) can help encourage tourists to return during winter months.

The Brecon Beacons National Park Authority has produced a leaflet for their area, which contains a mixture of specific local information and general information on viewing night skies. It have also recently set up an observatory, which has generated a lot of local interest. Such a move would provide a facility that would be of great interest to experienced astronomers and is a long term aim of the Preseli Astronomy Group.

## 7.6 Evidencing benefits to the local economy

Whilst this might be difficult to achieve, particularly with any high degree of accuracy, if data can be collected on the economic benefits of promoting dark skies this can help strengthen the case for further investment. In Galloway Forest Park a study was carried out into this and in a survey of approx. 35 local businesses it produced a figure of £1.93 return to the local economy for every £1.00 spent on the International Dark-Sky Park application and associated publicity. It added that this was only based on a partial impact assessment, and the benefits would actually be much higher. It also noted that there is a usually a lag between such investment and the benefits being realised.

Although less conclusive and harder to attribute any financial value to, tracking website usage is relatively straight forward and can provide some useful statistics.

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## 7.7 Links to other areas

With both the Brecon Beacons National Park and Snowdonia National Park clearly promoting their dark skies, there are important links to be made with both these authorities, and a good opportunity to pool resources whether that is in terms of promotion in the media, links between websites and on social media, developing of shared resources (such as the Supplementary Planning Guidance mentioned above), advertising campaigns or sharing of advice on how best to deal with any issues along the way.

There is a definite opportunity to develop this into a wider movement across the entire nation, as much of Wales currently offers far darker skies than most of the UK, including a number of areas not designated as national parks but still offering remote locations with excellent potential.

A combined and co-ordinated approach across a wider area has the potential to deliver greater results and provide increased levels of protection for dark skies.

## APPENDIX A

### Preseli Astronomy Group – Bortle Scale Assessment notes



Preseli Astronomy Group – Bortle Scale Assessment Notes

| Site No. | Site Name                      | Bortle Class | Comments  |
|----------|--------------------------------|--------------|---|
| 8        | Bedd Morris                    | 3            | <p>Magnitude 6.6 star seen directly and a 'limited magnitude star count' of 23 gave a limiting magnitude of 6.7. SQML reading 21.4<br/>           Good all round view to all points of the compass. A Faint glow of Haverfordwest and Milford seen to the SE.<br/>           Site is an easily accessible, flat, gravel/dirt car park but a road alongside makes it unsuitable for 'deep sky' observations as light from passing vehicles interfere with observations.</p>  |
| 24       | Car Park at St Ann's Head      | 3            | <p>Site is very easy to access having a good road right to it. The site itself is first class having a tarmac surface which is very flat, ideal for setting up any equipment. To the East the inevitable large dome of skyglow from Milford and Pembroke extends to 50°, but that is more than compensated for by the excellent view of the rest of the sky, superb views to the South, West and North completely free from any obstructions or skyglow making this a premier site, both for access and observations.</p> <p>Limiting Magnitude 6.8 Bootes<br/>           Hipparcos catalog number: HIP 73699</p>   |
| 29a      | Green Bridge of Wales,         | 3            | <p>Broad Haven South car park (substitute for Elugig stack car park due to range closure)</p> <p>Site access is easy via a fairly narrow road from the village of Bosherton. The site itself was very good being flat with very little in the way of obstructions all round.<br/>           The sky to the North and NNW had considerable light pollution from the towns of Pembroke, Milford Haven and the refinery complex, a lesser skyglow could be seen to the East from Tenby etc, but this was only to about 20° but either side of that fully round to the South the sky was very dark and free of any real glow, excellent views from ESE to WNW with the sea as horizon makes this an excellent site for observing.</p> <p>Limiting Magnitude 6.8 in the constellation of Bootes</p> <p>Hipparcos catalog number: HIP 73699</p>   |
| 35       | Skrinkle Haven middle car park | 5            | <p>The view to the south was clear of any obstructions and to the sea horizon, no sky glow. To the ENE there was a fairly bright sky glow from nearby Lydstep and also from Tenby which extended to about 30° above the horizon. To the WNW in the direction of Pembroke and Milford there was considerable light pollution to about 40° . To the immediate West and within a mile or so were both sodium and the whiter street lights, presumably for Manorbier, although these were not a bad source of light they were a distraction.</p> <p>A good site for viewing the southern or northern sky, allowing for difficult objects in such constellations as Sagittarius and Scorpio during the summer and Autumn months.</p> <p>Limiting magnitude 6.2 in the constellation of Gemini</p> <p>Hipparcos catalog number: HIP 37545</p> <p>Bortle class 5 as this site, despite the 6.2 LM does not fulfill the other criteria necessary for class 4.</p> |

|    |                                      |   |  |
|----|--------------------------------------|---|--|
| 4  | Poppit Sands                         | 4 | <p>Large easily accessible site with ample space on a flat, dirt/gravel surface. SQM reading of 21.27 (temp 5°C). Views to south slightly limited by as landscape rises and the odd large tree. Excellent viewing in all other directions. Glow of Cardigan evident to the NE and the hotel to the north. Several nearby dwellings may add to background when residents are present.</p> <p>Limiting magnitude 6.4 (with averted vision) in the constellation of Leo<br/>Hipparcos catalog number: HIP 50218</p>   |
| 1  | Bwlch Gwynt                          | 3 | <p>Good access to site and easy parking. Excellent all round visibility with superb views to the north and south, slightly limited to the West by Cerig Llandron and a little more so to the east southeast by Foel Cwmcerwyn.</p> <p>To the south a great number of distant lights are visible, but have little impact due to the distance, also the skyglow does not extend more than 10° above the horizon.</p> <p>To the north good dark sky to within a few degrees of the horizon.</p> <p>Limiting magnitude was 6.7 (star visible with averted vision) (Constellation Gemini)</p> <p>Hipparcos catalog number: HIP 37545</p> <p>Although the site has good potential, it also has a major drawback in that there is a regular passage of traffic, occasionally these also utilise the car park, meaning that it would disturb any dark adapted vision acquired.</p> |
| 3  | Rhos Fach Common                     | 4 | <p>Another excellent site with good access, though the road is narrow in parts. Excellent all round visibility and far enough from the surrounding hills to see to within 5° of the horizon to the North and East, and right to the horizon to the South and West.</p> <p>Very little traffic here with even less chance of disturbance, a first class location for astronomical observations.</p> <p>Limiting Magnitude about 6.4 based on star TYC 2454-1577-1 at 6.7 not being visible, but star (Magnitude 6.19) (Constellation Gemini) being clearly visible with direct vision.</p> <p>Hipparcos catalog number: HIP 35345</p> <p>Despite having excellent dark surroundings with very low altitude skyglow to the south, east and northeast, (none of which were more than 6 or 7 degrees above the horizon) I was unable to see the 6.7 star.</p>                  |
| 13 | Car park at Garn Fawr, Strumble Head | 3 | <p>Garn Fawr car park offers easy access and was surprisingly 'dark with a SQM reading of 21.51 (temp 2°C). As a gravel/dirt carpark it's good underfoot but probably on a 10/15 degree slope. Excellent viewing to the south, as far as the eye could see (between ESE and WSW). Distant lights are visible but have little impact. Two large TV transmitter are visible in the distance, offering opportunities to align finder scopes.</p> <p>Viewing to the N, E and W limited by the landscape (to the north by Garn Fawr itself). North is also affected by the sweeping light cone of the Strumble head light house.<br/>P 73699</p>  |

| Site No. | Site Name                  | Bortle Class | Comments  |
|----------|----------------------------|--------------|---|
| 18       | Abereiddi Bay              | 3            | <p>This location is stunning in the dark and gave a SQML reading of 21.8 This car park fronts onto the Irish Sea. The carpark is large and relatively flat, composing of stone, gravel and dirt. Excellent viewing to the W, over the sea. N and S restricted by hills that obscure about 15°. To the E there are 2 dwellings that are holiday lets and currently empty. Many faint magnitude 6+ stars clearly visible.</p> <p>Limiting magnitude, 6.8 star HIP 73699 in Bootes.</p>  |
| 22       | Car Park at Martin's Haven | 4            | <p>Site is easily accessed, even if a little remote. The carpark, which gently slopes from E to W (~5°), is gravel/stone/grass underfoot. There is good, unobstructed viewing in every direction. There is an obvious skyglow to the NE and S. The sodium street-lighting of Broadhaven, Brawdy and St David's sits far off to the N. A light cone from lighthouse in St David's Bay can be seen sweeping across to the N.</p> <p>Limiting magnitude 6.4 (with averted vision) in the constellation of Bootes<br/>                     Hipparcos catalog number:<br/>                     HIP 70385</p> |