



Moffat International Dark Sky Community



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Executive Summary

“A visit to Moffat will help you refresh mind, body, and spirit”

- Visit Moffat

Moffat is a spa town which has attracted visitors since 1685 when the spa waters were first discovered. People would flock to Moffat from across the country to “take the waters” and bathe or drink the sulphurous water piped down from the three wells in the hills above the town.

Much of Moffat’s architecture was built around this tourist industry, and many visitors still come to the town to get away from it all, but still more drive past on the M74 motorway - which links Scotland and England - just a few miles to the west.

Those who rush past and don’t stop for the night are missing something truly special.

Nestled amongst the rolling hills of the Southern Uplands, Moffat offers spectacular views of the night sky, but in the past one had to travel a little bit out of town to see the wonder of the Milky Way.

Not any longer! The foresight of Dumfries and Galloway Council has seen the investment of £7.4m over the last year in order to refit each and every street light in the council area, including all 579 street lights in Moffat, with night sky friendly street lights that only shine down and not up.

The effect has been striking. The town is no longer over-lit by the orange glow of sodium lights but basks in the warm yellow light of low-colour temperature LEDs. And the Milky Way is back! One can now stand in Moffat town centre and see the arc of our galaxy overhead, along with thousands of stars.

This application to the IDA to make Moffat an International Dark Sky Community is aimed to protect these amazing skies for generations to come.

It is the end product of many years of tireless work by local resident and lighting engineer Jim Patterson, known to the IDA for the Lighting Management Plans he created for Galloway Forest, Sark, Exmoor, Brecon Beacons, Northumberland, and Coll, the UK’s six dark sky places. Moffat hopes to make it lucky seven.

Moffat Community Council have supported this application, and so too has Dumfries and Galloway Council. As well as saving money and carbon their lighting refit investment could see the creation of Moffat International Dark Sky Community.

Designation as such would help further the spread of night sky friendly lighting as other councils in Scotland, and elsewhere in the UK, look to Dumfries and Galloway’s lead.

And finally, the recognition of the stunning skies visible from within and around the town of Moffat may bring stargazers flocking here to take the celestial waters, and refresh their mind, body and spirit.

Your Ref:

Our Ref: A/8 AMS/MS

4 October 2013

Mr Adam Anderson
Chairman
Moffat and District Community Council
c/o Mrs Jean Purves
Merecleugh
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Dear Mr Anderson

MOFFAT DARK SKY COMMUNITY STATUS APPLICATION

Thank you for giving me the opportunity to provide a letter of support for the bid to establish Moffat as a Dark Sky Town, possibly the first in Europe to achieve this status.

Over the past 12 months Dumfries and Galloway Council have been working in close harmony with your Community Council and have already changed more than 600 street lighting luminaires in the town. The new units use less energy than the previous units but also, just as importantly, have been carefully selected to provide the right amount of light on the public roads and footpaths without providing wasted upward light. This has markedly reduced town sky glow over both Moffat and Beattock. This came from our Council's commitment to reduce energy consumption and carbon emissions.

I understand that "before and after" sky quality meter readings in the town of Moffat are showing that the night sky is now darker as a direct result of our Council changing the street lighting and I hope that, apart from the energy and carbon savings for our Council, Dark Sky Status brings an added value to the winter tourism in Moffat in the same way that Galloway Forest Dark Sky Park provided the Newton Stewart area when it was awarded Gold Status by the International Dark Sky Association in 2009.

I believe that the Exterior Lighting Master Plan which has been developed for Moffat is a template which other towns in the Region can follow and I am in no doubt others will follow on from your initiative as our Council continues to change all of its street lights throughout the region.

Moffat/-

Dumfries 
& Galloway

Moffat is recognised as being an important tourist destination for our region and it has good access links and tourism infrastructure to support this. Should this initiative be successful it will enhance Moffat tourism especially during the winter period.

The ultimate vision would be for Dumfries and Galloway as a region to qualify as a dark sky community/reserve in the future once all street lighting has undergone the lamp conversion with the Gold Status Galloway Forest Dark Sky Park and Moffat Dark Sky Town being exemplars within that community/reserve.

On behalf of Dumfries and Galloway Council I support your application and wish the town of Moffat every success.

Yours sincerely



Alistair M Speedie
Director Planning and Environment Services

PM/Moffat Dark Skies
23 July 2013

Adam Anderson
Chairman
Moffat & District Community Council
c/o Mrs Jean Purves
Merecleugh
Ballplay Road
Moffat
DG10 9JU

Moffat Dark Sky Community Status Application

Thank you for giving VisitScotland the opportunity to provide a letter of support for the bid to establish Moffat as part of the UK's Dark Sky Community.

Recent years have seen Scotland's tourism industry maintain its position as a key contributor to the nation's economy, generating an annual visitor spend in excess of £4.5bn annually and day visitors contributing a further £6.2bn, giving a total spend close to £11bn (2011 figures). Not only that but tourism accounts for over 200,000 jobs – many in rural areas, helping less populous communities to prosper – across 20,000 different tourism-related businesses, while also feeding into other sectors such as food and drink, retail, transport and construction.

Visitor expectations have grown ever more sophisticated with a shift away from individual tourism attractions towards more rounded experiences, delivered to a consistently high quality at each point of the customer journey.

Any official "Dark Sky" status could add to the overall ambition to grow tourism numbers in Dumfries & Galloway and may be of benefit to the local area.

The Framework for Change also focuses on the need for quality products and services, working in collaboration and innovation - this proposal would seem to address these points and could provide a unique experience for tourists to the area.

Dumfries & Galloway is predominantly a leisure tourism destination and this development could add to the breadth of offering and contribute to the area becoming a sustainable year round destination.

It is a fact that most visitors to Scotland are attracted, more than anything else, by our scenery and natural environment. It is also a fact that Scotland has more forest cover than the rest of the UK (17% of Scotland is forested), so we know that Scotland's trees play a big part in adding to our visitors' enjoyment. Dark Sky Park status would add value to the existing experience provided by the Moffat to visitors.

Sustainability is a key theme in the Tourism Framework for Change and the local Area Tourism Partnership Plan. To become Europe's most sustainable destination we need to ensure that tourism growth doesn't result in the degradation of the very environment that is one of our unique selling points. A development of this nature is a good opportunity for the area to develop its sustainability product.

PM/Moffat Dark Skies
23 July 2013

VisitScotland's marketing campaigns are designed to attract visitors to Dumfries & Galloway throughout the year however seasonality can still be an issue. Dark Sky status could provide opportunities to promote the area during the quieter times of the year and give another reason to visit and stay longer.

Dumfries & Galloway is positioning itself as an area which is "Naturally Inspiring" and Dark Sky status for Moffat would fit well with this branding.

The Forestry Commission is a key partner in the Dumfries & Galloway Area Tourism Partnership (ATP), of which its personnel are active and supportive members. It contributes to the Area Tourism Strategy in conjunction with other public agencies and the trade members of the ATP. It also works closely with community groups at more local level in encouraging access and use of the forests. VisitScotland welcomes the opportunity to further develop this partnership approach relating to the aforementioned bid.

Hopefully the above observations will be useful in future discussions relating to this application.

Yours sincerely



Paula McDonald
Regional Director

1. Moffat Dark Sky Community

About Moffat

Moffat is a small town in Dumfries and Galloway, Scotland, with a population of around 2500. It is a former spa town on the River Annand, and sits just east of the M74 motorway joining Scotland to England.

Tourism is a big part of Moffat's economy, and the town has many hotels and restaurants. It sits in the Southern Uplands of Scotland, an area of outstanding beauty and rolling hills, and the Southern Upland Way long-distance walking route passes through Moffat.



Dumfries and Galloway itself covers 6426 km², and in the eastern part of the region 760 km² is owned by forestry commission as part of Galloway Forest Dark Sky Park (awarded IDSPark status in 2009). The population of the entire region is around 151,000.

Moffat is approx. one hour's drive from the eastern edge of Galloway Forest Park.



**The narrowest hotel in the world!
The Star Hotel, Moffat**

Moffat Dark Sky Town

As a result of the work done with Dumfries and Galloway Council during the creation of Galloway Forest Dark Sky Park, the council now recognises the value of dark skies street lighting, and in 2013 announced a £7.4m (\$124m) investment in street lighting across the entire council area.

Work has now been completed in almost every town in Dumfries and Galloway, including Moffat, where **the vast majority of the almost 600 old street lights have been replaced with modern zero-upward LED fixtures.**

Dumfries and Galloway Council want to recognise Moffat as the jewel in their crown of dark skies lighting, and so are seeking IDSC status from the IDA.



The Bigger Picture: Dumfries and Galloway Dark Sky County

Dumfries and Galloway Council are looking to establish Moffat as an IDSC, however **every town and village** in the council area could equally well qualify, given that **every street light in Dumfries and Galloway has been refitted as zero upward “night sky friendly” lighting.**

However rather than inundate the IDA with dozens of applications, Dumfries and Galloway Council intend to open a conversation with IDA about the possibility for designating the whole council area as a **Dark Sky County.**

This would be the largest area (6426 km²) of protected night sky in the world, and we believe the first of its kind. The lighting management plan on p16 and appended will protect the night sky of Dumfries and Galloway for decades to come, and the foresight of the council’s investment in night sky friendly lighting mean that it is now one of the best places in the UK to stargaze, free from the glow of light pollution.

Meeting the Eligibility Criteria

A. *A comprehensive lighting code with the following minimum standards:*

- i) Fully shielded or full cutoff standard for all lights over 3000 lumens*
- ii) Restrictions on total amount of unshielded lighting*
- iii) A policy to address over-lighting*

Dumfries and Galloway have commissioned and adopted a Lighting Management Plan from lighting engineer Jim Patterson (who was responsible for all of the UK's IDSP LMPs to date, and who is a resident of Moffat) which now applies across the whole council area, including Moffat. This LMP is included as an appendix.

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

- i) City lighting conforming with lighting code*
- ii) Municipal support for dark skies*

Refits have been made of all public ("city") lighting in Moffat in compliance with, and in most cases exceeding, the codes in the LMP. The Moffat Community Council along with Dumfries and Galloway Council, have commissioned this application, showing municipal support (see p4-5).

C. *Broad support for dark skies across the community*

The community in Moffat is united in favour of the lighting refits and IDSC status (see p xx for community letters of support).

D. *Community commitment to dark skies education*

Jim Patterson and Steve Owens run regular public talks and stargazing in Moffat. IDSC status will bring this to wider attention and help in the establishing of dark sky tourism in and around Moffat.

E. *Success in light pollution control*

The refits of all 600 public street lighting in Moffat have resulted in a marked improvement in sky quality from within and outside the town. For the first time in 20 years the Milky Way can now clearly be seen from Moffat's recreational park.

F. *A sky brightness measurement program*

SQM-L readings were taken before and after the refits of public street lighting and show marked improvement across the town.

2. Night Sky Monitoring

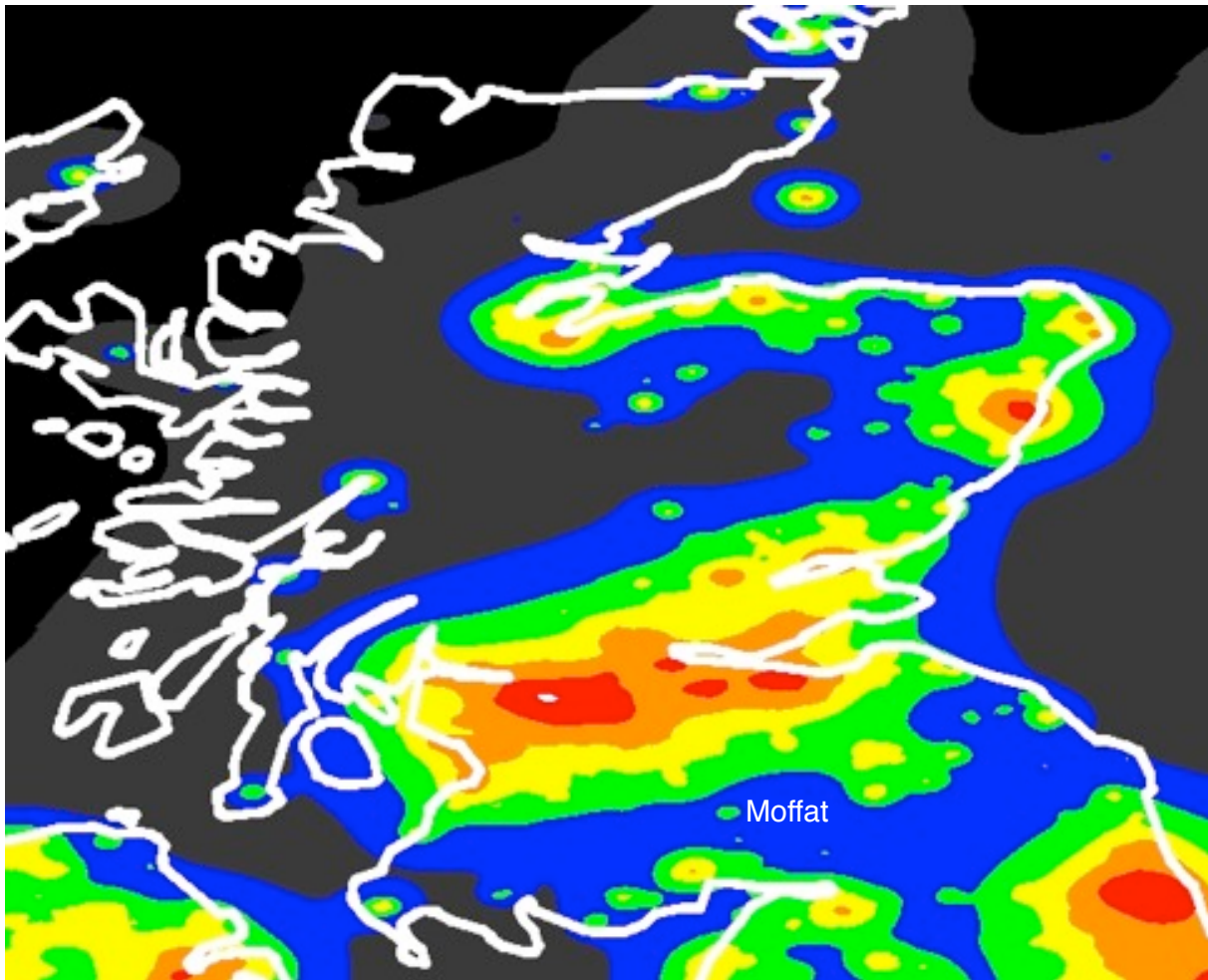
An extensive set of SQM readings was taken in and around Moffat on two separate dates: one before any refits were carried out; and one when refits had been 100% completed.

The data is included below, and shows an improvement in sky quality at all sites both with Moffat town and in the surrounding area.

Historical Conditions

This lighting pollution map of Scotland shows the location of Moffat, with major nearby towns also marked. This map uses data from Cinzano's 2000 Atlas of Artificial Night Sky Brightness, and Moffat can clearly be seen as an island of increased lighting pollution in an otherwise rural band across SW Scotland.

It is our contention that since the refit of all 600 public street lights in Moffat that the "green blob" on the map below will not be present in future light pollution mapping programmes.



Sky Quality Monitoring - NELM & Bortle

Using Ursa Minor the Naked Eye Limiting Magnitude (NELM) can be estimated.

This was carried out (post-refit) on the night of 3 December 2013 by Steve Owens at three sites: one in Moffat town, and two outside Moffat at a distance of several km from the town square.

These locations are numbered VP01, VP04, VP08 respectively on the map on p.12 and the results were as follows:

VP01 NELM 6.4
VP04 NELM 6.0
VP08 NELM 6.2

These agree broadly with the SQM-L data on p.14

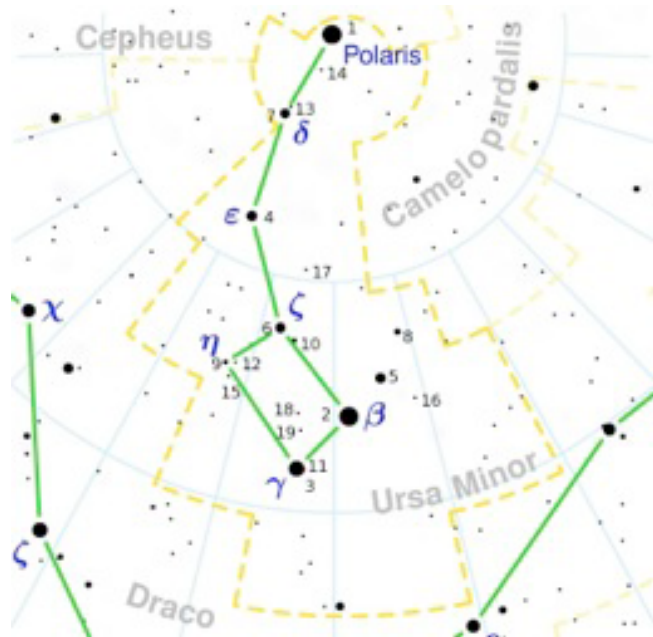
The estimated Bortle Scale at each site was:

VP01 Bortle 3-4
VP04 Bortle 4
VP08 Bortle 3-4

which is also consistent with the SQM-L readings on p.14.

A previous NELM / Bortle estimate from site VP04 was made pre-refit placing Moffat town square at Bortle 5.

This shows the dramatic impact of the lighting refits, so that now the Milky Way is clearly visible from the town, and stars as faint as magnitude 6.0 are now visible.



Sky Quality Monitoring - SQM-L

The map below shows the sites where SQM-L readings were taken, numbered VP01-VP10. The tables on pp.13-14 show the SQM-L readings taken at each site, and the dates they were taken. There were two sets of measurements taken at each site, one before, and one after the refits of public street lights.



Locations on the map:

VP01	Hillend Turning Circle, A708
VP02	Moffat Town, Green Frog Car Park
VP03	Moffat Town, EWM Car Park
VP04	Moffat Town, St Andrew's Church Car Park
VP05	Moffat Town, CAN
VP06	Golf Club Car Park
VP07	Beattock
VP08	Annan Water Hall
VP09	Well Road End
VP10	Moffat Town, Rosemount (Jim Patterson's home, reading control site)

SQM-L data from before lighting refit

Ref. No.	Pre Re-lighting Sky Quality Readings			SQM					
	Location	Map Reference	Read 1	Read 2	Read 3	Read 4	Read 5	Average	Date
VP01	Hillend Turning Circle	NY 10893 04682	20.78	20.88	21.3	21.46	21.43	21.17	2/1/13
21.31	Average of 4 averages		21.39	21.39	21.4	21.3	21.29	21.35	2/27/13
			21.41	21.37	21.33	21.27	21.23	21.32	3/29/13
			21.5	21.5	21.39	21.38	21.23	21.40	4/1/13
VP02	Green Frog Car Park	NT 08753 04648	21.45	21	21.11	21.12	21.14	21.16	2/6/13
20.91	Average of 4 averages		20.99	20.65	20.88	20.65	20.66	20.77	2/27/13
			20.27	20.93	20.94	20.91	20.95	20.80	4/1/13
			20.72	20.85	20.98	21	20.96	20.90	4/3/13
VP03	EWM Car Park	NT 08573 05019	20.73	20.05	20.72	21	21.07	20.71	2/4/13
20.77	Average of 2 averages		21.01	20.56	20.87	20.9	20.83	20.83	4/3/13
VP04	St Andrews Church C/Park	NT 08415 05126	19.52	19.53	19.35	19	18.83	19.25	2/1/13
19.68	Average of 3 averages		19.14	18.7	19.3	18.86	19.41	19.08	2/27/13
			20.83	20.68	20.85	20.61	20.6	20.71	4/3/13
VP05	Moffat CAN	NT 08314 05131	19.54	20.79	20.48	20.62	20.51	20.39	2/27/13
20.67	Average of 2 averages		21.03	21	20.95	20.92	20.9	20.96	4/3/13
VP06	Golf Club Car Park	NT 07679 04761	20.94	20.79	20.81	20.93	20.71	20.84	2/27/13
21.06	Average of 2 averages		21.18	21.47	21.21	21.21	21.32	21.28	4/3/13
VP07	Beattock	NT 08215 01674	20.9	21.01	20.91	20.99	20.92	20.95	2/27/13
21.01	Average of 4 averages		21.14	21.04	21.06	19.28	21.07	20.72	3/29/13
			20.8	20.83	20.79	20.63	20.75	20.76	4/1/13
			21.59	21.73	21.6	21.58	21.55	21.61	4/3/13
VP08	Annan Water Hall	NT 07514 10325	21.51	20.26	21.27	20.12	21.04	20.84	2/1/13
21.14	Average of 4 averages		20.78	20.76	20.77	20.76	20.73	20.76	2/27/13
			21.56	21.5	21.56	21.55	21.52	21.54	4/1/13
			21.6	21.38	21.4	21.34	21.34	21.41	4/3/13
VP09	Well Road End Cattle Grid	NT 09177 07213	21.43	21.48	21.49	21.41	21.42	21.45	2/6/13
21.48	Average of 3 averages		21.47	21.3	21.36	21.27	21.25	21.33	3/29/13
			21.73	21.66	21.67	21.63	21.64	21.67	4/1/13
VP10	Rosemount Rear Terrace	NT 09087 05509	21.22	21.2	21.04	21.02	21.04	21.10	2/1/13
	Reading Control Site		21.04	21.42	21.18	21.11	21.05	21.16	2/6/13
21.23	Average of 4 averages		21.22	21.41	21.25	21.32	21.23	21.29	4/1/13
			21.38	21.38	21.34	21.35	21.37	21.36	4/3/13

SQM-L data from after lighting refit

Ref. #	Post Re-Lighting Sky Quality					Average			Change		
	Location	Read 1	Read 2	Read 3	read 4	Read 5	After	Before			
VP01	Hillend Turning Circle	21.52	21.34	21.36	21.45	21.32	21.40	21.31	0.09		
VP02	Green Frog Car Park	21.21	21.2	21.22	21.2	21.2	21.21	20.91	0.30		
VP03	EWM Car Park	21	21.02	20.92	21.05	20.96	20.99	20.77	0.22		
VP04	St Andrews Church	20.95	20.94	21.01	21	20.95	20.97	19.68	1.29		
	11/4/13	20.86	20.81	20.85	20.97	20.83	20.86				
VP05	Moffat CAN	20.99	20.94	20.93	20.92	20.93	20.94	20.67	0.27		
VP06	Golf Club	21.16	21.11	21.08	21.14	21.11	21.12	21.06	0.06		
VP07	Beattock	21.32	21.38	21.36	21.36	21.32	21.35	21.01	0.34		
	11/4/13	21.14	21.1	21.23	21.14	21.12	21.15				
VP08	Annan Water Hall	21.42	21.38	21.36	21.35	21.36	21.37	21.14	0.23		
VP09	Well Road End	21.3	21.38	21.35	21.42	21.23	21.34	21.48	-0.14	drop*	
	11/4/13	21.09	21.08	21.14	21.22	21.12	21.13				
VP10	Rosemount control site	21.16	21.14	21.24	21.12	21.17	21.17	21.23	-0.06	drop*	
	11/4/13	Mist conditions with low readings - not recorded									
	4am 10/11/2013	21.18	21.21	21.16	21.12	21.23	21.18	21.23			
	3am 29/11/2013	21.33	21.34	21.34	21.35	21.35	21.34	21.23	0.11		

* poor seeing, sky hazy, later light mist

Summary of Sky Brightness Reduction

For all sites within the town of Moffat (VP02-05, VP10) i.e. those closest to the refitted street lights, as expected the readings show improvements, with increases of between 0.2 mpsas to 1.3 mpsas.

Even those readings taken further from the town, in the already dark countryside where one would expect a smaller improvement, there were increases of between 0.06 (negligible change) to 0.3 mpsas.

Only one site (Well Road End) showed an increase in sky brightness of 0.14 mpsas but this was taken on a night of light haze and poor seeing, and it is expected that this reading too will show a decrease in sky brightness when it is repeated in future.

Ongoing Monitoring

It is planned that readings from each of these ten sites will be repeated at least twice a year so that sky brightness improvements can continue to be tracked.

3. Lighting Management Plan

Dumfries and Galloway Council, the planning authority for the whole region, including Moffat, have commissioned Jim Patterson to produce the appended Lighting Management Plan **for the entire region**. Of course, this applies to Moffat, which lies within Dumfries and Galloway. The LMP has ten policy statements:

Plan Statement Number 1

Residential and business occupiers will be encouraged to recognise the benefits of switching off unwanted exterior lights after 22.00 hours (see section 2.2 of LMP)

Plan Statement Number 2

The Authority will endeavour to ensure that no lighting will be allowed to be projected from the adjacent light permitted Zones into the E0-0 Zones and any overspill lighting from properties to be no greater than 0.05 lux (horizontal) at ground level or 0.05 lux vertical at 1 metre (or higher) above ground on the E0-0 side of the property boundary. (see Section 2.3)

Plan Statement Number 3

Any new or replacement lighting within the E0-250 Zone boundary shown in Figure 2.3 should be “Fully Cut-Off” (Fully Shielded (IDA term)) regardless of light source lumen output. (See Section 2.3)

Plan Statement Number 4

Residents in the E0-50 and E0-250 Zone are to be encouraged to limit the visual perception of light output at their property boundary by adapting or modifying existing units to this end. (See Section 2.3)

Plan Statement Number 5

Residents in the E1 communities within an E0 area are to be encouraged to limit the overspill light at their property boundary to no more than 0.5 lux. (Remote residents within the E0 Zone have stricter recommendations see Plan Statement No. 4) (See Section 2.4)

Plan Statement Number 6

Through this LMP it will be possible to encourage developers, when required, to adopt and provide a lighting industry professionally prepared submission for planning consideration. (See Section 3.1)

Plan Statement Number 7

All design submissions for new lighting should be encouraged to show evidence of compliance with the zero candela intensity at 90° and above and encourage domestic luminaires to be selected from units having some form of upward light control. (See Section 3.2)

4. Light Pollution Mitigation

During 2013 Dumfries and Galloway Council undertook a refit of all public street lighting within the region, at a total cost of £7.4m (\$124m). This project was motivated by two factors: cost savings and carbon reduction.

Cost Saving

Although the initial cost of the refits was high, Dumfries and Galloway Council estimate that the investment will have paid itself back in cost savings within 6-8 years.

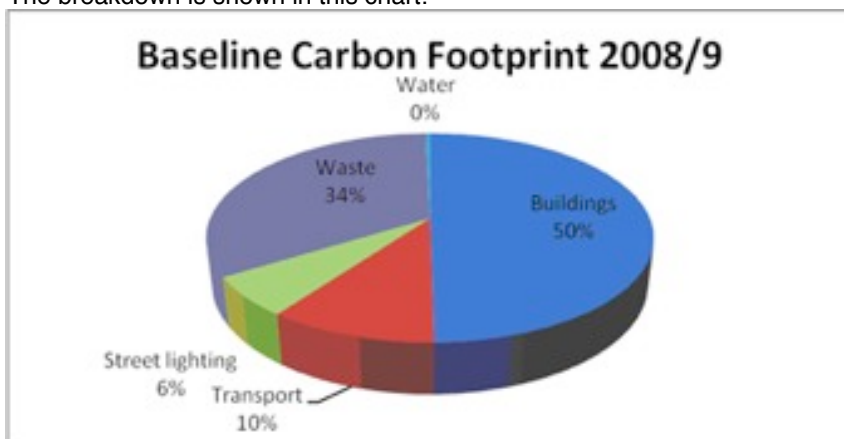
Carbon Reduction

The Climate Change (Scotland) Act 2009 sets out national targets for the reduction of greenhouse gas emissions, of 42% by 2020, and 80% by 2050

These are the most ambitious greenhouse gas reduction targets in the world to date, meaning Scotland is a world leader in this field. Scottish Local Authorities, therefore, have a duty to put plans in place to achieve these targets. Dumfries and Galloway Council's plan to reduce the carbon emissions associated with Council activity is the production of a revised Carbon Management Plan (CMP2).

One of the six Council priorities is 'We will protect and sustain our environment' and the first ambition under this heading in their Single Outcome Agreement is 'We will be a carbon neutral region'. The Council's carbon footprint for 2008/9, upon which the revised Carbon Management Plan is based, is 64,318 tonnes of carbon dioxide equivalent (tCO₂E). The existing street lighting connected load amounts to 2003.35 kilowatts at a current annual cost of £870,435.00 (\$1,311,924).

The breakdown is shown in this chart:



The footprint is made up of activities carried out by the Council, Police and Fire and Rescue Services and it includes the following:

- Street lighting: All Council street lighting, traffic signals and road signs throughout the Dumfries and Galloway Region.
- Transport: All travel carried out by Council, Police and Fire and Rescue staff on business using fleet vehicles or by other means.
- Buildings: Energy consumption in Council, Police and Fire and Rescue buildings
- Waste: Council internal waste and Municipal Solid Waste from the region.

Following the targets set out in the Climate Change (Scotland) Act 2009, in the revised Carbon Management Plan the Dumfries and Galloway Council pledges to reduce carbon emissions by 20% by 2014/15 and 42% by 2019/20. Following this, further targets will be set to achieve the 80% reduction required by 2050 in the Climate Change (Scotland) Act 2009.

Moffat New Public Street Light Inventory

Road name	Street Lighting Inventory			New Dark Sky Conversion – 0% ULR			140w Cosmo.
	Old Lamp	No.	Old Profile	<----- 41w LED	-----> 105w LED		
Beechgrove	45 CPO	8	CTG	8			
Old Edinburgh Rd.	45 CPO	8	CTG	8			
Old Edinburgh Rd.	55 SOX	10	Refractor	10			
Hillside Terrace	55 SOX	4	Refractor	4			
Hydro Avenue	55 SOX	5	Refractor	5			
Edinburgh Road	150 SON	12	Bowl			12	
Northfield Park	70 SON	2	Refractor		2		
Mearsdale Drive	55 SOX	2	Refractor	2			
Mearsdale	55 SOX	5	Refractor	5			
Meadow Place	55 SOX	5	Refractor	5			
Reid Street	55 SOX	5	Refractor	5			
Gallows Well	55 SOX	1	Refractor	1			
The Whins	55 SOX	4	Refractor	4			
Harthope Place	55 SOX	5	Refractor	5			
Grange Place	55 SOX	2	Refractor	2			
Grange Road	55 SOX	7	Refractor	7			
Academy Road	150 SON	5	Bowl			5	
Moffat House Lane	55 SOX	1	Refractor	1			
High Street	250 SON	8	Bowl				8
	70 SON	9	Conical		9		
	150 SON	11	Bowl			11	
Westpark	No Public Lighting						
Eastgate	55 SOX	11	Refractor	11			
Dundanion Road	55 SOX	5	Refractor	5			
Old Well Road	55 SOX	6	Refractor	6			
	35 SOX	2	Refractor	2			
Hartfell Crescent	35 SOX	6	Refractor	6			
Buccleuch Place	35 SOX	2	Refractor	2			
Dixon Street	55 SOX	2	Refractor	2			
Causway Street	55 SOX	3	Refractor	3			
	70 SON	1	Refractor		1		
Well Street	55 SOX	4	Refractor	4			
Star Street	55 SOX	2	Refractor	2			
Mansfield Square	55 SOX	6	Refractor	6			
Mansfield Place	55 SOX	4	Refractor	4			
Annangate	55 SOX	2	Refractor	2			
Church Street	55 SOX	2	Refractor	2			
Annanside	55 SOX	6	Refractor	6			
Rae Street	55 SOX	3	Refractor	3			
Buccleuch Street	55 SOX	3	Refractor	3			
Church Place	55 SOX	1	Refractor	1*			
Church Gate	150 SON	3	Bowl			3	
The Glebe	55 SOX	2	Refractor	2			
Beatoch Road	150 SON	31	Bowl			31	

Station Park	70 SON	8	CTG		8	
	70 SON	3	Conical		3	
Golf Hill Drive	70 SON	5	F/Glass		5	
Holm Street	150 SON	4	Bowl			4
	70 SON	4	Refractor		4	
Ladyknowe	55 SOX	1	Refractor		1	
Osborne Row		0				
Burnside	70 SON	6	Bowl			6
School Lane	55 SOX	2	Refractor		2	
Well Road	55 SOX	35	Refractor		35	
Hamilton Place	55 SOX	1	Refractor		1	
Greenwood Close	55 SOX	7	Refractor		7	
Millmeadows	55 SOX	2	Refractor		2	
Sidmount Avenue	55 SOX	5	Refractor		5	
Haywood Road	70 SON	7	F/Glass			7
	70 SON	7	Heritage			7*
Cinder Path	35 SOX	1	Refractor	1		
Millgreen	55 SOX	6	Refractor		6	
Millburn	55 SOX	2	Refractor		2	
Park Circle	55 SOX	16	Refractor		16	
	150 SON	1	CTG			1
St. Ninians Road	55 SOX	23	Refractor		23	
Annandale Road	55 SOX	8	Refractor		8	
Annandale Place	55 SOX	5	Refractor		5	
Annandale Way	55 SOX	8	Refractor		8	
Warriston Road	55 SOX	7	Refractor		7	
Warriston Place	35/55 S	12	Refractor	1	12	
Fingland Court	55 SOX	10	Refractor		10	
Pringle Court	55 SOX	9	Refractor		9	
The Holm	150 SON	19	CTG			19
Duncan Drive	55 SOX	7	Refractor		7	
Jeff Brown Way	150 SON	10	CTG			10
Old Carlisle Road	55 SOX	23	Refractor		23	
Hartfell Homes	45 CPO	8	CTG	8		
Selkirk Road	55 SOX	12	Refractor		12	
Ettrick Drive	55 SOX	8	Refractor		8	
Frenchland Drive	55 SOX	6	Refractor		6	
Crosslaw Burn	55 SOX	8	Refractor		8	
	70 SON	4	Refractor			4
Meadow Bank	55 SOX	1	Refractor		1	
	70 SON	7	Refractor			7
Meadow Bank Rise	70 SON	3	Refractor			3
Ballplay Road	55 SOX	24	Refractor		24	
Holm Park	35/55 S	2	Refractor	2	2	
Eastfield Rise	55 SOX	6	Refractor		6	

Total **579 lights refitted**

Technical Specification of New Street Lighting

Of the 579 newly installed lights, 571 (98.6%) are zero upward night sky friendly lights, flat glass LEDs. The remaining 8 (0.4%) of lights represent an historical refit using curved-glass fitting which are unfortunately not zero-upward.

The 41W LED (475 luminaires in total) is Philips Mini Iridium at 3480 lumens; the 105W LED (96 luminaires in total) is Philips Iridium at 9286 lumens. Both of these lamps emit light at 3200K, in warm white light.



The cut off of these lights is measured as **zero** above 90°, as shown in this image:



The images shown on pages 21 and 22 show pre- and post-refit views from two sites, showing the reduction in glare and the improved lighting on the ground.



View from The Holm pre (above) and post (below) retrofit



View from Old Edinburgh Road pre (above) and post (below) refit

Moffat Lighting Compliance Rates

Moffat Domestic Lighting Audit

In addition to the audit and refit of all 579 public street lights in Moffat an audit was done of domestic (private) outdoor lighting. Table 6.3 of the Lighting Management Plan details this audit but of the 535 domestic lighting units audited the compliance rate was 92%.

This compliance rate is measured against the controls outlined in the LMP, and show very high levels of compliance throughout the town of Moffat.

Total number of domestic (private) lights audited = 535

Total number of compliant domestic (private) lights = 494

Total compliance level of domestic (private) lights = 92%

Moffat Commercial Lighting Audit

In addition to the domestic (private) lighting audit, and audit was carried out of commercial (private) lighting, and can be found on table 6.4 of the LMP. The total level of compliance of commercial (private) lighting in Moffat is 76%, lower than domestic lighting compliance levels but still high.

Total number of commercial (private) lights audited = 375

Total number of compliant commercial (private) lights = 284

Total compliance level of commercial (private) lights = 76%

Overall Non-public Lighting Compliance

If both of these data sets are combined we find the total number of non public lights audited is 910, of which 778 are compliant, a compliance rate of private lighting of 85%.

Overall Lighting Compliance, Public and Private

If the public street lights are added into this, then the total number of lights audited rises to 1489, of which 1349 are compliant, giving a grand total compliance rate of all lights in Moffat of 90.6%

5. Education and Outreach

The refits of street lighting across Dumfries and Galloway have received positive coverage in Scottish media (see for example the following article from the Scotsman newspaper):

The screenshot shows the front page of The Scotsman newspaper website. The main headline is "Dumfries and Galloway install stargazer-friendly lights" by Julia Horton. The article text states: "A RURAL council is investing millions of pounds to install 'dark skies' lamps in all of its street lighting in a move which could make it one of the world's most astronomy-friendly communities. Dumfries and Galloway is spending £7.4 million to convert the region's 24,000 street lights from old-fashioned sodium models to new more efficient LED versions." To the right of the article is a "Picks of the day" section featuring a video titled "100 Weeks of Scotland: Ian Rankin | Val McDermid". Below the article is a social media sharing widget with options for Facebook, Twitter, Google+, and a share button.

<http://www.scotsman.com/news/scotland/top-stories/dumfries-and-galloway-install-stargazer-friendly-lights-1-2889142>

However it is hoped that an award from the IDA will dramatically increase the media coverage in the area, leading to more demand for public talks and stargazing events.

At the moment Jim Patterson and Steve Owens run such events during the winter months in Moffat, but with IDSC status and national (or global) recognition of the amazing dark skies above Moffat local residents could begin to develop their own astronomy tourism infrastructure, as has happened in Galloway Forest Dark Sky Park in the west of Dumfries and Galloway.

6. Other Letters of Support

Here is a collection of letters of support for IDSC status from within the community of Moffat. These letters are from local residents, businesses, and tourism agencies:

09.19.2013

To

Mrs. Jean Purves
Secretary
Moffat & District
Community Council

Dear Mrs. Purves

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies town.

There will be new opportunities for tourism in Moffat, and in particular hoteliers, if Dark Skies status is achieved.

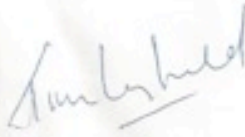
Currently, most visitors take their holiday in Moffat between Easter and October however if the application for Moffat is successful in becoming the first town in Scotland to have Dark Sky status, it would also be able to promote itself as a night-time or winter destination especially for those activities around star gazing and astronomy.

As a local hotelier we would welcome opportunities which would help to extend the tourism season to all year round business adding to our business in the quieter months of the year.

We hope the application will be successful and if so we could then highlight Moffat's status as a Dark Skies town in our future advertising.

Yours sincerely

Tim Leighfield



info@thefamousstarhotel.co.uk

THE FAMOUS STAR HOTEL MOFFAT

Tel 01683 220156
Fax 01683 221524

44 HIGH STREET
MOFFAT DG10 9EF

www.famousstarhotel.co.uk
info@famousstarhotel.co.uk



St Michael's Services Limited
9 St Michael Street, Dumfries, DG1 2QD.
Tel: 01387 254304



www.stmichaels-services.co.uk



Mrs Jean Purves, Secretary,
Moffat & District Community Council,
Merecleuch House,
Ballplay Road,
Moffat

31st July 2013

Dear Jean,

As a local business owner based in Moffat, we are delighted to support the Community Council in the work they have done with regard to the Dark Skies Status initiative for the town of Moffat.

As we depend mainly on tourists and passing traffic during the summer for our trade, we are sure that the Dark Skies Status would bring more tourists to the area not only in the summer months but throughout the year, thus increasing the trade in the town to all the businesses over the whole year.

We recently completed our own project at our premises at Benmar Services, Station Road Moffat, where we have been upgrading the site over the last year, providing new facilities for our customers to obtain fuel 24 hours a day by exchanging all the original 400watt bulbs in our canopy lighting, to 80 watt LED bulbs, producing the same amount of light on the forecourt, but considerably reducing our costs and carbon footprint. Also the introduction of dusk till dawn sensors and timer switches so that the lights automatically switch off after the customer has left the premises. This has enhanced the forecourt services, but has not affected the Council's plans for the Dark Skies Status.

Congratulations on a job well done!

If we can be of any further support please do not hesitate in contacting us via our email address:
benmargarge@gmail.com or direct dial 01683 220010

Yours sincerely

Jamie R Wood
Director.



**Moffat and District
Community Initiative**
1 Ladyknowe, Moffat DG10 9DY
www.visitmoffat.co.uk
Tel: 01683 220227
email: info@visitmoffat.co.uk
VAT No. 842 6143 38

20 August 2013

The Secretary
Moffat and District Community Council
Merecleuch House
Ballplay Road
Moffat
DG10 9JU

Dear Jean,

Re: Dark Skies Application

Moffat and District Community Initiative fully support and encourage this application, recognising that the actions taken to create dark skies over the town of Moffat in Dumfries and Galloway will become a very important aspect of the town. As Moffat was the first Walkers Welcome Town in Scotland and we continue to promote the opportunities for our visitors to experience the outdoor life, and all it has to offer, this proposal fits very well into our Business Plan to market Moffat to the wider world.

Many residents of the town are directly involved in the Tourism industry and are very much aware of how our night sky will enhance our attraction for tourists. The Initiative welcomes and encourages any actions that enhance the quality of holiday experience for visitors and that provide reasons or incentives for more people to visit the town.

Universal agreement amongst business owners and investors in Moffat recognises that the individuality of the town needs to be preserved and enhanced and this includes the avoidance of light pollution. Most of the tourism businesses in the town are open all year and the Initiative believes the dark skies could lead to more visitors discovering the peace and tranquillity of Moffat outside of the main holiday season.

Many actions have been taken recently to encourage more families to visit Moffat and it would be wonderful for youngsters from urban areas to have their first clear views of a sky full of stars here.

We believe the achievement of recognition as a Dark Skies Town would be good for Moffat businesses, good for employment, would benefit the town's community as well as promote fresh experiences to fulfil the aspirations for future generations of stargazers.

Yours sincerely,

Martin J. Brown
Chairman



Moffat and District Community Initiative is a Company Limited By Guarantee and Not Having a Share Capital. Registered in Scotland. Number: SC251002



Old Church Depot, Annan side,
Moffat DG10 9HB
Tel 01683 221847
E-mail: info@moffatcan.org
www.moffatcan.org

Dear Jean Purves

We are a Moffat community charity and social enterprise dedicated to carbon reduction.

We have been very impressed by the new low-energy lighting installed around Moffat and by the resulting decrease in light pollution and carbon emissions.

We feel that for Moffat to be recognised for this achievement via formal Dark Sky status would be highly beneficial in terms not only of enabling and developing maximum access to astronomy for local residents and for visitors but also of boosting the local economy via increased green tourism.

Yours sincerely,

A handwritten signature in black ink that reads 'Alis R. Ballance'. The signature is written in a cursive style with a long, sweeping underline.

Alis Ballance

Chief-Executive

An Cluain,
Ballplay Road,
MOFFAT,
Dumfriesshire,
Scotland DG10 9JU
Tel: 01683-221219

Attention of the Hon. Secretary,
Moffat Community Council.

18th April 2013

Dear Hon. Secretary,

New LED Street Lighting in Moffat

Now that the majority of the town's street lamps have been converted to LED format, I have taken time to observe and note the resultant lighting effects, both good and bad. Overall the new warm white lights are very good. I like them. I am most impressed by the uniformity and high level of the road illumination. I have also observed that the colour of vehicles and personal clothing is better rendered and much more natural than was the case with the earlier Sodium lamps.

More negatively, the illumination of nearby objects on the roadside, such as pedestrians and pavement obstacles, is less pronounced than before, although I find it quite adequate for most purposes.

Although I have little personal interest in astronomically observing Moffat Dark Skies as such, I do very much approve of the future visitor and tourist potential. Together with the vastly reduced costs of energy supply and maintenance, this has convinced me that the whole project was well worth the cost and effort.

I would like to express my personal thanks to our Community Council for their initiative, forward planning and satisfactory adoption of this modern lighting scheme. Well Done !

Yours truly,



Dr. Peter G. Bower

Hunters' Croft,
Haywood Road,
Moffat
DG10 9BU

22nd April 2013

Dear Mrs Purves,

I would like to pass on to the Community Council my pleasure at seeing the new street lights gradually coming into being. The actual lamp posts look very modern and quite discreet and I think the white downward lighting looks far more natural and attractive than the original sodium lights.

No doubt there are differing views in Moffat about this undertaking but I thought I should express a positive reaction.

Yours sincerely,

Judith Hobson

Mr R Mc Lean & Mr B Camm,
No29 Well Street Bed & Breakfast
Moffat
DG10 9DP

24th July 2010

Dear Sir/Madam

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies town. We have a Bed & Breakfast right in the middle of Moffat and the installation of the LED lights has added to the beauty of the night skies and the reduction of light pollution. We feel that the new lighting will be for the benefit of residents and visitors alike. Any boost to tourism, such as happened at Galloway forest Park, especially out of season, would be welcome and improve Moffat's status as an all year round visitor destination.

We hope the application will be successful and we will then include Moffat's status as a Dark Skies town in our future advertising.

Yours Sincerely

Ron Mc Lean & Bradley Camm



BEATTOCK STATION ACTION GROUP
Buckrig, Beattock, Moffat, DG10 9RL

Mrs. J. Purves,
Merecleuch House,
Ballplay Rd,
Moffat,
DG10 9JU

26th July 2013

Dear Mrs Purves,

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies Town.

As a group fighting to have Beattock railway station reopened we realise the importance of local support. Part of our argument is that the opening of Beattock station should increase tourism to the Moffat area and certainly the designation of Moffat and area as a Dark Skies Town should also do this.

In increasing the use of the railway by the reopening of Beattock station we see a reduction in pollution by less use of the car. By Moffat being a Dark Skies Town the light pollution will be greatly reduced. You could say that we are promoting a similar cause.

We wish you luck and success in your endeavours.

Regards,

Peter Gray,
Secretary.

Your Ref:

Our Ref: A/12.2 AMS/MS

6 October 2015

Dr John Barentine
Program Manager
International Dark Sky Association

Email: john@darksky.org

Planning and Environment Services

Directorate
Kirkbank House
English Street
Dumfries DG1 2HS

Any enquiries please contact

Alistair Speedie

Direct Dial 01387 260376

Fax 01387 260188

E-mail alistair.speedie@dumgal.gov.uk

Dear Dr Barentine

MOFFAT APPLICATION FOR DARK SKY COMMUNITY STATUS

As planning authority we have been working closely with representatives of the Moffat Dark Sky Community Initiative to assist them with their application for Dark Sky Community status. In this regard I am writing to explain how we plan to ensure that the Moffat Lighting Masterplan becomes part of our regulatory framework for controlling new lighting proposals.

The master document for Planning Regulation in Scotland emerges from the National Planning Framework. The importance of the attribute of a dark night sky environment to the winter tourist industry has been highlighted in the Scottish Government's publication of the third National Planning Framework (NPF3). This is a framework for the special development of Scotland as a whole and sets out the Government's priorities over the next 20-30 years.

The next level down of Government regulation is covered by the Scottish Planning Policy publication in which local authorities are required to produce Local Development Plans (LDP) outlining their localised responses to the Government's priorities. These plans must be reviewed every five years. Galloway Forest Dark Sky Park was included in the current LDP (adopted September 2014) as a priority protection following its formal designation by the International Dark Sky Association. Bearing in mind that Galloway Forest Dark Sky Park was granted Gold Status five years ago, a Statutory Supplementary Guidance Note, based on the new LDP policy, was completed this year. I am pleased to tell you that this guidance received Scottish Government approval in August this year.

As you know/-

As you know Moffat has not yet been granted any Dark Sky status and, since it had no current designation status, was not written into the LDP this time round. Assuming it achieves an IDA status it is our intention to include a protection policy within the next version of the LDP.

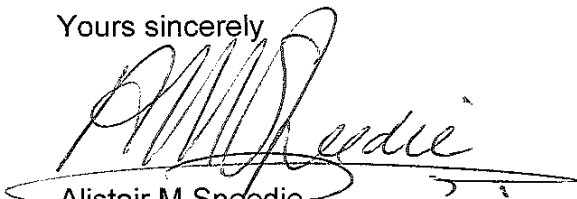
There is, however, an interim measure which, as a planning authority, we can apply and I hope you can accept this as a form of "regulation". Where priorities develop after the publication of the LDP there is a vehicle called non-statutory guidance into which Moffat lighting can be included. Non-statutory guidance does not go through the same lengthy process as statutory guidance in that it does not get published for public consultation and there is no requirement to send it to Scottish Ministers for approval as does the statutory guidance. However, although non-statutory guidance does not form part of the development plan, it does carry weight as a material consideration in future planning decision making. I refer you to Planning Circular 6/2013 Development Planning which sets out the processes for supplementary guidance, starting at paragraph 135 of the document if you wish to follow the process here in Scotland.

The technical requirements for Moffat are included within the non-statutory document that covers the remaining parts of Dumfries and Galloway region which are not covered by the statutory guidance produced for light control in and around Galloway Forest.

Both the statutory and the non-statutory guidance notes are now available for public viewing on the Dumfries and Galloway website, www.dumgal.gov.uk.

I hope the above addresses the regulatory issues you have raised with Steve Owens.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Alistair M. Speedie', with a long horizontal flourish extending to the right.

Alistair M. Speedie

Director Economy, Environment and Infrastructure

Moffat & District



Community Council

14th September 2015

Dr John Barentine
Program Manager
International Dark Sky Association
e-mail john@darksky.org

Dear Mr Barentine

Moffat Application for Dark Sky Community Status

Moffat & District Community Council has been kept fully up to date with the matters which have seen the delay in having the application processed and we are keen to see the matter resolved as soon as possible.

We understand that to qualify for Dark Sky Community Status the Moffat lighting master plan has to be regulatory and this requires the approval of Dumfries & Galloway Regional Council.

The Scottish Government is the body with overall responsibility for planning matters and they attribute considerable importance to a dark sky environment as this is very relevant in the promoting of winter tourist industry for towns such as Moffat where sustainable tourism is vital for the local community.

Dumfries & Galloway Council, along with all other local authorities in Scotland, is required to prepare a local Development Plan detailing their responses to the Government priorities and this was completed in 2014. Galloway Forest Dark Sky Park was part of the Scottish Government's National Planning Framework and as a result was included in the council's development plan as a priority protection. A Statutory Guidance Note on lighting based on the new Local Development Plan in which Galloway Forest Dark Sky Park featured was recently completed and this now received Scottish Government approval.

We are advised that as Moffat has not yet been granted any dark sky status and, no current designation status, it could not be written into the Local Development Plan in 2014. Should Moffat's application be successful in obtaining IDA status it will then be written in to the next edition of the Local Development Plan.

We understand that in situations arising after the publication of the Local Development Plan Dumfries & Galloway Council has an interim measure which, perhaps, could be applied as a form of "regulation". This in the form of what is known as a non-statutory guidance document which could include Moffat's lighting. This Non-statutory guidance is a simpler document and does not need to go out to public consultation and does not need Scottish Ministers approval. We understand that although not forming part of the current Local Development Plan, its contents would carry weight for consideration in any future planning decisions within the Moffat Community.

We are aware that Dumfries & Galloway Council are finalising the Non-Statutory Guidance notes and this should enable them to be in a position to submit a letter which will enable a decision to be reached on Moffat's application for Dark Sky Status.

Yours sincerely

Adam W. Anderson
Chairman

DUMFRIES and GALLOWAY – DARK SKY PLACES

EXTERNAL LIGHTING MASTER PLAN



Prepared for – Dumfries and Galloway Council
By James H Paterson BA(Hons), CEng, FILP, MCIBSE, MSL
Lighting Consultancy And Design Services Ltd.
Rosemount House, Well Road,
Moffat DG10 9BT. Tel: 01683 220 299

Dumfries & Galloway - Regional Dark Sky Status

External Lighting Master-Plan

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 - 2.2 Switching Regime**
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- Appendix B – Sky Brightness Nomogram**
- Appendix C – Commercial and Domestic equipment profiles**
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- Appendix E – Domestic Lighting – Equipment Profiles Handout**
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- Appendix G – Property Self-Audit Guidelines – The Next Step Handout**
- Appendix H - Supplementary Guidance / Lighting Design Brief**

1 Preamble

1.1.1 Introduction to External Lighting Master Plans

The provision of a Lighting Master Plan, and its continued implementation, is an essential requirement of the International Dark Sky Association (IDA) when considering the initial merits of an application for a Dark Sky Award. The IDA have the option of withdrawing their support of any award if future sky measurements show a marked decrease in star visibility. The continued monitoring of the night sky quality is therefore essential.

The initial purpose of this external Lighting Master Plan (LMP) is therefore to provide a base document of lighting ordinance for Dumfries & Galloway Regional Council to mitigate the effects of stray and obtrusive light, often incorrectly referred to as 'light pollution', from all exterior lighting whether it is intended for domestic, public or commercial use. This document will use the words '**light obtrusion**' to include the outward and upward transmission of wasted light into the night sky unless making reference to earlier documents produced by others.

The anti-social effects of obtrusive light is not limited to the vision of the night sky and in March 2012 the UK Government introduced the control of 'light pollution' through planning procedures in their National Planning Policy Framework. Although the document applies to the English planning framework paragraph 125 could be equally applied across the UK and Europe as good planning practice. The paragraph states "***By encouraging good design, planning policies and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.***"

Additionally an associated publication, National Planning Practice Guidance (2014), provides local authorities with a defined link between planning and lighting see <http://planningguidance.planningportal.gov.uk/blog/guidance/light-pollution/>

Of prime importance here is guidance for all local authorities to set up their own night time environmental zones applicable to all new planning design work.

- **In areas where there is a Dark Sky Award this task has already been fully outlined as an "IDA Lighting Ordinance" in a location specific Lighting Master Plan associated with each award.**

In Scotland the importance of the attribute of a dark night sky environment has been highlighted in the Scottish Government's publication of the Third National Planning Framework (NPF3). This is a framework for the special development of Scotland as a whole and sets out the Scottish Government's priorities over the next 20 - 30 years.

In Section 3 of NPF3 under the heading of "Tourism, recreation and the visitor economy" clause 3.17 identifies tourism potential for further development and sites the "Galloway and South Ayrshire Biosphere Reserve and Dark Skies Park" with other examples.

A Dark Sky Place is again referred to in Section 4.22 of NPF3 where it is identified as a "**distinctive attribute**" (in the form of reference to Galloway Dark Sky **Park** since this was the only form of dark sky place, in Scotland, when the document was commissioned.)

- **Working towards further Dark Sky Places within Dumfries and Galloway Regional boundary will therefore potentially increase the tourism profile for the South of Scotland.**

This LMP's principal aim is to provide practical advice on mitigating stray light, which astronomers, and others, may find obtrusive within the jurisdiction of Dumfries and Galloway Council (**D&GC**) planning boundary. The objectives given within the first 4 chapters are generic for any part of D&GC and their adjoining Municipal Authorities. Although the objectives given in the remaining chapters are relative to Moffat all the objectives could be equally followed in other towns in the region.

To this end the document relies on tables of technical parameters and lighting values contained in British Standards, the International Lighting Committee (CIE) and other UK Lighting Institutions all of which have been used, at times, in the UK Judiciary.

This LMP combines these lighting technical parameters to work within the framework of the International Dark Sky Association, the National Policy Planning Framework, Scottish Planning Policy and D&GC Local Development Plan with strategies of best working lighting practice to follow in:-

- Planning for lighting with appropriate design and planning guidelines.
- Protecting the natural and historic environment including wildlife.
- Maintaining or improving the existing dark sky attributes.
- Reducing the carbon emissions associated with external lighting.
- Preventing glare to respect the amenity of neighbouring land uses through the appropriate choice of lighting fixtures and correct lighting installation practice.

The LMP objectives can be followed to protect, maintain or even, hopefully, improve the existing dark sky attributes synonymous with the low district brightness associated with the local rural landscape.

Reducing upward obtrusive light to assist in a better view of the night sky may be seen as of prime importance in this document, however, to continue allowing light to spill beyond its intended objective also has a direct relationship with poor utilisation of electrical energy.

1.1.2 Carbon Reduction Commitment Background (D&GC website extract)

The **Climate Change (Scotland) Act 2009** sets out national targets for the reduction of greenhouse gas emissions, of

42% by 2020 - and- 80% by 2050

These are the most ambitious greenhouse gas reduction targets in the world to date, meaning Scotland is a world leader in this field. Scottish Local Authorities, therefore, have a duty to put plans in place to achieve these targets. Dumfries and Galloway Council's plan to reduce the carbon emissions associated with Council activity is the production of a revised Carbon Management Plan (CMP2).

One of the six Council priorities is **'We will protect and sustain our environment'** and the first ambition under this heading in their Single Outcome Agreement is **'We will be a carbon neutral region'**. The Council's carbon footprint for 2008/9, upon which the revised Carbon Management Plan is based, is 64,318 tonnes of carbon dioxide equivalent (tCO_{2E}).

The breakdown is shown in Figure 1.1. The existing street lighting connected load amounts to 2003.35 kilowatts at a current annual cost of £870,435.00 (**\$1,311,924**).

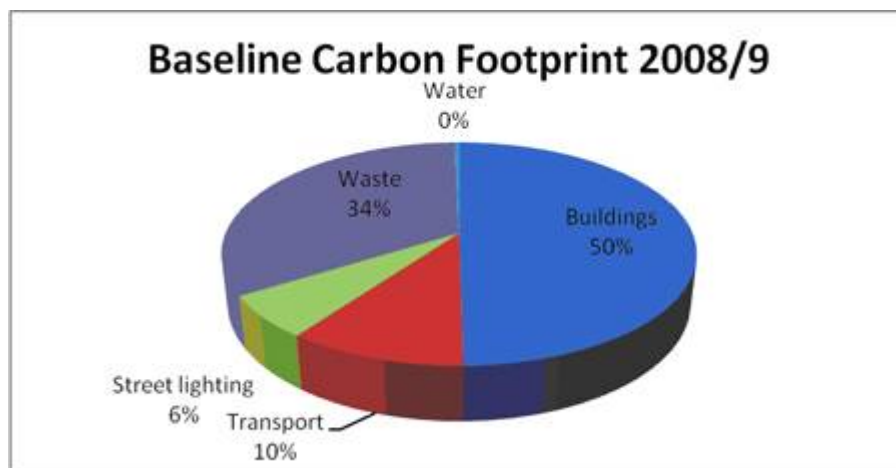


Figure 1.1

The footprint is made up of activities carried out by the Council, Police and Fire and Rescue Services and it includes the following:

- **Street lighting – All Council street lighting, traffic signals and road signs throughout the Dumfries and Galloway Region.**
- Transport – All travel carried out by Council, Police and Fire and Rescue staff on business using fleet vehicles or by other means.
- Buildings – Energy consumption in Council, Police and Fire and Rescue buildings
- Waste – Council internal waste and Municipal Solid Waste from the region.

Following the targets set out in the Climate Change (Scotland) Act 2009, in the revised Carbon Management Plan the Dumfries and Galloway Council pledges to reduce carbon emissions by **20% by 2014/15** and **42% by 2019/20**. Following this, further targets will be set to achieve the 80% reduction required by 2050 in the Climate Change (Scotland) Act 2009.

The 24,000 lights in the existing public lighting infrastructure of Dumfries and Galloway Council boundary forms an important element in this energy objective and the following is one of four statements regarding their formulation of new directions.

- **"New street lighting policies, to ensure any repair, refurbishment or replacement programme uses the lowest energy alternative lamps, and to widen the scope of dimming street lighting across the region"**

In addition to assisting selecting equipment with good optical control for the benefit of astronomical observations this LMP will also assist D&GC indirectly in their commitment to reducing their carbon footprint in not only their street lighting objectives but also in other private and commercial aspects which require planning approval.

The following section contains an executive summary of the overall plan statements as a generic design objective. **The specific needs of individual Dark Sky Community towns or villages will be discussed and outlined individually as "Community Specific" sections as additional Sections to this Regional Generic document.**

1.1.3 Executive Summary of Plan Statements

The declaration of intent to submit a Dark Sky Community application was submitted to the IDA in March 2013 and at a point in time when the "Community" lumen cap was 5,000 lumens. Submission of the "Community" application was achieved within the 6 month period thereafter.

After the submission of this LMP the IDA set a revised lumen cap of 3,000 lumens and the text in Issue 4 and onwards has been subsequently amended to encompass this and additional new IDA requirements in any future lighting schemes.

<p>Plan Statement Number 1</p> <p>Residential and business occupiers will be encouraged to recognise the benefits of switching off unwanted exterior lights after 22.00 hours (see section 2.2)</p>
<p>Plan Statement Number 2</p> <p>The Authority will endeavour to ensure that no lighting will be allowed to be projected from the adjacent light permitted Zones into the E0-0 Zones and any overspill lighting from properties to be no greater than 0.05 lux (horizontal) at ground level or 0.05 lux vertical at 1 metre (or higher) above ground on the E0-0 side of the property boundary. (see Section 2.3)</p>
<p>Plan Statement Number 3</p> <p>Any new or replacement lighting within the E0-250 Zone boundary shown in Figure 2.3 should be "Fully Cut-Off" (Fully Shielded (IDA term)) regardless of light source lumen output. (See Section 2.3)</p>
<p>Plan Statement Number 4</p> <p>Residents in the E0-50 and E0-250 Zone will be encouraged to limit the visual perception of light output at their property boundary by adapting or modifying existing units to this end. (See Section 2.3)</p>
<p>Plan Statement Number 5</p> <p>Residents in the E1 communities within an E0 area will be encouraged to limit the overspill light at their property boundary to no more than 0.5 lux. (See Section 2.4)</p>

Plan Statement Number 6

Through this LMP it will be possible to encourage developers, when required, to adopt and provide a lighting industry professionally prepared submission for planning consideration. (See Section 3.1)

Plan Statement Number 7

All design submissions for new commercial lighting will be required to show evidence of compliance with the zero candela intensity at 90° and above and encourage domestic luminaires to be selected from units having some form of upward light control. (See Section 3.2)

1.2 Introduction to Dumfries and Galloway Region

This Section contains extracts from several tourist web sites but has been reordered and interspersed with information relating to the general introduction and needs of the widespread readership of this dark sky application.

The boundary of Dumfries and Galloway covers 2,380 square miles (6,426 Km²) and is the home for a population of about 148,060 residents. Although approximately 30% of this area is covered in forest plantations, the population density equates to an average of 60 residents per square mile (23 per square Km) and as such is one of the least densely populated municipalities in Britain. The average population density in Scotland is in the order of 168 per square mile.

Dumfries and Galloway Municipal Authority (The Authority) was created in 1994 by combining 3 small county authorities and several smaller Burgh Councils. It is bounded in the north by four other municipal authorities, namely, South Ayrshire, East Ayrshire, South Lanarkshire and the Scottish Borders County Councils as shown in Figure 1.2A.

In addition to being the former home of several historically important personalities like John Paul Jones, a Scottish sailor and the United States' first well known naval fighter in the American Revolution, the poet Robert Burns, the famous Civil Engineer - Thomas Telford and the philosopher / historian Thomas Carlyle (et al) it is the home of Galloway Forest Park, the first Dark Sky Park in the UK to be designated by the International Dark Sky Association (IDA) in 2009.

Although Galloway Forest Park occupies 76,000 hectares of the county the Forestry Commission Scotland also own several more forests within Dumfries & Galloway Region and in all approximately 660 square miles (170,800 hectares (c.1995)) of forest provides the home for a large variety of wildlife and a few residences.

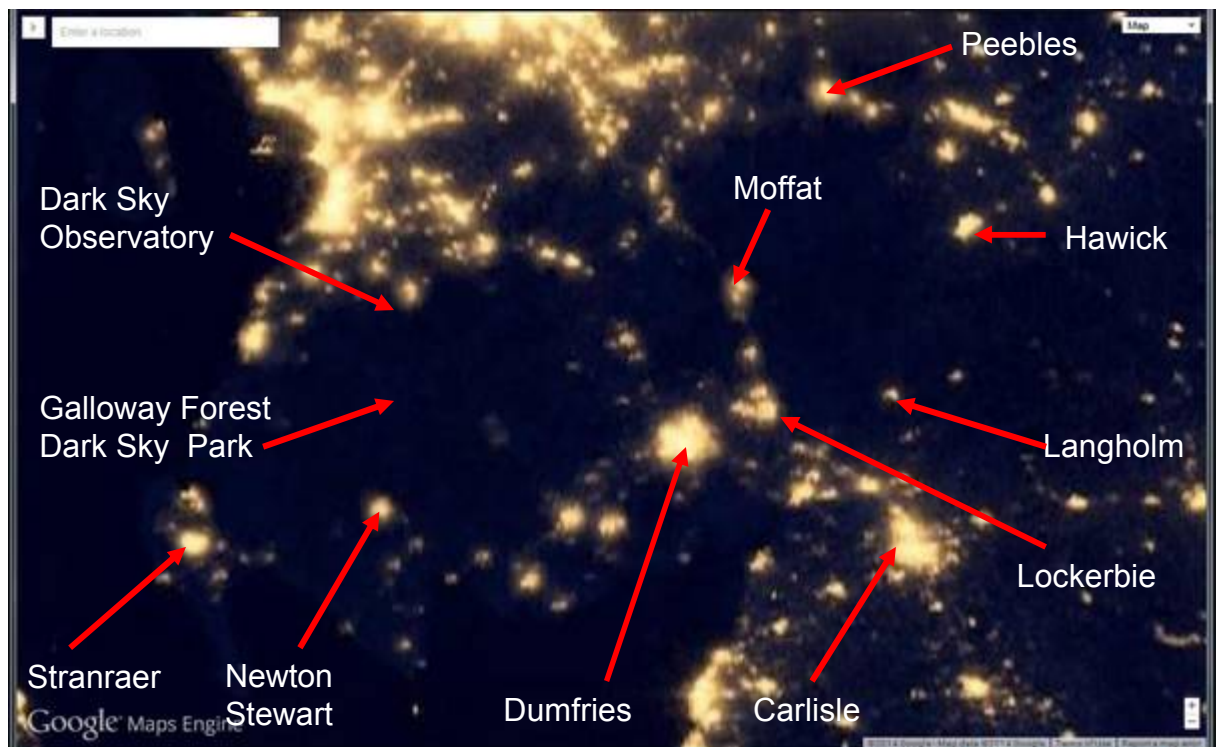
The three largest towns are Dumfries with 31,630 residents, Stranraer with 10,290 residents and Annan with 8,430 residents. Stranraer, in the west, was formerly a major ferry terminal port. Now that the ferries have moved their dock to near Cairnryan the harbour is being redeveloped as a marina. 80 miles to the east of Stranraer lies Lockerbie, scene of the Pan Am airline disaster in 1988 and 20 miles beyond that lies Langholm where astronaut Neil Armstrong was the first person to be awarded freedom of the Burgh, as it was then, in 1972.

It is quite easy to identify the various town locations on the night time images of the Earth at Night, however, more striking in Figure 1.2B is the expanse of zero light radiation areas to the east and west of the blob of light marking the position of Moffat and Beattock.

This application prepares the way to grow the Dark Sky concepts in reducing light obtrusion throughout Dumfries and Galloway Region and the local authority have committed £7.4 million (about 11 million US Dollars) over a period of 8 years to replace all the old street lighting luminaires with new technology light sources and electronic control gear. This programme commenced in April 2013 in the town of Moffat and more than 10% of this lighting stock (just over 2,000 luminaires) was completed prior to this application's first submission in September 2013.



Figure 1.2A above – Outline of Dumfries And Galloway Local Authority boundary
Figure 1.2B below - Earth at Night image dated 2012 and pre Dark Sky Community



Within the region boundary there are 135 registered Sites of Special Scientific Interest (SSSI) with Wigtown Bay Local Nature Reserve being the largest in Britain, three National Scenic Areas and four National Nature Reserves. The first bat reserve in Scotland is on the Threave Estate near Castle Douglas.

To the south the 320 Km of coast line contains 5 working harbours and the habitat for many sea birds. The wetland shores of the Solway Firth are internationally renowned for their excellent bird-watching, but the sheer number of birds which the coastline supports, makes it one of the premier all-season British destinations.

The Royal Society for Protection of Birds (RSPB) owns, leases or manages many hectares of land, in the interests of protecting important breeding grounds and conserving habitat. Half the population of Swalbard Barnacle Geese spend winter at the RSPB Mersehead Reserve.

More species of butterfly and moth can be found in Dumfries and Galloway than in any other part of Scotland.

43 core areas of "Wild Land" character have recently been mapped in Scotland and three of these lie within the boundary of Dumfries & Galloway. These are Merrick, within the "Core Zone" of Galloway Forest Dark Sky Park (2009) and two, namely Broad Dollar & Black Laws very close to Moffat. Wild Land is an incredibly valuable asset for Scotland and is also associated with our most impressive wildlife.

The local economy is primarily based on forestry and agriculture with the Belted Galloway beef as famous as Aberdeen Angus steaks. Formerly wool production and fishing was an essential activity however this has given way to the scenic and wildlife attraction for Tourism and this industry provides a wide variety of employment and income.

In addition to the first Dark Sky Place in Scotland the Galloway Forest Park now features as the Core and Buffer area of a much larger 'Biosphere', and another first for Scotland. A 'Biosphere' is a special award by the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) to places that demonstrate a balanced and sustainable relationship between people and nature. Biospheres are created to fulfil three main purposes namely:

- Conserving and protecting landscape, its wildlife and habitats.
- Encouraging the use of the landscape for education and sharing knowledge with others.
- Supporting sustainable development of the local economy and communities.

Amateur astronomy forms part of the tourism outreach to attract more visitors as is now recorded in part of the region near Galloway Forest and the protection of the dark night sky across the South of Scotland is crucial in this objective. Just as important in promoting tourism, astronomy and the physics of space forms an increasing engagement in secondary school curriculums.

"A Sense of Place Toolkit" for Community groups, businesses and organisations operating within or near the Biosphere and is available as a PDF download from www.gallowayandsouthernayrshirebiosphere.org.uk

The geographic extent of Galloway and Southern Ayrshire Biosphere is shown in Figure 1.2C (following page)

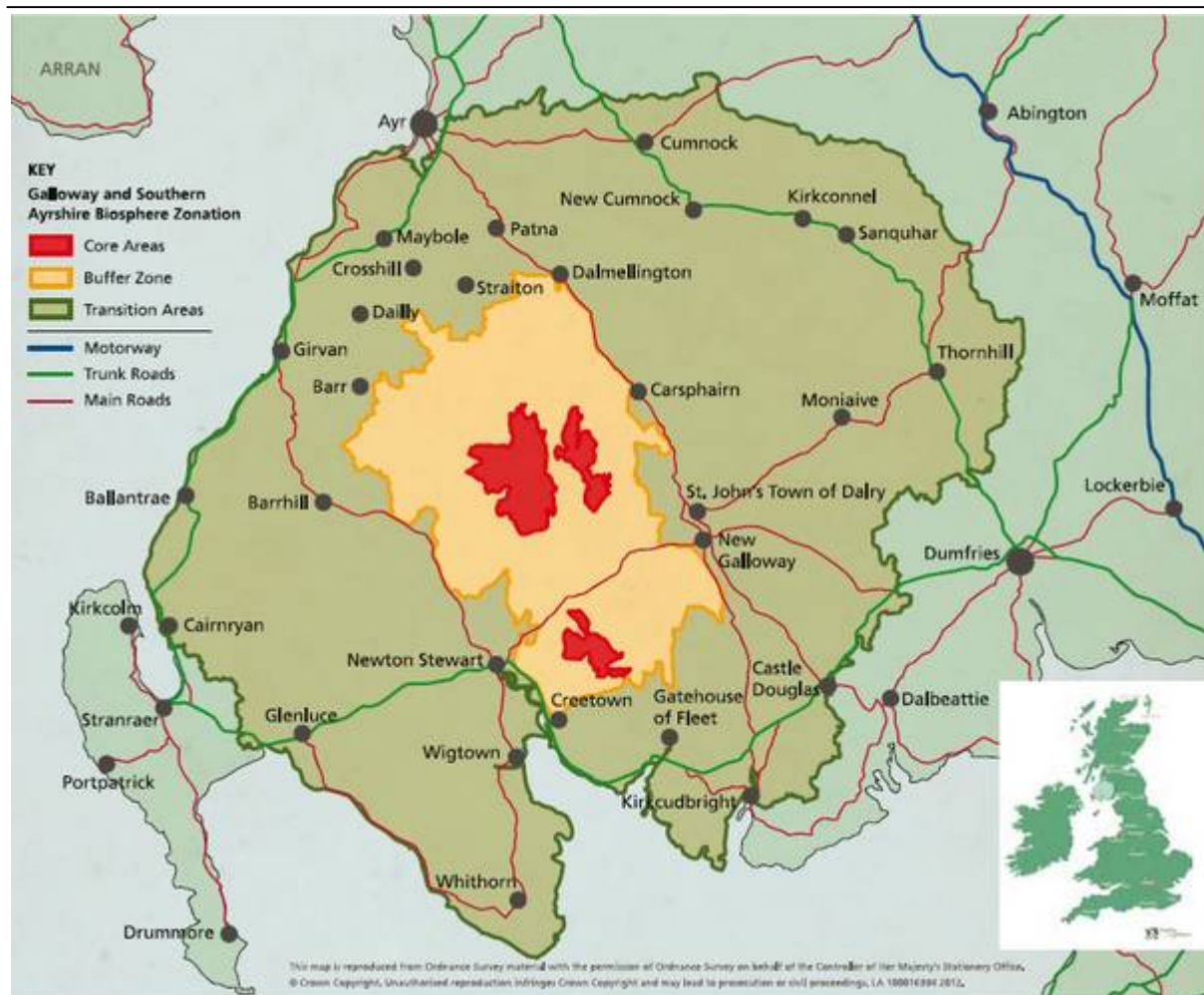


Figure 1.2C Extent of Biosphere taken from "A Sense of Place Toolkit"

Like the IDA Dark Sky Park UNESCO requires every Biosphere to be made up of three zones:

The Core areas lie at the heart of the Biosphere and include extensive areas of mountain, moorland, freshwater lochs and rivers. They are home to a wide range of scarce wildlife including iconic species like golden eagle, red deer and wild goats.

The Buffer zone of Galloway Forest Park is a working landscape managed to protect the natural heritage of the core areas. The area offers tremendous recreational opportunities in dramatic landscapes. Activities compatible with good ecological practices are encouraged and include facilities like the 7Stanes mountain bike routes and the Dark Sky Park viewing areas.

The Transition area is the part of the Biosphere Reserve where people live and can work together to make the best use of our local resources. Such as the development of low energy housing, environmentally friendly farming, and nature based tourism. **This transition zone boundary extends to about 5 miles from Moffat.**

1.3 The Astronomers' Viewpoint

More than 20 years ago the British Astronomical Association (BAA) forged links with the Institution of Lighting Engineers (now the Institution of Lighting Professionals (ILP) to open discussions on the plight of amateur astronomers. The problem was that views of the stars at night were being diminished by stray upward artificial light from outdoor lighting. This included elements such as old style street lighting and poorly installed floodlighting installations, as well as other commercial, advertising and domestic lighting.

There are many reasons why obtrusive light should be prevented but there are two prime objectives for adequate control and they are:-

- **To minimise the problems introduced by obtrusive light in the visual environment.**
- **To reduce unnecessary consumption of electrical energy and consequential demands on fossil fuels.**

Combating poor light control for astronomers assists in achieving these prime objectives but it is only part of an international obtrusive light control issue.

This document has been commissioned with the prime objective of promoting the use of the intrinsic darkness to view the stars in the night sky. It therefore concentrates on mitigating any obtrusive light elements which could cause a nuisance, from both the astronomers' and residents' viewpoint, by:-

- **Creating** a benchmark to achieve International Dark Sky Status from the International Dark-Sky Association (IDA) .
- **Maintaining** or improving the night sky darkness as a background to view the star constellations.
- **Providing** a practical working document for the communities commercial and agricultural use, and be accessible to residents, hoteliers and any other tourist related promotional material.
- **Introducing** the use of good quality lighting equipment with good light control.
- **Adopting** improvement, adaptation or changing outdated existing lighting equipment.

Unlike some other countries the UK has no regulatory governing body which provides exterior lighting. Professional Institutions such as the ILP, the Society of Light and Lighting (SLL), the Commission Internationale de l'Eclairage (CIE) and British Standards all provide illuminating engineering background for engineers to follow and adapt to suit different geographic locations.

Likewise it is important to understand that apart from Dumfries and Galloway owned property the authority had no statutory powers to change or alter lighting conditions or standards on existing private or commercial property. This role lies in the hands of residents, farmers, commerce and local authority managers to work in partnership and adopt the lighting objectives outlined herein. **Through this LMP future new development designs will be monitored via the planning approval process and developers will be required to follow the principles outlined in this LMP.**

1.4 Technical Lighting Data

It is not possible to produce a document on light control without introducing some light technical parameters and when used they will be defined as required with an appendix summary of technical definitions.

Detailed explanations of basic lighting terms can be found in Appendix A but in this document the three lighting terms most commonly used for expressing values of light are:

TERM	DESCRIPTION
lumen	Describes the total amount of light given off by a bare lamp. (abbreviation: lm (sometimes klm for 1000 lm))
candela	Describes the intensity (I) of light in a particular direction. (abbreviation: cd)
illuminance	Describes the amount of light falling on a surface area in lumens / square metre. (abbreviation: lux)

Table 1.1 Basic Lighting Terms

This LMP has been devised, principally, to control different forms of stray light. First, and foremost, is upward light which can obscure night-time astronomical observations when it reflects off air-borne particles of water or dust. The effect is commonly known as **sky glow**. However, direct light sources close to any field of observation are also problematic and are discussed later.

In addition to sky glow, astronomers do not like to see a visible source of light either and luminaires with a light source larger than 600 lumens, in a Dark Sky Park, and 3,000 lumens, in a Dark Sky Community, should be what the IDA call "**fully shielded**" from view, ie a completely flat glass window mounted horizontally, as shown in Figure 1.3 (right). Non-technical terms like this will be explained and mixed with technical descriptions later.



Figure 1.3 Fully "Shielded" luminaire

Upward light and source intensity limitation are only two of four aspects of stray light control explained in two complementary technical publications on the limitation of obtrusive light namely:-

- The Institution of Lighting Professionals (**ILP**) 'Guidelines for the Control of Obtrusive Light' GN01:2011 and
- The Commission Internationale de l'Eclairage (**CIE**) Technical Report 150:2003 'Guide on the limitation of the effects of obtrusive light from outdoor lighting installations'.

Both documents support the concept of setting out environmental zones based on the night time ambient light in the area. They then go on to recommend differing degrees of stray light control for each of 4 environmental zones. In previous years the most onerous limitations were in the zone of darkest ambience namely Environmental Zone E1 but since the introduction of Dark Sky Core Zones the ILP guidelines now includes an even more severe restriction in a new zone numbered "E0" where no new light presence will be permitted.

Table 1.1 - Typical Environmental Zones in the UK (Table 1 in ILP GN01:2011)

Zone Number	Surrounding	Night Environment	Typical examples
E0	Protected	Dark	Starlight Reserves, Dark Sky Parks or Islands, Typical of Core Zones
E1	Natural	Intrinsically dark	National Parks, Areas of Outstanding Natural Beauty or Dark Sky Park Buffer or Island Core
E2	Rural	Low district brightness	Village or relatively dark outer suburban locations
E3	Suburban	Medium district brightness	Suburban residential / commercial or small town centre locations
E4	Urban	High district brightness	Large town, commercial area or city centre with high levels of night time activity

With the exception of the principal towns, most of the region falls generally, from Table 1.1, into Environmental Zone E1 or E2, however, variations and adaptations of the CIE / ILP zones with typical light limiting factors to promote this Dark Sky application will follow in Section 2.

The maximum recommended value of light into windows, viewed intensity and direct upward light, based on the environmental zone, are only part of overall light control equation and some of the ILP recommended values have been reduced to suit this application as shown in Section 2.

The specific environmental settings and light limiting needs of individual towns / communities will be discussed and outlined individually in a separate Community Specific document (Section 5, 6, 7 and 8).

In addition to direct upward light limitations Dr Christopher Baddiley has shown in 'Towards Understanding Skyglow' (ILE:2007) that obtrusive glare from street lighting units, at or near the luminaire horizontal axis, can also diminish the astronomers' observations so the source horizontal intensity is also used in this LMP as a further means of providing both public nuisance reduction and better astronomical observations.

The simplistic polar diagram in Figure 1.4 (following) is a traditional way of illustrating a line of maximum intensity through the major and minor axis of a street lighting luminaire. For clarity Figure 1.4 shows only the major axis distribution for a street lighting luminaire ie the intensity of light emitted out of each side of the luminaire together with three angles where intensity limitations will be later applied to control horizontal and upward light, and a further two downward angles which are used in BS 13201 to control disability glare on the public road network. However, recent research has shown that downward intensity values at an angle of 70 degrees has an effect on the amount of light reflected upwards, off hard surfaces eg. highway / footpaths.

Regardless of luminaire light distribution characteristics recent research has also, more importantly, shown that off highway light absorbing landscape such as natural grass can reduce, by half, the upward reflected light of the installation and the use of asphalt surface lowers by half the upward light reflected off concrete.

Throughout this LMP Upward light control limitations are stated for the luminaire in its designed or “as-installed” condition on site and is not a factory measured parameter.

For industry consistency all photometric light distribution intensity values are based on the candela / 1000 lamp lumens method (sometimes abbreviated to cd/klm). The values shown in Figure 1.4 are typical of the most onerous light control values with the values at and above 90° equalling zero candelas. This condition is ideal in mitigating unwanted upward light.

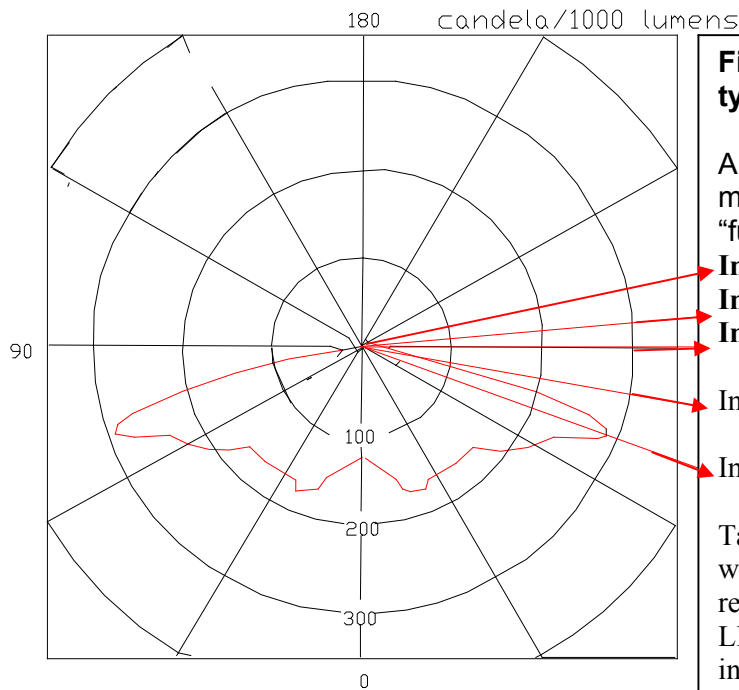


Figure 1.4 - Polar Diagram of typical street lighting luminaire

Also shows the angles and maximum intensity values for a “fully shielded (cut-off)” luminaire

Imax above 95° = 0 candela

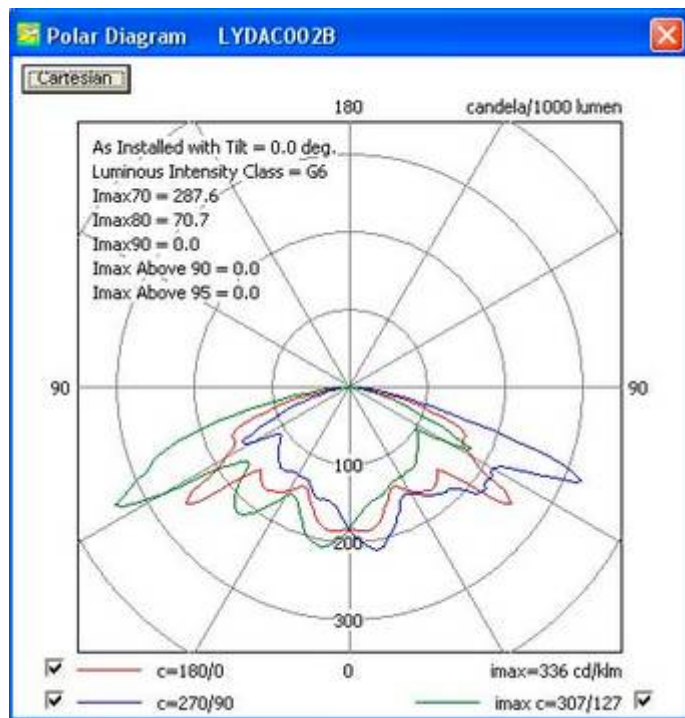
Imax above 90° = 0 candela

Imax at 90° = 0 candela

Imax at 80° = 100 cd/klm

Imax at 70° = 350 cd/k/lm

Tables extracted from BS publications will show all 5 angles with restrictions relative to glare control but in this LMP the important angles will be the intensity of **zero** at 90° and above.



Industry standard design software like Lighting Reality can be used to check luminaire “as installed” intensity values in a dynamic format as shown in Figure 1.5 at any stage in the lighting design process.

Another technical way of describing the limitation of upward light from luminaires is called the Upward Light Output Ratio and the ILP are considering the values of upward zonal flux in future editions.

In addition to the IDA term of “fully shielded” other non-technical terms like high beam, semi cut-off, cut-off, fully cut-off and aero-screened have, in the past, been used in the UK to categorise a luminaire’s light distribution. These luminaire category terms disappeared from the lighting industry usage in Europe and the UK some 30-40 years ago but sometimes still appear in UK planning publications. These old terms have therefore been combined, in this LMP, with more accurate technical descriptions with recommended limitations on intensity values in Section 2.

The light distribution from a floodlight is often shown as a Cartesian diagram (see example in Appendix A).

1.5 “Fully Shielded” Concept Visualisation as Electronic Model

The light limitations of a “fully shielded” luminaire is outlined in technical detail in section 1.4, however, Figure 1.6 and 1.7 display the effects, in a non technical format, from an electronic model village which was constructed and illuminated firstly with traditional low pressure sodium street lights as found in many rural streets as shown in Figure 1.6.



Figure 1.6 Traditional Low Pressure Sodium distribution - shows house details up to chimney pots

The luminaire positions were then replaced by luminaires with flat glass and mounted horizontally with an equivalent wattage consumption using LED light sources. The software used for the ensuing “before and after” visualisation used ray tracing techniques to calculate the effects of the light reflected off all surfaces from both types of luminaire.



Figure 1.7 Luminaires with Fully Shielded distribution showing distinct lack of upward spill light detail and distinct reduction in distant visual glare from the luminaires.

1.6 Typical Task Illuminance

Over a period of time most working tasks, and sports activities, have been analysed and researched. Recommendations have been relative to the quantity and quality of light required to carry out the task in comfort and safety.

For task lighting illuminance value recommendations for outdoor work places reference should be made to BSEN 12464-2:2007 – ‘Light and Lighting – Lighting of work places’ (Part 2: Outdoor work places) but a few of the typical regional tasks are contained below in Table 1.2.

Table 1.2 – Illuminance for typical rural tasks (extract from BSEN 12464-2:2007)

Ref No.	Type of area, task or activity	Eav lux	U _o	GR _L	R _a	ELMP Remarks
	Farms					
5.5.1	Farm Yard	20	0.10	55	20	
5.5.1	Equipment Shed (Open)	50	0.20	55	20	
5.5.3	Animals sorting pen	50	0.20	50	40	
	Equestrian (outdoor event)	100	0.50	55	20	Time limited
	Harbours					
5.4.1	Waiting quays at canals and locks	10	0.25	50	20	
5.4.2	Gangways and passages exclusively for pedestrians	10	0.25	50	20	
5.4.6	Coupling of hoses, pipes and ropes	50	0.40	50	20	
	Power, electricity, gas and heat plants					
5.11.1	<i>Pedestrian movement within electrically safe area</i>	5	0.25	50	20	
5.11.3	Overall inspection	50	0.40	50	20	
5.11.6	Repair of electric devices	200	0.50	45	60	Not permanent
		Use local close up lighting				
	Industrial sites and Storage					
5.7.1	Short term handling of large units and raw material, loading and unloading of solid bulk goods	20	0.25	55	20	
5.7.2	Continuous handling of large units, lifting and descending location for cranes	50	0.40	50	20	
5.9.1	Parking Areas – See Roadmap in section 1.7 following				20	
	Simple Summary for safety and security when no equivalent task recommendation can be found	Values during task operation time only No task – No Light				
	Very low risk	5	0.25	55	20	
	Low Risk	10	0.40	50	20	
	Medium Risk	20	0.40	50	20	
	High Risk	50	0.4	45	20	

Key to table abbreviations

Eav = Maintained average illuminance U_o = Overall uniformity R_a = min. colour rendering index
GR_L = Glare Rating limit (for internal work visibility benefit and not a visibility measure from outside the site)

Within any new design it is important to:-

- Provide the correct lighting levels for the task or sport game and grade playing level.
- Provide the lighting only when needed.
- **Recognise that providing light in excess of the recommendations not only increases an unnecessary addition to sky glow but it also wastes energy and increases the carbon footprint.**

If different tasks, from that shown in Table 1.2, are identified in individual communities the specific recommendations will be discussed and outlined in the Community Specific document later.

Most of the recommended values shown in Table 1.2 have been based on the premise that a lamp with a low colour rendering index will be used as shown in the column headed 'R_a'.

Although monochromatic low pressure sodium light is simple to filter out of astronomical observations a well controlled, zero upward light, white light source should be a more acceptable compromise with some energy saving advantages. Filtering out certain wavelengths of artificial light, however, has the effect of reducing the visibility of low magnitude stars by a factor of at least 4 (equivalent to 2 F-stops in a camera aperture).

The colour rendering index (R_a) of a standard high pressure sodium lamp (SON) (yellow coloured light) is about 20 but the colour rendering index of ceramic metal discharge lamp (CMD) (true white light) is better than 65 and some newer light sources are achieving >80.

Various research projects, carried out over several years (see ILP PGN 03:2013), have proved that human vision works better with high order colour rendering and in some tasks the illuminance design target value can be reduced by the Photopic / Scotopic (S/P) ratio if 'white' light is used instead of 'yellow' light. This S/P ratio varies with different light sources and different colour temperatures and the proportional reductions for possible light sources in this application are shown in Table 1.3. Different luminaire manufacturers publish their own S/P ratios and the values shown in Table 1.3 **should not be taken as generic.**

S/P values to suit each town will be shown in the Community Specific document.

Table 1.3 Reduced Target Illuminance depending on S/P Ratio

Baseline Target Values in BS13201 R _a < 60		S/P = 1.15 Philips CPO-/728		S/P = 1.37 Philips Warm white		S/P = 1.43 Philips Warm white LED	
E _{av} (lux)	E _{min} (lux)	E _{av} (lux)	E _{min} (lux)	E _{av} (lux)	E _{min} (lux)	E _{av} (lux)	E _{min} (lux)
15.0	5.0	13.5	4.5	13.15	4.4	13.05	4.4
10.0	3.0	8.7	2.6	8.45	2.5	8.35	2.5
7.5	1.5	6.3	1.3	6.05	1.2	5.5	1.1
5.0	1.0	4.0	0.8	3.8	0.8	3.8	0.8
3.0	0.6	2.2	0.5	2.1	0.5	2.1	0.5
2.0	0.6	1.3	0.5	1.2	0.5	1.2	0.5
Values above derived by linear interpolation from base values published in ILP PGN 03 by LCADS Ltd							

Illuminance recommendations were originally based on a numeric system to replicate visually perceptible increasing steps as shown in Table 1.4. This table also shows possible future illuminance step difference between low colour rendering lamps and very high colour rendering lamps (eg 6000⁰K).

Table 1.4 – Illuminance comparisons based on colour rendering index (R_a)

Colour Rendering Index	Task Maintained Average Illuminance Steps (lux)												
	2	3	5	7.5	10	15	20	30	50	75	100	200	300
R _a < 60													
R _a > 80		2	3	5	7.5	10	15	20	30	50	75	100	200
© LCADS Ltd 2013													

Light sources achieving an R_a > 80 are often in the CCT range of 6000⁰K and although ocular vision research has proved a case of improved visual acuity with “white light” current health research in the UK and the USA is studying the possible disturbing effect on the human circadian rhythm from “blue rich” white light and on the mental well being of humans and animals. This paragraph may need updating in the future as more information becomes available. (See Appendix A for Warm or Neutral White LED light source recommendations) Until more information is available the IDA are not encouraging the use of 6,000⁰K colour temperature.

Although BSEN 13201 recommends that average values should not be reduced lower than 2 lux there is no visual reason why 1 lux cannot be used on private paths or roads in rural locations, where appropriate, and only if lighting is found to be necessary.

Within the boundary of any Dark Sky application it is important to note here that if there is “NO TASK” in operation there should be “NO LIGHT” and that the recommended values given could be reduced if “white” light sources are used.

The Roadmap shown on the following page of this LMP has been compiled from information in BSEN13201-2:2003 - ‘Code of practice for the design of road lighting’ (parts 1 and 2) and the European CEN Standards. It has been designed to provide a simple selection process for light levels and quality criteria, including obtrusive light controls. The road lighting solution is derived from assessment of environmental zones, user types, user volume and crime volume via a flowchart.

Although BSEN13201-2:2003 is currently undergoing revision, and there will be changes in the Class numbers (ME to M, S to P et al), this LMP Roadmap does not use this Class selection process. Some previously recognised step values in the 2003 edition have been removed to allow individual S/P ratio information to determine the proportional reduction.

It is hoped to extend this, or develop a similar process, for lighting management within each Community as required.

3.2 Requirements for Traffic and Residential Area Lighting

Selection Matrix Starter

Main User Type	Typical Speed of Main User	Excluded UserType	Situation Set
Pedestrian & Cyclist	Walking Speed	Motors, Slow Vehicles & Motor Cycles	Remote Path - Set 8 "Shops" - Set 7
Vehicle conflict and shop users	10-30 MPH		"Streets" - Set 7 Car Parks - Set 6
Residential vehicles, Cycles & Pedestrians	10-30 MPH	Heavy goods vehicles	Set 5
Motorised traffic & Slow vehicles	20-40 MPH		Minor / Rural - Set 4 Secondary - Set 3
Motorised Traffic	30-70 MPH	None	Set 2
Motorway Regulations	70+	Slow vehicles, cycles & pedestrians	Set 1

Set 1 - Luminance Design Objectives

Typical Network:- Motorway & Motorway Link Roads

Traffic Flow ADT	<40,000					>40,000				
	Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR
Complex Interchange	2.0	0.4	0.7	10%	0.5	2.0	0.4	0.7	10%	0.5
Junction <= 3Km	1.5	0.4	0.7	10%	0.5	2.0	0.4	0.7	10%	0.5
Spacing > 3Km	1.5	0.4	0.7	10%	0.5	1.5	0.4	0.7	10%	0.5
Hard Shoulder	0.75	0.4	0.6	10%	0.5	0.75	0.4	0.7	10%	0.5

Set 2 - Luminance Design Objectives

Typical Network:- Strategic Routes, Trunk and some Principal "A" roads
Main Distributor Routes or
Routes between Strategic routes with peak time parking restrictions

Traffic Flow ADT		<15,000					>15,000					>25,000				
		Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR
Single Carriageway	Normally	1.0	0.4	0.7	15%	0.5	1.5	0.4	0.7	10%	0.5	<i>2.0</i>	<i>0.4</i>	<i>0.7</i>	<i>10%</i>	<i>0.5</i>
	>10,000 & E3 or E4	1.5	0.4	0.7	10%	0.5										
Dual Carriageway		1.0	0.4	0.7	15%	0.5	1.5	0.4	0.7	10%	0.5	<i>1.5</i>	<i>0.4</i>	<i>0.7</i>	<i>10%</i>	<i>0.5</i>

Set 3 - Luminance Design Objectives

Typical Network:- Secondary Distributor ("A,B & C" Classified)
Unclassified Urban Bus Routes
Urban Collector Road

Traffic Flow ADT	Low District Brightness					Medium District (E3)					High District Bright. E4				
	Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR
< 7,000	0.75	0.4	0.6	10%	0.5	1.0	0.4	0.5	15%	0.5	1.0	0.4	0.7	15%	0.5
7,000 - 15,000	1.0	0.4	0.6	10%	0.5	1.0	0.4	0.6	15%	0.5	1.5	0.4	0.7	10%	0.5
> 15,000	1.0	0.4	0.7	10%	0.5	1.5	0.4	0.7	10%	0.5	1.5	0.4	0.7	10%	0.5
> 25,000	<i>1.5</i>	<i>0.4</i>	<i>0.7</i>	<i>10%</i>	<i>0.5</i>	<i>1.5</i>	<i>0.4</i>	<i>0.7</i>	<i>10%</i>	<i>0.5</i>	<i>2.0</i>	<i>0.4</i>	<i>0.7</i>	<i>10%</i>	<i>0.5</i>

Set 4 - Luminance Design Objectives

Typical Network:- Local Rural Roads & Rural Bus Routes = 40MPH or less
Residential or Industrial Interconnecting Roads
Minor single carriageway & Link Roads between Secondary Distributors

	Traffic Flow ADT	Low District Brightness					Medium District (E3)				
		Lav	Uo	UI	TI	SR	Lav	Uo	UI	TI	SR
No Parking	< 7,000	0.5	0.4	0.4	10%	0.5	0.75	0.4	0.5	15%	0.5
Parking	<7,000 + high cycle	0.75	0.4	0.5	10%	0.5	0.75	0.4	0.6	15%	0.5
	< 7,000	0.75	0.4	0.5	10%	0.5	0.75	0.4	0.6	15%	0.5
	7,000 to 9,000	0.75	0.4	0.5	10%	0.5	<i>1.0</i>	<i>0.4</i>	<i>0.5</i>	<i>15%</i>	<i>0.5</i>
	> 9,000 use Set 3										

Set 8 - illuminance Design Objectives

Typical Network:- Footpath, cycle way and non-town centre pedestrian area

Pedestrian Flow Environmental Zone	Normal			High			Pedestrian Flow Measurement from IESNA in 1st hour of darkness Low = 10 or less Medium = 11 to 100 High = over 100
	E1/2	E3	E4	E1/2	E3	E4	
Normal Crime	Eav	0.6	3	5	3	5	7.5
	Emin	0.6	0.6	1	0.6	1	1.5
High Crime	Eav	7.5	10	15	10	15	20
	Emin	1.5	3	5	3	5	8

Where a light source with Ra>60 is used, the lighting level can be reduced by 1 class except 2 lux should not be reduced further.

Set 7 - illuminance Design Objective

Typically:- City & Town Centre Shopping Streets

Pedestrian / traffic flow Environmental Zone		Medium		High	
		E3	E4	E3	E4
Pedestrian Only	Eav	15	20	20	30
	Uo	0.4	0.4	0.4	0.4
Mixed on separate surface	Eav	20	30	30	30
	Uo	0.4	0.4	0.4	0.4
Mixed on shared surface	Eav	20	30	30	30
	Uo	0.4	0.4	0.4	0.4

Values in Set 6, 7 and 8 are based on a light source with Ra < 60

Set 6 - illuminance Design Objectives

Typical Network:- Car Parks & Motorway Rest Area

	Zone	Eav	Uo	GRL
Major shopping centre, sports & major multi purpose building complex		20	0.25	50
Small town shops, Department store office building, small sports complex		10	0.25	50
Village shops, schools, churches, terraced and apartment houses		5	0.25	50

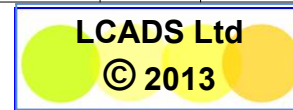
See BSEN12464-2:2007 for other external work task illuminance

Set 5 - illuminance Design Objectives

Typical Network:- Local Access Roads & roads serving limited number of properties
Urban Residential Loop Roads

Residential Traffic	Low traffic flow with pedestrians and cyclists	Normal traffic flow with pedestrians and cyclists				Normal traffic flow with pedestrians and cyclists			
		E1/E2		E3/E4		E1/E2		E3/E4	
Env. Zone		Eav	Emin	Eav	Emin	Eav	Emin	Eav	Emin
Crime rate	Ra value								
	<60	3	0.6	5	1	5	1	7.5	1.5
	>60	2	0.6	3	0.6	3	0.6	5	1
Med	<60	5	1	7.5	1.5	7.5	1.5	10	3
	>60	3	0.6	5	1	5	1	7.5	1.5
High	<60	10	3	10	3	10	3	15	5
	>60	7.5	1.5	7.5	1.5	7.5	1.5	10	3

LIGHTING DESIGN ROADMAP - Devised and Designed by
LCADS Ltd, Moffat : Tel 01683 220 299
Values in RED italics are additional CEN values to BSEN 5489 Recommendations



Page

not

used

2 Dark Sky Community Concept and Basic Light Limitation Plan

2.1 Dark Sky Community – Concept

This external LMP is a base document for Dumfries and Galloway in general and as an overall plan it is reasonable to suggest that the majority of the area is rural landscape as has already been described in the Galloway Forest Park application to the IDA (2009) is generally equivalent to the night time environmental zone setting of E1 as described in Table 1.1. There is however an area of E0 contained within the Galloway Forest Park and some of the larger towns like Stranraer and Dumfries may be currently appraised at night as being in an E3 or even an E4 zone.

This part of the LMP outlines the combination of the stray light control in each environmental zone and luminaire light output distribution control as being equivalent to the IDA concept of Core, Buffer and External Zones referred to in Dark Sky Parks and Reserves.

In order to combine the IDA recommendations within the concept of individual Communities this LMP introduces hybrid variations to the traditional CIE / ILP environmental zone settings.

As such each will require the application, in whole or in part, of fully cut-off (fully shielded) luminaires and the next section contains a method of describing the quality of light cut-off control in numeric terms for luminaires with a light source greater than 1000 lumens in open landscaped areas and 5,000 now 3,000 lumens in closely populated Community settings. This LMP was created before the IDA reduced the lumen cap from 5,000 to 3,000 lumens and subsequent amendments have been added to combine the new lumen cap.

Many domestic external lighting fittings use lamps less than 1000 lumens and although many variations on a theme can be found there are principally 3 different luminaire styles: Heritage (Figure 2.1.1), Bulkheads (Figure 2.1.2), and Floodlights (Figure 2.1.3).



Figure 2.1.1



Figure 2.1.2



Figure 2.1.3

A few other styles may also be found but the important element is not the style of the luminaire but its associated lamp output and more importantly the distribution of light being emitted. Most of the tungsten halogen floodlights use lamps which have an output greater than 3000 lumens. To be fully compliant with the IDA recommendations, the glass window should be totally horizontal (Fully Shielded) as shown previously in Section 1.4 (Figure 1.3). Floodlights which are tilted upwards can sometimes create a source of annoyance to neighbours in a residential community. (See Appendix G for a self audit improvement)

The external lighting audit and needs of individual Communities will be discussed and outlined individually as a Community Specific document.

2.2 Switching Regime (Time Limited Usage)

Many commercial premises have labels attached to light switches to say “switch off lights when room is not in use” and some buildings have energy management systems which automatically detect occupation and adjust accordingly. External lighting should be similarly treated, not only to limit energy usage but also to reduce the impact on the night sky.

Many domestic exterior luminaires can be purchased with a combined passive infra-red (PIR) presence detector and photoelectric switch unit (PECU) to do the same work as the commercial building management system. A time delay switch is just as good and it has the added advantage over PIR detection in that the luminaires will not be turned on by cats, dogs or other wildlife movement and will ensure that lights are not accidentally left on overnight.

The Environmental Zone tables which follow gives intensity recommendations for Pre and Post - 22.00 hours.

All residential and business occupiers will be helped to recognise the benefits switching off unwanted lights or adopt some form of light reduction after the time limitation of 22.00 hours. Even if the luminaire is not fitted with presence or darkness detection some DIY stores supply programmable light switches which are designed to replace existing internal manually operated switches.

Some sports or other work related applications may have earlier time limitations included in their original planning approval. This LMP suggested time limitation recommendation does not override any existing planning conditions, however, in some cases a voluntary earlier switch off time or later switch on time may be requested.

Plan Statement Number 1

Residential and business occupiers will be encouraged to recognise the benefits of switching off unwanted exterior lights after 22.00 hours.

2.3 Basic Light Limitation Plan - Environmental Zone E0's

Galloway Forest Dark Sky Park contains an area of zero inhabitants and within that area the plan of no new lighting is sustainable within what is known in the IDA as the Core Zone and that was described as a possible E0 in 2009, prior to the CIE/ILP recognition in 2011 as the values shown in Table 2.1.

Environmental Zone	Sky Glow ULR %	Light Intrusion (into windows) E _{vertical} (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m ²)	
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	
E0	0	0	0	0	0	0	-

There are now "Core Zones" in other Dark Sky Reserves where there are remote farms and residences within the "Core" boundary where the "no new lighting" concept is not sustainable. However, it can be made sustainable if the visual perception of source intensity is limited to the immediate vicinity of the property or the property boundary.

Table 2.2 shows adaptations of the CIE/ILP published values to replace "Core Zone" with three assessment notes below (added by this LMP) to identify where "presence" can be measured depending on the property density. Within a group of houses a distance limit of 50 meters is appropriate and in totally remote locations a measurement distance of 250 metres should be applied, assuming in both situations that the property boundary is more distant.

Table 2.2 Stray light control recommendations in Typical E0 Zone

Night Time Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) E _{vertical} (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m ²)	Assessment Point Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre & Post -10pm	Ev or Eh (lux)
E0-0	No New External Lighting Units Permitted (excluding the need for red filtered navigation / marker lights)						
E0-250	0	0	0	0*	0*	0	0.10
E0-50	0	0	0	0**	0**	0	0.25
E0-SL***	0	0.25	0.1	0	0	0	
© LCADS Ltd 2013							(IESNA = 0.5 lux)

(See following page for *** assessments notes associated with Table 2.2)

Assessment Note 1 Measurement or calculation of light intrusion should be in the vertical plane and parallel with the window pane in its centre.

* **Assessment Note 2** Measurement or calculation of the source intensity should be based on a 1.5 metre high visual receptor placed at any location on the property boundary or 250 meters beyond the new light source, **whichever is closer** (eg. remote house or farm).

** **Assessment Note 3** Measurement or calculation of the source intensity should be based on a 1.5 metre high visual receptor placed at any location on the property boundary or 50 meters beyond the new light source, **whichever is closer** (eg community within E0-250).

*** Note spill light from public street lighting unit only

Plan Statement Number 2

The Authority will endeavour to ensure that no lighting will be allowed to be projected from the adjacent light permitted Zones into the E0-0 Zones and any overspill lighting from properties to be no greater than 0.05 lux (horizontal) at ground level or 0.05 lux vertical at 1 metre (or higher) above ground on the E0-0 side of the property boundary.

Plan Statement Number 3

Any new or replacement lighting within the E0-250 Zone boundary shown in Figure 2.3 should be "Fully Cut-Off" (Fully Shielded (IDA term)) regardless of light source lumen output.

Plan Statement Number 4

Residents in the E0-250 and E0-50 Zones will be encouraged to limit the visual perception of light output at their property boundary by adapting or modifying existing units to this end.












		
<p>Deltalight</p>	<p>LED Deltalight</p>	<p>Zumtobel -</p>
		
<p>Kont Smide + others</p>	<p>Kont Smide - Torino</p>	<p>Kont Smide - Modena</p>
		
<p>liteCraft Stainless Wall Light</p>	<p>liteCraft Dacu 2x1 watt LED</p>	<p>liteCraft Savona (shielded version)</p>
	<p>Sitco + Others - Double Asymmetric Mini Flood</p> <p>All floodlights like this are designed to be mounted horizontally (not as shown in manufacturer's illustration)</p> <p>Additional shielding as illustrated right can limit light at task area boundary</p>	

Figure 2.2 Typical external domestic fittings which can provide the fully cut-off objectives of Plan Statement Number 2 and 3 when mounted correctly

2.4 Basic Light Limitation Plan - Environmental Zone E1

The CIE and ILP classify upward light as one segment above 90° but may consider upward light ratios in two segments in a future publication. This document uses a modified derivative of the glare restriction table in BS13201 until new UK data is published.

With the exception of most domestic style luminaires (like those shown in Appendix C) the luminous intensity from a luminaire is derived from photometric information, which has been measured under laboratory conditions. These measured values describe the luminaire's light distribution in numeric electronic format (commonly known as I-tables in IES, TM14 or any other software recognised format).

From the I-table for a particular luminaire and its installed angle of elevation the intensity of light at different elevation angles can be computed and classified, as shown in Figure 1.5, in glare classes, namely G1 to G6. G1 is the most relaxed and G6 is the most restrictive. G6 is the recommended restriction which should be applied throughout the E1 areas as shown in Table 2.3. Appendix D contains photographic profiles of some luminaires with light sources greater than 1,000 lumens and complying with the upper (and some lower) intensity limits of table 2.3.

Table 2.3 - Intensity limitation in E1 Zone

Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed location
		at 70° ^{up}	at 80° ^{up}	at 90° ^{up}	above 95° ^{up}	
Rural landscape	G6	350	100	0	0	Fully Cut-off (fully shielded) installation for all luminaires with source > 1,000 lumens rural with source > 3,000 lumens in community setting

Note ^{up} Table 2.3 restrictions apply at the luminaire's installed angle of upwards tilt

The application of zero intensity at and above the horizontal (90°) in an E1 environmental zone is an essential recommendation. The values of intensity below 90° are not as essential but will provide good glare restriction if achieved.

In order to cover the use of heritage equipment in conservation areas the following table is a hybrid adaptation of additional options in an E1 Zone. (Not a public street lighting system)

Table 2.4 Conservation Area Equipment in E1 Zone

E1 Zone Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed condition
		at 70° ^{up}	at 80° ^{up}	at 90° ^{up}	above 95° ^{up}	
Heritage bowl style	G4	500	100	10	0	
Heritage gas style	G4+	500	100	20	0	
© LCADS Ltd 2013						

In addition to the intensity controls presented in table 2.3 and 2.4 further light limitation recommendations are contained in table 2.5, below, to mitigate any obtrusive light in an E1 Environmental Zone. These two tables should be considered in tandem at the design stage for all new exterior lighting.

E1-DSC Adaptation							
Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) E _{vertical} (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m ²)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E1 in E0-250 area (E1-0)	0	0.5	0.25*	1,000	0	0	0.50
E1 (ILP guideline) (E1-1) (Beyond dark sky boundary)	0	2	0	2,500	0	0	-
© LCADS Ltd 2013							(IESNA = 1.0 lux)

* light from street lighting if installed - otherwise 0

Plan Statement Number 5

Residents in the E1 communities within an E0-250 area will be encouraged to limit the overspill light at their property boundary to no more than 0.5 lux. (Remote residents within the E0 Zone have stricter recommendations see Plan Statement No. 4)

2.5 Basic Light Limitation Policy - Environmental Zone E2

Table 2.6 Original CIE/ILP stray light limitations in E2 Zone

ILP and CIE Otrusive Light Limitations for Exterior Lighting Installations						
Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) E _{vertical} (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m ²)
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm
E2	2.5	5	1	7,500	500	5

Environmental Zone E2, as shown above, was created by the CIE many years before the introduction of Dark Sky areas and like the adaptations of E0 and E1, this LMP proposes an adaptation of the original Environmental Zone E2 to suit the exacting needs of the IDA in a town / community setting applying for Dark Sky Status.

The original upward light ratio of 2.5%, as shown in Table 2.6 is still a sustainable objective in low district brightness areas which have not been recently improved. However, the low district brightness of a Dark Sky Community (**DSC**) requires to maintain an installed 0% upward light ratio for all newly installed luminaires with a light source greater than 3,000 lumens. The only exception to this is in the hub or centre of the community where a 1% ULR can provide additional visual perception. As a result of this LMP there is no reason to continue accepting a 2.5% ULR limit for new planning applications if the old street lighting has recently been changed to cut-off distribution equipment but may need to be increased to 2.5% in areas with anti-social behaviour of CCTV for facial recognition.

Table 2.7 Adapted stray light limitations for Dark Sky Community (surrounded by E1 setting)

E2-DSC Adaptation							
Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) E _{vertical} (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m ²)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E2-0% (Residential)	0	2.5	1	2,500	0	0	1.0
E2-1% (Town Centre)	1	5	1	2,500	500	3	3.0
E2-2.5% (ILP guideline)	2.5	5	1	7,500	500	5	(IESNA = 3.0 lux)
© LCADS Ltd 2013							

In addition to the stray light controls presented in table 2.7 further light limitation recommendations are contained in table 2.8, below, to mitigate glare in a Dark Sky Community Zone. As in Section 2.4 these two tables should be considered in tandem at the design stage for all new exterior lighting.

Table 2.8 Intensity Distribution Control in Dark Sky Community Zone

DSC Zone Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed condition
		at 70 ⁰ up	at 80 ⁰ up	at 90 ⁰ up	above 95 ⁰ up	
New single light source > 3,000 lumens post May 2013	G6*	350	100	0	0	Fully cut-off installation in residential community
Single light source >1,000 but < 3,000 lumens	G5- derivative	350	100	5	0	Cut-off installation
New LED light source >3,000 lumens	G6*	350	100	0	0	Fully cut-off installation in residential community
Retrofitted LED light source >1,000 but < 5,000 lumens pre May 2013	G4	500	100	10	0	Part Cut-off installation (Part Shielded)
Community Hub with population < 3,000 (excluding conservation style streets)	G4	500	100	10	0	Tilted up installation using luminaires with Cut-off distribution for CCTV surveillance
Heritage bowl style	G4	500	100	10	0	
Heritage gas style	G4+	500	100	20	0	
© LCADS Ltd 2013						

Note ^{up} Table 2.7 restrictions apply at the luminaire's installed angle of upwards tilt which can be tested in UK industry standard design calculation software.

Note * Intensity relaxation may be appropriate at 70⁰ and 80⁰ depending on luminaire availability but the **values of intensity at 90⁰, 95⁰ and above are crucial.**

Note ** Requires discussions with adjacent land owners and local authorities to adopt similar controls in their individual environmental policy plan.

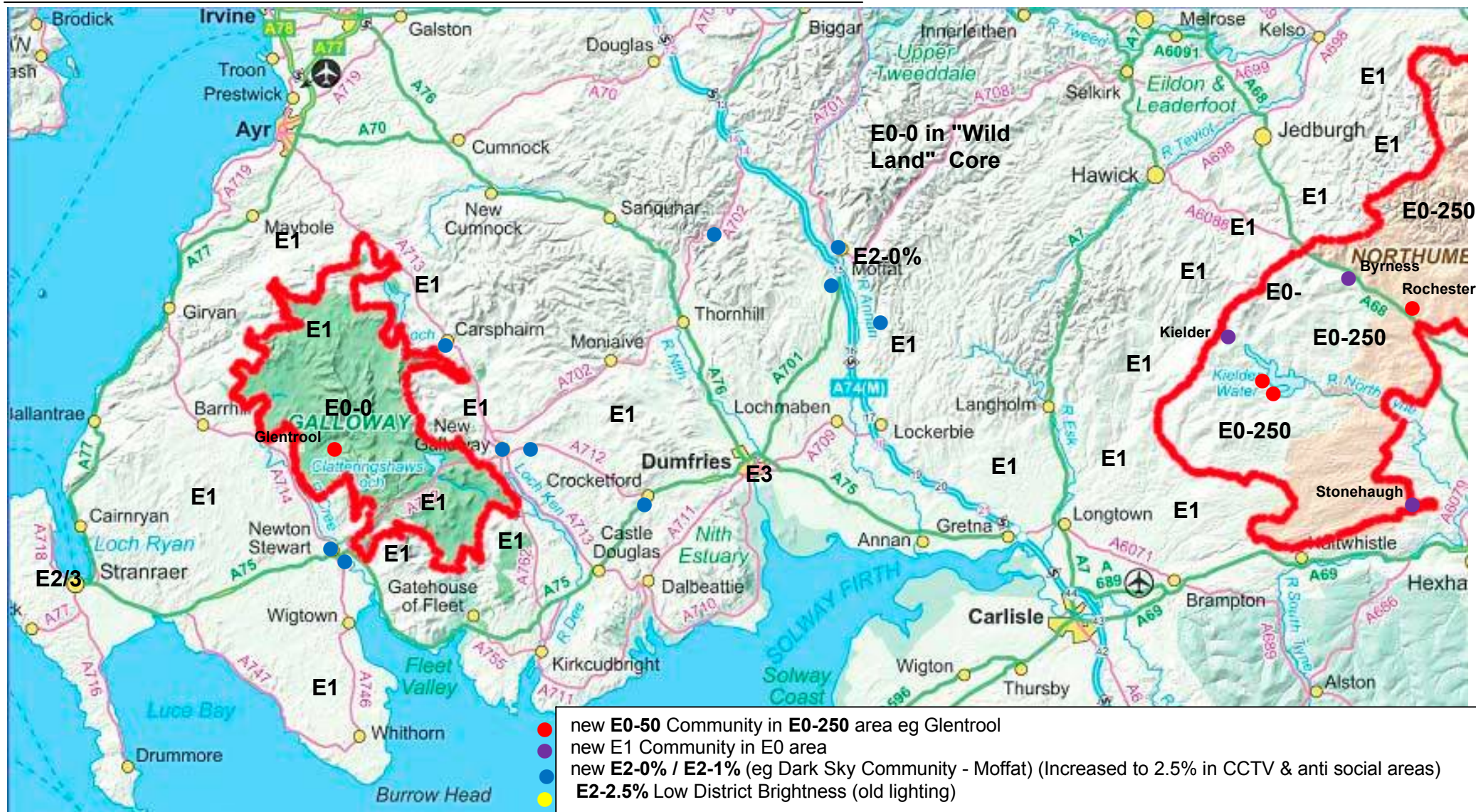


Figure 2.3 Current / Future Environmental Zone Map

Table 2.9 Luminaires Retrofitted between April and September 2013

Towns Already Changed	Number of LED's and Manufacturer		
Abbey Yard	23 x Orange Tek + 24 LED Urbis Axia		
Auchencairn	65 x 24 LED Urbis Axia		
Balmaclellan	15 x 24 LED Urbis Axia		
Beattock	66 x WRTL Mini Luma		
Borgue	20x 24 LED Urbis Axia		
Bridge of Dee	21 x 24 LED Urbis Axia		
Bridge of Urr	10 x 24 LED Urbis Axia		
Canonbie	111 x 37W Dim Holophane Mini Factor		
Cargenbridge	148 x 37W Dim Holophane Mini Factor		
Carsphairn	15 x 24 LED Urbis Axia		
Clarebrand	2 x 24 LED Urbis Axia		
Claygate	9 x 37W Dim Holophane Mini Factor		
Corsock	20 x 24 LED Urbis Axia		
Crocketford	15 x 24 LED Urbis Axia		
Crossmichael	60 x 24 LED Urbis Axia		
Dalry	84 x 24 LED Urbis Axia		
Dundrennan	16 x 24 LED Urbis Axia		
Edingham Ind Estate	11 x 24 LED Urbis Axia		
Evertown	10 x 37W Dim Holophane Mini Factors		
Gelston	34 x 24 LED Urbis Axia		
Glenlochar	10 x 24 LED Urbis Axia		
Glentroll	23 x 24 LED Urbis Axia		
Harelaw	7 x 37W Dim Holophane Mini Factor		
Hightae	58 x GE Odeysey 50W Dim Streetwise		
Kendon Power Station	9 x 24 LED Urbis Axia		
Kirkpatrick Durham	32 x Sapphire 1 60W Dim Cosmo		
Laurieston	21 x 24 LED Urbis Axia		
Minnigaff	217 x Orange Tek		
Moffat	568 x Dim Philips Mini Iridium + Irdium		
Mossdale	5 x 24 LED Urbis Axia		
New Galloway	83 x 24 LED Urbis Axia		
New Luce	23 x Orange Tek		
Newton Stewart	499 x Orange Tek		
Palnackie	33 x 24 LED Urbis Axia		
Parton	2 x 24 LED Urbis Axia		
Rhonehouse	22 x 24 LED Urbis Axia		
Rigg	23 x 90W Dim Urbis Evolo		
Ringford	24 x 24 LED Urbis Axia		
Rowanburn	32 x 37W Dim Holophane Mini Factor		
Southerness	14 x Sapphire 1 45W Dim Cosmo		
Springholm	31 x 24 LED Urbis Axia		
Tongland	20 x 24 LED Urbis Axia		
Wamphray	29 x 24 LED Urbis Axia		
Wanlockhead	73 x 37W Dim Holophane Mini Factor		
	TOTAL of 6613 as at 1st September 2013		

3 Planning Requirements

3.1 General

In order to avoid a combination of light polluting the night sky and also possible light nuisance (see **Public Health (Scotland) Act 2005**) problems Section 2 contains basic recommended numeric objectives to this end. However, this section explains how planners and engineers need to work in partnership, both internally and externally, to help maintain or enhance the sky darkness at night.

As indicated in the Preamble the guidance given in this document will assist in the defence of the existing night sky. However, there is a national problem with obtrusive and nuisance light. Part of the problem emanates from the random standards of some planning applications containing external lighting proposals.

The lack of a published lighting design & assessment methodology has resulted in planning applications, being presented in a variety of formats, sometimes with a few extracts from manufacturers' catalogues and scant calculation techniques. This has created major difficulties in appraising applications both subjectively and technically. Whilst it may not be necessary for new residences it is certainly needed for sports complexes or container / warehouse distribution centres as examples but not limited to these two applications.

A new ILP document (PLG04:2013 "Guidance on Undertaking Environmental Impact Assessments") focuses on the lighting aspects of creating a Lighting Impact Assessment. Whilst most of these are effects on people and their perception of the surroundings, assessments must also include effects on flora and fauna. A summary of some of the sections covered are included below.

Lighting Impact Assessment - Checklist	
Baseline Descriptions	
	Baseline Assessment Procedures
	Day time visit
	Night time visit
	Viewpoint Scheduling
	Baseline Assessment Layout
	Location Plan
	Brief Description
	Viewpoint Pages
	Baseline Summary
Proposed Development – Lighting Design	
	Design – General
	Preliminary Assessment
	Provisional Design
	Final Design
	Maintenance Factors

Table 3.1 Typical Lighting Impact Assessment Checklist

In addition to the ILP rational covering the process of carrying out Lighting Impact Assessments the Scottish Executive have published a complementary Planning Guidance Note (**Controlling Light Pollution and Reducing Energy Consumption**) which provides a rationale to all lighting design proposals.

An abbreviated 12 point summary checklist of the design methodology is shown in Table 3.2 below but reference to the full document will provide the reasoning behind a 20 bullet point checklist. This LMP should encourage Development Control Committees, both within the County and adjacent Local Authorities, to insist on a thorough design process by the developer before submitting proposals. Although only 12 points are included in Table 3.2 these should be treated as an absolute minimum requirement and there are no reasons why the full 20 point plan is not set as a standard requirement.

See Appendix H for a more detailed description of the design and assessment methodology.

Table 3.2 Design Methodology Checklist

Good External Lighting Design Practice
<ul style="list-style-type: none">• Survey of surrounding area environment• Identification of critical viewpoints or receptors• Analysis of task lighting level recommendations and game level if sports lighting application• Establish environmental light control limits• New lighting design quality objectives• Calculated measurement of Task working area(s) Overspill area(s)• Obtrusive light calculation of Property intrusion Viewed source intensities Direct upward light output ratios• Compare design achievement with baseline values• Schedule of luminaire types, mounting height and aiming angles• Schedule of energy usage and lumens per square metre• Schedule of luminaire profiles• Layout plan with beam orientation indication and site relationship with surrounding residential and commercial properties

Plan Statement Number 6

Through this LMP it will be possible to encourage developers, when required, to adopt and provide a lighting industry professionally prepared submission for planning consideration.

3.2 Design Stage

Luminaires are designed to have light distributions which are appropriate for specific applications. Even though a luminaire has a Dark Sky Fixture Award it can produce sky glow, light intrusion or glare if it is installed improperly. By following the recommendations relating to viewed intensity and vertical illuminance limits at lighting design stage this should mitigate the obtrusive nature of stray light.

This assessment is not possible by inspecting luminaire catalogue information, however, industry standard software, complete with obtrusive light evaluation criteria, eg Philips Calculux, is essential and is available as a free download from their web site. Some luminaire manufacturers also provide a design service but this may be limited in application and may not include obtrusive light analysis.

All planning applications involving external lighting should be encouraged to follow the 12 point plan outlined in Section 3.1 to ensure that viewed intensity and obtrusion are mitigated accordingly.

Over-lighting an area is just as obtrusive and wasteful as pushing light into the night sky. Designing for, and providing, the correct task illuminance on the ground is just as important as controlling stray light.

However, some luminaire manufacturers / suppliers, especially budget range DIY equipment, cannot provide photometric intensity tables. This precludes the use of computer algorithms to check either the essential information about fundamental illuminance values or check for obtrusive light situations.

At design and planning application stages the answer is simple, do not accept the use of such equipment and at installation stage do not substitute a non-photometrically measured equivalent look-a-like.

Although most of the commercial luminaires have photometric files many of the 1,000 lumen range of domestic residential exterior lighting does not have photometric files and therefore requires a non-photometric method. A lumen cap methodology is explained in the next section.

Plan Statement Number 7

All design submissions for new commercial lighting will be encouraged to show evidence of compliance with the zero candela intensity at 90⁰ and above and encourage domestic luminaires to be selected from units having some form of upward light control.

3.3 Non-photometric Lumen Cap method for domestic exterior lighting

Budget range DIY equipment usually takes the form of a simple area floodlight with a high wattage tungsten halogen lamp. They are popular because they are cheap, easy to install, and are often combined with photo-electric (PECU) switches to prevent daytime operation and with passive infra red (PIR) detectors to switch on and off automatically during the hours of darkness.



In the majority of cases these fittings, or luminaires, are installed typically on garage or porch fascias at about 2-3 metres above ground level, and arranged to direct their main beams towards the property boundary to operate as vehicles or people enter. This high beam arrangement can result in glare to road users, light intrusion into adjacent property and a source of possible complaint.

This type of installation is not in keeping with the light control required in a rural setting and as from the effective date of implementation of this ELMP no new floodlights of this type will meet the IDA Dark Sky requirements unless they are installed with the glass face horizontal.

As described previously a light source output limit of 1000 lumens in luminaires with poor light control is considered to be a generalised rule of thumb marker. However Table 3.3 provides a more accurate lumen and wattage prescription, which is based on the overall area of the building structures on each residential plot of land.

Appendix E contains examples of exterior lighting equipment which should be considered when purchasing new exterior lighting. This Appendix could be made available to all the residents within each participating community.

Lamp lumens is a consistent value and although difficult to find on some lamp packaging it will gradually superseding the lamp wattage. Lamp watts can vary with the efficacy of the lamp. Table 3.3 (following page) has therefore been constructed using the lamp lumens as the base from which to start followed by tables which show the equivalent lamp wattages for different lamp types.

Table 3.3 - Total Lumen Limit for each residence

	Environmental Zone				
	E0-50 / E0-250 and E1		E2	E3***	E4***
Total Lumens for domestic Exterior Lighting	750 lm plus 4.5 lm / m ² of site structures*		2250 lm plus 4.5 lm / m ² of site structures*	4500 lm plus 4.5 lm / m ² of site structures*	6000 lm plus 4.5 lm / m ² of site structures*
Fully cut-off luminaires each lamp lumen maximum	1200 lm		1650 lm	2400 lm	3200 lm
Part cut-off luminaires each lamp lumen maximum	E0's none	E1 750 lm	1200 lm	1650 lm	2400 lm
No light control luminaires each lamp lumen maximum	E0's none	E1 480 lm**	750 lm**	750 lm	750 lm
© LCADS Ltd 2013					

* Site structures is the sum of the land area of residential buildings, habitable structures, garages, recreational buildings and storage structures on each property plot.

** The maximum watts or lumens for each lamp in this section relates to replacing lamps in existing lighting units only. No new luminaires with little or no light control should be considered, especially in environmental zones E0's and are shown in Table 3.3 as not allowed.

*** Environmental zones E3 and E4 do not relate to any conditions in or near rural or Community living and should be excluded from any considerations for domestic lighting. They are shown here as an example for large town centres to follow if appropriate.

From table 3.3 a total site structure in the Zone E1 with say 255 m² would provide for a total of 1,897 lumens which can be distributed as 1 or more luminaires up to the total allowance. (see Appendix F for list of lower lumen and wattage lamps)

Table 3.4 - Lamp watts for each luminaire with Compact Fluorescent


	Environmental Zone				
	E0's	E1	E2	E3***	E4***
Fully cut-off luminaires each lamp watts maximum	13w.	20 watts	24 watts	32 watts	42 watts
Part cut off luminaires each lamp watts maximum	0	11 watts	20 watts	24 watts	32 watts
No light control luminaires each lamp watts maximum	0	9 watts**	12 watts**	12 watts	12 watts
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Table 3.5 - Lamp watts for each luminaire with Tungsten Halogen


	Environmental Zone				
	E0-50 / 250	E1	E2	E3***	E4***
Fully cut-off luminaires each lamp watts maximum	60 w.	100 watt	120 watts	150 watts	200 watts
Part cut off luminaires each lamp watts maximum	none	none	60 watts	100 watts	150 watts
No light control luminaires each lamp watts maximum	none	none	none	none	none
© LCADS Ltd 2013					

Table 3.6 - Lamp watts for each luminaire with Incandescent / Candle / Capsule Lamp


	Environmental Zone				
	E0-50 / 250	E1	E2	E3***	E4***
Fully cut-off luminaires each lamp watts maximum	2x35 w. halostar	2x35w. halostar	2x60 watt Capsule	See 3.4	See 3.4
Part cut off luminaires each lamp watts max.	none	60 watts	See 3.4	See 3.4	See 3.4
No light control luminaires each lamp watts max.	none	40w candle	40w candle	60w candle	60w candle
© LCADS Ltd 2013					

Table 3.7 - Lumen and Watts exception for Ceramic / Metal Halide discharge lamps








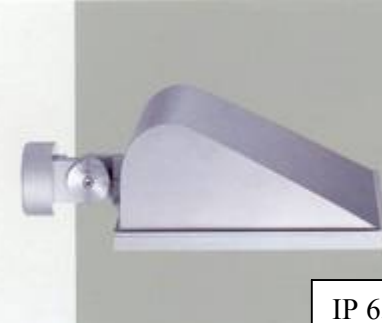




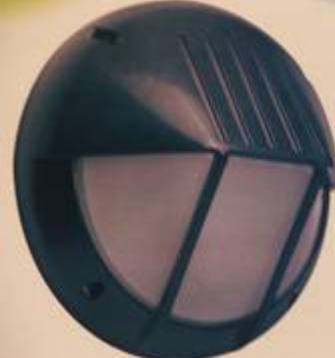
	Environmental Zone				
	E0-50 / 250	E1	E2	E3***	E4***
Fully shielded luminaires each lamp lumen maximum each lamp watts maximum	none	1500 lm 20w	2400 lm 35w	5500 lm 70w	5500 lm 70w
Part or No light control luminaires are not allowed with this light source					
© LCADS Ltd 2013					

Table 3.8 on following page contains pictorial examples of fully cut-off (fully shielded), part cut-off (part shielded) and no light control luminaires.

Table 3.8 – Light Control Examples

Fully Cut-off Examples	Partly Cut-off Examples	No light Control Examples
 <p>IP 65</p> <p>SILL 420 Full range of compact fluorescent and low wattage metal halide</p>	 <p>IP 44</p> <p>100w halogen = 1650 lm 150w halogen = 2200 lm 300w halogen = 5000 lm</p>	 <p>no new units</p>
 <p>Zumtobel Bega 2489 18w PLC</p>	 <p>Solar power LED</p>	 <p>no new units</p>
 <p>IP 65</p> <p>ERCO Parscoop 42w fluorescent = 3200 lm 70w metal halide = 5000 lm Acceptable substitute for 300 or 500 watt tungsten halogen replacement</p>	 <p>limit to 40 watt tungsten or 6 watt compact fluorescent</p>	 <p>limit to 40 watt candle or 6 watt compact fluorescent</p>
		 <p>18 watts = 1200 lm and too large for E0's & E1 Dark Sky</p>

3.4 Sports Lighting

With a growth in leisure pursuit comes a growth in the need to extend the hours that play areas can be used and there are several game areas adjacent to this application with floodlighting facilities but some have poor light control. Nationally some sports areas contain some of the worst cases of over-lighting and it is essential that this does not happen in or around this application.

BS EN 12193:2007 “Light and Lighting. Sports Lighting” contains both indoor and exterior lighting recommendations for not just the players but also the audience, the referees, the cameras and last but not least the neighbours. It also contains recommendations for lighting designers in the form of typical calculation areas and the number of calculation points to include in any assessment.

The illuminance recommendations are based on the quality of the game. There are 5 levels of competition from National to Recreational, all with different illuminance requirements. Table 3.3 shows some of these extremes.

Some manufacturers provide free design outlines like the one shown in Figure 3.1 but that is only a very small part of sports lighting design considerations. It is essential to consider both light overspill and light intrusion, especially when the sports field is close to residential property.

In order to protect the existing dark sky it is essential to ensure the playing surface of any new sports facilities requesting floodlighting is not over lit.

Double asymmetric flat glass luminaires should be used with the luminaire window completely horizontal as shown in Figure 1.3 and 3.2.

It may also be necessary to limit the average illuminance to that of recreational level depending on the distance the sports facility is from the Core Zone. (see Appendix A for the definition of ‘average’).

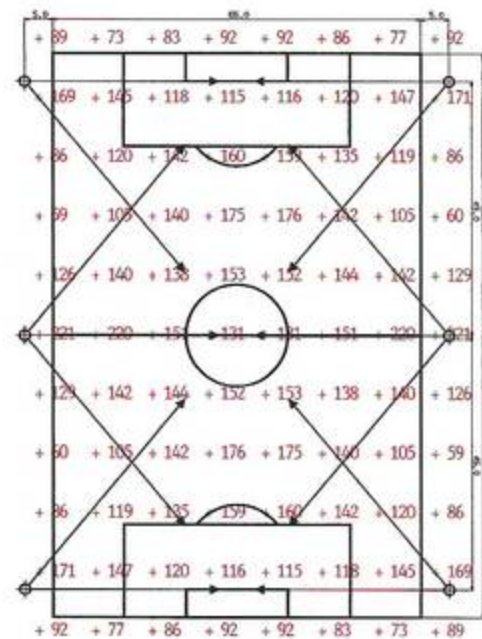


Figure 3.1 – Typical Football Area - Free Design

Note:- Free Design like this never includes an impact assessment on the surrounding landscape.

Table 3.3 - Game maintained average typical illuminance variations

Game	National				Recreational
Football, Rugby, Basketball, Netball, Volleyball	500 lux				75 lux
Equestrian and Cycle Racing	500 lux				100 lux
Hockey and Tennis	500 lux				200 lux



4 Special Lighting Application Considerations

4.1 Excluded Applications

The following applications will be prohibited from any part of rural landscape and other areas that are not designated as Environmental Zone E3 or E4:-

- Aerial Laser Shows
- Sky Tracking Searchlights
- High intensity light sources greater than 200,000 lumens
- Sports complexes requiring an average playing surface greater than 100 lux.

4.2 Temporary Applications

Typical lighting applications not excluded but requiring Short Time Planning Permission - but not limited to the following applications:

- Sports facilities with column mounted luminaires.
- Construction site lighting.
- Churches, public monuments or buildings.
- Travelling Fair Grounds - theme and amusement parks.

4.3 Planning Application

The **Light Control Zone** will be deemed to include the existing Dark Sky Parks and Dark Sky Communities.

To obtain planning permission, applicants shall demonstrate that the proposed lighting installation application:

- (a) Contains an analysis of at least 12 essentials in the 20 point Good Design Practice Checklist produced by the Scottish Executive (see also Section 3.1)
- (b) A statement that shows every reasonable effort to mitigate Sky Glow and Light Intrusion has been addressed and accompanied by a computer calculation indicating average task illuminance, uniformity, horizontal values of overspill beyond the property line and vertical illuminance values of light intrusion on adjacent property windows.
- (c) Employs lighting controls to reduce the quantity of lighting at the project specific 'switch-off' time which has been established in the LMP.
- (d) Complies with all light limitation factors outlined in this LMP.

4.4 Lighting Applications Excluded from the Objectives of this LMP

- Temporary festive Christmas lighting switched on between the last Saturday in November and the following year's January 6th only.

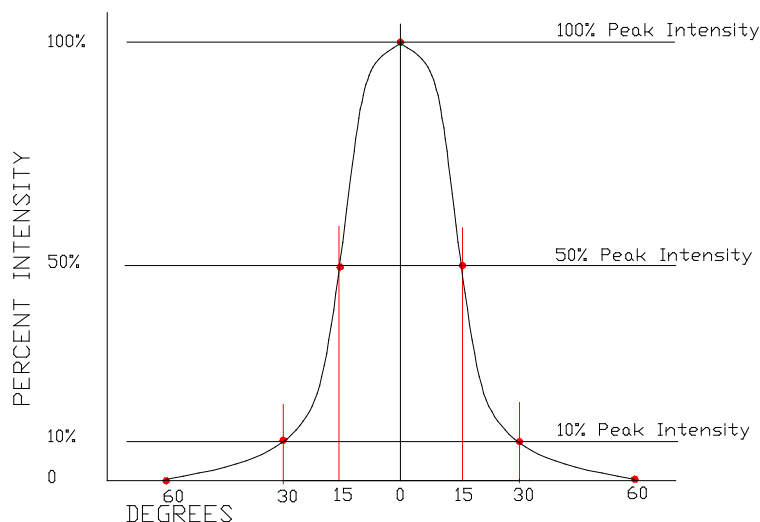
Appendix A – Definitions

Unit/Term

lumen	A unit of light (luminous flux) emitted from a point source of one candela intensity, sometimes expressed in kilolumens - (klm)
candela	A unit of luminous intensity
illuminance	The quantity of luminous flux incident upon a unit area, expressed as lumens per square metre or lux
luminance	The luminous intensity (or brightness) of a surface or source expressed in terms of surface area i.e. candelas per square metre (cd/m²) To convert dark sky 'brightness' to luminance Use the formula: $[\text{value in cd/m}^2] = 10.8 \times 10^4 \times 10^{(-0.4 \times [\text{value in visual magnitudes/arcsec squared}])}$
reflectance	The reflection factor (or index) of a surface or material
inter-reflection	The result of various reflections
efficacy	In lighting terms - the value of light obtained per unit of electrical energy input i.e. lumens per watt
wattage	The nominal load rating of a lamp (excludes any allowances for associated operating gear losses usually taken as averaging 10% of the nominal wattage value (lower for electronic control gear))
luminaire	The total package of lantern, lamp and all associated integral items of operating control and switch gear
projector	A special luminaire designed to provide a concentrated pattern of light
skylight	The variable brightness value of daytime sky caused by sunlight scattered by particles of dust and vapour in the earth's atmosphere (skylight can reach values in excess of 2,000 candelas per square metre)
moonlight	The luminous flux emitted by the moon received at the earth's surface at an average value of between 0.3 and 0.5 lux (a rural surface under moonlight conditions will have an average brightness of about 0.002 candelas per square metre i.e. 1/500 cd/m ²)
sky glow	The variable brightness value of night-time sky caused by upward components of light from direct and inter-reflected light off the earth's surface (the brightness of sky glow is dependent on the amount of upward light and the presence and density of atmospheric particles and their distance above ground level)
aura	The hemisphere of light rising up from ground level encircling a light source or lighting array caused by low level mist and fog particles

Disability glare This is glare from a lamp or luminaire which prevents a visual task from being carried out by obscuring ones vision. It is sometimes associated with visual pain.

Cartesian diagram



IES, TM14, & Elumdat

Are different electronic formats of luminaire intensity distribution. They are not a meaningful representation in hard copy printed format, like a Cartesian or polar diagram, however, as numeric data input for a computer algorithm they represent a 3-dimensional array. Some computer algorithms recognise all three different formats whilst other algorithms only recognise one format.

Light intrusion Is light entering or illuminating windows beyond the intended area requiring illumination. Sometimes referred to incorrectly as 'light trespass' since the word 'trespass' has different legal implications in the UK.

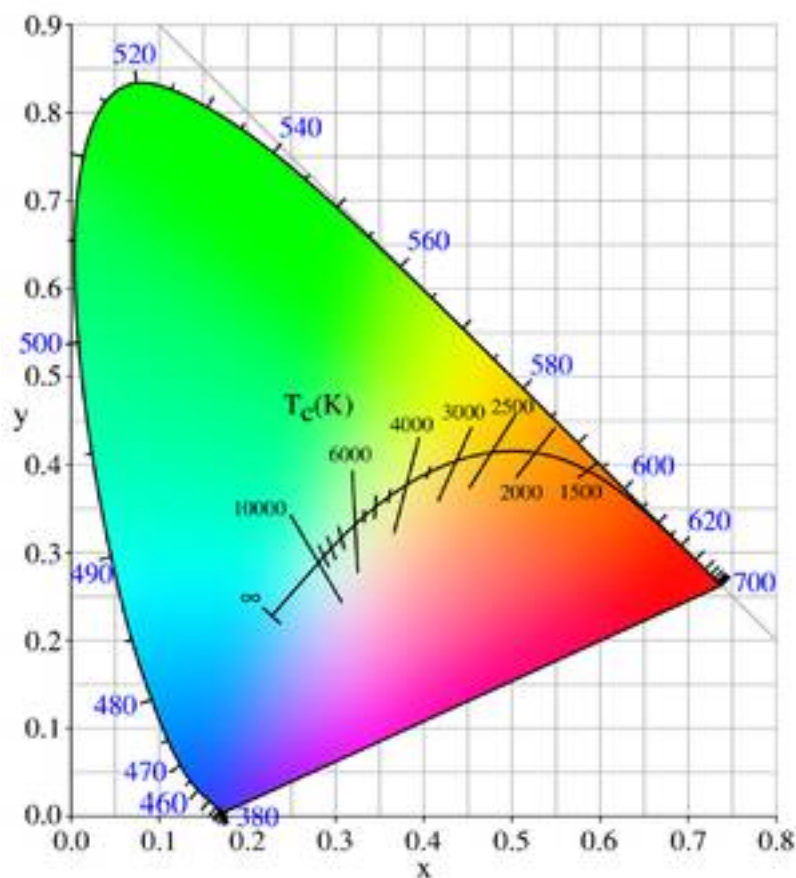
Average luminance Or average illuminance

Are all based on a maintained average which means the lowest average value to which the installation will fall before lamp replacing and luminaire cleaning takes place as part of a maintenance regime cycle.

Light Source Temperature, Colour, and Appearance

Colour Temperature

The **colour temperature** of a light source is the [temperature](#) of an ideal [black-body radiator](#) that radiates light of comparable [hue](#) to that of the light source. Colour temperature is a characteristic of [visible light](#) that has important applications in [lighting](#), [astrophysics](#), [horticulture](#), and other fields. In practice, colour temperature is only meaningful for light sources that do in fact correspond somewhat closely to the radiation of some black body, i.e., those on a line from reddish/orange via yellow and more or less white to blueish white; it does not make sense to speak of the colour temperature of, e.g., a green or a purple light. Colour temperature is conventionally stated in the unit of absolute temperature, the [Kelvin](#), having the unit symbol K.



*The CIE (1931)
x,y chromaticity space*

*also showing the chromaticities
of black-body light sources of
various temperatures ([Planckian
locus](#)), and lines of
constant [correlated colour temperature](#).*

Source Wikipedia

The “Correlated Colour Temperature” (CCT / T_{cp})** provides guidance of the colour appearance of lamps whether or not their chromaticity point (from the x & y values) is on the black body locus line.

BS 5489-1:2013 and BSEN 12665:2002 use the abbreviation of T_{cp} to replace CCT. The abbreviation CCT is still used in American documents

Colour Appearance

The colour appearance of a light source can be defined objectively in terms of the temperature, in degrees Kelvin, to which a thermal radiator (e.g. a black body) would have to be heated to have the same colour appearance as that of the light source being assessed. A GLS tungsten filament lamp (traditional domestic light bulb) has a colour temperature of c.2700° Kelvin (usually written as 2700K).

The CIE categories of “Warm”, “Intermediate” and “Cool” relate to CCTs as follows:

- | | | |
|---------------|---|--------------------------------|
| Below 3300K | - | WARM |
| 300K to 5300K | - | INTERMEDIATE or NEUTRAL |
| Above 5300K | - | COOL |

Dark Sky Light Source Colour Issues

In 2010 the International Dark-Sky Association (IDA) produced a paper "**Visibility, Environmental and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting**" which is a compilation of various research abstracts available at that time. All the research abstracts chosen relate to the possible 'harmful' effects of the blue content in most 'white' light sources. The IDA terminology of 'blue-rich white' includes metal halide, fluorescent, induction and **all CCT versions of LED** light sources. The following pages show the various spectral power radiation of these and other light sources which have no or very little blue content in their spectrum (ie below 500 nanometers).

Four years later when exterior lighting, especially highway lighting in the UK, was undergoing a substantial light source change from yellow sodium to various forms of white light the IDA reviewed their dark sky friendly fixtures approval process. In addition to their 'fully shielded' requirements they will now limit approval to luminaires which use a light source CCT of 3,000K or less. **This may not be a sustainable decision in the UK.**

There are two issues in the 2010 paper which point towards limiting astronomy and also general vision 'glare'. Both of the main issues and also secondary ecology issues are linked to the blue content of white light. The paper supports continued use of yellow light which as shown in the following spectral analysis are deficient in blue spectral content. The paper cites the Rayleigh Scatter Index effect of the blue radiation appearing to be greater than yellow radiation.

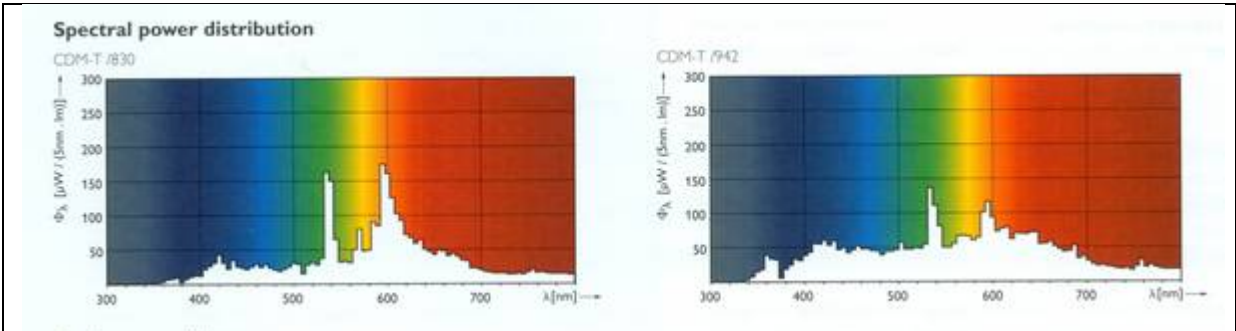
In the UK yellow low pressure sodium lamps are regarded as "grand-fathered" old technology and the overwhelming majority of UK local authorities have a policy of not installing any more new low pressure sodium street lighting installations. While this lamp has been the mainstay of many street lighting installations for more than 50 years it is now scheduled to be phased out shortly in the UK and there is also growing evidence that the high pressure sodium lamp may also follow. Maintaining these two yellow sources is becoming increasingly more expensive and this will only add to their eventual extinction. It is therefore difficult to promote their continued use and a sustainable white light compromise is required for dark sky preservation.

'Glare' results from the quantity and quality of light distribution from a luminaire and not solely from the colour of the light source. BSEN13201-2 use technical metrics to define limits of 'glare' in street lighting and the **full distribution of G6 for neutral white LED sources should be applied** in preference to limiting the colour temperature of the light source in dark sky places.

The use of light sources with a CCT / Tcp greater than 4,000K is therefore not permitted in a UK Dark Sky Place.

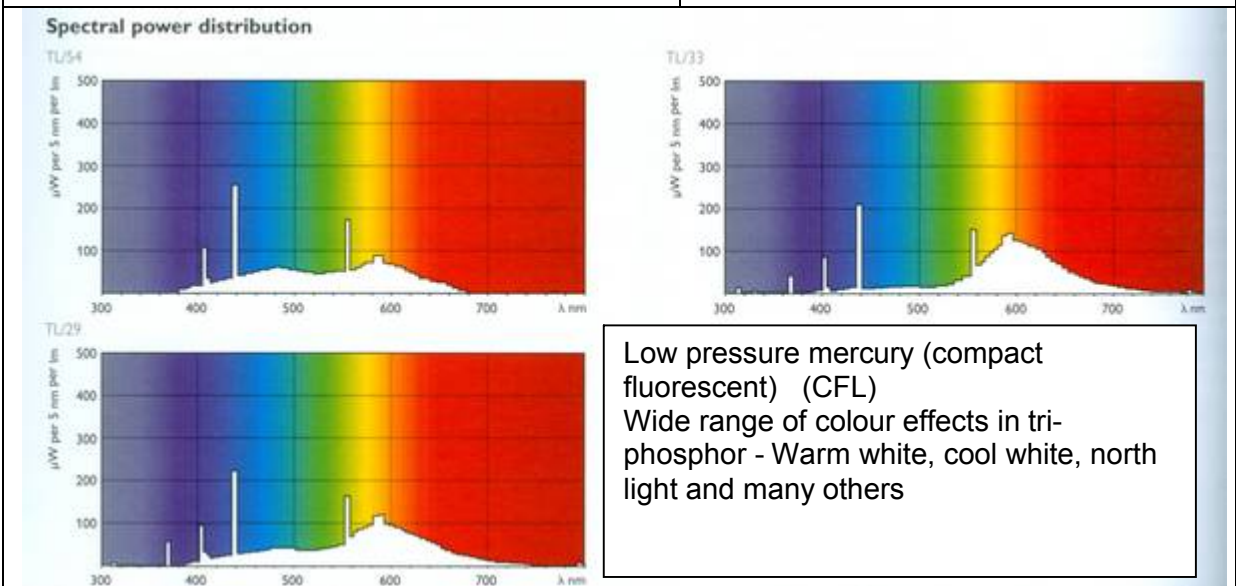
Light source Spectral Power and Colour Temperature Analysis

<p>Spectral power distribution</p>	<p>Low pressure sodium (SOX) Colour Temperature CCT = 1800K Colour rendering index Ra = minus 40</p> <p>No radiation below 500nm</p> <p>nm = wavelength in nanometers</p>
<p>Spectral power distribution</p>	<p>High pressure mercury with fluorescent coating to convert UV radiation into visible light. (MBF/U) CCT = 3300K, Ra = 52 (Comfort version)</p> <p>More than 50% radiation below 500nm</p> <p>Some MBF/U still exists in some National Parks</p>
<p>Spectral power distribution</p>	<p>High pressure sodium (SON/T plus) CCT = 2000⁰ K, Ra = 22 to 25</p> <p>25% radiation below 500nm but no radiation in UV range</p> <p>“White SON” CCT = 2500K, Ra = 83</p>
<p>Spectral power distribution</p>	<p>Spectral power distribution</p>
<p>Metal halide warm white CCT= 3300K, Ra = 52</p> <p>Less than 25% radiation below 500nm</p>	<p>Metal halide cool white CCT= 4000K, Ra = 65</p> <p>About 50% radiation below 500nm</p>

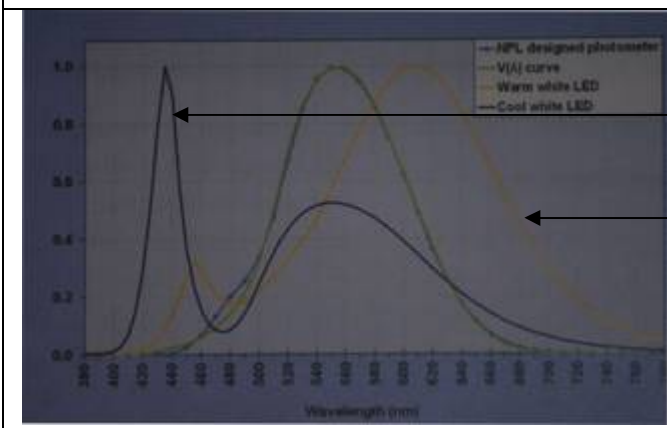


CDM-T warm white CCT = 3000K, Ra = 85
About 30% radiation below 500nm

CDM-T cool white CCT = 4200K, Ra = 96
About 50% radiation below 500nm



Low pressure mercury (compact fluorescent) (CFL)
Wide range of colour effects in tri-phosphor - Warm white, cool white, north light and many others



Warm White about 3,200K
Neutral White about 4,500K
Cool White about 6,000K

LED Recent Research by Dr Paul Miller NPL

Cool White Spectral Distribution 6,000K - black curve

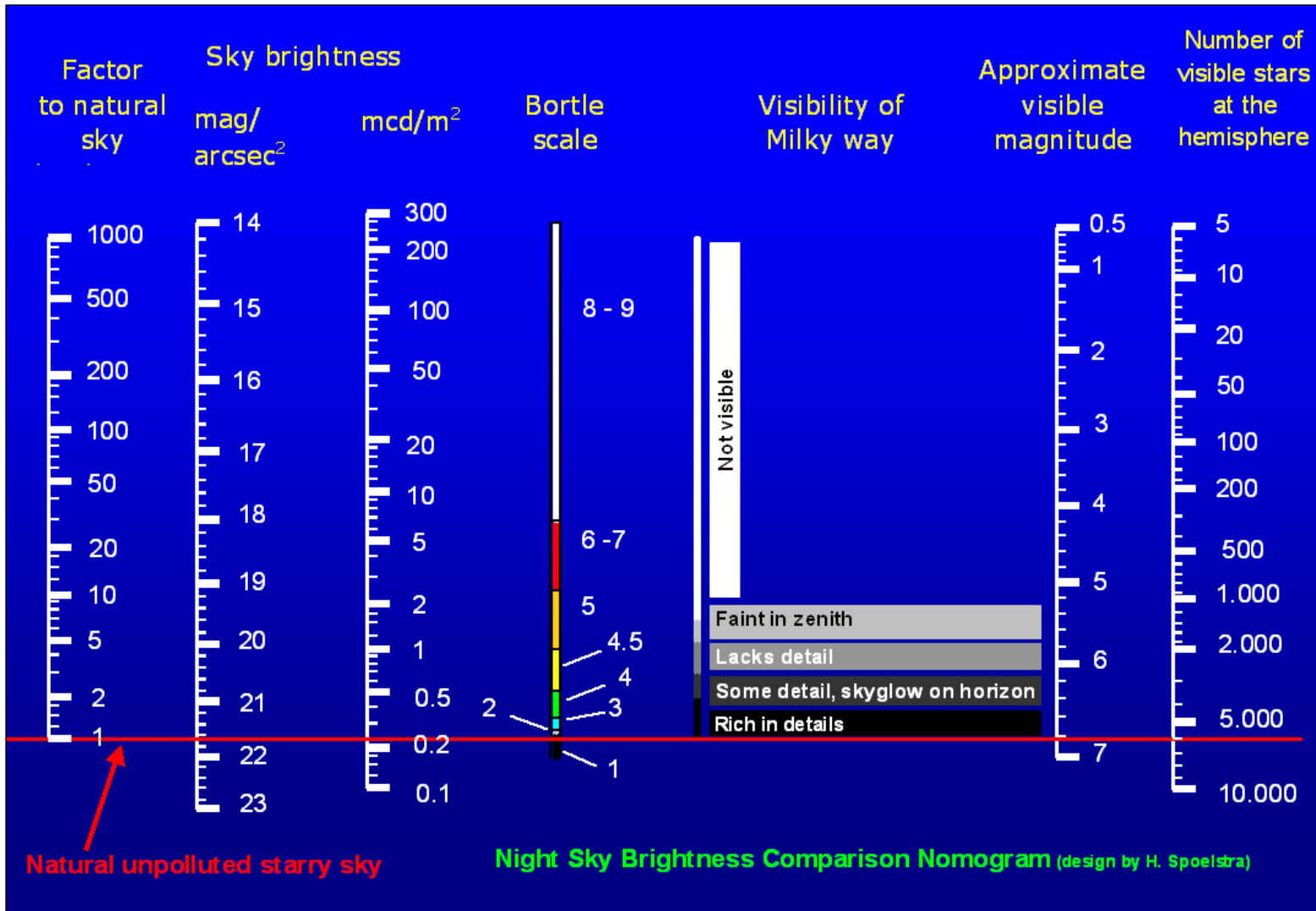
Warm White Spectral Distribution 3,200K - yellow curve

3 colour temperatures available

LMP Note: September'13 Data Use Warm or Neutral White in residential side streets, conservation areas and in IDA Dark Sky areas.

Exclude the use of Cool White in IDA Dark Sky Places

Appendix B – Sky Brightness Nomogram (by kind permission of Heck Spoelstra)






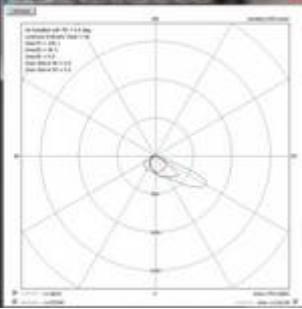

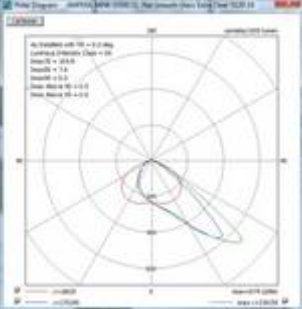
Appendix C
Domestic External Lighting Units
Suitable for exacting needs of Core Zone / E0-50 / E0-250 Retro-fits




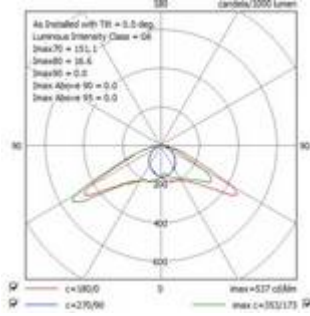


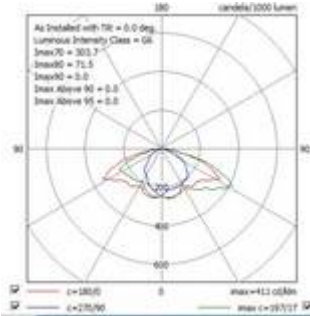
		
Deltalight Dox	Deltalight Mono	Deltalight Visionair
		contact Deltalight 94 Webber Street London SE1 0ON www.deltalight.co.uk
Deltalight Nox	Deltalight Lookout	
		
Norlys Halden Also in - Konst Smide	Norlys Koster A	Norlys Narvic

 <p>Norlys Asker</p>		<p>Norlys & Lutec see Elstead Lighting Elstead House Mill Lane Alton Hampshire GU34 2QJ</p> <p>www.elstead-lighting.co.uk</p>
 <p>liteCraft Stainless Steel Down-light</p>	 <p>liteCraft Dacu 40 watt & LED</p>	 <p>liteCraft Savona (shielded version)</p>
	<p>Unknown Maker</p>	<p>liteCraft Showroom Seaward Street Kinning Park Glasgow G41 1HJ</p> <p>www.liteCraft.co.uk</p>
	<p>Zumtobel - Bega 2489 Triangular Bulkhead 18w PLC 3000⁰K</p>	
	<p>B&Q</p>	


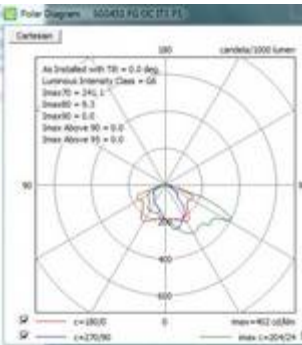
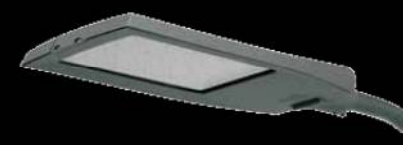
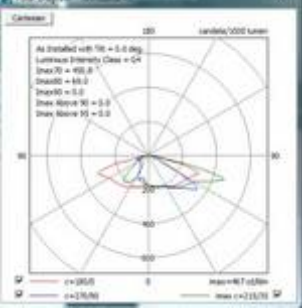
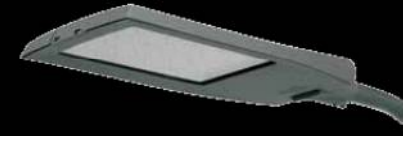
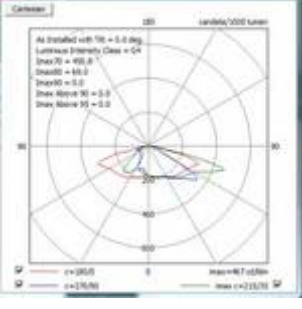
Appendix D



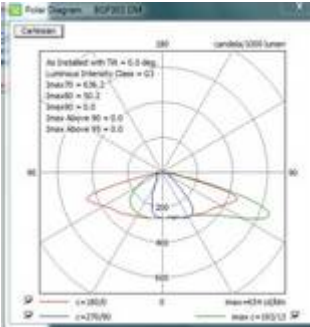

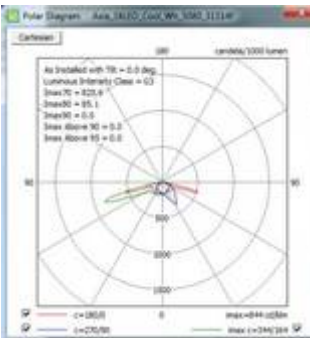

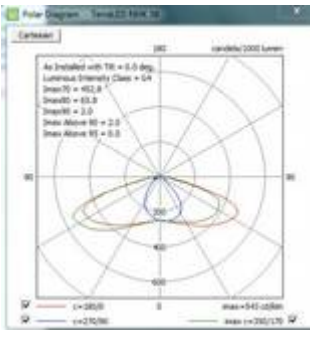
Luminaire Profile Examples for Environmental Zone E1 / E2-0%
with typical intensity distribution of light emerging near the horizontal axis


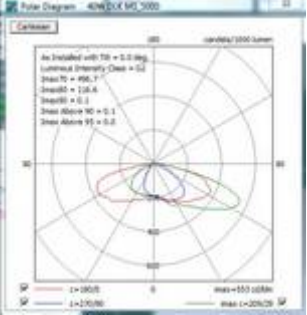




 <p>GE – ALE - 4000K LED</p> <p>Double ASY4/126/CCT/AT +4/139 +4/152 +4/165 +4/178 +4/190</p>	 <p>Also Double SS5/101/CCT/AT +5/126 +5/152 +5/178 +5/202 Single ASY4/50/CCT/AT +4/63 +4/76 +4/89 + 4/101</p>	<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/ klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>12.8</td> </tr> <tr> <td>70°</td> <td>334.5</td> </tr> </tbody> </table> <p>✓</p> <p>G6 compliant</p> <p>Warning No 5,700K LEDs in dark sky places</p>	I max	Cd/ klm	Above 95°	0	Above 90°	0	90°	0	80°	12.8	70°	334.5
I max	Cd/ klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	12.8													
70°	334.5													
 <p>Thorn R2L2 LED Neutral White Large, Medium and Small versions have G6 options</p>		<p>108 luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/ klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>40.5</td> </tr> <tr> <td>70°</td> <td>336.1</td> </tr> </tbody> </table> <p>✓</p> <p>G6 compliant</p>	I max	Cd/ klm	Above 95°	0	Above 90°	0	90°	0	80°	40.5	70°	336.1
I max	Cd/ klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	40.5													
70°	336.1													
 <p>Urbis Ampera</p> <p>Mini 335672 8-24 LED = G6</p> <p>Midi 336052 32-64 LED = G6 + Midi Zebra</p> <p>Maxi 341042 80-128 LED= G6 + Maxi Zebra</p>		<p>24 luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/ klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>7.6</td> </tr> <tr> <td>70°</td> <td>104.8</td> </tr> </tbody> </table> <p>✓</p> <p>G6 compliant</p>	I max	Cd/ klm	Above 95°	0	Above 90°	0	90°	0	80°	7.6	70°	104.8
I max	Cd/ klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	7.6													
70°	104.8													

 <p>Urbis Teceo 1 Flat Glass 5120 16-48 LED</p> <p>Neutral White</p>	 <p>Also Teceo 2 Flat Glass 5120 56-114 LED in Neutral White = G6</p>	<p>48 luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>15.7</td> </tr> <tr> <td>70°</td> <td>113.2</td> </tr> </tbody> </table> <p>G6 compliant</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	15.7	70°	113.2
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	15.7													
70°	113.2													
 <p>WE-EF RFL530 TW/E (on IDA approved list + VFL + PFL and RFS) 45w Cosmo</p>	 	<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>16.6</td> </tr> <tr> <td>70°</td> <td>151</td> </tr> </tbody> </table> <p>45w = G6 compliant</p> <p>I-tables no longer in Lighting Reality update</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	16.6	70°	151
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	16.6													
70°	151													
 <p>Phosco P850 200 mA LED</p>		<p>237w luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>35.4</td> </tr> <tr> <td>70°</td> <td>349.6</td> </tr> </tbody> </table> <p>87w-237w G6 compliant Neutral white LED</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	35.4	70°	349.6
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	35.4													
70°	349.6													
<p>Phosco P851 -12-M-STD-G6 range LED</p> <p>31w-145w G6 compliant Neutral white LED</p>		<p>145w luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>21.7</td> </tr> <tr> <td>70°</td> <td>256.4</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	21.7	70°	256.4
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	21.7													
70°	256.4													





<p>Phosco P852 -12-M-STD-NW-B range LED</p> <p>No G6 luminaires in this range Not recommended in Dark Sky Place</p>		<p>39w luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>61.8</td> </tr> <tr> <td>70°</td> <td>488.2</td> </tr> </tbody> </table> <p>14w-39w G4 compliant Neutral white LED</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	61.8	70°	488.2
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	61.8													
70°	488.2													
 <p>Urbis Neos Flat Glass 5121 16-24 LED Neutral White</p>		<p>24 luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>9.1</td> </tr> <tr> <td>70°</td> <td>330.3</td> </tr> </tbody> </table> <p>G6 compliant</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	9.1	70°	330.3
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	9.1													
70°	330.3													
 	<p>Light Emitting Diodes Flat Glass</p> <p>Ruud / CU Phosco Ledway Road 30 x LED's @ 3000°K or 50 x LED's @ 4000°K Caution 6000°K also available</p>	<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>71</td> </tr> <tr> <td>70°</td> <td>287</td> </tr> </tbody> </table> <p>G6 compliant</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	71	70°	287
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	71													
70°	287													
 	<p>453 CityLiter</p> <p>26w PII and 35w CDM</p>	<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>8</td> </tr> <tr> <td>70°</td> <td>84</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	8	70°	84
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	8													
70°	84													




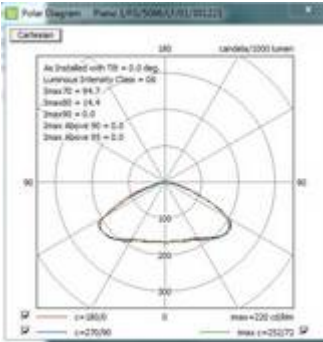
 <p>Philips - Mini Iridium 45w Cosmopolis Warning:- Pole Top mounting elevates lantern 10°. Must be side entry on 0° bracket</p> <p>No BGS451 LEDs are G6 Typical G3 but G6 @ 90 and above</p> <p>BGP352 range includes G6 mixed in with G3 and G4 variations</p>		<p>SGS451 FG luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>10</td> </tr> <tr> <td>70°</td> <td>246</td> </tr> </tbody> </table> <p>45w = G6 compliant At 5° tilt output = G5</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	10	70°	246
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	10													
70°	246													
 <p>Philips/WRTL - Mini Luma R6 Optic</p> <p>Note I₇₀ maximum for G6 = 350 cd/1000 lm</p>		<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>71</td> </tr> <tr> <td>70°</td> <td>384</td> </tr> </tbody> </table> <p>Typically G4 but G6 at 80 and above</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	71	70°	384
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	71													
70°	384													
 <p>Philips/WRTL - Mini Luma R5 optic</p>		<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>69</td> </tr> <tr> <td>70°</td> <td>451</td> </tr> </tbody> </table> <p>Typically G4 but G6 at 80 and above</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	69	70°	451
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	69													
70°	451													

 <p>G4 optic (warning also G2 version)</p>	<p>Light Emitting Diodes Flat Glass</p> <p>Urbis Remus 16, 24, 32 or 48 LED's</p> <p>3500⁰K or 4250⁰ K</p> <p>Caution 6000⁰K also available</p>	<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>89</td> </tr> <tr> <td>70°</td> <td>447</td> </tr> </tbody> </table> <p>Typically G4 but G6 at 80 and above</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	89	70°	447
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	89													
70°	447													
 <p>Philips Clearway LED 23/740</p> <p>Note I₇₀ maximum for G4 = 500 cd/1000 lm</p>		<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>50</td> </tr> <tr> <td>70°</td> <td>636</td> </tr> </tbody> </table> <p>Typically G3 but G6 at 80 and above</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	50	70°	636
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	50													
70°	636													
 <p>Urbis - Axia 3500⁰K or 4250⁰ K 16, 24, 32 or 48 LED's</p> <p>No true G6 in range</p>		<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>85</td> </tr> <tr> <td>70°</td> <td>825</td> </tr> </tbody> </table> <p>Typically G3 but G6 at 80 and above</p>	I max	Cd/klm	Above 95°	0	Above 90°	0	90°	0	80°	85	70°	825
I max	Cd/klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	85													
70°	825													
 <p>OrangeTEC TerraLED</p>		<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>2</td> </tr> <tr> <td>90°</td> <td>2</td> </tr> <tr> <td>80°</td> <td>65.8</td> </tr> <tr> <td>70°</td> <td>452.8</td> </tr> </tbody> </table> <p>G4 Compliant</p>	I max	Cd/klm	Above 95°	0	Above 90°	2	90°	2	80°	65.8	70°	452.8
I max	Cd/klm													
Above 95°	0													
Above 90°	2													
90°	2													
80°	65.8													
70°	452.8													

<p>OrangeTEC</p>  <p>Aria</p>		<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95⁰</td> <td>0</td> </tr> <tr> <td>Above 90⁰</td> <td>0.1</td> </tr> <tr> <td>90⁰</td> <td>0.1</td> </tr> <tr> <td>80⁰</td> <td>116</td> </tr> <tr> <td>70⁰</td> <td>496</td> </tr> </tbody> </table> <p>G2 Compliant</p>	I max	Cd/klm	Above 95 ⁰	0	Above 90 ⁰	0.1	90 ⁰	0.1	80 ⁰	116	70 ⁰	496
I max	Cd/klm													
Above 95 ⁰	0													
Above 90 ⁰	0.1													
90 ⁰	0.1													
80 ⁰	116													
70 ⁰	496													
	<p>Thorn Lighting Plazora Wall Light 26w TC-D fluorescent</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95⁰</td> <td>0</td> </tr> <tr> <td>Above 90⁰</td> <td>0</td> </tr> <tr> <td>90⁰</td> <td>0</td> </tr> <tr> <td>80⁰</td> <td>8</td> </tr> <tr> <td>70⁰</td> <td>50</td> </tr> </tbody> </table> <p>√</p>	I max	Cd/klm	Above 95 ⁰	0	Above 90 ⁰	0	90 ⁰	0	80 ⁰	8	70 ⁰	50
I max	Cd/klm													
Above 95 ⁰	0													
Above 90 ⁰	0													
90 ⁰	0													
80 ⁰	8													
70 ⁰	50													
	<p>And others (white paint on louvers reflects upward light)</p> <p>Up to 8% ULR and not suitable in Dark Sky Places</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95⁰</td> <td>1</td> </tr> <tr> <td>Above 90⁰</td> <td>7</td> </tr> <tr> <td>90⁰</td> <td>7</td> </tr> <tr> <td>80⁰</td> <td>22</td> </tr> <tr> <td>70⁰</td> <td>35</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95 ⁰	1	Above 90 ⁰	7	90 ⁰	7	80 ⁰	22	70 ⁰	35
I max	Cd/klm													
Above 95 ⁰	1													
Above 90 ⁰	7													
90 ⁰	7													
80 ⁰	22													
70 ⁰	35													
 <p>0% ULR</p>	<p>Thorlux Probe 57w TC-T Compact fluorescent 4,300 lumens 7-10 days delivery Glare control = G3</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95⁰</td> <td>0.2</td> </tr> <tr> <td>Above 90⁰</td> <td>0.4</td> </tr> <tr> <td>90⁰</td> <td>0.4</td> </tr> <tr> <td>80⁰</td> <td>8.1</td> </tr> <tr> <td>70⁰</td> <td>11.5</td> </tr> </tbody> </table> <p><i>Almost G6</i> 0% ULR</p>	I max	Cd/klm	Above 95 ⁰	0.2	Above 90 ⁰	0.4	90 ⁰	0.4	80 ⁰	8.1	70 ⁰	11.5
I max	Cd/klm													
Above 95 ⁰	0.2													
Above 90 ⁰	0.4													
90 ⁰	0.4													
80 ⁰	8.1													
70 ⁰	11.5													
	<p>Urbis Isla 35watt CDM or 42watt CFL G6 optic (warning G2 optic also available)</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95⁰</td> <td>0</td> </tr> <tr> <td>Above 90⁰</td> <td>0</td> </tr> <tr> <td>90⁰</td> <td>0</td> </tr> <tr> <td>80⁰</td> <td>31</td> </tr> <tr> <td>70⁰</td> <td>274</td> </tr> </tbody> </table> <p>√</p>	I max	Cd/klm	Above 95 ⁰	0	Above 90 ⁰	0	90 ⁰	0	80 ⁰	31	70 ⁰	274
I max	Cd/klm													
Above 95 ⁰	0													
Above 90 ⁰	0													
90 ⁰	0													
80 ⁰	31													
70 ⁰	274													

The following examples do not fully comply with zero intensity at and above the horizontal but have been selected from many others as being the closest to “Fully Shielded” conditions and need to be located near other natural shields like buildings or trees.

	<p>G1/96 Philips Fortino optic</p> <p>45w LED unit</p> <p>Vertical lamps and refractors are not compliant with G6 or E1 objectives.</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0.3</td> </tr> <tr> <td>90°</td> <td>0.3</td> </tr> <tr> <td>80°</td> <td>33</td> </tr> <tr> <td>70°</td> <td>93</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95°	0	Above 90°	0.3	90°	0.3	80°	33	70°	93
I max	Cd/klm													
Above 95°	0													
Above 90°	0.3													
90°	0.3													
80°	33													
70°	93													
	<p>Sugg Rochester and Tunbridge</p> <p>50watt SON/T = G4 compliant with cgp stb optic</p> <p>80w MBF/U = G5 compliant with cgp stb optic</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>8</td> </tr> <tr> <td>90°</td> <td>8</td> </tr> <tr> <td>80°</td> <td>78</td> </tr> <tr> <td>70°</td> <td>480</td> </tr> </tbody> </table> <p>$U_h = 0.0$ $U_l = 0.2$ total ULOR = 2%</p>	I max	Cd/klm	Above 95°	0	Above 90°	8	90°	8	80°	78	70°	480
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Above 90°	8													
90°	8													
80°	78													
70°	480													
	<p>Sugg Lighting</p> <p>Large Grosvenor</p> <p>50w SON/T</p> <p>Optic and lamp located in lantern top section to act as “fully shielded” but as in all heritage equipment the glass refracts some light upwards</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>17</td> </tr> <tr> <td>90°</td> <td>17</td> </tr> <tr> <td>80°</td> <td>83</td> </tr> <tr> <td>70°</td> <td>206</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95°	0	Above 90°	17	90°	17	80°	83	70°	206
I max	Cd/klm													
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Above 90°	17													
90°	17													
80°	83													
70°	206													
	<p>Urbis St. Giles</p> <p>50watt SON/T</p> <p>G3 compliant with SGS Clear P/1200/095/-38.5/911381</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>10</td> </tr> <tr> <td>Above 90°</td> <td>7.7</td> </tr> <tr> <td>90°</td> <td>7.7</td> </tr> <tr> <td>80°</td> <td>23</td> </tr> <tr> <td>70°</td> <td>148</td> </tr> </tbody> </table>	I max	Cd/klm	Above 95°	10	Above 90°	7.7	90°	7.7	80°	23	70°	148
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80°														
70°														
	<p>DW Windsor Garda LED Hand Rail</p>	<table border="1"> <thead> <tr> <th>I max</th> <th>Cd/ klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>4</td> </tr> <tr> <td>Above 90°</td> <td>10</td> </tr> <tr> <td>90°</td> <td>10</td> </tr> <tr> <td>80°</td> <td>66</td> </tr> <tr> <td>70°</td> <td>165</td> </tr> </tbody> </table>	I max	Cd/ klm	Above 95°	4	Above 90°	10	90°	10	80°	66	70°	165
I max	Cd/ klm													
Above 95°	4													
Above 90°	10													
90°	10													
80°	66													
70°	165													
	<p>Emergency Exit Lighting Unit (mounted horizontally not as illustration) Raylux 25 8 x LED's and complete with wall mounting bracket Unit to be mounted pointing down for G6 compliance</p>	<p>Currently undergoing photometric tests to prove zero intensity at and above horizontal</p>												
 <p>Urbis Piano 1 No longer available ? 3200K Caution 6000°K also available but not approved in dark sky place</p>		<p>luminaire elevated 0°</p> <table border="1"> <thead> <tr> <th>I max</th> <th>Cd/ klm</th> </tr> </thead> <tbody> <tr> <td>Above 95°</td> <td>0</td> </tr> <tr> <td>Above 90°</td> <td>0</td> </tr> <tr> <td>90°</td> <td>0</td> </tr> <tr> <td>80°</td> <td>14</td> </tr> <tr> <td>70°</td> <td>95</td> </tr> </tbody> </table> <p>G6 compliant</p>	I max	Cd/ klm	Above 95°	0	Above 90°	0	90°	0	80°	14	70°	95
I max	Cd/ klm													
Above 95°	0													
Above 90°	0													
90°	0													
80°	14													
70°	95													

rayLUX 25

DIRECTIONAL WHITE-LIGHT

High Performance White-Light LED illuminators provide class leading performance, long life, energy efficiency and zero maintenance. They incorporate the very latest surface mount LED's to deliver excellent optical output and outstanding reliability, providing even illumination and excellent night time images for surveillance cameras and general area lighting.

The RAYLUX 25 provides a world class 'White-Light' output of 110lm/W at the LED source, and an independently tested luminaire output of 800 lm at 15lm/w.

Each unit is fitted with Active LED Life Control to carefully control LED output, delivering consistent illumination power and a projected working life of 10 years.

RAYLUX illuminators are supplied with bracket and power supply. Control features on the power supply include adjustable power output, photocell and telemetry control. RAYLUX 25 is designed for low light installations up to 20m (66ft).

RAYLUX 25 is also available with low voltage PSU.



POWERFUL

- Quick Start
- **PLATINUM** LED technology
- High Power - Low Running Costs

FLEXIBLE

- Various Angles (30, 50 or 120°)
- Fully Controllable Power Supply
- Optional Low Voltage PSU

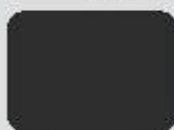
RELIABLE

- 10 year life
- Active LED Life Control
- Vandal resistant

CONTROLLED

- Excellent Colour Rendition
- Even Output Illumination
- Low Running Costs

WHITE-LIGHT IN USE:



White-Light off



White-Light on

Version 3.2

APPLICATIONS



rayTEC[®]

General Domestic Lighting Equipment Profiles

Through this leaflet we hope to provide you with examples of well designed equipment which you may wish to consider when purchasing new lighting units. The leaflet also contains examples of poor design relative to the exacting demands of light control within Dark Sky Places.

Unless otherwise noted the equipment illustrated is available from local DIY Stores.



Good – Reflector shaped to direct light down. Boxed as dark sky friendly and has PIR sensor separate from the lamp unit pointing. For rural setting look for unit with a 150 watt lamp or less. Also provides reduced illumination dusk to dawn for courtesy and full power on presence detection.



Poor – Lamp reflector and PIR detector point in same elevation and rotational direction. 300 / 500 watts Tungsten Halogen lamps provide too much light for use in rural settings.



Good – Can direct light in 2 directions and lamps are less than 100 watts. Limit elevation angle to less than 45 degrees. Various other similar styles with integral PIR detector on mounting. 60w capsule with dimming for courtesy or LED lamps



Good – (above and below) 70w or 150w metal halide lamp. Must be installed with glass window **horizontal – and not as illustrated**. When the lamp is located at the bottom of the reflector the main beam will emerge from the glass window at about 45 degrees. Known technically as a double asymmetric light distribution.



APPENDIX E



Very Good – (SILL 453 CityLiter) Designed to be mounted horizontally and available in a range of low wattage lamps. Luminaire has IDA Dark Sky Friendly Fixture Award. Fluorescent range + 35/70w metal halide



Poor – Low wattage light source but projects light upwards when mounted as shown and needs to be near horizontal to limit sky glow. **(Bracket does not allow horizontal fixing)**
18 watt PL-C = 1,200 lm



Poor – No light control



Fair – Upward light limited but lamp must be less than 600 lm.



Poor – No light control



Good – Porch light with downward light



Poor – Bollard with no light control and produces glare



Good – External louvers limit upward light and reduces glare. Lamp must be less than 600 lm

The output of lamps will shortly be valued in lumens rather than watts as at present. The table below provides interim user guidance when comparing lamp watts and lumens.







Lamp type & Watts	Lamp Lumens (lm)
Clear Bulb GLS 60w	710
Candle Lamp clear 60w	660
Candle Lamp LED 45w	710
Superlux Krypton 40w	455
Halogen energy saver 42w	625
Halogen linear 60w	840
12v Tungsten Halogen 42w	624
T2 linear fluorescent 8w	540
T8 linear fluorescent 10w	650
Compact Fluorescent Elegance globe 11w	610
Elegance candle 9w	405
Elegance spiral 9w	450
2D compact fluorescent 10w	650
3 loop compact fluor't 13w	900
1 loop compact fluor't 11w	900
LED Opal globe 15w	664




In order to protect the dark night sky it is proposed to limit the lamp output on existing poor or no light-controlled luminaires to **600** lumens in dark sky parks and reserves with **3,000** lumens in dark sky communities.

<i>Illustration</i>	<i>Lamp Name</i>	<i>Lamp Type</i>	<i>Nominal Watts</i>	<i>Output Lumens</i>
	Standard, clear bulb	Incandescent GLS	15 w 25 w 40 w 60 w 100 w	90 220 420 710 1,330
	Standard, pearl frosted bulb	Incandescent GLS	15 w 25 w 40 w 60 w 100 w	90 220 415 700 935
	LED equivalent in Edison Screw or Bayonet Cap	2,700 K Colour temperature	6.5 w 9.5 w 13 w 16 w	470 806 1,055 1,300
	Halolux Halogen energy saver in Edison Screw or Bayonet Cap	Incandescent Tungsten Halogen	28 w 42 w 45 w 52 w 70 w	370 625 710 835 1,180
	Candle, clear bulb	Incandescent Tungsten	25 w 40 w 60 w	220 400 660
	Candle, opal bulb	Incandescent Tungsten	25 w 40 w 60 w	190 390 640
	Twisted Candle, clear bulb	Incandescent Tungsten	15 w 25 w 40 w 60 w	90 200 400 660

<i>Illustration</i>	<i>Lamp Name</i>	<i>Lamp Type</i>	<i>Nominal Watts</i>	<i>Output Lumens</i>
	Twisted Candle, opal bulb	Incandescent Tungsten LED equivalent	15 w 25 w 40 w 60 w 3 w	90 200 400 660 245
	GE Candle Lamp (B&Q)	Incandescent Tungsten Incandescent Tungsten Halogen	18 w 30 w 45 w 18 w 28 w 42 w	170 415 710 205 370 625
	Round, clear bulb	Incandescent Tungsten	25 w 40 w 60 w	200 400 660
	Round, opal bulb	Incandescent Tungsten	25 w 40 w 60 w	200 400 660
	Superlux Krypton mushroom, opal Standard	Incandescent Tungsten	25 w 40 w 60 w 75 w	240 455 760 1,000
	Superlux Krypton mushroom, opal And burning position		25 w 40 w 60 w	160 300 530
	Haloline linear	Incandescent Tungsten Halogen	60 w 80 w 100 w 120 w 130 w 230 w	840 1,380 1,900 2,216 2,440 4,650

<i>Illustration</i>	<i>Lamp Name</i>	<i>Lamp Type</i>	<i>Nominal Watts</i>	<i>Output Lumens</i>
	Halostar 12V	Incandescent Tungsten Halogen	G4 10w G4 14w G4 20w G4 25w G9 25w G9 18w G9 28w G9 30w G9 42w G9 45w	100 215 240 470 255 204 370 415 624 710
	LED Parathom clear globe	Solid State Light Emitting Diode	1.6 w 2 w 3 w	70 100 165
	Master LED opal globe	Solid State Light Emitting Diode	6 w 7.5 w 12 w	337 470 650
	Master LED reflector	Solid State Light Emitting Diode	4 w 7 w GU10 4w	110 230 200
	Lumilux T2 tubular	Discharge Linear Fluorescent T5 Tubular T8 Tubular	6 w 8 w 11 w 13 w 4 w 6 w 8 w 13 w 10 w 15 w	330 540 750 940 130 270 385 830 650 950

<i>Illustration</i>	<i>Lamp Name</i>	<i>Lamp Type</i>	<i>Nominal Watts</i>	<i>Output Lumens</i>
	Biax Extra Mini	Discharge Compact Fluorescent	9 w 11 w 15 w	480 600 900
	Elegance Globe	Discharge Compact Fluorescent	7 w 9 w 11 w 15 w 20 w	286 405 610 830 1,152
	DIALL Globe (B&Q)	Discharge Compact Fluorescent	13 w 15 w 23 w 30 w	664 820 1,400
	Elegance Candle	LED Discharge Compact Fluorescent	3 w 5 w 7 w 9 w	245 200 286 405
	Spiral	Discharge Compact Fluorescent	9 w 13 w 15 w 20 w 23 w 35 w	450 741 970 1,230 1,450 2,285
	2D Square	Discharge Compact Fluorescent	16/14 w 21/19 w 28 w 38/34 w	1,100 1,375 2,150 3,020
	Circular	Discharge Compact Fluorescent	22 w 32 w 40 w	1,000 2,250 3,100

<i>Illustration</i>	<i>Lamp Name</i>	<i>Lamp Type</i>	<i>Nominal Watts</i>	<i>Output Lumens</i>
	Biax S/E	Discharge Compact Fluorescent	5W	265
			7W	425
			9W	600
			11W	900
	Biax D	Discharge Compact Fluorescent	10W	600
			11W	610
			13w	900
	Biax T	Discharge Compact Fluorescent	13W	900
			15W	845
			18/20W	1,200
			42W	3,200

Appendix G Property Self-Audit Guidelines – The Next Step for Improvement

Of particular interest in the lighting audit was the high percentage of security style floodlights, many of them with the glass almost vertical. The application for a dark sky status would benefit greatly if more “security” style floodlights were tilted down, preferably horizontal.

Are you ready to help improve the dark night time sky conditions ?????

If so survey your property externally (all buildings and any free-standing lighting eg. on poles in exercise yards or ménage areas)

Tungsten Halogen Floodlights



Preferred Step

Replace with new fitting having good light control & meeting the Lighting Management Plan requirements

or **Option 1**

Tilt down until glass is horizontal and thereby meeting the requirements of a “fully shielded” luminaire.

Reduce lamp size if possible (500watts to 300watts or 150watts to 100watts).

or **Option 2**

Tilt down as far as fitting allows (integral sensor units sometimes limits the downward angle).

Fabricate shielding from aluminium or similar material and fix securely in place.

Ensure that shielding as fixed, allows no light at or above the horizontal axis.

Reduce lamp size if possible.

Remember:-

**SWITCH OFF - AFTER YOUR WORK IS FINISHED
NO TASK – NO LIGHTING**

For all other fittings which are **not “fully shielded” or “fully cut-off”**, consider implementing changes or upgrades as follows:-

1) No or very minimal Light Control



Preferred

Measure the building footprint and consider replacing these types of light unit with new fitting(s) having good light control, preferably “fully cut-off” like the examples on the following page and thereby meeting the Lighting Master Plan (LMP) requirements.

Try not to exceed the total lumen limit in the table below for your size of property.

	Environmental Zone				
	E0-50 / E0-250 and E1		E2	E3***	E4***
Total Lumens for domestic Exterior Lighting	750 lm plus 4.5 lm / m ² of site structures*		2250 lm plus 4.5 lm / m ² of site structures*	4500 lm plus 4.5 lm / m ² of site structures*	6000 lm plus 4.5 lm / m ² of site structures*
Fully cut-off luminaires each lamp lumen maximum	1200 lm		1650 lm	2400 lm	3200 lm
Part cut-off luminaires each lamp lumen maximum	E0's none	E1 750 lm	1200 lm	1650 lm	2400 lm
No light control luminaires each lamp lumen maximum	E0's none	E1 480 lm**	750 lm**	750 lm	750 lm

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Table - Total lumen limit and individual lamp lumen limit per property

* Site structures is the sum of the land area of residential buildings, habitable structures, garages, recreational buildings and storage structures on each property plot.

***** Environmental zones E3 and E4 exist but do not relate to any conditions in National Scenic Areas, Regional Scenic Areas, National Parks, Starlight Reserves or Dark Sky Communities.**

A full list of domestic lamp types, their wattage and their lumen outputs are shown in the previous appendix as reference data. However, lamp manufacturers are continually improving lamp efficiency and some lamp lumen outputs may change through time.

		
Fully cut-off example	Fully cut-off example	Fully cut-off example
		
Only part shielded so limit lamp size as per table 3.1	Only part shielded so limit lamp size as per table 3.1	Only part shielded so limit lamp size as per table 3.1

or **Option 1**

Shield to fully comply with LMP requirements.

Fabricate shielding from aluminium or similar material and fix securely in place.

Ensure shielding as fixed, allows no light at or above the horizontal axis.

or **Option 2**

If high power lamp, replace lamp with one having less than 1000 lumen output (see tables in Appendix).

Consider shielding as well.

2) Partly Cut-off Fittings



Keep luminaire tilted down to lowest limit

Preferred

Adjust tilt angle down to meet LMP requirements.

or **Option 1**

Tilt down if adjustable and

Provide additional shielding to comply with LMP requirements.

Fabricate shielding or cowl from aluminium or similar material and fix securely in place.

Ensure that shielding / cowl as fixed, allows no light at or above the horizontal axis.

or **Option 2**

Consider replacing with new fitting having improved light control & meeting LMP requirements

or **Option 3**

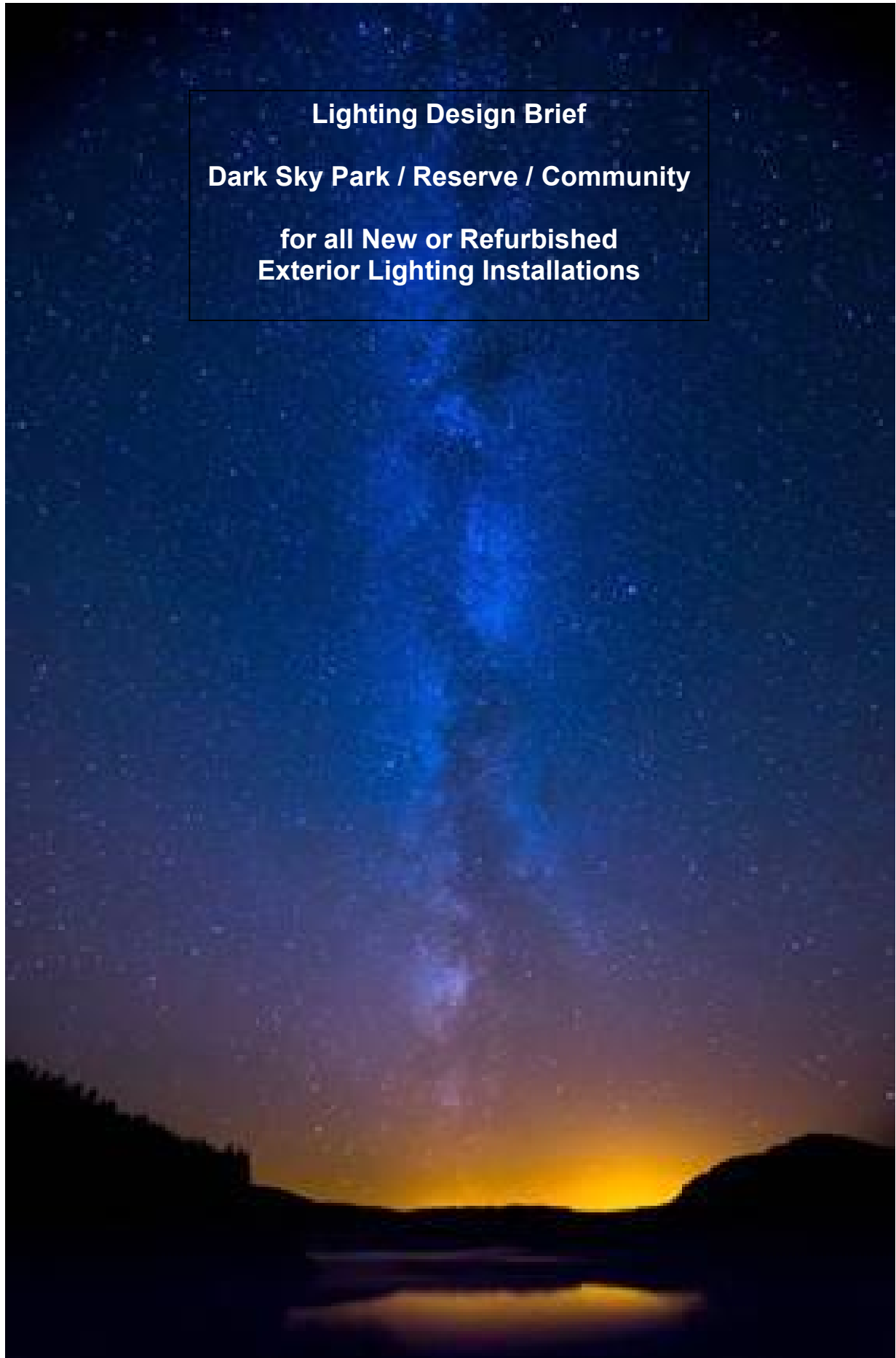
If high power lamp, replace lamp with one having less than 1000 lumen output (see tables in Appendix)

Consider tilt reduction as well, if possible.

Consider shielding as well.

For all external lighting:-

- Check switching times are sensible / consider time limitation as appropriate.
- PIR detectors are properly aimed to avoid nuisance switching.
- Consider installing a push button switch with short time delay facility.



Lighting Design Brief
Dark Sky Park / Reserve / Community
for all New or Refurbished
Exterior Lighting Installations

Design Brief for External Lighting Design Planning Proposals

Forward - Controlling "Light Obtrusion"

The purpose of this Special Guidance Note is to provide a lighting design brief to mitigate the effects of stray and obtrusive light, often incorrectly referred to as 'light pollution', from all exterior lighting whether it is intended for domestic, public or commercial use. This document uses the words '**light obtrusion**' to include the outward and upward transmission of wasted light into the night sky unless referig to earlier documents produced by others.

The anti-social effects of obtrusive light is not limited to the vision of the night sky and in March 2012 Her Majesty's Government introduced the control of 'light pollution' through planning procedures in their National Planning Policy Framework. Although the document applies to the English planning framework paragraph 125 could be equally applied across the UK and Europe as good planning practice. The paragraph states "**By encouraging good design, planning policies and decisions should limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.**"

In Scotland the importance of the attribute of a dark night sky environment has been highlighted in the Scottish Government's publication of the third National Planning Framework (NPF3). This is a framework for the special development of Scotland as a whole and sets out the Scottish Government's priorities over the next 20 - 30 years. The identification of Dark Sky Places as a "**distinctive attribute**" can be found in Section 4.22 of NPF3. (in the form of reference to Galloway Dark Sky Park since this was the only form of dark sky place, in Scotland, when the document was commissioned.)

On a worldwide base the International Dark Sky Association (IDA), in Arizona, created awards for the quality of sky darkness for three different "Places" namely, a "Park", a "Reserve" and a "Community" to suit three different types of inhabited areas. (for IDA definitions see www.darksky.org). Within Dumfries and Galloway Region there is a nationally unique potential of having both a "Park" and a "Community" within the same municipal boundary. Additionally the eastern boundary of the Region is only 8 miles from the Northumberland Dark Sky Park designated by the IDA in November 2013.

A Dark Sky Place is an area with exceptionally dark night skies, where there is a positive commitment to keeping the night sky dark by mitigating wasteful upward light, often generally referred to as "light pollution". The International Dark Sky Association awarded part of Galloway Forest a Gold Tier Dark Sky Award on 16 November 2009. This award highlights how clear the night environment is in the Park and gives international recognition to its unique qualities. It also represents a significant achievement and an exciting opportunity for South of Scotland in support of local tourism. (*The town of Moffat was granted IDA "Community" status five years later.*)

The management of all external lighting in an IDA designated Dark Sky Place is contained in a Lighting Master Plan (LMP) specifically written for each Dark Sky Place. From each LMP Dumfries & Galloway Council have produced an abbreviated planning control in the form of a Supplementary Planning Guidance note in support of protection to the Dark Sky Places within their boundary. This Lighting Design Brief provides all the supporting technical data relating to the design of lighting which is not contained within the generality of Supplementary Planning Guidance which provides the necessary planning regulation to maintain and enhance the South of Scotland dark sky attributes. This brief is also based on extracts from the LMP for Dumfries & Galloway Council upon which the design of all new or refurbished external lighting within the Region should be based.

Zone General:-

- E0's:** *No Light Source perception* - eg *Dark Sky Core*
- E1's:** *Intrinsically dark Areas* - eg *Dark Sky Buffer Zone, Area of Outstanding Natural Beauty and National Parks*
- E2's:** *Low district brightness* - eg *Dark Sky External Zone - or Dark Sky Community locations*
- E3 and E4 (in CIE150:2005) do not relate to conditions expected in or close to a Dark Sky designated award area**

For indicative map see page 3-5.

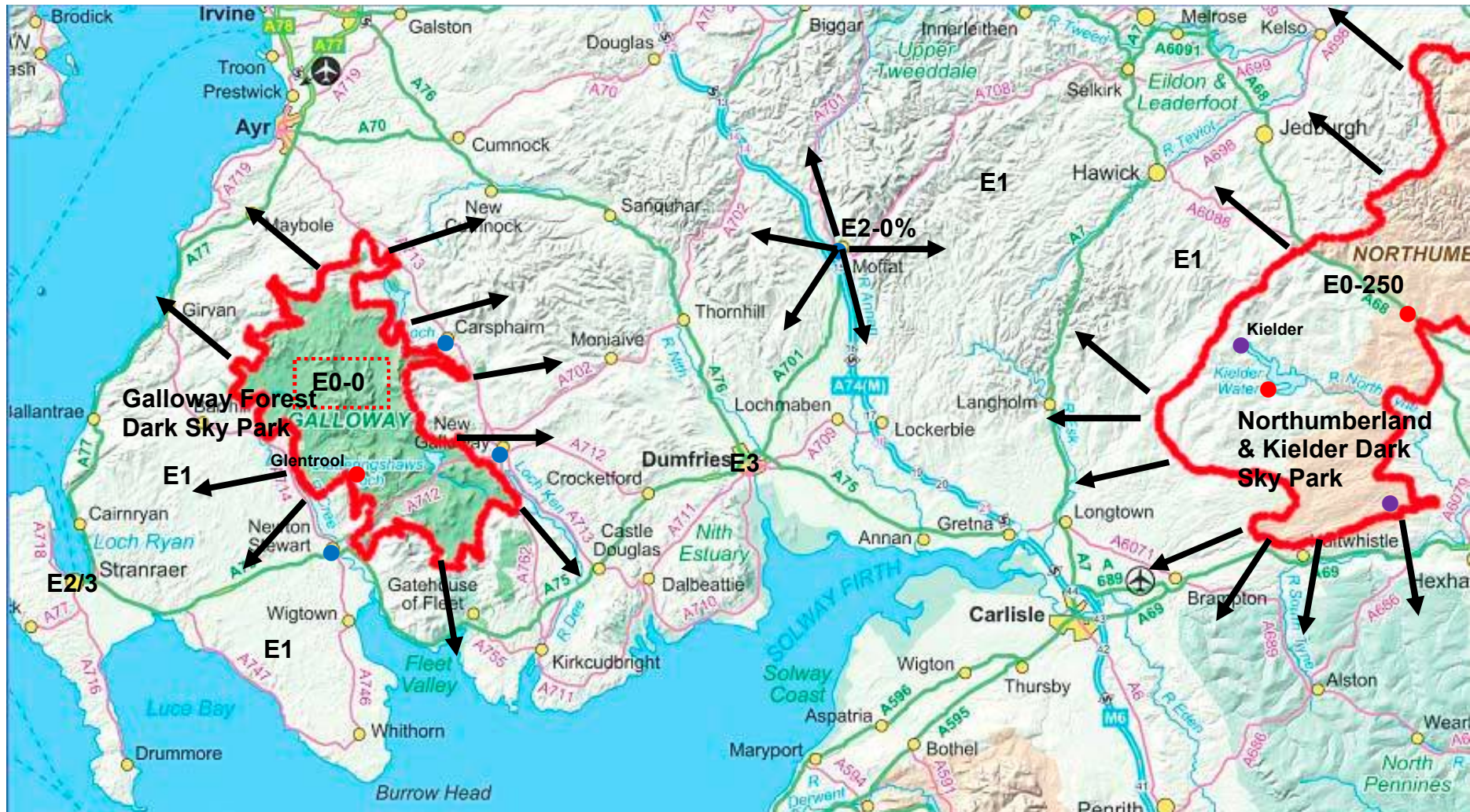
Zone Detail:-

- E0 Core** - A designated central area within the Dark Sky Place and sub-divided for lighting as follows:-
- E0-0** Un-inhabited Core (no light permitted) (Galloway Forest)
 - E0-50** Inhabited Rural Settlement groups in Park or Reserve
 - E0-250** Remote Rural Property in Park or Reserve
 - E0-SL** Street Lighting in Park or Reserve
- E1 Buffer Zone** - Majority of Place around the Core Zone if Core is designated and sub-divided as follows:-
- E1-CIE150** Generality of all rural parts of Dumfries & Galloway region including all small towns with new LED street lighting
 - E1 in E0** In Park where there is no Core designated (Northumberland)
- E2**
- E2-0%** Dark Sky Community eg Moffat
 - E2-1%** Community hub with CCTV
 - E2-2.5%**

Some parts of D&G may appear to be medium or high district brightness (E3 or E4) eg Dumfries, Stranraer, Annan or other town centres through earlier, more relaxed light control requirements. All new lighting design work should be aimed at **reducing** ambient brightness at every opportunity.

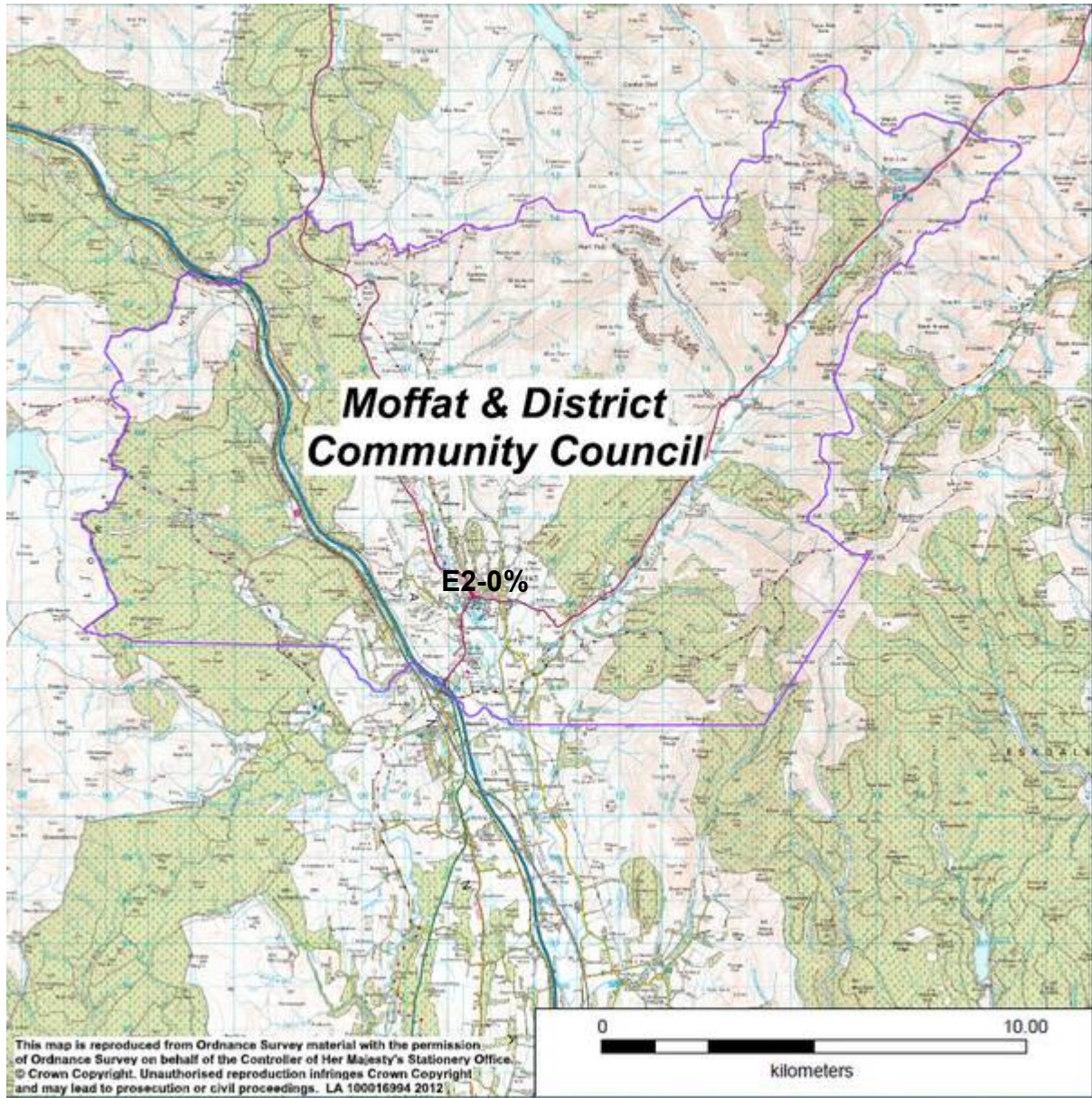
An upward light ratio of 0% should be the target throughout Dark Sky designated areas and generally throughout all the rural parts of the region but with a 1% relaxation in the central hub of Dark Sky Communities.

Environmental Zone E3 and E4 do not relate to any part within, or adjacent to, the dark sky place boundary and stray light limitations should be within the natural setting of the new development surrounds.



- new E0-50 Community in E0-250 area eg Rochester / Greenhaugh
- E1 Community in E0 area eg Kielder
- new E2-0% / E2-1% (eg Dark Sky Community)
- old E2-2.5% Low District Brightness
- ➔ 10 mile transition dark sky protection





Select lighting equipment and / or develop a lighting design, based on the following:-

Design Procedure Part 2A

For all domestic new build or refurbishment applications

Table A (3.3 in main document) - Permitted Total Lumen Limit for each residence

	Environmental Zone				
	E0	E1	E2	E3	E4
Total Lumens for domestic Exterior Lighting	750 lm plus 4.5 lm / m ² of site structures*	750 lm plus 4.5 lm / m ² of site structures*	2250 lm plus 4.5 lm / m ² of site structures*		
Fully cut-off luminaires each lamp lumen maximum	1200 lm	1200 lm	1650 lm		
Part cut-off luminaires each lamp lumen maximum	N/A	750 lm	1200 lm		
No light control luminaires each lamp lumen maximum	N/A	480 lm**	750 lm		



* Site structures is the sum of the land area of residential buildings, habitable structures, garages, recreational buildings and storage structures on each property plot.

** The maximum watts or lumens for each lamp in this section relates to replacing lamps in existing lighting units only.

No new luminaires with little or no light control are permitted.

Lamp lumens are now indicated on the packaging of lamps instead of wattage. Some lumen / wattage equivalents and a worked example is indicated in the main document.

Typical Domestic External Lighting Units
Suitable for exacting needs of Core Buffer Zone / E0-50 / E0-250 Retro-fits

		
Deltalight Dox	Deltalight Mono	Deltalight Visionair
		contact
Deltalight Nox	Deltalight Lookout	Deltalight 94 Webber Street London SE1 0ON www.deltalight.co.uk

 <p>Norlys Halden Also in - Konst Smide</p>	 <p>Norlys Koster A</p>	 <p>Norlys Asker see Elstead Lighting Elstead House Mill Lane, Alton, Hampshire GU34 2QJ</p>
 <p>liteCraft Stainless Steel Down-light</p>	 <p>liteCraft Dacu 40 watt & LED</p>	 <p>liteCraft Savona (shielded version)</p>
	 <p>Zumtobel - Bega 2489 Triangular Bulkhead</p>	<p>liteCraft Showroom Seaward Street Kinning Park Glasgow G41 1HJ www.liteCraft.co.uk</p>
 <p>First Light - Delta LED/ 5watt 455mm and 805mm post height</p>	 <p>First Light - York Wall Light</p>	 <p>Fusion First Light -Fusion</p>
 <p>LED Outdoor Wall L First Light - 6402</p>	 <p>First Light - Vegas</p>	<p>Contact First Light Products 22 Erica Road Stacey Bushes Milton Keynes MK12 6HS www.firstlight-products.co.uk</p>

Part 2B

For all commercial development applications

Use relevant British Standard to select task illuminance. Table 3.1 is only included as a general guidance and is not exhaustive of various other tasks which could take place in or around the dark sky zone.

Table B (3.1 in main document)
Illuminance for typical tasks within Dark Sky Place

Ref No.	Type of area, task or activity	Eav lux	Uo	GR _L	R _a	Remarks
	Farms					
5.5.1	Farm Yard	20	0.10	55	20	
5.5.1	Equipment Shed (Open)	50	0.20	55	20	
5.5.3	Animals sorting pen	50	0.20	50	40	
	Equestrian (outdoor event)	100	0.50	55	20	
	Industrial sites and Storage					
5.7.1	Short term handling of large units and raw material, loading and unloading of solid bulk goods	20	0.25	55	20	
5.7.2	Continuous handling of large units and raw material, loading and unloading of freight, lifting and descending location for cranes	50	0.40	50	20	
5.9.1	Parking Areas – See Roadmap in section 3.2 main document				20	
	Simple Summary for safety and security					
	Very low risk	5	0.25	55	20	
	Low Risk	10	0.40	50	20	
	Medium Risk	20	0.40	50	20	
	High Risk	50	0.4	45	20	

Key to table abbreviations

Eav = Maintained average illuminance, Uo = Overall uniformity, R_a = minimum colour rendering index, GR_L = Glare Rating limit (for internal work visibility benefit and not a visibility measure from outside the site)

Illuminance recommendations are based on steps which are generally perceptible as shown in Table C. This table also shows the illuminance step difference between low colour rendering lamps, as in table B, and high colour rendering lamps.

The use of light sources with a CCT / T_{cp} greater than 4,000K is not permitted in a UK Dark Sky Place.

Table C (3.2 main document)
Illuminance comparisons based on colour rendering index (R_a)

Colour Rendering Index	Task Maintained Average Illuminance Steps (lux)												
	2	3	5	7.5	10	15	20	30	50	75	100	200	300
R _a < 60	2	3	5	7.5	10	15	20	30	50	75	100	200	300
R _a > 60		2	3	5	7.5	10	15	20	30	50	75	100	200

R_a < 60 poor colour rendering, eg. 'orange' or 'pinkish' SOX & SON sodium street lights etc.

R_a > 60 broader spectrum 'white' light e.g. most fluorescent, compact fluorescent, tungsten / tungsten halogen lamps & some mercury discharge (CDM & Cosmopolis) and LED light sources.

Table D (part of 2.3 main document)

Intensity Distribution Recommendations in Core Zone (E0)

Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed condition
		at 70 ⁰ az	at 80 ⁰ az	at 90 ⁰ az	above 95 ⁰ az	
Core Zone	G6*	350	100	0	0	Horizontal flat glass Fully cut-off installation in environmental zone E0

Note * Intensity relaxation may be appropriate at 70⁰ and 80⁰ depending on luminaire availability but the **values of zero intensity at 90⁰, 95⁰ and above are crucial.**

Intensity distribution recommendations apply to the luminaire's installed angle of inclination (tilt) which can be tested in UK industry standard design calculation software.

Stray light control recommendations in Core Zone:-

No stray light is permitted within the E0 Core Zone

Values for Upward light, Light intrusion into windows and source intensity are all zero. No decorative external lighting (floodlighting etc.), is permitted.

Assessment Note 1 Measurement or calculation of light intrusion should be in the vertical plane and parallel with the window pane in its centre.

Assessment Note 2 Measurement or calculation of the source intensity should be based on a 1.5 metre high visual receptor placed at any location on the property boundary or 500 meters beyond the new light source, whichever is closer.

Table E (part of 2.3 main document)

Intensity Distribution Recommendations within E1 sections of the Park (ie excluding Core Zone)

Zone Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed condition
		at 70 ⁰ az	at 80 ⁰ az	at 90 ⁰ az	above 95 ⁰ az	
Between Core Zone and nearest population cluster > 1,000	G6*	350	100	0	0	Fully cut-off installation in environmental zone E1
Residential buffer between town centre and rural remainder (or centre of town with < 1,000)	G5-derivative	350	100	5	0	Cut-off installation
Town Centre with population > 1,000 (excluding heritage style streets)	G4	500	100	10	0	Part Cut-off installation
Heritage bowl style	G4	500	100	10	0	
Heritage gas style	G4+	500	100	20	0	
External for 5 miles beyond Park boundary (lamps < 20,000 lumens)	G3	.	100	20	2.5%	Semi-Cut-off installation in environmental zone E2
All luminaires with lamps greater than 20,000 lumens between Core Zone boundary and Region boundary	G6**	350	100	0	0	Fully cut-off installation regardless of night time environmental zone

Note ^{az} Table 2.3 restrictions apply to the luminaire's installed angle of inclination (azimuth) which can be tested in UK industry standard design calculation software.

Note * Intensity relaxation may be appropriate at 70⁰ and 80⁰ depending on luminaire availability but the **values of zero intensity at 90⁰, 95⁰ and above are crucial.**

Note ** Requires discussions with adjacent land owners and local authorities to adopt similar controls in their individual environmental policy plan.

In addition to the intensity controls presented in table 2.3 further light limitation recommendations are contained in Table F (2.4), following, to mitigate any obtrusive light in an E1 Environmental Zone and the two tables should be considered in tandem at the design stage for all new exterior lighting.

Table F Obtrusive Light Marker Points
Summary of Light Limitation Tables used for Design Objectives

Environmental Zone E0 variations							
Night Time Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	Assessment Point Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre & Post -10pm	Ev or Eh (lux)
E0-0	No New External Lighting Units Permitted						
E0-50	0	0	0	0*	0*	0	0.25
E0-250	0	0	0	0**	0**	0	0.10
E0-SL***	0	0.25	0.1	0	0	0	-
© LCADS Ltd 2013							(IESNA = 0.5 lux)

CIE Zone E1- Dark Sky Park Adaptation							
Night Time Environmental Zone	Sky Glow Upward Light Ratio %	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E1 in E0 area	0	0.5	0.25	1,000	0	0	0.50
E1 (ILP guideline)	0	2	0	2,500	0	0	-
© LCADS Ltd 2013							(IESNA = 1.0 lux)

CIE Zone E2- Dark Sky Community Adaptation							
Night Time Environmental Zone	Sky Glow Upward Light Ratio	Light Intrusion (into windows) $E_{vertical}$ (lux)		Source Intensity I (cd)		Maximum Luminance L (cd/m^2)	Property Boundary Illuminance
		Pre-10pm	Post-10pm	Pre-10pm	Post-10pm	Pre-10pm	Ev or Eh (lux)
E2-0% (Residential)	0%	2.5	1	2,500	0	0	1.0
E2-1% (Town Centre)	1%	5	1	2,500	500	3	3.0
E2-2.5% (ILP guideline)	2.5%	5	1	7,500	500	5	(IESNA = 3.0 lux)
© LCADS Ltd 2013							

Design Procedure Part 3A For all small scale lighting proposals eg domestic property with light sources less than 1,000 lumens

Details for low intensity lighting proposals shall include where on site each light is located, what height each light is to be positioned, the type of light frame or bracket for each light, the orientation/direction of each light and the strength of each light in lumens is proposed.

Part 3B For all Medium and Large Scale lighting proposals eg commercial development applications eg factory development or sports facility

All planning applications, with the exception of a singular new-build or modernised home, should contain a night time environmental impact based on recommendations given in the ILP Technical Report 'Guidance on undertaking environmental lighting impact assessments PLG04', The Institution of Lighting Professionals, 2013

Table 2.5
Lighting Impact Assessment - Outline

Baseline Descriptions

Baseline Assessment Procedures

- Day time visit
- Night time visit
- Viewpoint Scheduling
- Baseline Assessment Layout
- Location Plan
- Brief Description
- Viewpoint Pages
- Baseline Summary

Proposed Development – Lighting Design

- Design – General
- Preliminary Assessment
- Provisional Design
- Final Design
- Maintenance Factors

The LMP for both the Dark Sky Park and the Dark Sky Community encourages Development Control Committees, both within the Region and adjacent Local Authorities, to insist on a thorough design process by the developer before submitting proposals.

Scottish government links: www.scotland.gov.uk/Publications/2007/03/14164512/0
"Controlling Light pollution and Reducing Lighting energy consumption" contains a 20 point check list typical of the data required for a large scale lighting impact assessment when it forms part of a larger Environmental Statement. Reference to the full document will provide the reasoning behind a 20 bullet point checklist.

An abbreviated 12 point summary checklist of the design methodology is shown in the LMP and is typical of the detail required for medium scale proposals where there is a stand alone lighting impact assessment report.

Table 2.6
Good External Lighting Design Practice

- Survey of surrounding area environment
- Identification of critical viewpoints or receptors
- Analysis of task lighting level recommendations and game level if sports lighting application
- Establish environmental light control limits
- New lighting design quality objectives
- Calculated measurement of
 - Task working area(s)
 - Overspill area(s)
- Obtrusive light calculation of
 - Property intrusion
 - Viewed source intensities
 - Direct upward light output ratios
- Compare design achievement with baseline values
- Schedule of luminaire types, mounting height and aiming angles
- Schedule of energy usage and lumens per square metre
- Schedule of luminaire profiles
- Layout plan with beam orientation indication and site relationship with surrounding residential and commercial properties

Although only 12 points are included in Table 2.6 these should be treated as an absolute minimum requirement and there is no reason why the full 20 point plan is not set as a standard design objective as will be the case in applications for large scale lighting proposals regardless of being part of an Environmental Impact Statement.

Lighting Impact Assessment Provision Matrix

	Park Core	Park Buffer or Community	10 mile Transition Zone	Beyond the Dark Sky Place
Small Scale eg House Group of up to 6 houses	part LIA recommended Minimal details essential	Minimal details essential	Minimal details recommended	No details required if light source is less than 3,000 lumens - otherwise part LIA recommended
Medium Scale eg Farm	Full LIA essential	Full LIA essential	Part LIA essential Full LIA recommended	Source greater than 3,000 lumens full LIA recommended if not in EIA
Large Scale eg Sports field Sports complex Trade / Commerce Distribution centre	Not permitted	Full LIA essential	Full LIA essential	Source greater than 3,000 lumens Full LIA essential if not in EIA

James H Paterson

MOFFAT - DARK SKY COMMUNITY

EXTERNAL LIGHTING MASTER PLAN



Prepared for – Dumfries and Galloway Council
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Moffat - Dark Sky Community Status

External Lighting Master Plan

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- Appendix 1 – St. Ninians Road - Baseline**
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- Appendix 6 - Vertical Isolux curve from tilted LED luminaire**
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5.1.1 Community Preamble

The concept of a Lighting Management Plan for Dumfries and Galloway is covered in a generic document with four sections and several Appendices as listed below. These sections are applicable standards to follow when applying to the IDA for Dark Sky Community Status within Dumfries and Galloway only.

- Section 1 Concept of light pollution and electrical energy reduction
- Section 2 Environmental Zone definitions and stray light recommendations
- Section 3 Planning Requirements for exterior lighting applications
- Section 4 Excluded lighting applications

Appendix A – Definitions

Appendix B – Sky Brightness Nomogram

Appendix C – Commercial and Domestic equipment profiles

Appendix D – Public Lighting equipment profiles

Appendix E – Domestic Lighting – Equipment Profiles Handout

Appendix F – Domestic Lamp Wattage and Lumen Output Chart

Appendix G – Property Self-Audit Guidelines – The Next Step Handout

Appendix H - Supplementary Design Guidance /
- Planning Application Guidance Note

Section 5 and 6 contains Community specific data for the town of Moffat within the boundary of Dumfries and Galloway Local Authority and as such is the forerunning template for other Communities to follow in time.

The declaration of intent to submit a Dark Sky Community application was submitted to the IDA in March 2013 and at a point in time when the "Dark Sky Community" lumen cap was 5,000 lumens as shown on the following page. The street lighting relighting program and submission of the "Community" application was achieved within the 6 month period thereafter.

In May 2013 the IDA published new additional requirements for their Dark Sky Places programme and due to a delay in appraising the first application Moffat Community was asked to consider how it could comply with the new requirements.

Section 7 and 8 was added in 2014 following further new additional requirements and comments from the IDA.

International Dark-Sky Association The Nightscape Authority

Process

- Nomination by IDA member in good standing with supporting signatures of at least three additional IDA members, two from outside the community receiving the nomination, and supporting information to demonstrate that the minimum requirements have been met;
- Official supporting letter for nomination from elected representatives of the community, such as mayor and/or council of a municipality;
- Approval of nomination by the IDA Board of Directors by a majority vote.

Minimum Requirements

- 1. A quality comprehensive lighting code**
with the following minimum standards:
 - Full shielding or full cutoff standard for all lighting fixtures over 5000 lumens initial lamp output (or equivalent wattages);
 - Restrictions on total amount of unshielded lighting, such as a limit on lumens per acre or total site lumens in unshielded fixtures (or equivalent wattages);
 - A method to address overlighting, such as energy density caps, lumens/acre caps, or illuminance specifications.
- 2. Community commitment to dark skies and quality lighting**
as shown by:
 - City-owned lighting conforming with, or committed to conforming with, the lighting code (if the latter, a published plan with a timeline for completion in no more than 5 years);
 - Municipal support of dark skies and good lighting as indicated through city publications, flyers, PSAs, funding of lighting upgrades, etc. (just to name a few).
- 3. Broad support for Dark Skies from a wide range of community organizations**
such as:
 - Chamber of Commerce
 - Local electrical utility
 - Local IDA section
 - Lighting retailers
 - Others
- 4. Success in light pollution control**
at least one of the following conditions must be demonstrated:
 - Examples of a minimum of ten projects built under the lighting code, demonstrating effective application of the local lighting code;
 - Alternative demonstration of success in light pollution control, to be discussed with IDA for compliance.

Benefits

Designation as an International Dark Sky Community entitles the community to display the IDSC logo (see below) in official community publications and promotions, and use of this logo by commercial or other groups within the community when identifying the community itself (i.e., an organization can say "located in Star City, an International Dark-Sky Community" or other words to the same effect). IDA will maintain a Web page identifying and describing all IDSCs. Designation as an International Dark-Sky Community is permanent, but subject to review and possible revocation upon request of any IDA Board member.

After the submission of this LMP the IDA set a revised lumen cap of 3,000 lumens and the text in Issue 4 and onwards has been subsequently amended to encompass this and additional new IDA requirements in any future lighting schemes.

5.1.2 Summary of Moffat Community Plan Statements

<p>Plan Statement Number DG10.01</p>

<p>All retrofit (pre September 2013) luminaires using any light source greater than 5,000 lumens must be installed as a horizontal fully cut-off (fully shielded) example. (see section 5.5)</p>

<p>Plan Statement Number DG10.02</p>

<p>For all retrofitted lighting using any light source less than 5,000 lumens but greater than 3,000 lumens must be installed with electronic dimming control to provide a light output of less than 3,000 lumens between the hours of midnight and 6.00 am.</p>

<p>Plan Statement Number DG10.03</p>

<p>All new or damage replacement lighting using any light source greater than 3,000 lumens must be designed and installed as a horizontal fully cut-off (fully shielded) example (no luminaire tilt). (see section 5.5)</p>

<p>Plan Statement Number DG10.04</p>

<p>All new street lighting (except main arterial routes) shall include light output electronic dimming controls between midnight and 6.00 am. (see section 5.5)</p>

5.2 Introduction to Moffat



Moffat is located some 60 miles south of Glasgow and adjacent to the main arterial north / south motorway which runs from Glasgow to London. Its origins began as a village with a notable location in the wool trade. In the 17th Century, however, it's mineral springs provided a health giving reason for wealthy Glasgow and Edinburgh businessmen to visit and develop it a Spa town. The sulphurous waters of Moffat Spa were believed to have healing properties and several springs were piped down from the hills into a specially built bath house in the town centre. This building is now the Town Hall but an old tariff board still exists showing a hot bath cost of 1/- (shilling) and a cold bath costing 6d (pence). The town still retains many of the hotels which developed from this old tourist attraction, one of which is recorded as the narrowest in the world being only 20 feet (6 metres) wide. At the other end of the scale the town also had a 300 bedroom Hydropathic Hotel, built in 1878 but sadly destroyed by fire in 1922. However, Georgian and Victorian architecture can be seen in most of the buildings in the town and this has resulted in issuing preservation orders to capture the remaining grandeur of the past.

In the 17th and 18th Century Moffat was a good day journey by horse and carriage from Glasgow or Edinburgh, but today its main influx of visitors only stop for refreshment between more distant sources of departure or arrival.

This application seeks to revive some of the lost residential tourist trade but more importantly re-introduce an interest in the heavenly beauty of the night sky which has been eroded by today's night time illumination for a 24 hour society.

5.3 Moffat Community

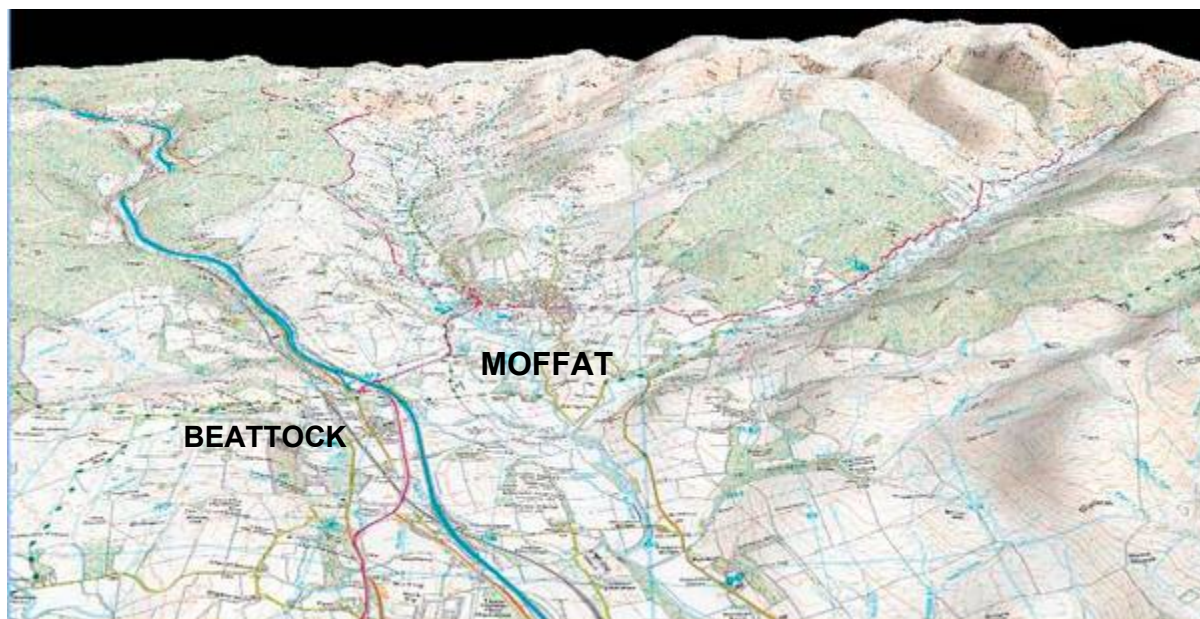


Figure 5.2 Topography in locality of Moffat and Beattock

Although the town of Moffat and the village of Beattock are separated by about 1½ miles they have their own separate Community Councils so that local issues can be addressed at source. Each Community Council has its own constitution and has an input to the Local Municipal Authority via the Elected Member allocated to each Community. Although the Local Municipal Authority has the legal powers to set standards and planning conditions, throughout the region, the Community Council have a channel to make input statements of interest, approval or rejection via the allocated Elected Member of the Local Authority cabinet who attends each Community Council meeting.

In the latter half of 2012 the Scottish Government offered The Authority an allocation of £240,000 to finance a large scale case study of energy reduction using the new technology of light emitting diodes (LED) as the primary light source in preference to high intensity discharge sources.

Since Moffat is the home of the author of six previously successful UK Lighting Master Plans for Dark Sky Status the concept of combining an electrical energy reduction with a Dark Sky Town application was presented to the Moffat Community Council meeting in November 2012. The concept was unanimously approved and an open letter from the Community Council invited the public to a lighting clinic in the Town Hall in February 2013.

In addition to the Scottish Government's small project grant for Moffat other Community Councils were advised, via their Elected Member meetings, of The Authority's £7.4M commitment to replace old street lighting units over the next 8 years as part of their carbon reduction commitment (see section 1.1.1) with Beattock receiving early attention due to its close proximity to Moffat.

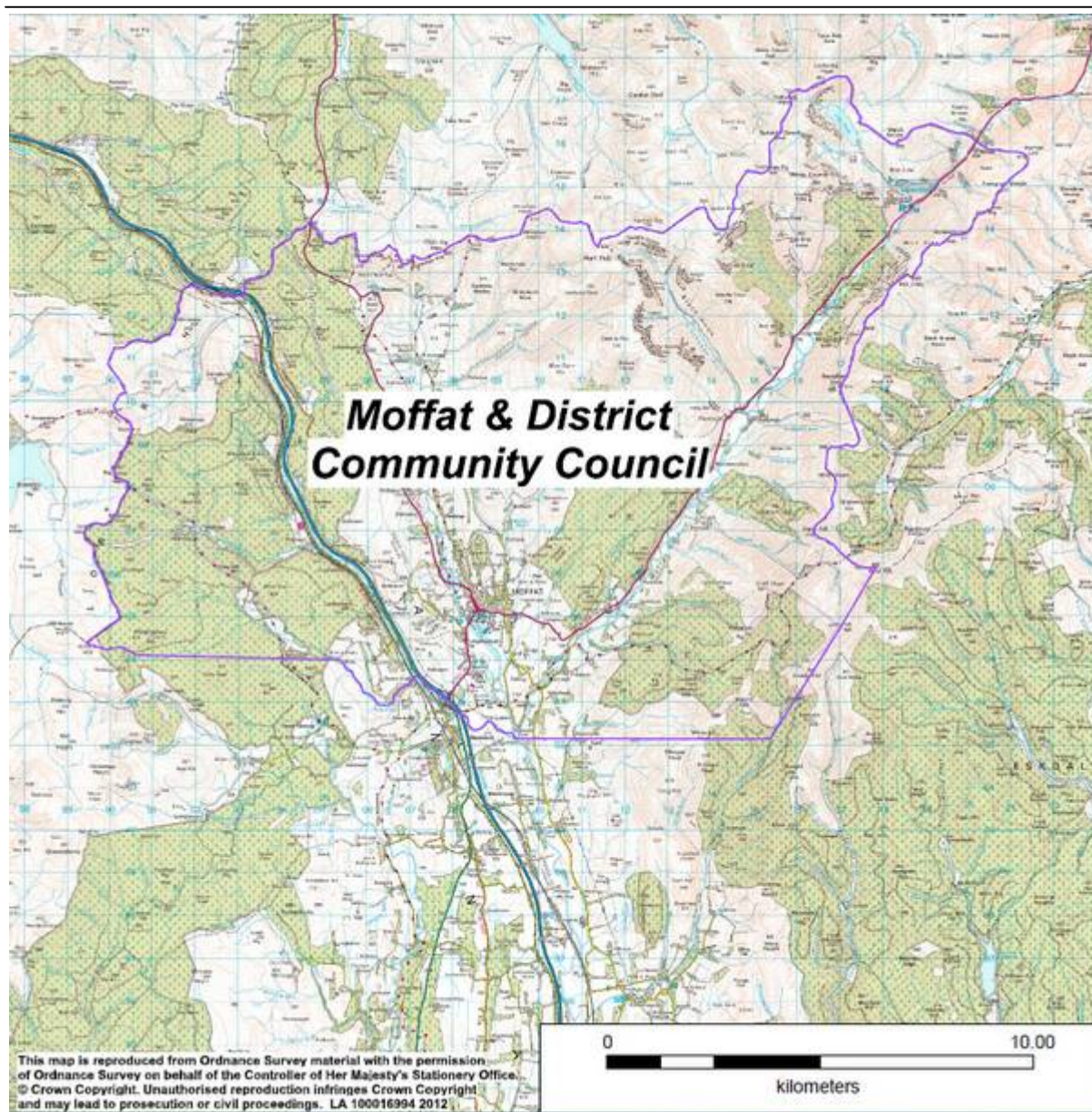


Figure 5.3 Moffat Community Council Boundary (purple line)

5.4 Pre-Application Public Lighting Infrastructure

With the major light source of low pressure sodium on all residential side streets and high pressure sodium on the main road network in Moffat it is clear to see in Figure 5.4 that the stray light effects of the old sodium infrastructure can illuminate chimney pots and tree tops. This sodium sky glow condition above Moffat will certainly not be acceptable as a Dark Sky Town without a complete overhaul or retrofitting with new luminaires providing zero intensity at and above the horizontal axis.



Figure 5.4 Example of upward light effects

Five typical areas in Moffat were chosen to model the illumination values of not only the upward light but also the effect on the public highway, the gardens behind and the house frontages. From these initial baseline calculations (see Table 5.1 for three of these locations) the existing side street luminaires emitted an Upward Light Ratio (ULR) of 7% and the lighting arrangement in the town centre emitted an average ULR of 15%. These values were clearly not in keeping with the objective of minimising stray upward light as set out by the IDA. In financial terms it is also a "luxury" no longer affordable.

Table 5.1 Table of Baseline Results

Model Test Area	St Ninians Road	Pringle Court	Town Centre
Highway Average	4.66 lux	9.75 lux	22.58 lux
Highway Minimum	1.27 lux	0.13 lux	2.03 lux
Overall Uniformity	0.27	0.01	0.09
House 1 Front Max.	5.8 lux	13 lux	
Garden 1 Max.	21 lux	12 lux	
House 2 Max	2.19 lux	19 lux	
Garden 2 Max	1.99 lux	14 lux	ULR WallPack 45%
ULR	7%		ULR average 15%
See Detail Calcs. in	Appendix 1	Appendix 2	Appendix 3

Table 5.2 Inventory of "pre-application" public street lighting

Road name	Street Lighting Inventory			Pre Carbon Reduction / Dark Sky Conversion					
	Lamp	No.	Profile	35 SOX	45 CPO	55 SOX	70 SON	150SON	250SON
Beechgrove	45 CPO	8	CTG		8				
Old Edinburgh Rd.	45 CPO	8	CTG		8				
Old Edinburgh Rd.	55 SOX	10	Refractor			10			
Hillside Terrace	55 SOX	4	Refractor			4			
Hydro Avenue	55 SOX	5	Refractor			5			
Edinburgh Road	150 SON	12	Bowl					12	
Northfield Park	70 SON	2	Refractor				2		
Mearsdale Drive	55 SOX	2	Refractor			2			
Mearsdale	55 SOX	5	Refractor			5			
Meadow Place	55 SOX	5	Refractor			5			
Reid Street	55 SOX	5	Refractor			5			
Gallows Well	55 SOX	1	Refractor			1			
The Whins	55 SOX	4	Refractor			4			
Harthope Place	55 SOX	5	Refractor			5			
Grange Place	55 SOX	2	Refractor			2			
Grange Road	55 SOX	7	Refractor			7			
Academy Road	150 SON	5	Bowl					5	
Moffat House Lane	55 SOX	1	Refractor			1			
High Street	250 SON	8	Bowl						8
	70 SON	9	Conical				9		
	150 SON	11	Bowl					11	
Westpark	No Public Lighting								
Eastgate	55 SOX	11	Refractor			11			
Dundanion Road	55 SOX	5	Refractor			5			
Old Well Road	55 SOX	6	Refractor			6			
	35 SOX	2	Refractor	2					
Hartfell Crescent	35 SOX	6	Refractor	6					
Buccleuch Place	35 SOX	2	Refractor	2					
Dixon Street	55 SOX	2	Refractor			2			
Causway Street	55 SOX	3	Refractor			3			
	70 SON	1	Refractor				1		
Well Street	55 SOX	4	Refractor			4			
Star Street	55 SOX	2	Refractor			2			
Mansfield Square	55 SOX	6	Refractor			6			
Mansfield Place	55 SOX	4	Refractor			4			
Annagate	55 SOX	2	Refractor			2			
Church Street	55 SOX	2	Refractor			2			
Annanside	55 SOX	6	Refractor			6			
Rae Street	55 SOX	3	Refractor			3			
Buccleuch Street	55 SOX	3	Refractor			3			
Church Place	55 SOX	1	Refractor			1			

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Church Gate	150 SON	3	Bowl			3
The Glebe	55 SOX	2	Refractor		2	
Beatock Road	150 SON	31	Bowl			31
Station Park	70 SON	8	CTG			8
	70 SON	3	Conical			3
Golf Hill Drive	70 SON	5	F/Glass			5
Holm Street	150 SON	4	Bowl			4
	70 SON	4	Refractor			4
Ladyknowe	55 SOX	1	Refractor		1	
Osborne Row		0				
Burnside	70 SON	6	Bowl			6
School Lane	55 SOX	2	Refractor		2	
Well Road	55 SOX	35	Refractor		35	
Hamilton Place	55 SOX	1	Refractor		1	
Greenwood Close	55 SOX	7	Refractor		7	
Millmeadows	55 SOX	2	Refractor		2	
Sidmount Avenue	55 SOX	5	Refractor		5	
Haywood Road	70 SON	7	F/Glass			7
	70 SON	7	Heritage			7
Cinder Path	35 SOX	1	Refractor	1		
Millgreen	55 SOX	6	Refractor		6	
Millburn	55 SOX	2	Refractor		2	
Park Circle	55 SOX	16	Refractor		16	
	150 SON	1	CTG			1
St. Ninians Road	55 SOX	23	Refractor		23	
Annandale Road	55 SOX	8	Refractor		8	
Annandale Place	55 SOX	5	Refractor		5	
Annandale Way	55 SOX	8	Refractor		8	
Warriston Road	55 SOX	7	Refractor		7	
Warriston Place	35/55 S	12	Refractor	1	12	
Fingland Court	55 SOX	10	Refractor		10	
Pringle Court	55 SOX	9	Refractor		9	
The Holm	150 SON	19	CTG			19
Duncan Drive	55 SOX	7	Refractor		7	
Jeff Brown Way	150 SON	10	CTG			10
Old Carlisle Road	55 SOX	23	Refractor		23	
Hartfell Homes	45 CPO	8	CTG	8		
Selkirk Road	55 SOX	12	Refractor		12	
Ettrick Drive	55 SOX	8	Refractor		8	
Frenchland Drive	55 SOX	6	Refractor		6	
Crosslaw Burn	55 SOX	8	Refractor		8	
	70 SON	4	Refractor			4
Meadow Bank	55 SOX	1	Refractor		1	
	70 SON	7	Refractor			7
Meadow Bank Rise	70 SON	3	Refractor			3

Ballplay Road	55 SOX	24	Reflector		24
Holm Park	35/55 S	2	Reflector	2	2
Eastfield Rise	55 SOX	6	Reflector		6

SUMMARY of TABLE 5.2 TOTALS						
Pre Application light sources	35 SOX	45 CPO	55 SOX	70 SON	150SON	250SON
Pre Application individual Totals	14	24	374	66	96	8
Individual Circuit watts	45	52	74	80	169	276
Pre Application Load (watts)	630	1248	27676	5280	16224	2208
Connected Total Load	53.27	kWatts				

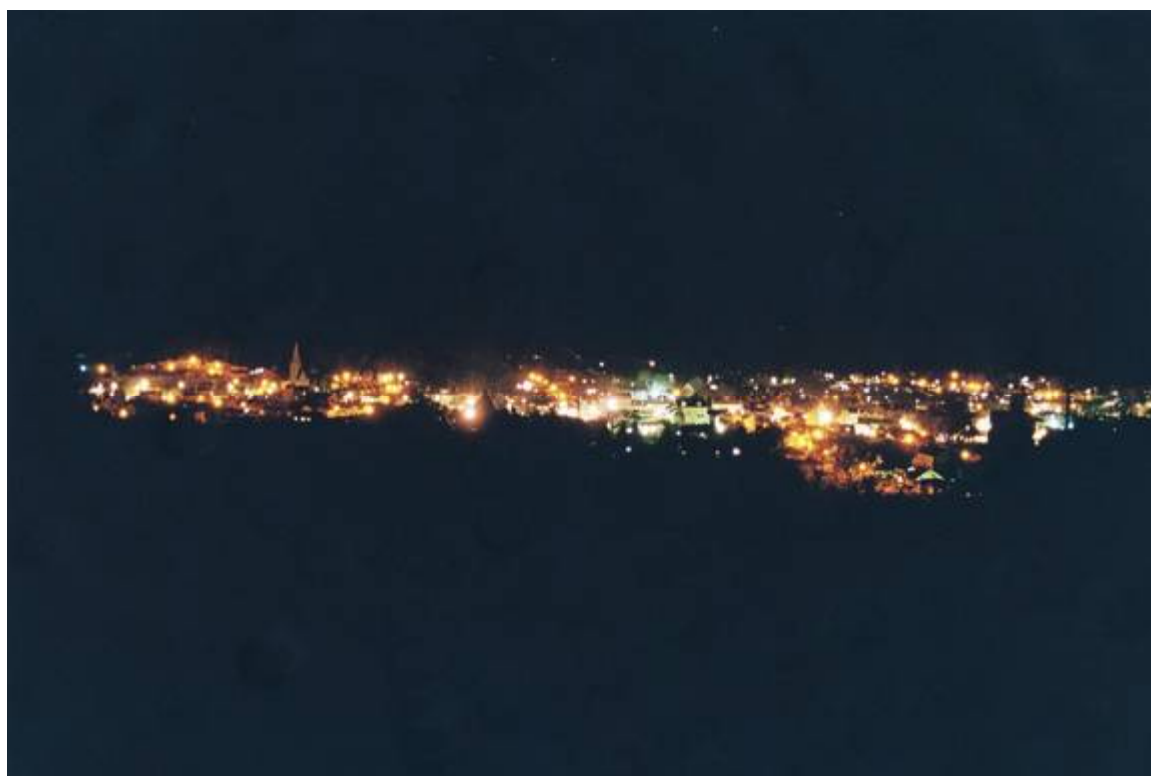


Figure 5.5 View of Moffat by night looking down from Golf Hill (Pre-Application)

5.5 Review of new light sources and luminaires

Table 5.3 (following) shows a series of calculated results on one test site obtained from various luminaires. Each luminaire was subjected to the same site parameters as that in the baseline (baseline results repeated in yellow highlight) with the exception that each new luminaire was tested at a 5 degree upward tilt, as in the baseline, and also at 0 degree upward tilt.

At the time of this LMP development the IDA recommend that in Dark Sky Parks or Reserves all luminaires using a light source greater than 1,000 lumens should be mounted "fully shielded"(see LMP section 1). In a Community setting, however, this cut-off limit was set at 5,000 lumens (pre September 2013). All the luminaires in Table 5.3, with the exception of the old baseline sodium source, use a light source less than 5,000 lumens but never the less provide a "flat glass" light distribution with very little visual distribution when elevated 5 degrees on existing brackets as in the case of a retrofit condition (ie luminaire change only on existing bracket).

Plan Statement Number DG10.01

For all retrofit (pre September 2013) luminaires using any light source greater than 5,000 lumens must be installed as a horizontal fully cut-off (fully shielded) example (no luminaire tilt).

Plan Statement Number DG10.02

For all retrofitted lighting using any light source less than 5,000 lumens but greater than 3,000 lumens must be installed with electronic dimming control to provide a light output of less than 3,000 lumens between the hours of midnight and 6.00am.

After the original submission of this LMP the IDA set a revised lumen cap of 3,000 lumens and the text in Issue 4 and onwards has been subsequently amended to encompass this new requirement in any future lighting schemes.

Plan Statement Number DG10.03

All new or damage replacement lighting using any light source greater than 3,000 lumens must be designed and installed as a horizontal fully cut-off (fully shielded) example (no luminaire tilt).



Figure 5.6 Degree of "cut-off" from luminaire finally selected

The same calculation procedure as shown in Table 5.3 was also carried out in Pringle Court, The Holm and Beattock Road to ensure that the finally selected luminaires met all the requirements of the highway infrastructure at the same time as reducing upward light and intrusive light into bedroom windows.

Table 5.4 POTENTIAL WATTAGE SAVING						
Pre Application light sources	35 SOX	45 CPO	55 SOX	70 SON	150 SON	250 SON
Pre Application individual Totals	14	24	374	66	96	8
LED Retrofit Circuit watts	41	41	41	41	105	153*
New Application Load (watts)	574	984	15334	2706	10080	1224
New Connected Total Load	30.9	kWatts				* not LED

This equates to a potential saving of £9,722 in annual energy costs in addition to the long life maintenance savings using LED lighting.

The calculation process of the finally selected luminaire, the mini Iridium with 3,480 lumen warm white LED light source, for all the residential side streets in Moffat is shown in Appendix 4. Since the project was based on a retrofit principal the calculation allows for a 5 degree upward tilt. This tilt allowance was cleared with the IDA before progressing but without appreciating the power of the luminaire cut-off when installed in a light pollution free environment.

Following the completion of the retrofitting process only 3 complaints, out of a population of about 2,500, were voiced publically. One related to an area in which the new luminaires were installed on 5 metre columns and appeared to have zero tilt. Although the road and footpath appeared to be lit satisfactorily the house fronts appeared duller than others and a 5 degree upward tilt may have been more applicable to add a little more light particularly on the house fronts which are set back further than the general average of 15 metres.

The Park Circle is also another example of perceived reduction in stray illumination from the public street lighting system. This section of roadway has a circular arrangement of houses located on the inside of the circle. The lighting units are correctly located on the outside of the bend pointing in towards the houses. To the rear of the lighting units is an open park area.

From a pedestrian viewpoint in Park Circle illumination can be seen on garden paths and house fronts but from a distant view across the open park the houses are perceived to be in complete darkness. The position and colour of parked cars can be clearly seen but the dark brown roughcast finish on all the houses does not appear, from a distance, to reflect any light

Appendix 6 contains a vertical isolux distribution, from a Philips Mini Iridium luminaire tilted up 5 degrees, which shows that the computed prediction of 0.01 lux does not exist above the horizontal. (0.01 lux is about 1/10th of quarter moonlight)

As indicated in Section 1.1.1 the Authority is committed to adding dimming technology and all the lighting units in the residential streets dim by/to 1/3rd between mid-night and 6am. All the main roads in and out of Moffat and the town centre where CCTV cameras operate, however, maintain a constant light output throughout the night.

In addition to the public street lighting system dimming during the "quiet" hours one of the local fuel filling stations has introduced a 24 hour fuel availability facility and in doing so has changed their forecourt lighting to LED units with presence detection so that at unattended times the lighting operates at a reduced level and brightens to normal when fuel delivery is required.



Figure 5.7.1 Petrol Filling Station

Figure 5.7.2 LED Lighting Units located in Canopy





Figure 5.8 Example of new door lights installed during house renovation in Holm Street

5.6 Moffat Sky Quality (pre Retrofitting)

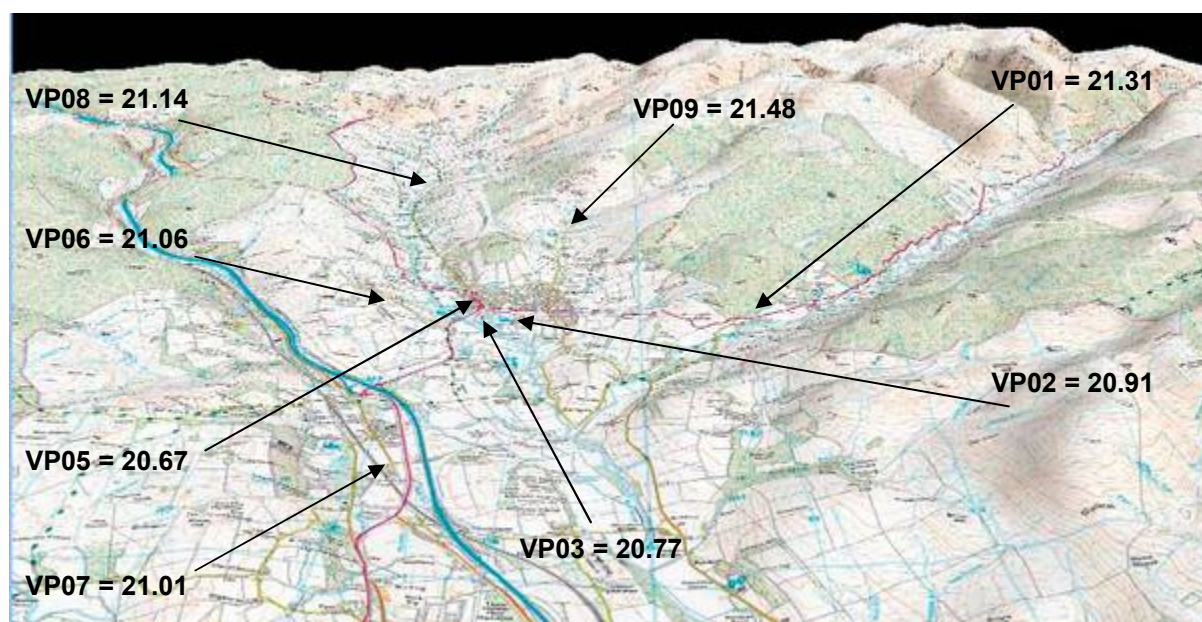


Figure 5.9 Viewing Points in and around Moffat with sky quality values pre-retrofitting



Figure 5.10 View South over Moffat from View Point 09 (Old Well Car Park, Well Road)

Ref.	Pre Re-lighting Sky Quality Readings					SQM				
No.	Location	Map Reference	Read 1	Read 2	Read 3	Read 4	Read 5	Average	Date	
VP01	Hillend Turning Circle	NY 10893 04682	20.78	20.88	21.3	21.46	21.43	21.17	01/02/2013	190m
21.31	Average of 4 averages		21.39	21.39	21.4	21.3	21.29	21.35	27/02/2013	good s
			21.41	21.37	21.33	21.27	21.23	21.32	29/03/2013	
			21.5	21.5	21.39	21.38	21.23	21.40	01/04/2013	
VP02	Green Frog Car Park	NT 08753 04648	21.45	21	21.11	21.12	21.14	21.16	06/02/2013	good a
20.91	Average of 4 averages		20.99	20.65	20.88	20.65	20.66	20.77	27/02/2013	school
			20.27	20.93	20.94	20.91	20.95	20.80	01/04/2013	patchy
			20.72	20.85	20.98	21	20.96	20.90	03/04/2013	
VP03	EWM Car Park	NT 08573 05019	20.73	20.05	20.72	21	21.07	20.71	04/02/2013	bulkhe
20.77	Average of 2 averages		21.01	20.56	20.87	20.9	20.83	20.83	03/04/2013	
VP04	St Andrews Church C/Park	NT 08415 05126	19.52	19.53	19.35	19	18.83	19.25	01/02/2013	poor a
19.68	Average of 3 averages		19.14	18.7	19.3	18.86	19.41	19.08	27/02/2013	hall in
			20.83	20.68	20.85	20.61	20.6	20.71	03/04/2013	
VP05	Moffat CAN	NT 08314 05131	19.54	20.79	20.48	20.62	20.51	20.39	27/02/2013	poor a
20.67	Average of 2 averages		21.03	21	20.95	20.92	20.9	20.96	03/04/2013	
VP06	Golf Club Car Park	NT 07679 04761	20.94	20.79	20.81	20.93	20.71	20.84	27/02/2013	good n
21.06	Average of 2 averages		21.18	21.47	21.21	21.21	21.32	21.28	03/04/2013	
VP07	Beattock	NT 08215 01674	20.9	21.01	20.91	20.99	20.92	20.95	27/02/2013	good a
21.01	Average of 4 averages		21.14	21.04	21.06	19.28	21.07	20.72	29/03/2013	
			20.8	20.83	20.79	20.63	20.75	20.76	01/04/2013	patchy
			21.59	21.73	21.6	21.58	21.55	21.61	03/04/2013	
VP08	Annan Water Hall	NT 07514 10325	21.51	20.26	21.27	20.12	21.04	20.84	01/02/2013	3miles
21.14	Average of 4 averages		20.78	20.76	20.77	20.76	20.73	20.76	27/02/2013	possib
			21.56	21.5	21.56	21.55	21.52	21.54	01/04/2013	
			21.6	21.38	21.4	21.34	21.34	21.41	03/04/2013	
VP09	Well Road End Cattle Grid	NT 09177 07213	21.43	21.48	21.49	21.41	21.42	21.45	06/02/2013	207m
21.48	Average of 3 averages		21.47	21.3	21.36	21.27	21.25	21.33	29/03/2013	
			21.73	21.66	21.67	21.63	21.64	21.67	01/04/2013	
VP10	Rosemount Rear Terrace	NT 09087 05509	21.22	21.2	21.04	21.02	21.04	21.10	01/02/2013	171m
	Reading Contrd Site		21.04	21.42	21.18	21.11	21.05	21.16	06/02/2013	
21.23	Average of 4 averages		21.22	21.41	21.25	21.32	21.23	21.29	01/04/2013	
			21.38	21.38	21.34	21.35	21.37	21.36	03/04/2013	

5.7 Future Design Objectives

Most of the street lighting in Moffat was installed to various British Standards which preceded the introduction of computerised lighting quality objectives and although it has been possible to predict baseline conditions on some of the test roads most of the results do not fall within current recommended design objectives. It was therefore deemed necessary to select a luminaire which provided similar quantity of light on the public highway.

Section 1.6 of the generic plan contains current advice on the reduced illuminance necessary when "white light" is used in comparison with the values needed when "yellow light" is used. This step reduction was not applied when the luminaire selection process was being considered since the ensuing reduction in light pollution was the main target and of unknown psychological acceptance in the community. A counterbalance was necessary and an equalling the illumination values could be used, if needed, as showing a betterment of public highway conditions.

There are plans however to develop a 200 house area in the near future and any new lighting will fall within the new British Standard recommendations as outlined in this section.

The Scotopic / Photopic (S/P) Ratio provided by Philips Lighting, the manufacturers of the new LED street lighting units are as follows in Table 5.5.

S/P Ratios for Philips LED Lanterns						
	CW (5700K typical)		NW (4000K typical)		WW (typical)	
Product	Current		Current		Current	
Range	Low	Nominal	Low	Nominal	Low	Nominal
Luma	1.73	1.96	1.37	1.61	1.18	1.43
Speedstar	2.00	2.01	1.60	1.61	?	?
Iridium 2	2.00	2.01	1.60	1.61	?	?
Stela	1.71	1.86	x	x	x	x
Stela 2	1.73	1.96	1.37	1.61	1.18	1.43
Clearway	x	x	1.61	1.63	x	x
Cit Soul	2.00	2.01	1.60	1.61	?	?
Milewide 2	2.00	2.01	1.60	1.61	?	?
Mini Iridium	2.04	2.09	1.68	1.75	1.35	1.37
Note: These values only apply to Philips products and should not be taken as generic values.						

Table 5.5 Manufacturer's published data

CPO - TW 45/140w = 1.15 Some existing 45w in Moffat. New 140w in town centre
 Mini Iridium (Nominal) = 1.37 Majority of new side street lighting
 Indal Luma = 1.43 Possible use in new development

Old side street lighting in Moffat equates to an average value of 5.0 lux and a minimum of 1 lux. This is equivalent to a classification in BS 13201:2003 as "S4" and may change to "P4" in a new revision. The old or new classification number or letter is not essential but the target design illuminance is essential and table 5.6 gives the correct design objectives for all new work with LED and CPO light sources in Moffat (assuming Philips equipment is maintained).

Table 5.6 Reduced Target Illuminance depending on S/P Ratio

Baseline Target Values in BS13201 $R_a < 60$		S/P = 1.15 Philips CPO-/728		S/P = 1.37 Philips Warm white		S/P = 1.43 Philips Warm white LED	
Eav (lux)	Emin (lux)	Eav (lux)	Emin (lux)	Eav (lux)	Emin (lux)	Eav (lux)	Emin (lux)
15.0	5.0	13.5	4.5	13.15	4.4	13.05	4.4
10.0	3.0	8.7	2.6	8.45	2.5	8.35	2.5
7.5	1.5	6.3	1.3	6.05	1.2	5.5	1.1
5.0	1.0	4.0	0.8	3.8	0.8	3.8	0.8
3.0	0.6	2.2	0.5	2.1	0.5	2.1	0.5
2.0	0.6	1.3	0.5	1.2	0.5	1.2	0.5

Plan Statement Number DG10.04

All new street lighting (except main arterial routes) shall include light output dimming controls between midnight and 6.00 am.

6 Private Lighting Infrastructure

6.1 Lighting Audit - General

There are approximately 1000 properties in Moffat and a 25% property audit yielded a total of 913 lighting units. Included within this 25% survey were all commercial properties. From experience in other application surveys where lighting audit unit totals exceed the 1,000 mark the compliance rate tends to flatten regardless of further units being added to the list. In the case of Moffat the 25% mark was therefore deemed to represent the remainder of the town. The survey contains data from domestic and commercial properties and when analysed the combined compliance percentage equated to 85%. However, almost all of the domestic "non-compliant" floodlights are connected to presence detection devices and may not therefore be providing continuous illumination. Since this is the first application to the IDA from a town Community there are no other similar application statistics to compare figures. Table 6.1 contains data from other "community" applications but they are based on remote island life where lower lamp lumen limits (1,000 lumens) were used to determine the compliance percentage.

Table 6.1 Comparison of Percentage Compliant with other applications

Dark Sky Application	Quantity Surveyed	Quantity Compliant	Percentage Compliant
This Dark Sky Town Application	910	778	85%
Other "Community" applications			
Isle of Sark Dark Sky Island	582	436	75%
Isle of Coll Dark Sky Island	272	222	81%

Where new or replacement external lighting is required the most onerous light control conditions should be applied to maintain this condition. To assist in this objective, Section 2.4 contains recommendations on luminous intensity recommendations for new luminaires, with a lamp output greater than 3,000 lumens. For domestic style luminaires with no intensity data Section 3.3 contains a lumen cap evaluation method.

6.2 Recommended Changes

All existing lighting units within the application boundary, which utilise lamps greater than 3,000 lumens, should be brought into line with the light limitation recommendations in this ELMP within the timescale indicated in the guide to Table 6.2 and 6.3 following.

All existing street lighting within Moffat and Beattock was retrofitted with "flat glass" LED lighting units within three months of the project starting. In addition Dumfries and Galloway Council have retrofitted at least 10% of the street lighting stock in other parts of the County during the same time period. The remainder of the County is continuing to be replaced through the Carbon Reduction programme as local authority improvement budgets permit. Each street will be equipped with new luminaires and bracket arms, where necessary, to meet zero light intensity limitation at 90° and above as recommended in this ELMP.

Change of property size

If a major addition occurs on a property, or street, lighting for the entire property, or street, shall comply with the recommendations in this LMP. The following are considered major additions:

- An addition of 50% or more in terms of residential houses, gross floor area, seating capacity, parking space or street length.
- Single or cumulative additions, modifications or replacement of 50% or more of installed exterior lighting luminaires.

Change of Property Ownership

If a property, with non-conforming lighting eg Old Moffat Academy, changes ownership or usage a new external lighting application must be made. The application must include a complete lighting inventory and site plan detailing all existing and proposed new exterior lighting. If the existing exterior lighting is no longer required all non-conforming lighting should be disconnected and removed.

Guide to Table 6.2 and 6.3 “Compliant” column

In both tables the last column contains 3 grades of luminaires namely:-

- (1) Those which are "fully or part shielded" regardless of their lumen output (shown as 1 or more in clear cells) and are not at issue
- (2) Those with lamps less than 5,000 lumens although they are not "fully shielded" (shown as 1 or more in clear cells) and are also not at issue.
and
- (3) Those with lamps greater than 5,000 lumens and not "fully shielded" (shown as red cells) in the table.

As previously indicated priority should be given to modifying the over 5,000 lumen units, in the red cells, followed by those over 3,000 lumens during the next 5 years.

A Red bar across the complete record should be treated as top priority since some are technically incorrectly installed, regardless of the dark sky application, and some may have incorrect luminaires to suit the lighting application.

Cells with 1 or greater mean that these luminaires are fully compliant and are not at issue.

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
1.01	wellglass	3	house	0	no	3		8	switch	access	no	3	0
1.01	spotlight	2	house	5	yes	2		35	pir	corner	yes	2	0
1.02	bulkhead	3	house	90	no	1		18	switch	steps	part	3	0
1.02	bulkhead	1	house	0	no	1		18	switch	door	yes	1	0
1.02	wellglass	1		0	no	1		60	pir	corner	no	1	0
1.03	bulkhead	2	house	0	no	2		18	switch	door	yes	2	0
1.03	heritage	2		90	no	2		40	switch	path	no	2	0
1.03	Heritage	1		90	no	1		8	switch	door	part	1	0
1.04	floodlight	1	house	70	yes	1		150	pir	yard	no	1	0
1.04	spotlight	1		60	yes	1		4	pir	steps	no	1	0
1.04	heritage	1		40	no	1		40	switch	door	no	1	0
1.05	wellglass	2	house	0	no	2		8	switch	path	no	2	0
1.06	bulkhead	2	house	90	no	2		40	pir	path	no	2	0
1.06	floodlight	1	house	90	yes	1		150	pir	garden	no	1	0
1.06	bulkhead	1	outhouse	0	no	1		8	pir	door	no	1	0
1.07	bulkhead	2	house	0	no	2		60	switch	path	no	2	0
1.08	wellglass	1	house	0	no	1		60	switch	access	no	1	0
1.08	spotlight	2	house	60	yes	2		par 38	pir	drive	no	2	0
1.09	wellglass	2	house	0	no	2		60	switch	path	no	2	0
1.09	globe	2	house	180	no	2		8	switch	door	no	2	0
1.10	bulkhead	16	flats	90	no	6		18	switch	balcony	no	16	0
1.10	bulkhead	2	flats	90	no	2		18	pecu	door	no	2	0
1.10	black bollard	10	gardens	45	no	10		8	pecu	path	yes	10	0
1.10	globe	2	pole	90	no				pecu	car park	no		2
1.11	heritage	2	house	0	no	2		11	switch	door	no	2	0
1.11	heritage	3	pole	180	no	3		40	switch	drive	no	3	0
1.11	floodlight	1	garage	90	yes		1	300	pir	drive	no		1
1.12	bulkhead	1	house	0	no	1		8	switch	door	part	1	0
1.12	bulkhead	2	house	90	no	2		60	switch	path	no	2	0
1.13	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
1.14	wellglass	4	flats	0	no	4		60	switch	corner	no	4	0
1.14	floodlight	3	flats	80	yes		3	300	pir	stairs	no		3
1.14	bulkhead	1	outhouse	90	no	1		60	pir	access	part	1	0
1.15	258 lm	3	house	45	yes	3		3.6w	pir	access	part	3	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
	floodlight							led					
1.15	wellglass	1	house	0	no	1		60	switch	garden	no	1	0
1.15	heritage	1		180	no	1		40	switch	path	no	1	0
1.15	bulkhead	1	garage	90	no	1		8	pir	drive	no	1	0
1.15	floodlight	1	porch	80	yes		1	300	pir	path	part		1
1.16	contemporary	2	garage	90	no	2		13	pecu	access	part	2	0
1.16	heritage	8	house	90	no	8		8	pecu	path	no	8	0
1.17	globe	2	house	180	no	2		40	switch	access	part	2	0
1.18	bulkhead	3	house	90	no	3		60	pir	door	no	2	1
1.18	floodlight	1	garage	0	yes		1	300	pir	access	yes	1	0
1.18	floodlight	1	garage	20	yes	1		120	pir	drive	no	1	0
1.19	floodlight	2	house	90	yes		2	300	pir	yard	part		2
1.19	heritage	2	house	180	no	2		20	switch	door	no	2	0
1.19	bulkhead	4	barn	90	no	4		28	switch	access	no	4	0
1.19	floodlight	1	barn	80	yes		1	300	switch	yard	no		1
1.20	heritage	4	house	180	no	4		60	switch	access	part	4	0
1.20	bulkhead	1	garage	90	no	1		60	switch	yard	part	1	0
1.20	led	8	ground	90	no	8		3	solar	drive	part	8	0
1.20	heritage	2	gate	180	no	2		40	switch	access	no	2	0
1.21	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
1.21	wellglass	2	house	0	no	2		60	pir	corner	no	2	0
1.21	bulkhead	3	house	90	no	3		60	pir	path	no	3	0
Sub1	92%		135								124		
2.01	plaza	2	sports hall	90	no			50	switch	car park	no		2
2.01	street light	1		5	no		1	35	switch	corner	no	1	0
2.01	bulkhead	2		90	no	2		8	emerg.	exit	no	2	0
2.02	bulkhead	1	clubhouse	90	no	1		11	switch	door	part		1
2.03	floodlight	1	garage	70	yes		1	300	pir	drive	no		1
2.04	heritage	2	house					8	switch	door	part	2	0
2.05	bulkhead	1	house	90	no	1		60	pir	access	no	1	0
2.06	garage	2	garage	45	yes		2	150	pir	drive	no	2	0
2.06	heritage	4	house	180	no	4		11	switch	porch	part	4	0
2.07	bulkhead	1	house	90	no	1		16	switch	path	no	1	0
2.08	bulkhead	1	house	0	no	1		40	switch	door	part	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
2.08	ds floodlight	3	house	0	yes		3	150	pir	path	yes	3	0
2.09	wellglass	1	house	0	no	1		60	switch	path	no	1	0
2.10	no lights												0
2.11	bulkhead	2	house	90	no	2		16	switch	door	no	2	0
2.12	bulkhead	2	house	90	no	2		16	switch	door	no	2	0
2.13	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
2.13	bulkhead	2	house	90	no	2		11	pir	path	no	2	0
2.14	wellglass	2	house	90	no	2		60	switch	door	no	2	0
2.15	heritage	1	house	180	no	1		40	switch	door	no	1	0
2.15	bulkhead	1	house	90	no	1		16	pecu	drive	no	1	0
2.15	floodlight	1	hut	45	yes		1	200	pir	drive	part	1	0
2.16	wellglass	1	house	0	no	1		60	switch	path	no	1	0
2.17	floodlight	1	house	90	yes		1	150	pir	drive	no		1
2.17	floodlight	2	house	45	yes			300	pir	parking	no		2
2.19	heritage	2	house	180	no	1		60	switch	path	no	2	0
2.20	heritage	1	house	180	no		1	par 38	switch	path	no	1	0
2.21	bulkhead	1	house	90	no	1		60	pir	door	no	1	0
2.21	floodlight	1	house	0	yes		1	150	pir	door	yes	1	0
2.22	bulkhead	1	house	90	no	1		60	switch	access	no	1	0
2.23	wellglass	2	house	0	no	2		60	switch	access	no	2	0
2.24	wellglass	1	house	45	no	1		60	switch	corner	no	1	0
2.25	wellglass	1	house	0	no	1		60	switch	door	no	1	0
2.26	floodlight	1	house	45	yes		1	120	pir	access	no	1	0
2.27	wellglass	1	house	0	no	1		60	switch	door	no	1	0
2.27	bulkhead	1	porch	90	no	1		60	pir	door	no	1	0
2.28	heritage	1	house	180	no	1		40	switch	door	no	1	0
2.29	bulkhead	1	garage	90	no	1		60	pir	access	no	1	0
2.30	bulkhead	1	house	90	no	1		60	switch	door	no	1	0
2.31	bulkhead	13	sheltered	90	no	13		16	switch	door	no	13	0
2.31	floodlight	1	sheltered	20	yes		1	42	pir	path	no	1	0
2.32	globe	1	house	90	no	1		60	switch	door	no	1	0
2.33	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
2.34	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
2.35	bulkhead	1	house	90	no	1		40	switch	access	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
2.36	heritage	1	house	180	no	1		60	switch	door	no	1	0
2.37	bulkhead	1	house	90	no	1		13	switch	path	no	1	0
2.38	heritage	1	garage	180	no	1		40	switch	door	no	1	0
2.39	heritage	1	house	180	no	1		60	switch	rear	no	1	0
2.39	bulkhead	1	house	90	no	1		60	pir	rear	no	1	0
2.40	heritage	2	house	90	no	2		40	pir	door	no	2	0
2.40	bulkhead	3	house	90	no	3		16	switch	access	no	3	0
2.41	floodlight	1	hotel	0	no		1	150	pir	rear	yes	1	0
2.41	heritage	2	hotel	180	no	2		8	switch	door	no	2	0
2.42	heritage	1	house	180	no	1		60	switch	door	no	1	0
2.42	heritage	1	house	180	no	1		8	switch	access	no	1	0
2.42	bulkhead	1	house	0	no	1		60	switch	rear	no	1	0
Sub2	92%		88								81		
3.01	heritage	2	house	180	no	2		40	switch	door	no	2	0
3.02	bulkhead	1	house	90	no	1		8	switch	door	no	1	0
3.03	no light												0
3.04	heritage	1	house	0	no	1		8	switch	door	no	1	0
3.04	wellglass	1	house	0	no	1		60	switch	rear door	part	1	0
3.05	heritage	3	house	180	no	3		8	switch	door	no	3	0
3.06	no light												0
3.07	heritage	1	house	0	no	1		60	switch	door	no	1	0
3.08	heritage	1	house	180	no	1		40	switch	door	no	1	0
3.09	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
3.09	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
3.10	no light												0
3.11	heritage	1	house	0	no	1		8	switch	rear access	part	1	0
3.11	heritage	2	house	180	no	2		8	switch	door	no	2	0
3.12	heritage	2	house	0	no	2		8	switch				2
3.12	floodlight	2	house	0	yes		2	300	switch	patio	yes	2	0
3.12	bulkhead	1	house	90	no	1		60	switch	access	no	1	0
3.12	bulkhead	2	house	0	no	2		8	switch	lane	yes	2	0
3.13	floodlight	1	pole	45	yes			70	switch	car park	no		1
3.13	bulkhead	1	house	90	no	1		60	switch	car park	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
3.13	heritage	1	house	0	no	1		11	switch	door	no	1	0
3.13	asymmetric	1	garden	180	yes			70	switch	wall wash	no		1
3.15	wellglass	1	house	0	no	1		60	switch	door	no	1	0
3.16	no light												0
3.17	heritage	1	house	180	no	1		20	switch	door	no	1	0
3.18	wellglass	2	house	0	no	2		60	switch	corner	no	2	0
3.18	bulkhead	1	garage	90	no	1		60	switch	drive	no	1	0
3.19	floodlight	1	house	0	no		1	300	switch	door	yes	1	0
3.20	wellglass	1	house	0	no	1		8	switch	door	no	1	0
3.21	heritage	1	house	180	no	1		60	switch	door	no	1	0
3.21	street light	1	house	0	no			55 sox	switch	corner	no		1
3.21	wellglass	1	outhouse	0	no	1		60	switch	access	no	1	0
3.22	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
3.23	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
3.23	wellglass	2	house	0	no	2		8	pir	access	no	2	0
3.23	floodlight	1	outhouse	0	yes		2	150	pir	access	yes	1	0
3.24	wellglass	2	house	0	no	2		60	switch	access	no	2	0
Sub3	88%		43								38		5
4.01	heritage	1	house	0	no	1		11	switch	door	no	1	0
4.01	wellglass	1	house	0	no	1		8	switch	corner	no	1	0
4.01	bulkhead	2	house	90	no	2		60	pir	access	no	1	1
4.02	wellglass	1	house	0	no	1		60	switch	access	no	1	0
4.02	coach lamp	1	house	90	no	1		60	pir	door	no	1	0
4.03	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
4.04	heritage	1	house	0	no	1		20	switch	door	no	1	0
4.05	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
4.05	heritage	1	house	0	no	1		60	switch	door	no	1	0
4.06	heritage	1	house	180	no	1		60	switch	door	no	1	0
4.06	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
4.07	bulkhead	1	house	0	no	1		60	switch	door	part	1	0
4.08	bulkhead	1	house	0	no	1		60	switch	door	part	1	0
4.09	wellglass	1	house	0	no	1		8	switch	access	no	1	0
4.10	floodlight	1	house	0	yes			300	switch	drive	yes	1	0
4.10	wellglass	1	house	0	no	1		8	switch	door	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
4.11	floodlight	1	house	45	yes			300	pir	steps	no		1
4.11	wellglass	2	house	0	no	2		60	switch	access	no	2	0
4.12	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
4.13	heritage	1	house	180	no	1		60	pir	door	no	1	0
4.13	floodlight	1	house	45	yes			300	pir	drive	no		1
4.14	bulkhead	2	house	90	no	2		60	switch	access	no	2	0
4.14	floodlight	1	house	90	yes			300	pir	drive	no		1
4.15	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
4.16	par38	2	house	60	yes		2	150	pir	drive	no	2	0
4.16	globe	1	house	90	no	1		60	switch	path	no	1	0
4.17	bulkhead	2	Carehome	90	no		2	28	pecu	path	no	2	0
4.17	bulkhead	2		90	no	2		8	emerg.	door	no	2	0
4.18	par38	2	house	60	yes		2	150	pir	drive	no	2	0
4.18	wellglass	1	house	0	no	1		60	switch	door	no	1	0
4.19	bulkhead	1	house	0	no	1		8	switch	door	no	1	0
4.20	heritage	1	house	0	no	1		60	switch	door	no	1	0
4.21	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
4.22	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
4.22	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
4.23	bulkhead	1	house	90	no	1		60	switch	path	no	1	0
4.23	heritage	1	house	180	no	1		60	switch	door	no	1	0
4.24	wellglass	4	house	0	no	4		60	switch	path	no	4	0
4.25	pathlight	3	drive	0	no	3		60	switch	drive	yes	3	0
4.26	heritage	1	house	0	no	1		60	switch	access	no	1	0
4.27	wellglass	1	house	0	no	1		40	switch	path	no	1	0
4.27	floodlight	1	house	45	yes	1		300	pir	drive	no	0	1
4.27	contemporary	2	house	180	no	2		35	switch	door	no	2	0
4.28	heritage	1	post	180	no	1		60	switch	garden	no	1	0
4.28	wellglass	1	house	0	no	1		60	switch	garden	no	1	0
4.28	bulkhead	3	house	90	no	3		13	switch	path	no	3	0
4.29	wellglass	2	house	0	no	2		60	switch	path	no	2	0
4.29	bulkhead	1	garage	90	no	1		60	switch	drive	no	1	0
4.30	floodlight	1	house	0	no			300	switch	door	yes	1	0
4.30	bulkhead	1	house	90	no	1		60	pir	access	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
4.31	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
4.31	floodlight	1	house	45	yes			300	pir	access	no	0	1
4.32	no lights	0										0	0
4.33	no lights	0										0	0
4.35	heritage	4	house	180	no	4		60	switch	access	no	4	0
4.35	floodlight	1	house	45	yes			300	pir	access	no	0	1
4.36	wellglass	3	house	0	no	3		60	switch	access	no	3	0
4.36	bulkhead	2	house	90	no	2		13	switch	door	no	2	0
4.37	wellglass	2	house	0	no	2		60	switch	access	no	2	0
4.38	heritage	1	post	180	no	1		8	switch	drive	no	1	0
4.38	heritage	2	house	180	no	2		8	switch	access	no	2	0
4.39	heritage	7	house	180	no	7		40	switch	access	no	7	0
4.39	heritage	2	post	180	no	2		8	switch	drive	no	2	0
4.40	heritage	1	house	180	no	1		11	switch	stair	no	1	0
4.40	heritage	4	house	90	no	4		40	switch	access	no	4	0
4.41	spotlight	2	workshop	60	yes		2	150	pir	access	part	2	0
4.41	floodlight	1	workshop	45	yes		1	150	pir	steps	part	1	0
4.42	wellglass	1	house	0	no	1		60	switch	access	no	1	0
4.43	floodlight	1	house	45	yes			300	pir	access	no	0	1
4.43	heritage	1	post	180	no	1		60	switch	drive	no	1	0
Sub4	92%		103								95		
5.01	spotlight	4	house	20	yes	4		35	pir	garden	part	4	0
5.01	wellglass	2	house	0	no	2		60	switch	garden	no	2	0
5.02	heritage	2	flats	0	no			80	24hour	door	no		2
5.03	heritage	2	house	180	no	2		40	switch	door	no	2	0
5.04	floodlight	1	house	10	yes			300	pir	drive	part	1	0
5.04	heritage	1	house	180	no	1		60	pir	steps	no	1	0
5.05	heritage	1	house	180	no	1		60	pir	steps	no	1	0
5.06	bulkhead	1	house	0	no	1		60	switch	access	no	1	0
5.07	bulkhead	2	house	90	no	2		18	switch	access	no	2	0
5.07	contemporary	1	house	180	no	1		35	switch	door	no	1	0
5.08	spotlight	1	house	10	yes	1		60	pir	path	no	1	0
5.08	wellglass	1	house	0	no	1		8	switch	path	no	1	0
8.08	bulkhead	1	house	0	no	1		60	switch	path	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
5.09	wellglass	1	house	0	no	1		60	switch	corner	no	1	0
5.09	bulkhead	3	house	90	no	3		60	pir	rear	no	3	0
5.10	bollard	3	wall top	90	no	3		60	pir	drive	no	3	0
5.10	heritage	3	house	90	no	3		40	switch	path	no	3	0
5.11	heritage	5	house	90	no	5		8	switch	access	no	5	0
5.11	bulkhead	2	house	90	no	2		18	switch	path	no	2	0
5.12	bollard	2	gate post	90	no	2		60	switch	access	no	2	0
5.13	globe	2	gate post	90	no	2		60	switch	access	no	2	0
5.13	bulkhead	1	garage	90	no	1		60	pecu	door	no	1	0
5.13	bulkhead	1	house	0	no	1		60	pecu	door	part	1	0
5.14	heritage	1	house	180	no	1		60	switch	path	no	1	0
5.14	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
5.14	floodlight	1	outhouse	0	yes			300	pir	garden	yes	1	0
5.14	floodlight	1	house	45	yes			300	pir	path	part		1
5.14	bulkhead	1	house	90	no	1		60	switch	door	no	1	0
5.14	wellglass	1	house	0	no	1		20	switch	corner	no	1	0
5.15	floodlight	1	post	45	yes		1	150	pir	gate	part	1	0
5.15	heritage	2	post	180	no	2		11	switch	gate	no	2	0
5.15	wellglass	1	house	0	no	1		60	switch	door	no	1	0
5.15	floodlight	1	house	45	yes			300	pir	drive	no		1
5.16	heritage	1	house	180	no	1		60	switch	path	no	1	0
5.17	7 bulkhead		old school	90	no			mix 8/13	switch	emerg.	no		0
5.17	1 floodlight		old school	0	no			300	pir	path	yes		0
5.17	5 wallpack		old school	90	no			70	switch	play area	no		0
5.17	5 sonpack		old school	45	yes			250	switch	play area	no		0
5.17	1 bysymmetric		old school	0	yes			70	switch	play area	yes		0
5.17	4 caribe		old school	90	no			70	switch	play area	no		0
5.18	bulkhead	4	flats	90	no	4		16	switch	door	no	4	0
5.19	wellglass	2	house	0	no	2		60	switch	door	no	2	0
5.19	heritage	1	house	180	no	1		60	switch	door	no	1	0
5.20	bulkhead	1	house	0	no	1		60	switch	path	no	1	0
5.21	bulkhead	2	house	90	no	2		60	switch	door	no	2	0
5.21	wellglass	1	house	0	no	1		60	switch	corner	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
5.22	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
5.23	bulkhead	1	house	0	no	1		16	switch	path	no	1	0
5.24	heritage	2	house	180	no	2		11	switch	front	no	2	0
5.25	heritage	1	house	0	no	1		40	switch	door	no	1	0
5.26	bulkhead	1	house	90	no	1		13	switch	door	no	1	0
5.26	floodlight	1	house	0	yes			300	pir	steps	yes	1	0
5.27	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
5.28	heritage	2	house	180	no	2		40	switch	door	no	2	0
5.29	heritage	1	house	180	no	1		60	switch	door	no	1	0
5.30	heritage	2	house	180	no	2		8	switch	door	no	2	0
Sub5	95%		79			empty building not included					75		
6.01	no lights												0
6.05	no lights												0
6.06	bulkhead	14	house	90	no	14		16	switch	sheltered	no	14	0
6.06	floodlight	1	house	45			1	42	pir	sheltered	no	1	0
6.19	globe	1	house	0	no	1		60	switch	door	no	1	0
6.20	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
6.21	no lights												0
6.22	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
6.23	bulkhead	1	house	90	no	1		13	switch	path	no	1	0
6.24	heritage	1	house	180	no	1		8	switch	path	no	1	0
6.25	bulkhead	1	house	90	no	1		13	switch	door	no	1	0
6.26	heritage	1	garage	180	no	1		20	switch	door	no	1	0
6.27	no lights												0
6.28	heritage	1	house	180	no	1		60	switch	yard	no	1	0
6.28	bulkhead	1	house	90	no	1		60	pir	yard	no	1	0
6.29	bulkhead	1	house	90	no	1		13	switch	yard	no	1	0
6.29	bulkhead	1	house	90	no	1		18	switch	access	no	1	0
6.30	heritage	2	house	180	no	2		40	pir	path	no	2	0
6.31	floodlight	1	hotel	0	yes			300	pir	yard	yes	1	0
6.31	heritage	3	hotel	180	no	3		8	switch	door	no	3	0
6.32	heritage	1	house	180	no	1		8	switch	path	no	1	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
6.32	bulkhead	2	house	90	no	2		60	switch	path	no	2	0
6.33	contemporary	1	house	180	no	1		35	switch	table	no	1	0
6.34	bulkhead	2	house	90	no	2		60	switch	door	part	2	0
6.35	bulkhead	1	house	0	no	1		60	switch	door	part	1	0
6.36	heritage	1	house	0	no	1		20	switch	door	no	1	0
6.37	no lights												0
6.38	bulkhead	1	house	90	no	1		60	switch	garden	no	1	0
6.39	floodlight	1	house	0	yes			300	pir	garden	yes	1	0
6.40	bulkhead	1	house	0	no	1		13	switch	door	no	1	0
6.41	heritage	1	house	0	no	1		40	switch	door	no	1	0
6.42	bi-symmetric	4	office	45	yes			70	pecu	yard	part		4
6.43	floodlight	1	house	90	yes			300	pir	garden	no		1
6.44	bulkhead	1	house	90	no	1		60	switch	garden	no	1	0
6.45	heritage	3	house	180	no	3		60	switch	front	no	3	0
6.46	heritage	1	post	180	no	1		40	switch	garden	no	1	0
6.47	heritage	1	house	180	no	1		60	switch	door	no	1	0
6.48	bulkhead	1	house	90	no	1		60	switch	door	no	1	0
6.49	bulkhead	1	house	90	no	1		60	switch	door	no	1	0
6.50	wellglass	1	surgery	0	no	1		60	switch	corner	no	1	0
6.51	heritage	1	house	180	no	1		11	switch	door	no	1	0
6.51	floodlight	1	house	10	yes			300	pir	drive	no		1
6.51	bulkhead	1	house	90	no	1		13	switch	path	part	1	0
6.52	heritage	3	house	0	no	3		60	switch	path	no	3	0
6.52	bulkhead	1	house	0	no	1		60	switch	path	no	1	0
6.52	wellglass	1	garage	0	no	1		60	switch	drive	no	1	0
6.53	wellglass	3	house	0	no	3		60	switch	corner	no	3	0
6.53	heritage	2	pole	180	no	2		20	switch	garden	no	2	0
6.53	floodlight	1	house	0	yes			300	pir	drive	yes	1	0
6.54	heritage	3	house	180	no	3		60	switch	path	no	3	0
6.55	bulkhead	1	house	0	no	1		60	switch	door	no	1	0
6.55	heritage	3	house	180	no	3		20	switch	path	no	3	0

Table 6.3 Domestic Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
6.55	bulkhead	1	garage	90	no	1		60	switch	path	no	1	0
6.56	heritage	4	house	180	no	4		8	switch	path	no	4	0
6.56	bulkhead	2	house	0	no	2		60	switch	door	no	2	0
6.56	floodlight	1	house	0	yes			300	pir	drive	yes	1	0
Sub 6	93%		87								81		
Part Domestic Totals		535			84%	448	39				92%	494	46

Table 6.3 Domestic Property Audit Summary

Total Domestic Units Surveyed = 535		2,500 lumens Compliance = 84%				5,000 lumens Compliance = 92%	
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Table 6.4 Non-Domestic & Commercial Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
7.01	Bollard	8	post	90	no	8		11	pecu	drive	no	8	0
7.01	road light	6	column	5	no		6	55SOX	pecu	car park	no		6
7.01	wallpack	8	hospital	90	no		8	50son	pecu	path	no		8
7.01	asymmetric	1	hospital	45	yes			400	switch	steps	no		1
7.02	bi-symmetric	10	pole	70	yes			150mbi	time limit	training	no		10
7.02	bulkhead	4	clubhouse	90&0	no	4		16	switch	access	part	4	0
7.03	bulkhead	2	office	90	no	2		8	switch	access	no	2	0
7.03	floodlight	1	office	45	yes		1	300	switch	yard	no		1
7.04	bulkhead	7	office	90	no	7		28	pecu	access	no	7	0
7.04	bulkhead	1	office	90	no	1		8	switch	door	no	1	0
7.04	asymmetric	1	pole	0	yes			250	8pm limit	training	yes	1	0
7.04	asymmetric	2	pole	45	yes			250	8pm limit	training	no		2
7.05	floodlight	1	cafe	0	no		1	120	switch	yard	yes	1	0
7.05	led floodlight	2	cafe	45	yes	2			pir	yard	no	2	0
7.05	bulkhead	2	cafe	90	no	2		8	switch	access	no	2	0
7.05	floodlight	1	cabin	0	yes			300	switch	pre 6pm	yes	1	0
7.06	bulkhead	6	toilet	90&0	no	6		11	pecu	access	part	6	0
7.06	power point	21	post	90	no	21		8	pecu	marker	no	21	0
7.06	bi-symmetric	2	post	0	yes			150	switch	storage	yes	2	0
7.06	new proposal	2	post	0	yes			150	switch	entry	yes	2	0
7.07	bulkhead	16	mill	90	no	16		16	pecu	access	no	16	0
7.07	floodlight	2	mill	0	yes			150	pir	door	yes	2	0
7.07	bysymmetric	1	mill	90	yes			400	switch	coach park	no		1
7.07	bi-symmetric	1	mill	90	yes			70	switch	coach park	no		1
7.07	asymmetric	1	mill	90	yes			150	switch	coach park	no		1
7.08	bi-symmetric	4	post	80	yes			250	switch	yard	no		4
7.08	bulkhead	14	shop	0	no	14		8	pecu	path	no	14	0
7.08	asymmetric	1	shop	0	yes			150	pecu	atm	yes	1	0
7.08	downlight	4	shop	0	no				pecu	atm	yes	4	0
7.08	street light	10	post	0	no			80	10pm off	drive	no		10
7.08	bi-symmetric	1	shop	80	yes			250	switch	yard	part		1

Table 6.4 Non-Domestic & Commercial Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
7.09	3 asymmetric		old hotel	45	yes			250	dead	parking	no		
7.10	bulkhead	2	office	90	no	2		16	pecu	access	no	2	0
7.10	bi-symmetric	1	office	90	yes			70	switch	car wash	no		1
7.10	downlight	11	canopy	0	no			Multiled	dimmable	petrol pump	yes	11	0
7.11	bi-symmetric	4	pub	90	yes			70	switch	tables	part		4
7.11	heritage	10	pub	180	no	10		11/24	switch	footpath	part	10	0
7.11	sign light	12	pub	0	no	12		13	switch	wall wash	yes	12	0
7.12	street light	1	garage	15	no		1	35	switch	yard	part	1	0
7.12	floodlight	2	garage	45	yes		2	300	pir	yard	part	2	0
7.13	bulkhead	5	restaurant	90	no	5		8	pecu	path	part	5	0
7.13	sign light	2	restaurant	0	no	2		24	pecu	front wash	yes	2	0
7.14	floodlight	1	garage	20	yes			300	pir	yard	part	1	0
7.15	floodlight	1	centre	10	yes		1	100	pir	yard	part	1	0
7.15	bulkhead	2	centre	90	no	2		8	switch	yard	no	2	0
7.15	globe	1	centre	0	no	1		60	switch	door	no	1	0
7.15	heritage	2	centre	180	no	2		24	switch	door	no	2	0
7.16	heritage	4	hotel	180	no	4		8	switch	door	no	4	0
7.17	bulkhead	1	bandb	90	no	1		13	switch	door	part	1	0
7.18	floodlight	2	shop	0	no		2	120	switch	pavement	yes	2	0
7.19	heritage	2	bandb	180	no	2		11	switch	door	no	2	0
7.20	bulkhead	1	shop	90	no	1		12	switch	door	no	1	0
7.20	sign light	2	shop	0	no	2		8	switch	sign	yes	2	0
7.21	heritage	2	hotel	180	no	2		24	switch	door	no	2	0
7.21	bi-symmetric	2	hotel	90	yes			70	switch	wall wash	part	2	0
7.21	asymmetric	1	ground	180	yes			250	switch	wall wash	no		1
7.21	heritage	1	chalet	180	no	1		8	switch	door	part	1	0
7.21	floodlight	1	hotel	45	yes		1	300	switch	courtyard	part	1	0
7.21	bulkhead	2	hotel	90	no	2		60	switch	courtyard	part	2	0
7.22	downlight	11	canopy	0	no			250	switch	pumps	yes	11	0
7.22	bi-symmetric	2	pole	0/30	yes			250	switch	car wash	no		2
7.22	bulkhead	1	office	90	no	1		8	switch	door	no	1	0

Table 6.4 Non-Domestic & Commercial Property Lighting Audit

Ref No	Type of Fitting	Qty.	Building Type	Elevation	Adaptable	<2500	2500-5000	wattage	Switching	Application	Fully Shielded	Compliant	Non-Cply.
7.23	heritage	1	restaurant	0	no	1		11	switch	door	no	1	0
7.24	bi-symmetric	2	hotel	45	yes			250	12 pm off	car park	no		2
7.24	bi-symmetric	1	hotel	90	yes			250	2pm off	wall wash	part		1
7.25	wallglass	2	shop	0	no	2		60	switch	path	no	2	0
7.25	bi-symmetric	2	shop	45	yes		2	80	6pm off	plant stall	no	2	0
7.26	heritage	5	hotel	0	no	5		11	switch	pavement	no	5	0
7.26	heritage	3	hotel	180	no	3		40	switch	front	no	3	0
7.26	signlight	2	hotel	0	no	2		60	switch	sign	yes	2	0
7.26	bulkhead	3	hotel	90	no	3		8	switch	doors	part	3	0
7.26	bi-symmetric	3	hotel	145	yes			70	switch	wall wash	part		3
7.26	floodlight	2	hotel	10	yes			300	pir	courtyard	part	2	0
7.27	signlight	3	cafe	0	no	3		60	switch	sign	yes	3	0
7.28	heritage	4	hotel	180	no	4		11	switch	doors	no	4	0
7.28	heritage	4	post	180	no	4		20	switch	courtyard	no	4	0
7.29	bulkhead	4	health	90	no	4		8	switch	courtyard	no	4	0
7.30	floodlight	2	surgery	45	yes			300	pir	courtyard	part		2
7.30	bulkhead	5	shops	90	no	5		60	switch	rear access	part	5	0
7.31	streetlight	24	pole	0	no			150	t/switch	c.park/f.path	part		24
7.31	bulkhead	18	school	90	no	18		8	emerg.	fire exit	no	18	0
7.31	asymmetric	14	school	0	yes			150	t/switch	area	yes	14	0
7.31	asymmetric	7	school	45	yes			150	t/switch	quadrangle	part	0	7
7.31	asymmetric	8	pole	0	yes			400	switch	sport	yes	8	0
7.31	asymmetric	1	pole	0	yes			150	switch	exit	yes	1	0
7.31	denver/wall	12	school	90	no		12	42	t/switch	access	no	12	0
7.31	denver/below	10	school	90	no		10	42	t/switch	access	part	10	0
		430				204	50		All 7.31	11.00pm off		305	
				Compliant								71%	
	Domestic Units		535	494	92%								
	Commercial Units		430	305	71%								
	Total		910	799	87%								

6.5 New Sky Quality Results - Post Retrofitting

Table 6.5

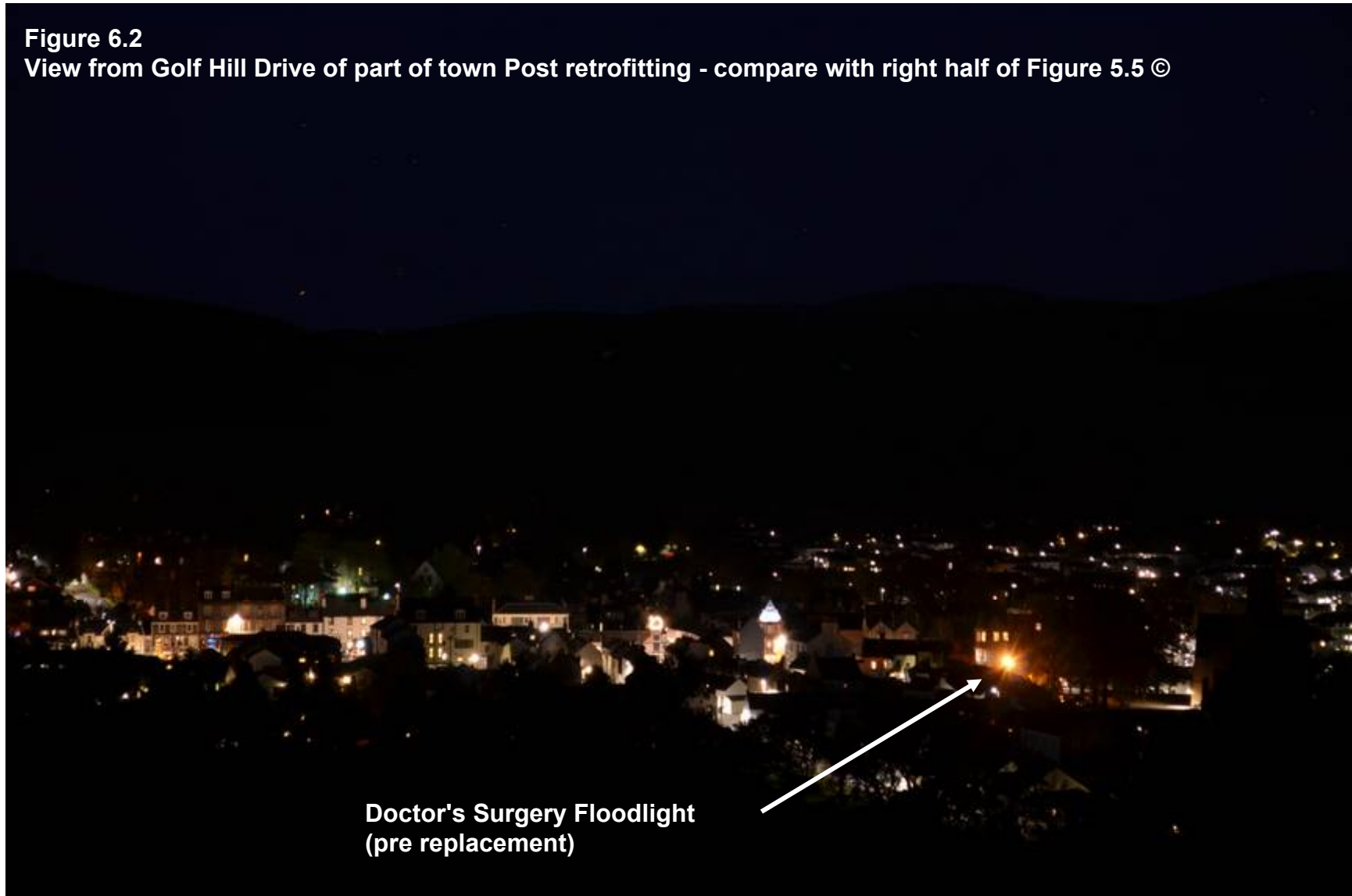
Ref. #	Post Re-Lighting Sky Quality						Average	Average	Change		
	Location	Read 1	Read 2	Read 3	read 4	Read 5	After	Before			
VP01	Hillend Turning Circle	21.52	21.34	21.36	21.45	21.32	21.40	21.31	0.09		
VP02	Green Frog Car Park	21.21	21.2	21.22	21.2	21.2	21.21	20.91	0.30		
VP03	EWM Car Park	21	21.02	20.92	21.05	20.96	20.99	20.77	0.22		
VP04	St Andrews Church	20.95	20.94	21.01	21	20.95	20.97	19.68	1.29		
	04/11/2013	20.86	20.81	20.85	20.97	20.83	20.86				
VP05	Moffat CAN	20.99	20.94	20.93	20.92	20.93	20.94	20.67	0.27		
VP06	Golf Club	21.16	21.11	21.08	21.14	21.11	21.12	21.06	0.06		
VP07	Beattock	21.32	21.38	21.36	21.36	21.32	21.35	21.01	0.34		
	04/11/2013	21.14	21.1	21.23	21.14	21.12	21.15				
	23/11/2014	21.23	21.22	21.23	21.24	21.24	21.23				
VP08	Annan Water Hall	21.42	21.38	21.36	21.35	21.36	21.37	21.14	0.23		
	23/11.2014	21.32	21.37	21.38	21.37	21.38	21.36				
VP09	Well Road End	21.3	21.38	21.35	21.42	21.23	21.34	21.48	-0.14	drop??	
	04/11/2013	21.09	21.08	21.14	21.22	21.12	21.13				
	23/11.2014	21.25	21.25	21.25	21.23	21.24	21.24				
VP10	Rosemount control site	21.16	21.14	21.24	21.12	21.17	21.17	21.23	-0.06	drop??	
	04/11/2013	Mist conditions with low readings - not recorded									
	4am 10/11/2013	21.18	21.21	21.16	21.12	21.23	21.18	21.23			
	3am 29/11/2013	21.33	21.34	21.34	21.35	21.35	21.34	21.23	0.11	better	



Figure 6.1
Photograph taken from Rosemount House, Moffat during Persied Meteor Shower 2013 by James H Paterson ©

Figure 6.2

View from Golf Hill Drive of part of town Post retrofitting - compare with right half of Figure 5.5 ©



**Doctor's Surgery Floodlight
(pre replacement)**

6.5 Inventory of Retrofitted Public Street Lighting Pre September 2013

Road name	Street Lighting Inventory			New Dark Sky Conversion - 0% ULR					140w Cosmo.
	Old Lamp	No.	Old Profile	41w LED	41w LED	41w LED	41w LED	105w LED	
Beechgrove	45 CPO	8	CTG		8				
Old Edinburgh Rd.	45 CPO	8	CTG		8				
Old Edinburgh Rd.	55 SOX	10	Refractor			10			
Hillside Terrace	55 SOX	4	Refractor			4			
Hydro Avenue	55 SOX	5	Refractor			5			
Edinburgh Road	150 SON	12	Bowl					12	
Northfield Park	70 SON	2	Refractor				2		
Mearsdale Drive	55 SOX	2	Refractor			2			
Mearsdale	55 SOX	5	Refractor			5			
Meadow Place	55 SOX	5	Refractor			5			
Reid Street	55 SOX	5	Refractor			5			
Gallows Well	55 SOX	1	Refractor			1			
The Whins	55 SOX	4	Refractor			4			
Harthope Place	55 SOX	5	Refractor			5			
Grange Place	55 SOX	2	Refractor			2			
Grange Road	55 SOX	7	Refractor			7			
Academy Road	150 SON	5	Bowl					5	
Moffat House Lane	55 SOX	1	Refractor			1			
High Street	250 SON	8	Bowl						8
	70 SON	9	Conical				9		
	150 SON	11	Bowl					11	
Westpark	No Public Lighting								
Eastgate	55 SOX	11	Refractor			11			
Dundanion Road	55 SOX	5	Refractor			5			
Old Well Road	55 SOX	6	Refractor			6			
	35 SOX	2	Refractor	2					
Hartfell Crescent	35 SOX	6	Refractor	6					
Buccleuch Place	35 SOX	2	Refractor	2					
Dixon Street	55 SOX	2	Refractor			2			
Causway Street	55 SOX	3	Refractor			3			
	70 SON	1	Refractor				1		
Well Street	55 SOX	4	Refractor			4			
Star Street	55 SOX	2	Refractor			2			
Mansfield Square	55 SOX	6	Refractor			6			
Mansfield Place	55 SOX	4	Refractor			4			
Annangate	55 SOX	2	Refractor			2			
Church Street	55 SOX	2	Refractor			2			
Annanside	55 SOX	6	Refractor			6			
Rae Street	55 SOX	3	Refractor			3			
Buccleuch Street	55 SOX	3	Refractor			3			

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Church Place	55 SOX	1	Refractor		1*	
Church Gate	150 SON	3	Bowl			3
The Glebe	55 SOX	2	Refractor		2	
Beatock Road	150 SON	31	Bowl			31
Station Park	70 SON	8	CTG			8
	70 SON	3	Conical			3
Golf Hill Drive	70 SON	5	F/Glass			5
Holm Street	150 SON	4	Bowl			4
	70 SON	4	Refractor			4
Ladyknowe	55 SOX	1	Refractor		1	
Osborne Row		0				
Burnside	70 SON	6	Bowl			6
School Lane	55 SOX	2	Refractor		2	
Well Road	55 SOX	35	Refractor		35	
Hamilton Place	55 SOX	1	Refractor		1	
Greenwood Close	55 SOX	7	Refractor		7	
Millmeadows	55 SOX	2	Refractor		2	
Sidmount Avenue	55 SOX	5	Refractor		5	
Haywood Road	70 SON	7	F/Glass			7
	70 SON	7	Heritage			7*
Cinder Path	35 SOX	1	Refractor	1		
Millgreen	55 SOX	6	Refractor		6	
Millburn	55 SOX	2	Refractor		2	
Park Circle	55 SOX	16	Refractor		16	
	150 SON	1	CTG			1
St. Ninians Road	55 SOX	23	Refractor		23	
Annandale Road	55 SOX	8	Refractor		8	
Annandale Place	55 SOX	5	Refractor		5	
Annandale Way	55 SOX	8	Refractor		8	
Warriston Road	55 SOX	7	Refractor		7	
Warriston Place	35/55 S	12	Refractor	1	12	
Fingland Court	55 SOX	10	Refractor		10	
Pringle Court	55 SOX	9	Refractor		9	
The Holm	150 SON	19	CTG			19
Duncan Drive	55 SOX	7	Refractor		7	
Jeff Brown Way	150 SON	10	CTG			10
Old Carlisle Road	55 SOX	23	Refractor		23	
Hartfell Homes	45 CPO	8	CTG	8		
Selkirk Road	55 SOX	12	Refractor		12	
Ettrick Drive	55 SOX	8	Refractor		8	
Frenchland Drive	55 SOX	6	Refractor		6	
Crosslaw Burn	55 SOX	8	Refractor		8	
	70 SON	4	Refractor			4
Meadow Bank	55 SOX	1	Refractor		1	

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	70 SON	7	Refractor		7
Meadow Bank Rise	70 SON	3	Refractor		3
Ballplay Road	55 SOX	24	Refractor		24
Holm Park	35/55 S	2	Refractor	2	2
Eastfield Rise	55 SOX	6	Refractor		6

Table 6.6 Summary		POTENTIAL WATTAGE SAVING					
		35 SOX	45 CPO	55 SOX	70 SON	150 SON	250 SON
Pre Retrofit light sources							
Pre Application individual Totals		14	24	374	66	96	8
LED Retrofit Circuit watts		41	41	41	41	105	153*
New Application Load (watts)		574	984	15334	2706	10080	1224
New Connected Total Load	30.9	kWatts					* not LED

7.0 Community Sky Quality Management

7.01 Background

In addition to publishing new lumen caps in the 2013 IDA revisions to dark sky applications there are now fuller responsibility requirements to maintain records of the ongoing sky quality.

The IDA now require the maintenance of records showing sky darkness measurements at various times throughout the typical astronomy viewing months together with at least one permanently installed sky quality meter and also participation in the IDA Global Sky Monitor website.

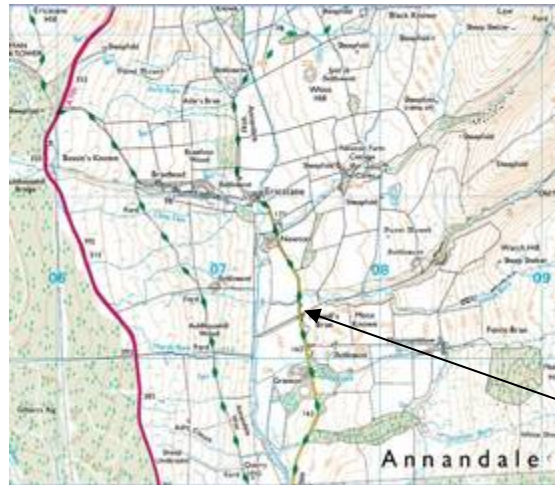
At the Community Council meeting on 28th November 2014 the nomination of two committee members to carry out this recording was unanimously approved. It will be the requirement of the Community Sky Quality Managers to measure, record and report their findings to the IDA on an annual basis.

In order to engage an educational side to monitoring the night time environment a permanent measuring device is proposed to be installed on or close to Moffat Academy. Two 6th Form pupils already attend the Community Council meeting each month and will add the permanent monitor results to the Community Agenda each astronomical month.

Sky Quality Management measurements will be undertaken as follows:

- Measurement locations to be the same as that previously used for this application and shown in Figure 5.9.
- Measurements to be taken on or close to a new moon.
- Measurements to be taken using Unihedron SQM-L meter.
- At each location 6 readings are required with the first reading discarded and the average value calculated using the 2nd through to 6th. Record all except 1st reading.
- Record percentage of cloud cover.
- Where access to any of the various measurement points becomes problematic new locations will be selected and added to the report. A linking 'same evening hour' measurement will be taken at both old and new locations as a linking quality control monitor.
- A GPS map reference shall be recorded for all new measurement locations.

7.02 Sky Quality Monitor Template
Darkest Post Relighting SQM Average



VP08
 Darkest = 21.37



VP09
 Darkest = 21.34

VP05
 Darkest = 20.94

VP01
 Darkest = 21.40

VP04
 Darkest = 20.77

VP06
 Darkest = 21.12

VP02
 Darkest = 20.91

VP03
 Darkest = 20.77

VP07
 Darkest = 21.35

7.03 New Sky Quality Results - Post Retrofitting

Ref.	Date	Consecutive SQM Readings					Average	Cloud	Time
		2	3	4	5	6			
VP01	10/3/15	21.31	21.3	21.4	21.3	21.33	21.33	10%	8pm
Hillend									
VP02									
G/Frog									
VP03	10/3/15	20.46	20.47	20.47	20.48	20.48	20.47	10%	8.15
EWM									
VP04	04/11/13	20.86	20.81	20.85	20.97	20.83	20.86		
church	10/3/15	20.36	20.35	20.37	20.39	20.45	20.38	20%	9pm
VP05	10/3/15	20.97	20.72	20.69	20.69	20.71	20.72	20%	8.45
M'can									
VP06	10/3/15	21.19	21.22	21.22	21.21	21.21	21.21	20%	8.45
golf									
VP07	04/11/13	21.14	21.10	21.23	21.14	21.12	21.15		
Beat'ck	23/11/14	21.23	21.22	21.23	21.24	21.24	21.23		
	10/3/15	21.2	21.19	21.1	21.1	21.26	21.17	15%	8.30
VP08	23/11/14	21.32	21.37	21.38	21.37	21.38	21.36		
A/water									
VP09	04/11/13	21.09	21.08	21.14	21.22	21.12	21.13	50%	
Well/rd	23/11/14	21.25	21.25	21.25	21.23	21.24	21.23		
	10/3/15	21.35	21.37	21.35	21.3	21.32	21.34	20%	9pm
VP10	04/11/13	Total mist – readings abandoned							
control	29/11/13	21.33	21.34	21.34	21.35	21.35	21.34		3am
	10/3/15	20.99	20.98	21.03	21.0	20.98	21.00	20%	9pm





Table 7.01 Template for readings taken after original September 2013 application submission.

Refer to Section 5.6 for the sky quality measurements taken prior to the removal of the low and high pressure sodium street lighting and Table 6.5 for measurements taken following the street lighting improvement works..

**8.0 Community Lighting Improvements
following original LMP submission in September 2013**

This section will be expanded as more improvements are brought into LMP compliance.

8.01 The Famous Star Hotel

	<p>70w High Pressure Sodium uplighting (see left)</p> <p>Replaced by</p> <p>20 watt LED Horizontal down-light and 10 watt LED close offset wall wash below ground level (see right and below)</p>	
 <p>Amitex 20 watt LED Down-light > 3,000 lumens</p>	 <p>Amitex 10 watt LED Basement Wall Wash <3,000 lumens</p>	

8.02 Memorial to the Fallen Residents of Moffat in Both World Wars



Four ground mounted spotlights located at each plinth corner and elevated 45 degrees to illuminate the four plinth faces only.

**4 x Design Plan - Centaur 4xLED Spotlight cat. no. CESB 100
Total output = 550 lumens**



Renovation work to clean the Memorial during 2014 to commemorate the 100th anniversary of WW1 included the installation of permanent lighting to comply with the objectives in Moffat's application for dark sky status. The light sources were placed on each corner of the plinth to accentuate the names on the plinth.

This angular incidence of upward light provides a shadow effect on each letter and although the names cannot be read in the photograph they can be read easily by night, on site, due to the light / dark modelling on the plinth.

This has been achieved with a light source less than the 600 lumen cap demand in a Dark Sky Park or Reserve.



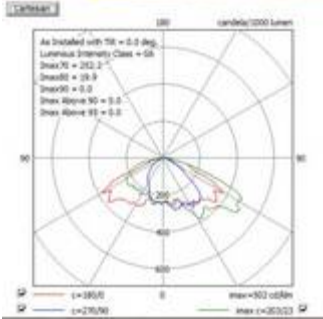
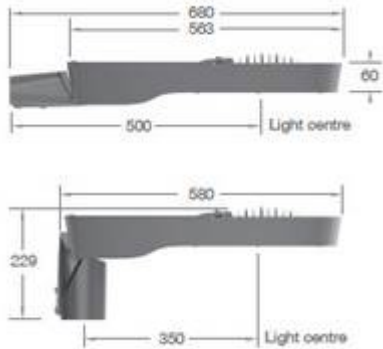
NOTE: Prior to the introduction of LED light sources this plinth would have been illuminated by a metal halide or sodium discharge light source greater than 5,000 lumens.

8.03 Moffat Cottage Hospital





View of Hospital property after public street lighting was changed to LED lighting



Moffat Lighting Master Plan recommends that all new external lighting using a light source greater than 3,000 lumens must be horizontal flat glass and that all light sources (including LED's) should be Warm White (about 3,100⁰K).


Existing Profile	Equipment Profiles Comments	Proposal
	<p>Car Park Lighting</p> <p>6 no. 35 or 55 watt low pressure sodium lanterns On 5 metre hockey stick column with 5⁰ or 10⁰ tilt</p>	<p>CU - Phosco P851 as -5⁰ or -10⁰ side entry option - cost about £200</p>  <p>Cat No P851-12-M-WID-G6-NW-D0200-31W (LED)</p>
		

	<p>Footpath Circulation round Hospital building</p> <p>11 no. Large Bulkhead - Plaza Type</p> <p>50 or 70w High pressure sodium Some are under cover but most are open to external view</p>	 <p>Siteco CW 27-5 Downlight Cat. 5NA 275 2-1MT2D 08 70w CDM-TT (but may now have 35w or LED version)</p>
<p>Alternative options</p>  <p>SILL 420</p>	 <p>ERCO - Parscoop (may now have LED version)</p>	 <p>iGuzzini Platea - BC46 (warm white LED version)</p>
	<p>2 no.</p>	 <p>Deltalight - Nox</p>
	<p>9 no</p> <p>Bollards</p> <p>(only 3 required if entry road is lit by wall mounted P851's)</p>	 <p>Thorlux - Probe</p> <p>57w TC-T Compact fluorescent</p> <p>4,300 lumens</p>

	<p>1 no. LED bi-symmetric floodlight with PECU</p> <p>Recent replacement for old 250/400w HPS floodlight</p>	<p>Phosco P851 on wall bracket</p> <p>Or</p> <p>iGuzzini Platea</p>
		<p>Bulkhead (8 watt)</p> <p>11 no.</p> <p>All units have lamps less than 3,000 lumens and are not at issue with dark sky objectives in a Dark Sky Community</p>
	<p>1 no.</p> <p>Par 38 spotlight on PIR presence detection</p>	<p>All units have lamps less than 3,000 lumens and are not at issue with dark sky objectives in a Dark Sky Community</p>

This project is awaiting funding

8.04 Residential Domestic Improvements

	<p>An example of upward light limitation from domestic Heritage lanterns where the owner resident has installed Crown Silvered lamps, normally associated with spotlight type projectors, to redirect upward waste light which would normally be expected from a similar wattage tungsten filament or compact fluorescent lamp.</p> <p>Location in Old Well Road.</p>
<p>DB improvement</p>	

8.05 Moffat and Beattock Domestic Waste Amenity Site

	
	<p>This site originally closed at 4.00 pm but recently the closing time was increased to 6.00 pm. During the winter months, with a sunset of 4.00 pm, there was therefore a need to illuminate the site for public safety.</p> <p>The flood lighting was designed and installed by Dumfries & Galloway Council to comply with the fully shielded requirements of LMP.</p> <p>All lights are extinguished at 6.30pm.</p>

**8.06 Beechgrove Tennis Club Moffat
Proposed Installation of 12 x 10 metre mounting floodlights**

Planning Application Stage - Fully shielded and compliant with IDA dark Sky requirements as in LMP

However on environmental approach average illuminance = 524lux and is over-lit for local club play.

Initial application has 2 public objections and is being re-considered.

DO NOT SCALE THIS DRAWING

Outline Specification

Luminaires

M1, M3, M4, M7 and M8 to have 1no. 2kw Sports Light (Thorn Champion).
M2 and M6 to have 2no. 2kw Sports Lights (Thorn Champion).
M5 to have 3no. 2kw Sports Lights (Thorn Champion).
Osram HQI 2kw Lamps.

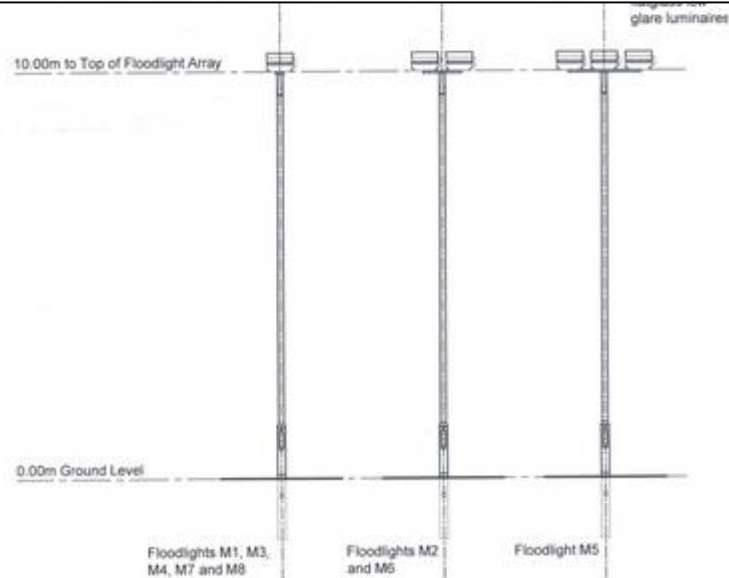
Columns

Mast/ste root mounted 10m corner and 10m intermediate columns.
galvanised steel finish.

PLANNING & BUILDING
SERVICES

11 AUG 2015

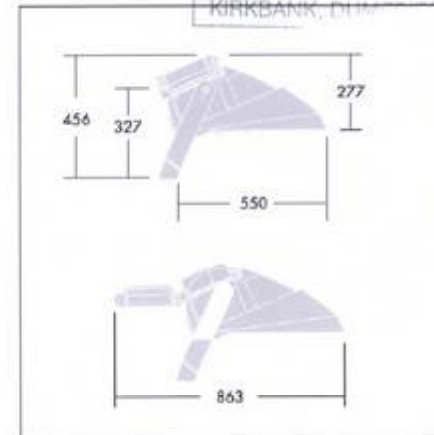
KIRK BANK, DUMFRIES



Thorn Champion - 2kw Sports Light

A high performance discharge floodlight with best in class optic for control of obstrusive light

- Compact asymmetric floodlight for 2 kW metal halide lamps, incorporating the flat glass concept and integrated visor for total control of glare and obstrusive light (0 cd at 90°), with additional accessories also available
- Maximum optical efficiency and accurate light distribution with minimum light spill
- Three lamp positions, adjustable on site, from just one installed position
- Tool-free aiming in azimuth with integrated aiming sights



The tennis courts and associated floodlight operating hours will be between 8.00am and 10.00pm

Rev	Date	Amendments	INT.

<p>Dumfries & Galloway</p> <p>Chief Executive Service Property & Architectural Services, Cargen Tower, Cargenoch Business Park, Cargenoch, Dumfries DG2 8RN</p> <p>T: 01387 271100 F: 01387 271168</p>	<p>client: Dumfries & Galloway Council Leisure & Sport</p>	<p>drawing title: Floodlight Column Details</p>			
	<p>project: Beechgrove Tennis Club Edinburgh Road, Moffat, DG10 9HY Tennis Court Development</p>	<p>scale: 1:100@A3</p>	<p>drawn: AMG</p>	<p>checked: </p>	<p>date: 04.08.2015</p>
	<p>job no: 15EL008</p>	<p>disc: AT</p>	<p>dwg no: L03</p>	<p>rev: </p>	

8.07 Gallow Hill
Proposed sale of land from Private Ownership into Communal Woodland Trust



Gallow Hill lies immediately North of Moffat and following the removal of a 40 year old Conifer Forest had opened the hill as a visual vantage point.

A Trust has recently been formed and a feasibility study has been commissioned. There is a preliminary thought that, together with other uses, it would provide an ideal spot to install hard standing for astro viewing or better still a small observatory if Moffat becomes a Dark Sky Town.

Appendix 1-5 Calculation Software Output - See Separate File

APPENDIX 6

The following 3 figures show the vertical distribution of light through the minor axis of a Philips BGS 451 1xECO35-2S_830 WSO road lighting luminaire at different angles of upward tilt.

It is not normal to compute values between 0.1 and 0.01 but have been included here to show that there is no upward light from this particular luminaire regardless of the bracket arrangement on which retrofitted. This is due to the excellent control of light from LED sources.

In each figure

the value of Isolux lines are:- 0.01, 0.05, 0.1, 1.0, 5.0, 10 and 25 lux

Light source:- 41watt LED

source lumens:- 3,800

colour temperature:- 3,000⁰K

grid points are at 0.5 metre intervals

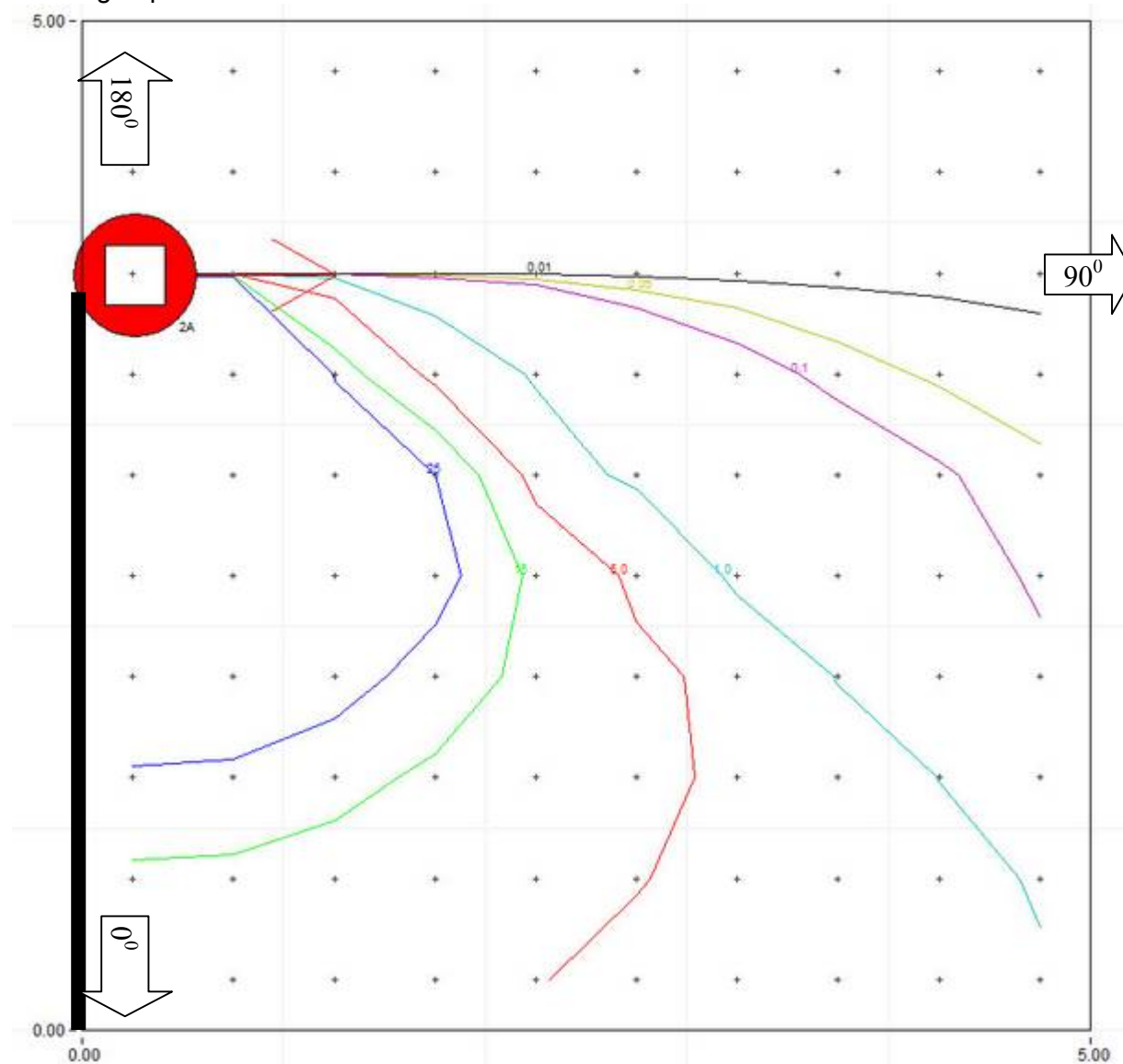


Figure A6.1 Philips BGS 451 tilted up 0 degrees

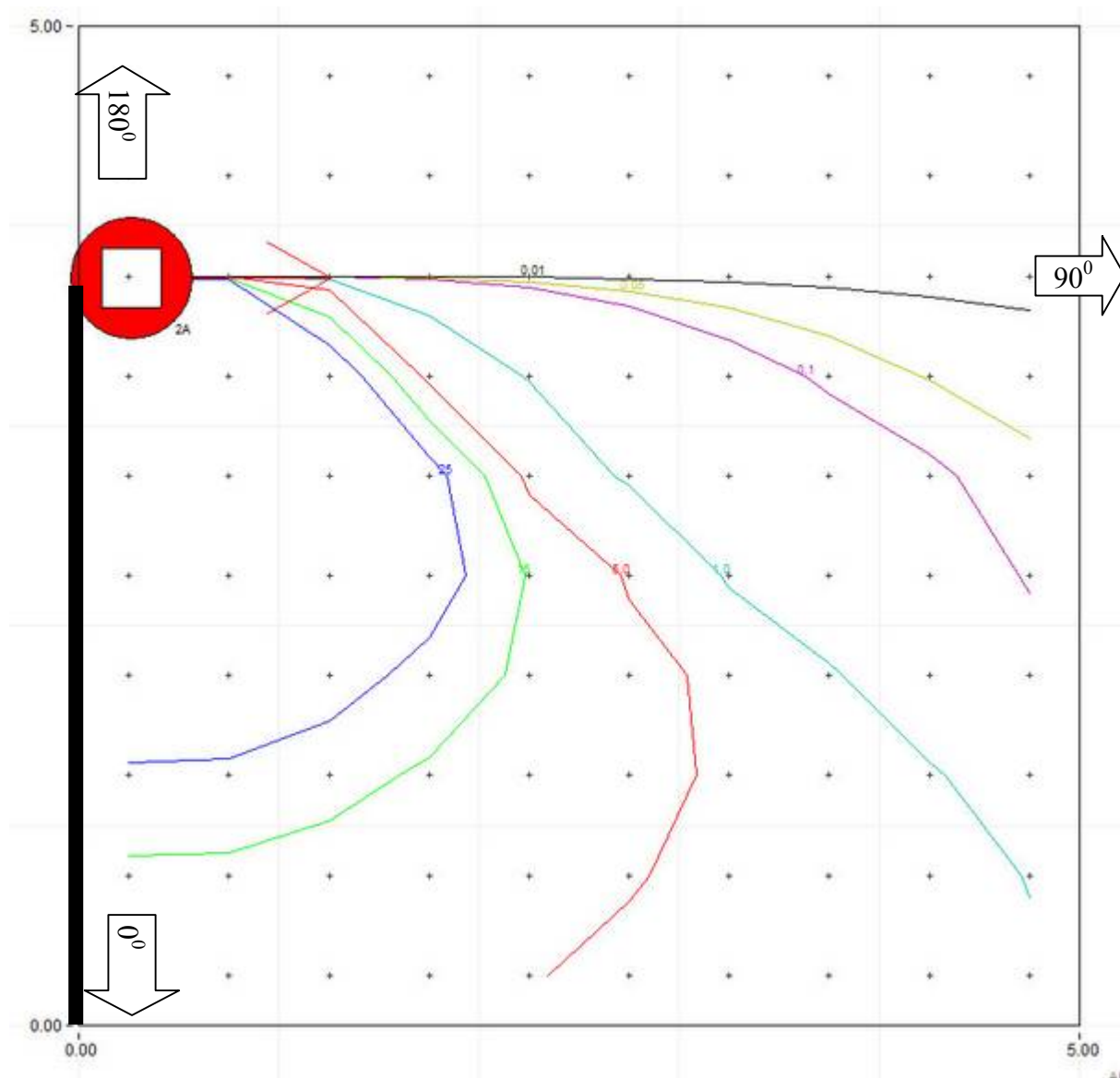


Figure A6.2 Philips BGS 451 tilted up 5 degrees

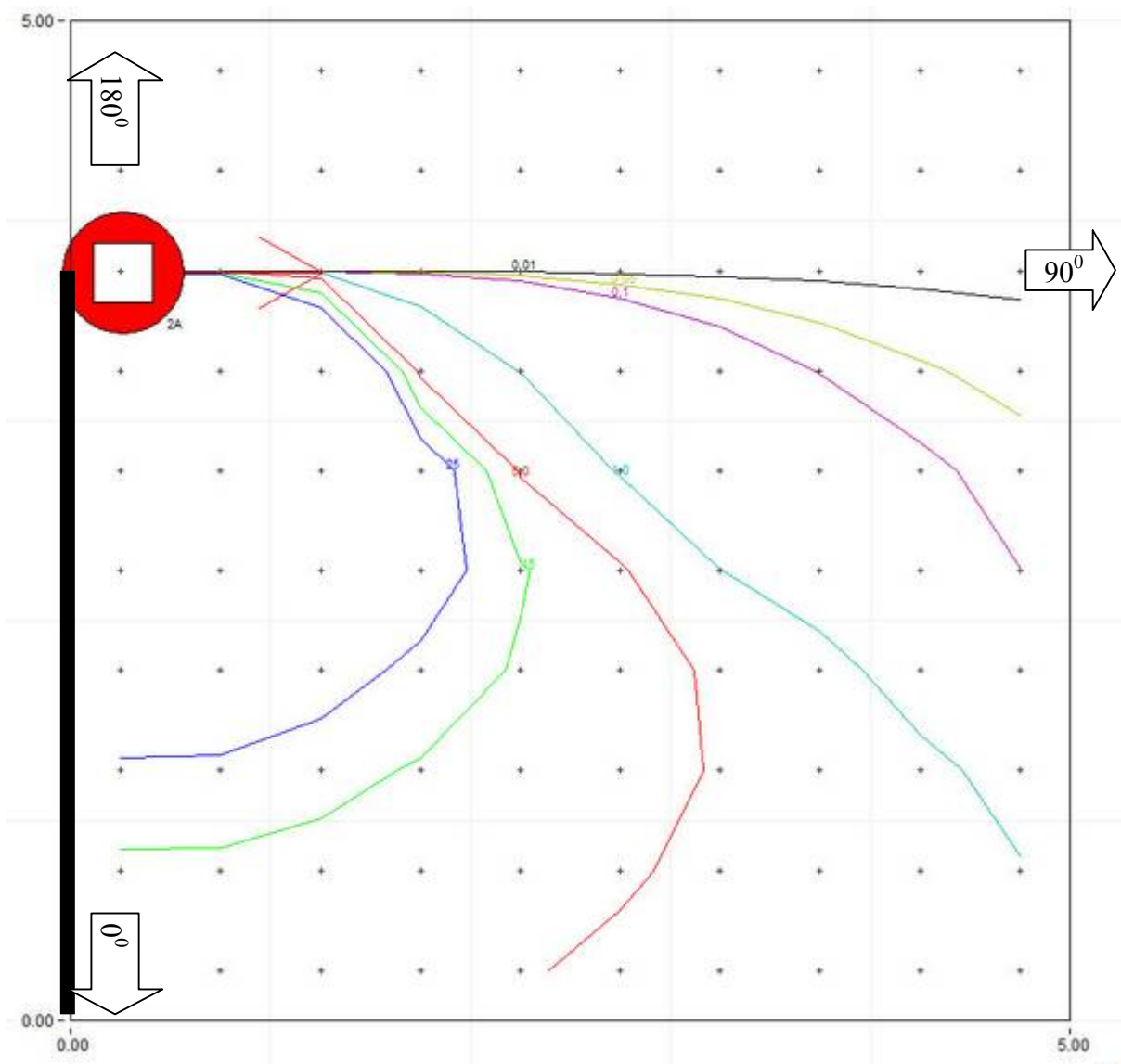


Figure A6.3 Philips BGS 451 tilted up 10 degrees

APPENDIX 7

Supporting Letters for Moffat - Dark Sky Community

Scottish / National Government

Joan McAlpine MSP - Scottish Parliament
Aileen McLeod MSP - Scottish Parliament

Municipal Authority

Sir Neil McIntosh CBE DL - Former Chief Executive Dumfries & Galloway
Mrs Jean Tulloch – Her Majesty’s Lord Lieutenant of Dumfries & Galloway
Alistair Speedie 1st letter - Director of Planning & Environmental Services
Adam Anderson – Chairman Moffat & District Community Council

Tourist Authority

Paula McDonald - Regional Director - Visit Scotland Tourist Board

Moffat Commerce

Martin Brown – Chairman Moffat & District Initiative
Tim Leighfield – Manager -The Famous Star Hotel
Moffat CAN 1st letter
Benmar Service Station
Ron McLean - B&B
Peter Grey- Beattock Station Action Group
David Major - Architect - White Hill Studio

Moffat Wildlife Trust

Iain Anderson - Club Chairman

Moffat Residents - Better Quality of Life

Evelyn Atkins
Peter Dreghorn

Moffat Residents - Dark Sky

Dr Peter Bower
Judith Holden
Colin Brydon
David Elliot
Jon and Christine Haydon

Moffat Academy Students

G Thompson	C F	F Rankin	R Crosby
D Lenox	C Dowds	C Wise	C Smith
A Paten	M	C Morgan	B Kirkpatrick
G Fritsch	E Carlyle	F Margerison	L Crawford
J Craig			

Recent Moffat Initiatives

Moffat CAN 2nd later letter
Green Frog Café
Neil Adams
David Booth



The Scottish Parliament
Pàrlamaid na h-Alba

Joan McAlpine MSP
South of Scotland Region

Mrs. Jean Purves,
Chairperson Moffat and District Community Council
Merecleuch House,
Ballplay Road,
MOFFAT
DG10 9JU

2nd October, 2013.

Dear Mrs. Purves,

Moffat Dark Skies Project.

I follow with interest the moves to have Moffat recognised as a dark sky park and wish the project every success.

The new lighting scheme should help with your project but if there is any way I can be of assistance please do not hesitate to contact me.

Yours sincerely,

Joan McAlpine
MSP for South of Scotland

Room M3.10, The Scottish Parliament, Edinburgh, EH99 1SP
Unit 7, Loreburne Centre, High Street, Dumfries DG1 2BD
Tel: 0131 348 6885 01387 255334 Email: Joan.McAlpine.msp@scottish.parliament.uk

Subj: **RE: Dark Sky Moffat**
Date: 10/04/2014 16:29:39 GMT Daylight Time
From: Aileen.McLeod.msp@scottish.parliament.uk
To: Lcadslimited@aol.com
CC: steve@owens-online.co.uk, calum.edgar@dumgal.gov.uk

Hi Jim

Many thanks for your email below and really good to have the chance to meet you the other Monday in Glasgow.

I really appreciate you drawing the wording of NPF3 with regard to dark sky Places to my attention and I take your point completely. I'm not sure if we will be able to secure the required re-wording of NPF3 at this late stage of its development. However, there is no harm in trying and we can but ask.

I've therefore written to Derek Mackay MSP, the Local Government and Planning Minister and drawn his attention to this issue and asked him what needs to be done to secure the necessary amendments to the text. I know Derek visited the Observatory at Dalmellington not that long ago so I have also mentioned to him what we are trying to do in a wider context in terms of maximising and promoting the potential of Scotland's international dark sky Places, how we can be encouraging the development of more such Places and how we can showcase Scotland as the place for dark sky tourism and also mentioned to him about the International Year of Light next year.

Lets see what he comes back with in his response to my letter to him and I will let you know as soon as I know more.

Thanks again for drawing this to my attention – very much appreciated on my part.

Kind regards
Aileen

**Birnock Lodge
Well Road
Moffat
DG10 9JT**

17th March, 2012

Dear Sir,

Moffat Dark Sky Community Status Application

I write in my capacity as a Deputy Lieutenant of Dumfriesshire and former Chief Executive of Dumfries & Galloway Council to support the bid by Moffat Community Council to establish Moffat as a Dark Sky Town. I have been a resident of Moffat for the past 29 years and fully recognise the significance which this status would have for the town and the wider community in this region coupled with the wider national interest for Scotland given that Moffat could be the first in Europe to achieve such special recognition.

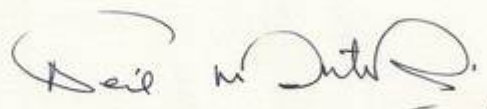
The reduction of light pollution in the town has been lead, in part, by the Community Council, their Lighting Engineer and Dumfries and Galloway Council Engineering staff. All have been working in close harmony over the past 12 months and have already changed most of the old street lighting luminaires in the town. The new units use less energy than the previous units but also, more importantly, have been carefully selected to provide the right amount of light on the public roads and footpaths without providing wasted upward light. This has markedly reduced town sky glow over both Moffat and the adjacent village of Beattock.

I understand that "before and after" sky quality meter readings in the town of Moffat are showing that the night sky is now darker as a direct result of the Council changing the street lighting and I hope that, apart from the energy savings for the Council, Dark Sky Status will bring an added value to the winter tourism in Moffat in the same way that Galloway Forest Dark Sky Park provided the Newton Stewart area when it was awarded Gold Status by the International Dark Sky Association in 2009.

I believe that the Exterior Lighting Master Plan which has been developed for Moffat and the generality of Dumfries and Galloway Council is a template which other towns in the Region can follow and I am sure some will follow on if the Community Council's initiative is successful.

On a wider view I hope local astronomy groups and a renewed interest in astronomy, across the South of Scotland and the North of England, flourishes out of this initiative to become a Dark Sky Town and wish the Community Council every success.

Sincerely



Sir Neil McIntosh CBE DL



DUMFRIES

Mr Adam Anderson
Chairman Moffat and District Community Council
C/o Mrs Jean Purves - Secretary
Merecleugh
Ballplay Road
Moffat
DG10 9JU

**GILLESBIE
LOCKERBIE
DG11 2LF**

Tel: 01576 610230

Fax: 01576 610240

Dear Mr Anderson,

Moffat Dark Sky Community Status Application

Thank you for giving me the opportunity to provide a letter of support for the bid to establish Moffat as a Dark Sky Town, possibly the first in Europe to achieve this status.

Over the past 12 months Dumfries and Galloway Council Engineering staff have been working in close harmony with your Lighting Consultant and have already changed more than 600 street lighting luminaires in the town. The new units use less energy than the previous units but also, just as importantly, have been carefully selected to provide the right amount of light on the public roads and footpaths without providing wasted upward light. This has markedly reduced town sky glow over both Moffat and Beattock.

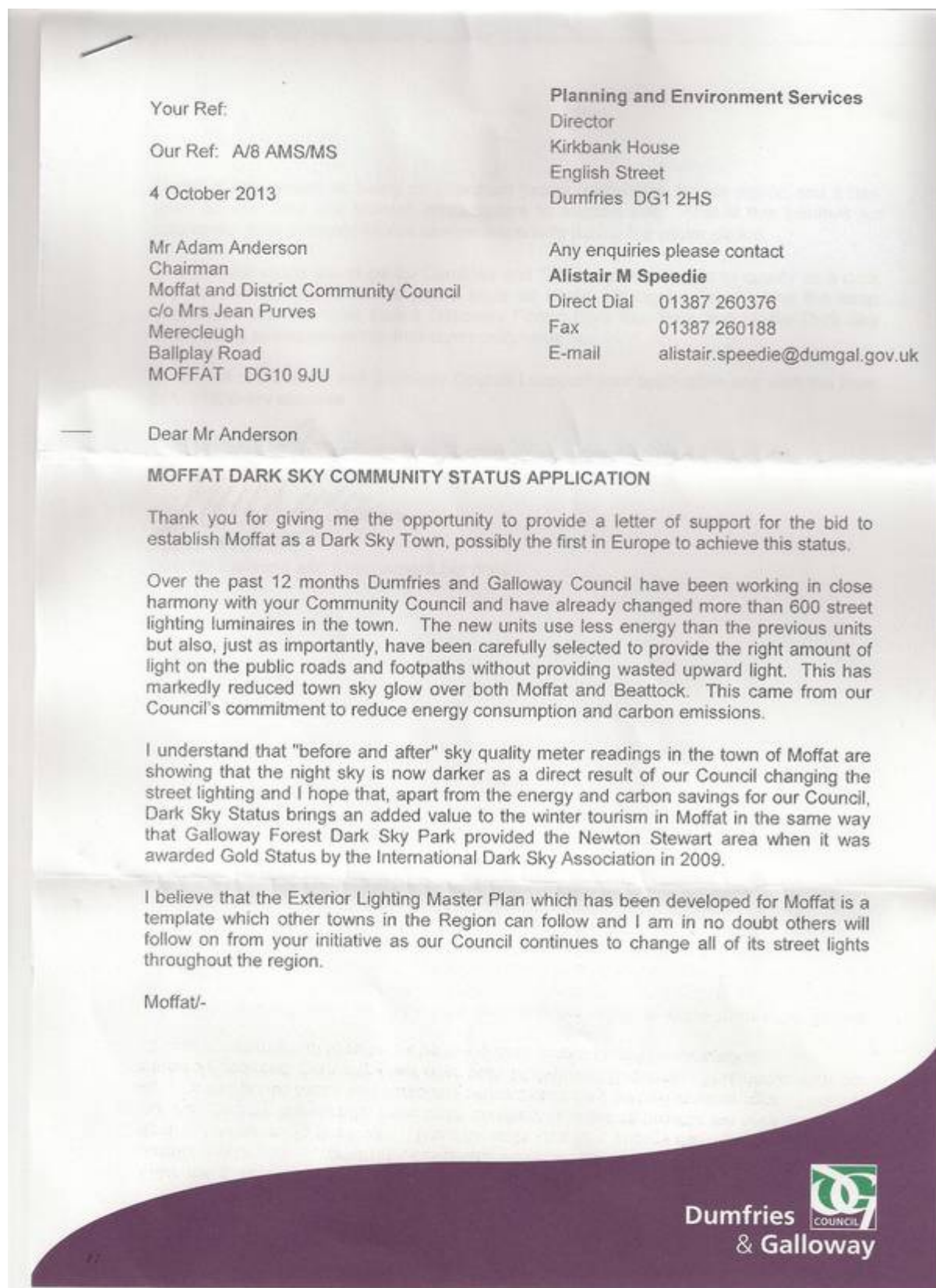
I understand that "before and after" sky quality meter readings in the town of Moffat are showing that the night sky is now darker as a direct result of the Council changing the street lighting and I hope that, apart from the energy savings for the Council, Dark Sky Status brings an added value to the winter tourism in Moffat in the same way that Galloway Forest Dark Sky Park provided the Newton Stewart area when it was awarded Gold Status by the International Dark Sky Association in 2009.

I believe that the Exterior Lighting Master Plan which has been developed for Moffat and the generality of Dumfries and Galloway Council is a template which other towns in the Region can follow and I am sure some will follow on if your initiative is successful.

On a wider view I understand that Northumberland National Park, together with Kielder Water & Forest Park have also prepared a parallel Exterior Lighting Master Plan and will be submitting it about the same time as Moffat. I hope astronomy groups, and a renewed interest in astronomy, across the South of Scotland and the North of England flourishes out of your initiative to become a Dark Sky Town and wish you every success.

Kind regards,

Jean 'elloch



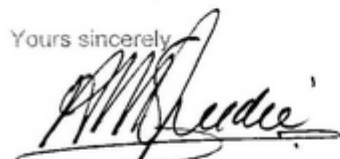
-2-

Moffat is recognised as being an important tourist destination for our region and it has good access links and tourism infrastructure to support this. Should this initiative be successful it will enhance Moffat tourism especially during the winter period.

The ultimate vision would be for Dumfries and Galloway as a region to qualify as a dark sky community/reserve in the future once all street lighting has undergone the lamp conversion with the Gold Status Galloway Forest Dark Sky Park and Moffat Dark Sky Town being exemplars within that community/reserve.

On behalf of Dumfries and Galloway Council I support your application and wish the town of Moffat every success.

Yours sincerely



Alistair M Speedie
Director Planning and Environment Services

22

Moffat & District



Community Council

Maple Lodge
Ballplay Road
Moffat
DG10 9JU
Ref: MDCC/JP/805

International Dark Sky Association

14th March 2014

Dear Sir

Moffat – A Dark Sky Town

As a direct result of Scottish Government funding, to create an energy reduction programme in street lighting, the Moffat & District Community Council is very keen to apply for **International Dark Sky Community** status and has already endorsed Dumfries and Galloway Council's commitment to replace the existing street lights in Moffat and Beattock with new units which, at the same time as reducing their carbon footprint, will provide less upward light.

By improving the quality of our sky at night, we not only retain a quality of life appreciated by residents, but could see the development of new and sustainable events and activities around star gazing and astronomy that could attract more visitors and be beneficial for local businesses.

Businesses, especially accommodation providers, will be able to promote opportunities for star gazing alongside the many other activities and attractions on offer. The Community Council will also support the development of astro-tourism, and the hosting of star gazing events, around Moffat and Beattock in the future.

The Community Council will continue to encourage residents and local businesses to replace their lighting with LED lights and fully supports the efforts of Mr Jim Paterson to assist us with achieving our goal to be recognised as a dark sky community.

Yours faithfully

Adam Anderson
Chairman

Adam Anderson
Chairman
01683 – 221164
e-mail: adamanderson2@btinternet.com

Jean Purves
Secretary/Treasurer
01683 – 221202
merecleuch93@btinternet.com

PM/Moffat Dark Skies
23 July 2013

Adam Anderson
Chairman
Moffat & District Community Council
c/o Mrs Jean Purves
Merecleugh
Ballplay Road
Moffat
DG10 9JU

Moffat Dark Sky Community Status Application

Thank you for giving VisitScotland the opportunity to provide a letter of support for the bid to establish Moffat as part of the UK's Dark Sky Community.

Recent years have seen Scotland's tourism industry maintain its position as a key contributor to the nation's economy, generating an annual visitor spend in excess of £4.5bn annually and day visitors contributing a further £6.2bn, giving a total spend close to £11bn (2011 figures). Not only that but tourism accounts for over 200,000 jobs – many in rural areas, helping less populous communities to prosper – across 20,000 different tourism-related businesses, while also feeding into other sectors such as food and drink, retail, transport and construction.

Visitor expectations have grown ever more sophisticated with a shift away from individual tourism attractions towards more rounded experiences, delivered to a consistently high quality at each point of the customer journey.

Any official "Dark Sky" status could add to the overall ambition to grow tourism numbers in Dumfries & Galloway and may be of benefit to the local area.

The Framework for Change also focuses on the need for quality products and services, working in collaboration and innovation - this proposal would seem to address these points and could provide a unique experience for tourists to the area.

Dumfries & Galloway is predominantly a leisure tourism destination and this development could add to the breadth of offering and contribute to the area becoming a sustainable year round destination.

It is a fact that most visitors to Scotland are attracted, more than anything else, by our scenery and natural environment. It is also a fact that Scotland has more forest cover than the rest of the UK (17% of Scotland is forested), so we know that Scotland's trees play a big part in adding to our visitors' enjoyment. Dark Sky Park status would add value to the existing experience provided by the Moffat to visitors.

Sustainability is a key theme in the Tourism Framework for Change and the local Area Tourism Partnership Plan. To become Europe's most sustainable destination we need to ensure that tourism growth doesn't result in the degradation of the very environment that is one of our unique selling points. A development of this nature is a good opportunity for the area to develop its sustainability product.

PM/Moffat Dark Skies
23 July 2013

VisitScotland's marketing campaigns are designed to attract visitors to Dumfries & Galloway throughout the year however seasonality can still be an issue. Dark Sky status could provide opportunities to promote the area during the quieter times of the year and give another reason to visit and stay longer.

Dumfries & Galloway is positioning itself as an area which is "Naturally Inspiring" and Dark Sky status for Moffat would fit well with this branding.

The Forestry Commission is a key partner in the Dumfries & Galloway Area Tourism Partnership (ATP), of which its personnel are active and supportive members. It contributes to the Area Tourism Strategy in conjunction with other public agencies and the trade members of the ATP. It also works closely with community groups at more local level in encouraging access and use of the forests. VisitScotland welcomes the opportunity to further develop this partnership approach relating to the aforementioned bid.

Hopefully the above observations will be useful in future discussions relating to this application.

Yours sincerely



Paula McDonald
Regional Director




**Moffat and District
Community Initiative**
1 Ladyknowe, Moffat DG10 9DY
www.visitmoffat.co.uk
Tel: 01683 220227
email: info@visitmoffat.co.uk
VAT No. 842 6143 38

20 August 2013

The Secretary
Moffat and District Community Council
Merecleuch House
Ballplay Road
Moffat
DG10 9JU

Dear Jean,

Re: **Dark Skies Application**

Moffat and District Community Initiative fully support and encourage this application, recognising that the actions taken to create dark skies over the town of Moffat in Dumfries and Galloway will become a very important aspect of the town. As Moffat was the first Walkers Welcome Town in Scotland and we continue to promote the opportunities for our visitors to experience the outdoor life, and all it has to offer, this proposal fits very well into our Business Plan to market Moffat to the wider world.

Many residents of the town are directly involved in the Tourism industry and are very much aware of how our night sky will enhance our attraction for tourists. The Initiative welcomes and encourages any actions that enhance the quality of holiday experience for visitors and that provide reasons or incentives for more people to visit the town.

Universal agreement amongst business owners and investors in Moffat recognises that the individuality of the town needs to be preserved and enhanced and this includes the avoidance of light pollution. Most of the tourism businesses in the town are open all year and the Initiative believes the dark skies could lead to more visitors discovering the peace and tranquillity of Moffat outside of the main holiday season.

Many actions have been taken recently to encourage more families to visit Moffat and it would be wonderful for youngsters from urban areas to have their first clear views of a sky full of stars here.

We believe the achievement of recognition as a Dark Skies Town would be good for Moffat businesses, good for employment, would benefit the town's community as well as promote fresh experiences to fulfil the aspirations for future generations of stargazers.

Yours sincerely

Martin J. Brown
Chairman



Moffat and District Community Initiative is a Company Limited By Guarantee and Not Having a Share Capital. Registered in Scotland. Number: SC251002

St Michael's Services Limited
9 St Michael Street, Dumfries, DG1 2QD.
Tel: 01387 254304



www.stmichaels-services.co.uk

Mrs Jean Purves, Secretary,
Moffat & District Community Council,
Merecleuch House,
Ballplay Road,
Moffat

31st July 2013

Dear Jean,

As a local business owner based in Moffat, we are delighted to support the Community Council in the work they have done with regard to the Dark Skies Status initiative for the town of Moffat.

As we depend mainly on tourists and passing traffic during the summer for our trade, we are sure that the Dark Skies Status would bring more tourists to the area not only in the summer months but throughout the year, thus increasing the trade in the town to all the businesses over the whole year.

We recently completed our own project at our premises at Benmar Services, Station Road Moffat, where we have been upgrading the site over the last year, providing new facilities for our customers to obtain fuel 24 hours a day by exchanging all the original 400watt bulbs in our canopy lighting, to 80 watt LED bulbs, producing the same amount of light on the forecourt, but considerably reducing our costs and carbon footprint. Also the introduction of dusk till dawn sensors and timer switches so that the lights automatically switch off after the customer has left the premises. This has enhanced the forecourt services, but has not affected the Council's plans form the Dark Skies Status.

Congratulations on a job well done!

If we can be of any further support please do not hesitate in contacting us via our email address:
benmargarqe@gmail.com or direct dial 01683 220010

Yours sincerely

Jamie R Wood
Director.

09.19.2013

To

Mrs. Jean Purves
Secretary
Moffat & District
Community Council

Dear Mrs. Purves

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies town.

There will be new opportunities for tourism in Moffat, and in particular hoteliers, if Dark Skies status is achieved.


Currently, most visitors take their holiday in Moffat between Easter and October however if the application for Moffat is successful in becoming the first town in Scotland to have Dark Sky status, it would also be able to promote itself as a night-time or winter destination especially for those activities around star gazing and astronomy.

As a local hotelier we would welcome opportunities which would help to extend the tourism season to all year round business adding to our business in the quieter months of the year.

We hope the application will be successful and if so we could then highlight Moffat's status as a Dark Skies town in our future advertising.

Yours sincerely

Tim Leighfield



info@thefamousstarhotel.co.uk

THE FAMOUS STAR HOTEL MOFFAT

Tel 01683 220156
Fax 01683 221524

44 HIGH STREET
MOFFAT DG10 9EF

www.famousstarhotel.co.uk
info@famousstarhotel.co.uk





Old Church Depot, Annanrude,
Moffat DG10 9HB
Tel 01683 221847
E-mail: info@moffatcan.org
www.moffatcan.org

Dear Jean Purves

We are a Moffat community charity and social enterprise dedicated to carbon reduction.

We have been very impressed by the new low-energy lighting installed around Moffat and by the resulting decrease in light pollution and carbon emissions.

We feel that for Moffat to be recognised for this achievement via formal Dark Sky status would be highly beneficial in terms not only of enabling and developing maximum access to astronomy for local residents and for visitors but also of boosting the local economy via increased green tourism.

Yours sincerely,

A handwritten signature in black ink that reads 'Alis R. Ballance'. The signature is written in a cursive style with a long horizontal flourish underneath.

Alis Ballance

Chief-Executive

Moffat CAN Ltd Co. No. 354379 Scottish Charity No. SC040255

Mr R Mc Lean & Mr B Camm,
No29 Well Street Bed & Breakfast
Moffat
DG10 9DP

24th July 2010

Dear Sir/Madam

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies town. We have a Bed & Breakfast right in the middle of Moffat and the installation of the LED lights has added to the beauty of the night skies and the reduction of light pollution. We feel that the new lighting will be for the benefit of residents and visitors alike. Any boost to tourism, such as happened at Galloway forest Park, especially out of season, would be welcome and improve Moffat's status as an all year round visitor destination.

We hope the application will be successful and we will then include Moffat' status as a Dark Skies town in our future advertising.

Yours Sincerely

Ron Mc Lean & Bradley Camm



Mrs. J. Purves,
Merecleuch House,
Ballplay Rd,
Moffat,
DG10 9JU

26th July 2013

Dear Mrs Purves,

We are writing to you in support of Moffat's application for designation and recognition as a Dark Skies Town.

As a group fighting to have Beattock railway station reopened we realise the importance of local support. Part of our argument is that the opening of Beattock station should increase tourism to the Moffat area and certainly the designation of Moffat and area as a Dark Skies Town should also do this.

In increasing the use of the railway by the reopening of Beattock station we see a reduction in pollution by less use of the car. By Moffat being a Dark Skies Town the light pollution will be greatly reduced. You could say that we are promoting a similar cause.

We wish you luck and success in your endeavours.

Regards,

Peter Gray,
Secretary.

STATEMENT

White Hill
DESIGN  STUDIO

To: James Paterson
Rosemount
Well Road
Moffat
DG10 9BT

Our Ref: Moffat Dark Sky
WHDS Moffat Dark Sky 141202

Your Ref:

Date: 02 December 2014

Dear Jim

Moffat Dark Skies Project

I am writing to offer my support to the Moffat Dark Skies Project which I feel is of significant benefit to the community.

Since discussing the project with you, I have been promoting the use of Dark-Sky light fittings to clients on a range of local projects and will incorporate a Dark-Sky lighting specification into future projects.

I will also meet with the local electrical contractors to see if we can promote appropriate external fittings for use within the town to make information on these more widely available.

I look forward to working with you on the project.

Yours sincerely,



David Major
White Hill Design Studio LLP
\\enc.

EXPRESSION

ENQUIRY

T: 01683 221 898 F: 01683 501 064
E: info@whitehilldesignstudio.com
W: www.whitehilldesignstudio.com
A: Annan Water, Moffat, DG10 9LS

Members
David Major B Arch ARIAS
Jane Gray BA Hons MSc

White Hill Design Studio LLP is a limited liability partnership, registered in Scotland with number SO300531 and having its registered office at Melkeholmside Cottage, Annan Water, Moffat, DG10 9LS.

Moffat Wildlife Club
November 25th 2014

Dear Mrs Purves,

I am writing on behalf of Moffat & District Wildlife Club in support of the plans for Moffat to acquire dark sky status.


We are completely behind the initiative to replace the old sodium lighting with LED lighting, which is much more energy efficient. I understand that the new lights will save around half of the energy used in the old system, making a significant contribution to reduction in CO2 emissions, which of course is critical in long term reduction of climate change.

Clearly, the Wildlife Club's main concern in relation to artificial light is its effect on the natural world. The intensity of natural light varies around the lunar cycle, the seasons and of course day / night cycle. Organisms have evolved to respond to these changes in ways which impact on their feeding, breeding, migration and hibernation (fauna) and flowering, vegetative growth and direction of growth (flora). It is pretty certain that the introduction of artificial light will disturb the normal routines of many plants and animals. There are many examples of this disruption, including negative effects on migrating birds, early breeding in some bird species, the feeding behaviour of bats caused by insects clustering around outdoor light sources, and temporary visual impairment in frogs and toads. All these issues are addressed in the Royal Commission on Environmental Pollution report on artificial light, published in 2009.

We would be broadly supportive of any efforts to reduce artificial light in the environment. Having achieved this with regard to the street lighting in Moffat, we can see the wider benefits of continuing with a bid for Dark Sky status. These include the possibility of further raising awareness of the impact of artificial light upon the environment, as well as economic benefits to Moffat from tourism.

We know the Community Council have been supportive of the initiative, and trust that they will continue to provide all necessary support in the future.

Yours sincerely,



Iain Anderson
Club Chairman

Mrs Jean Purves,
Secretary,
Moffat & District Community Council

9 Nethermiln Meadow
Moffat
DG10 9QG

12 November 2014

Dear Mr Paterson,

I would like to congratulate Moffat on their forward thinking regarding the dark sky initiative. I moved to Moffat on 31 October, coming from a busy town with harsh street lighting. For many years I have had sleep problems, and often commented on the harshness of the lights, which seeped into my bedroom. Since coming to Moffat I have noticed that I sleep sounder and wake refreshed, I can only attribute this to the new LED lighting that is used in the town.

Perhaps health is an aspect of the new LED lighting that has not been considered.

Yours sincerely

Evelyn Atkins

Evelyn Atkins.

Subj: **Re: Moffat Stars**
Date: 25/11/2014 16:51:11 GMT Standard Time
From: pbdreghorn@btinternet.com
To: l.cadsinscotland@aol.com

To Jim Paterson

I write in support of current and future developments towards a Dark Sky status in Moffat. The replacement of the sodium street lights have not only provided a darker sky for viewing stars and planets but a directional light on the streets and pavements which is both brighter and focused. This is of great benefit to me as I suffer from Glaucoma and have very reduced peripheral vision. So, ironically reduction of lighting has improved the lighting from diffuse to directional and with stronger outlines for people to see.

Further restrictions on lighting of doorways, security lights and decorative lights would be appropriate, working collaboratively with residents and business outlets. Photovoltaic on/off lighting would good in places where constant lighting is unnecessary.

The other compliment I would like to pay is the awareness raising session you held in Moffat which was joyful, scientific and empathetic to residents. Also no funding nor committee was needed for the work to go ahead which was unique in developments in the area.

Lastly as a member of Borders Forest Trust Corehead Project we would like to measure the darkness of sky with your equipment to establish the feasibility of a dark sky viewing point.

Best wishes

Peter Dreghorn M.Sc. Biodiversity, Wildlife and Ecosystem Health
Corehead Steering Group, River Annan Trust, Beattock Station Action Group.

Adamsholm
Annan Water
Moffat
DG109LS

For station news
www.beattock.com

**An Cluain,
Ballplay Road,
MOFFAT,
Dumfriesshire,
Scotland DG10 9JU
Tel: 01683-221219**

Attention of the Hon. Secretary,
Moffat Community Council.

18th April 2013

Dear Hon. Secretary,

New LED Street Lighting in Moffat

Now that the majority of the town's street lamps have been converted to LED format, I have taken time to observe and note the resultant lighting effects, both good and bad. Overall the new warm white lights are very good. I like them. I am most impressed by the uniformity and high level of the road illumination. I have also observed that the colour of vehicles and personal clothing is better rendered and much more natural than was the case with the earlier Sodium lamps.

More negatively, the illumination of nearby objects on the roadside, such as pedestrians and pavement obstacles, is less pronounced than before, although I find it quite adequate for most purposes.

Although I have little personal interest in astronomically observing Moffat Dark Skies as such, I do very much approve of the future visitor and tourist potential. Together with the vastly reduced costs of energy supply and maintenance, this has convinced me that the whole project was well worth the cost and effort.

I would like to express my personal thanks to our Community Council for their initiative, forward planning and satisfactory adoption of this modern lighting scheme. Well Done !

Yours truly,



Dr. Peter G. Bower

Hunters' Croft,
Haywood Road,
Moffat
DG10 9BU

22nd April 2013

Dear Mrs Purves,

I would like to pass on to the Community Council my pleasure at seeing the new street lights gradually coming into being. The actual lamp posts look very modern and quite discreet and I think the white downward lighting looks far more natural and attractive than the original sodium lights.

No doubt there are differing views in Moffat about this undertaking but I thought I should express a positive reaction.

Yours sincerely,

Judith Hobson



29-05-15

Dear Lighting Section,

Thank you for the new street lighting in Moffat. It's great, no more yellow glow, no more intrusive light in the house, now we can (on the rare cloud-free occasions) see the stars, now we can see the colours of the cars at night.

My congratulations and thanks to all responsible - you have enhanced our lives

Colin Brydon

..

NJ

DGFIRST
LOCAL SERVICES
ANNANDALE & ESKDALE

19 SEP 2013

HARTHILL DEPOT
LOCKERBIE

David & Niamh Elliott
Archbald Moffat House
Academy Road
Moffat DG10 9HW
01683 221 899

26 SEP 2013

DG First

Harthill Depot
Glasgow Road
Lockerbie DG11 2SE

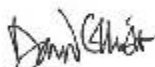
Dear sirs

Street Lighting

May take this opportunity to congratulate your department on the choice and installation of the new street lights in Moffat. They are a significant benefit to the environment and probably use less energy.

Unfortunately the private lighting installed over the entrances to St Marys [converted] doesn't have the same ethos.

Yours sincerely



David & Niamh Elliott

Flat 2
Birnock Water
Moffat
DG10 9DY
November 14th 2014

Dear Mrs Purves,

We are writing in support of the plans for Moffat to acquire dark sky status.

I know that some people had understandable concerns about the strength of the new street lighting when it was installed, but we find it to be entirely satisfactory as both pedestrians and motorists. In fact, on a day to day basis I doubt that anybody wishes for the return of the old lighting.

The new lighting has many benefits, however, including it being much less obtrusive to those of us who have a lamp post close to their property. The two greatest benefits, however, are on the one hand hidden and on the other extremely noticeable. The hidden benefit is the reduced carbon footprint (and cost) of using the LED technology which is a contribution to the greatest problem facing humanity – that of man-made climate change. The noticeable benefit is the significant improvement that many of us have observed in the visibility of the stars on a clear night.

This improved night sky visibility is something that we could now capitalise upon, by completing Moffat's designation as a dark sky community. Once this is achieved, there are significant potential gains for the town from tourism – both direct winter 'dark sky' tourism, repeat visits at other times of the year, and more generally from the increased media exposure that would follow a dark sky designation.

We know the Community Council have been supportive of the initiative, and trust that they will continue to provide all necessary support in the future.

Yours sincerely,



Jon & Christine Haydon

Mrs Jean Purves,
Secretary,
Moffat & District Community Council

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
DG10 9QF

Dark Sky Initiative

Dear Sir/Madame

I am 13 years of age and a pupil at Moffat Academy ^{Scotland} and I'm studying Physics. A big area of our curriculum is space every year and it would be nice to have International Dark Sky Status, so that we could do even night trips but not needing to pay much if any for a trip. I find space is a really great part of physics because it is something that is always changing and that we can always find out more.

As a community it would help Moffat because it would cut incursions and Moffat already has Light Emitting Diodes (LED) ^{and} lights in our street lights. Then if we do get International Sky Status we could get an obscenity for the whole community and or the school, if we could fundraise enough buy a school telescope. Then the whole community could start a Astronomy Club if we got all that. What I'm trying to say is that it would be great to have Dark Sky Status for all of us.

Yours Sincerely

Graham Thompson

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
DG10 9BF

International Dark sky Reserve

Dear Sir/Madams

I am a 13. year old student at Moffat Academy. Fin is 52 and I am hoping we can get Dark Sky Status in Moffat.

We are going to go around Moffat and raise money for the funding. We ~~are~~ could do this by bike sales etc. We are hoping that it would raise enough around about half so the school could pay the other half. If we achieved this we would be the first place in Dumfries and Galloway region to have Dark Sky Status. All the physics students in Moffat Academy are extremely keen on getting this.

Tourism would increase in Moffat making it easier to expand and upgrade the observatory.

Yours Sincerely

Camille Smyth

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
DG10 9QF

Rej international dark sky reserve.

Dear sir/madam

I am 14 years old boy who took phisics at Moffat Academy, I really like the space but there is only one problem I can't get a good view because we don't have a telascope. But we have all ready got LED street lights.

At Moffat academy in phicics we all want a International dark sky resrvorty to get this we are going to go round moffat area and see how many people want dark sky resrvorty and then raise money for the resrvorty. Hopefully you see where I am coming from

yours sincerly

Frdzer Rankine

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
DG10 9QF

Ref Dark Sky Status

Dear Sir/Madam

My name is Robbie Crosby and I am writing about seeing if my little town named Moffat could be eligible to become an international dark sky reserve. Since a young age I have loved going on holidays to the country side and looking up to the sky and seeing star constelations. I also now have a telescope but it isn't used very much as from where I live you can't see the stars very well. I am a physics student at Moffat Academy in Scotland and I am very keen on space. My teacher (Mr Wrightson) is very enthusiastic about trying to achieve Dark Sky Status and being honest after reading about it when I got home I am too.

If Moffat became a Dark Sky Town and achieved Dark Sky Status it would help Moffat as a town and everyone in Moffat as a community. We have already switched to LED street lights which will hopefully let us see the stars better. Moffat is a tourist town and if it became an international Dark Sky reserve it would help a lot with tourism. As a student whos curriculum consists of a lot of topics about space achieving Dark Sky Status would help with our learning. Currently most of Moffat supports Dark Sky and would love Moffat to have it, so the next generation will grow up looking up to the stars.

Yours Sincerely *Robbie Crosby*
ROBBIE CROSBY

10/10/14

Moffat Academy
Jess Brown Drive
Moffat
DG10 9QF

Dear Sir / Madam

I am writing to you today to inform you of our bid to gain Dark Sky Status in our area.

At Moffat Academy, I have been studying physics and we recently have been discussing space and the stars. We eventually came up with a idea that we could gain Dark Sky Status in Moffat. We already have been reducing emissions in many ways so at night you can see the stars.

I enjoy the thought of sitting at night with a telescope, identifying the stars. Moffat is a town with a population of 2,000. Nearby are a couple of small villages such as Beattock. We recently installed in the town, new led street lamps which use less energy and cause very little light pollution.

Not far from here (around 70 miles) is another area which has gained Dark Sky status called Balkhaz Forest Park. We hope that we become the second area in Dumfriesshire and Galloway. I hope you go ahead with the proposal for our town to gain Dark Sky status.

Yours sincerely,
David Lemoor, S2 - Moffat Academy.

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
Scotland
DG10 9QF

ref: International Dark Sky Reserve

Dear Sir/Madam,

As a member of the local community and physics student at Moffat Academy I would like to express my support for a Dark Sky Reserve around Moffat. I am currently studying physics at National 5 level and I am intending to carry it forward to higher and advanced higher levels in my following years at school. My interest in Physics extends out with school and is one of my personal hobbies which I enjoy studying and pursuing in my spare time. My favourite area of physics is electronics however I do enjoy learning about astronomy and cosmology and feel it is an extremely important area of physics that has yielded some of the most amazing and important discoveries about our world. In the last century light pollution has damaged the relationship between humanity and the stars and in many areas people cannot see the stars at all. For this reason, I would like to strengthen the link by controlling the light pollution and granting the people of Moffat, Scotland and the rest of the world a place to visit and enjoy the stars.

Already the community have made progress by installing

LED streetlights to minimise light and further measures are planned for the future. I hope that Moffat will be granted reserve status in the near future and will participate in supporting the cause in any way possible

Yours sincerely,

Ciaran Donalds

10/10/19

Moffat Academy
Jesse Brown Drive
Moffat
Dumfries & Galloway
Scotland
DG10 9QF

Re: International Dark Sky Reserve

Dear Sir/Madam

I am a 4th year student at Moffat Academy and currently studying Physics at Nationals level. I would love for a Second Dark Sky Reserve in my region as quite often looking up at the stars ~~is~~ I am puzzled on how large space actually is and wonder if it ever ends. Our old system used sodium lighting but was recently changed to LED lighting. I am writing this letter because I think a Dark Sky Reserve would really benefit my community and other communities around the ~~area~~ so people has an enhance view on how beautiful space is and how lucky we actually are.

Yours sincerely
Cameron Wylie

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
Dumfries and Galloway
Scotland
DG10 9QF

Ref: International Dark Sky Reserve

Dear Sir/Madam,

I am an S4 student studying National 5 physics at Moffat Academy. A large part of the course is focused around the study of space and the physics behind it. I would like to express my support for Moffat to become an International Dark Sky Reserve. I believe this would help the community and would also increase my knowledge of physics. As it would allow us to further our studies in physics. The street lighting has recently been changed from sodium lighting to LED lighting. The physics departments are hoping to acquire a telescope to further observe the sky. I am expressing my support for Moffat to become an International Dark Sky Reserve and I hope it will be granted in due course.

Yours sincerely

G. Smith

Gary Smith

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
Dumfries + Galloway
Scotland
DG10 9QF

ref: International Dark Sky Reserve

Dear, Sir / Madam

I am a S4 student at
Moffat academy in Dumfries and Galloway
studying national 5 Physics.

A substantial part of our
course deals with Astronomy and
space. To be listed as an
International Dark Sky Reserve
would benefit me, and my community
by being able to exploit the
natural resources we have to
learn from, the stars.

The local community have replaced
the old sodium lighting in the streets,
there are now LED lighting
which substantially reduces light
pollution helping us see the
sky more at night.

I would love to see my town granted
Dark Sky status, I hope this is granted in due
course.

yours sincerely Alison Paton.

10 October 2014

Moffat Academy
Jeff, Brown Drive
Moffat
Dumfries and Galloway
Scotland
DG 10 9RF

ref: International Dark Sky Reserve

Dear Sir/Madam

I am a student studying Higher Physics at Moffat Academy. I am currently in S6. Part of our course has topics relating to astrophysics.

I live in a beautiful place and ~~would~~ don't want to be able to look at the sky and see the stars. So if we got rid of the street lights and replaced them with LED lights we would be able to see the sky at night.

~~Your~~ Yours Sincerely Michelle

10th October 2014

Moffat Acad
Jeff Brown Drive
DG10 9QF
Moffat

Dear Sir/madam

Hello, my name is Callum, I am currently studying Physics in S3. And one of our topics involves Space. Personally, space amazes me. And it's hard to believe that there is so much more out there.

In Moffat, we have LED lights so we can see the sky at night. And I wouldn't like it if I couldn't see the stars. So I think Moffat should become part of the International Dark Sky Reserve so I, and many others can see the stars. If we did, I think Moffat would branch out in Astronomy and do so much more. There are a lot of children in Moffat, and I think most of them would agree that Moffat is a great place to see the sky.

Yours,
Callum Morgan

10/10/14

Moffat Academy
Jeff Brown Drive
Moffat
Dumfries and Galloway
Scotland
DG10 9BF

Dear Sir/Madam

I am writing to you with regards to the Dark Sky Reserve. Currently I am a student at Moffat Academy and I am in my fifth year of Secondary. I am studying Higher Physics at the moment and part of the course is related to space. In an effort to achieve Dark Sky status the community of Moffat have come together and replaced all of the old street lights with new LEDs.

Living in the countryside, we take these things for granted and don't actually realise how privileged we are to actually get to see the stars in the sky each night. Watching the stars, many questions come to mind and I hope that by being given Dark Sky status, many more people will look to the stars.

Yours Sincerely

Bruce Kirkpatrick

Eloise Fritsch
Moffat Academy
Moffat
Elk Brown Drive
DG10 9AF

10th October 2024
International Dark Sky Reserve

Dear Sir/Madam,

I am Eloise Fritsch, a physics student at Moffat Academy. As I take physics, I have to study Space and that is actually one of the reasons why I chose the subject.

In Moffat, we have LED lighting and lots of people in the community hope to add to this by building an observatory. The physics department in Moffat Academy also wants to get a telescope and set up an astronomy club.

Personally, I think that the stars are beautiful and I am glad that the community are trying to get a Dark Sky Status. And although I am not particularly interested in the astronomy behind stars, I know that having things like an observatory and Dark Sky Reserve would benefit my studies and please people in my area.

Yours sincerely,

Eloise Fritsch

Emma Carlyle
Moffat Academy
Jeff Brown Drive
Moffat
DG10 9QF

International Dark Sky Reserve
Dear Sir / Madam,

I am Emma Carlyle, a physics student in 3rd Year at Moffat Academy. As part of our physics course we have to study space.

In Moffat we currently have LED street lights to stop light pollution & secure the Dark Sky status we have.

I personally don't have any interests in the stars but I can see how it would benefit others & my education, when we come on to learning about stars.

Yours sincerely
Emma Carlyle

International Dark Sky Reserve Fraser Macrae

Moffat Academy
Jeff Brown Drive
Moffat
Dunbarton & Galloway
Scotland
DG10 9GF

10/10/14

Reference :- International Dark Sky Reserve

Dear Sir/Madams,

As a pupil at Moffat Academy who studies Physics at National 5, not being a substantial part of our curriculum based around space and astrophysics I am a keen supporter of the dark sky initiative.

As a step towards this the local community have started using LED lighting to replace the previous sodium lights, this has been able to decrease light pollution in our community.

Our physics department are hoping to obtain a telescope and the local community an observatory.

I'm writing this letter to support my school and community in hope that this is granted in due course.

Yours Sincerely
Fraser Macrae

Fraser Macrae

10/10/2014

Moffat Academy
Jeff Brown Drive
Moffat
DG10 9QF

Reference: International Dark Sky Reserve

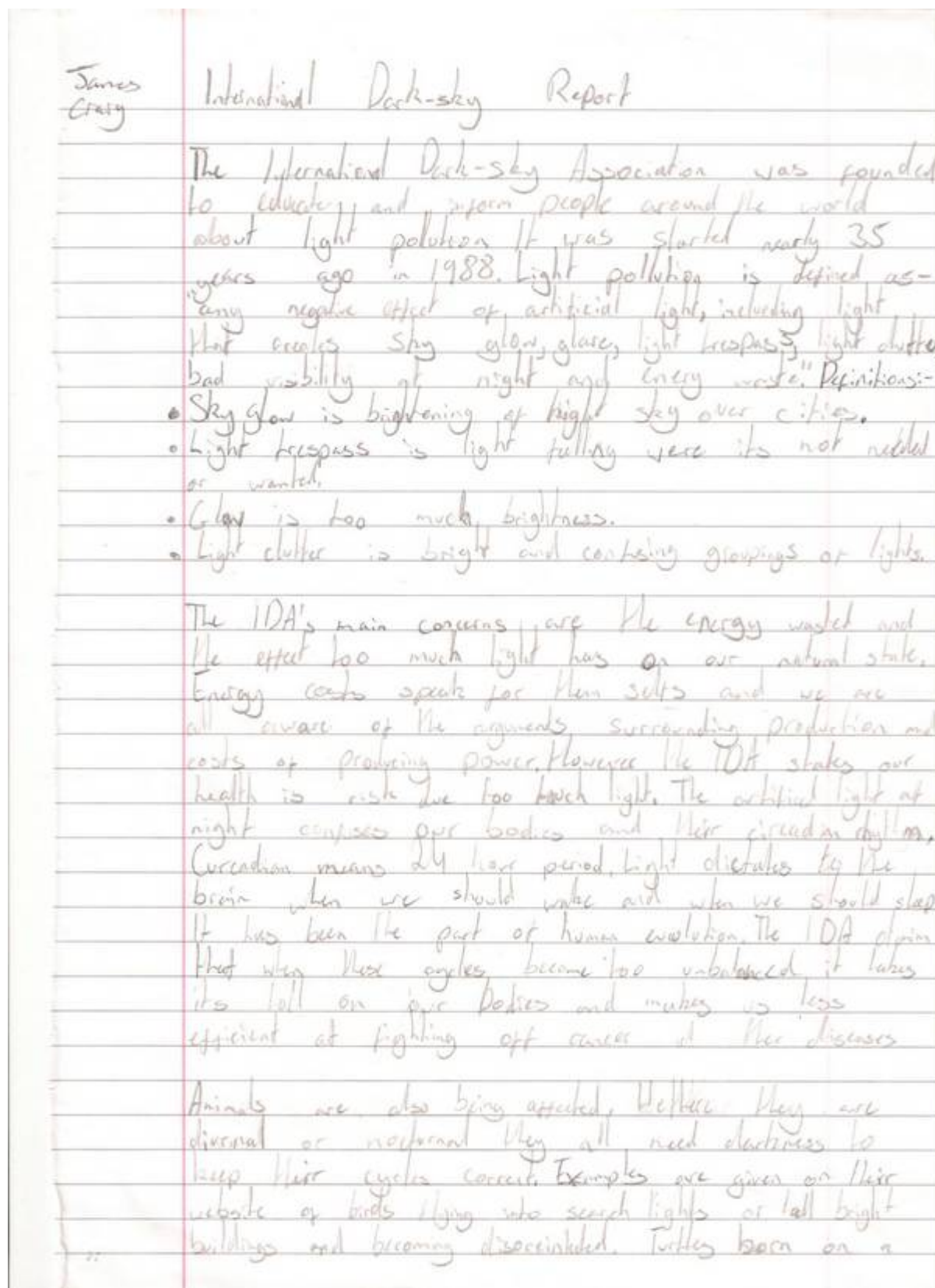
Dear Sir/Madam,

I am a 13 year old physics student at Moffat Academy, Dumfries and Galloway, Scotland. Our class has been looking at space, and as space is a big part of the curriculum in physics, we are all ~~writing~~ hoping that we could get to be a part of the Dark Sky Initiative.

The Dark Sky ~~Initiative~~ Initiative has interested me ever since our physics teacher, Mr Wightson, brought it up in class. I feel that, if we could get it in Moffat the Moffat region, it would benefit both the school and the community. We've already got LED lighting in the streets in and around Moffat, and the community is getting involved as well.

As I have already said, space is a big part of the curriculum, and I think that it would really benefit our community if we were a part of this project. It would give us a chance to look more closely at our solar system, and it would help encourage more students to learn about physics and take it up as a subject.

The school, the community and I all think that this project has ~~great potential~~ will have a very positive impact in our area, albeit for different reasons. It would help reduce our carbon-footprint, help us learn more about space and get us all involved in the community. We are all hoping that the ^{International} Dark Sky Reserve will help us achieve our goal of getting Dark Sky Status in the



James
Craig

beach at night should lead to the ocean drawn by the light of the moon on the water but beach front street and house lighting is causing confusion. They are being headed in the wrong direction leaving them exhausted and vulnerable to prey.

Companies, councils and governments around the world are being encouraged to change their lighting to acceptable models which limit uplight. The street lights in Moffat were changed last year to white downlighters replacing the old yellow lights which create a glow in the sky. There was an immediate noticeable difference. On the down side the light does not travel as far making streets darker than we have been used to. The advantages besides to hopefully our environment and our health is the brighter views we have of the stars on a clear night.



Old Church Depot, Annan side,
Moffat DG10 9HB
Tel 01683 221847
E-mail: info@moffatcan.org
www.moffatcan.org

27th August 2014

Dear Dark Sky Association,

I am writing on behalf of Moffat CAN (Carbon Neutral) www.moffatcan.org. We are a registered charity with aims which focus on carbon reduction and education. We operate as a social enterprise, offering local jobs and training, especially for those with barriers to employment. In line with our aims we have projects and enterprises in the key areas of concern for climate change: energy, food, waste, transport and purchasing. We run Scotland's first aquaponicum, harvesting fish and fruit and veg in water and Scotland's first mushrooms from waste coffee enterprise.

Our site in Moffat is set up as a microcosm of a low-carbon society, and we run thousands of tours every year for visitors from around the country and abroad. At the moment we are planning to develop this side of our educational activity by developing our community-owned building and land.

We are, in particular, keen to develop the tower of our building, which is an old church. We wish to build up the old tower to its original height, based on old photos given to us by a local historian. We very much wish to transform this tower into an Observatory, having been inspired by the likelihood of Dark Sky Status for Moffat, following the recent very successful project in our town, converting all street lighting to low energy lighting. This is something we feel very strongly about, as tackling light pollution is of importance to us as a carbon reduction organisation.

We wish to move forward with funding applications to turn our tower into an Observatory, but would really need to back up any application with Dark Sky Status, to have any chance of success. We had thought that Dark Sky Status would be awarded to our town, given the success of our street-lighting project. However, we understand there has been a delay with this. We would be really grateful if you could update us on progress, as we are enthusiastic to be a part of acquiring the status for our town and to build it into our development plans. Our organisation has a very strong record of achieving funding and delivering successful projects on time.

I look forward to hearing from you.

With best wishes,

Alis R Ballance
Alis Ballance, CEO

Moffat CAN Ltd Co. No. 354379 /Scottish Charity No. /SC040255

SUPPORTING
THE SOPHIE NORTH TRUST FUND



Rosemount
Well Road
Moffat
5/8/14

Dear Mr Patterson,

I am writing to you with regards to the Moffat Dark Sky Initiative and to show our support for such a worthy gathering.

Just to give you some background on The Green Frog. We are a combination of Garden Centre, fishery and fishing centre, shop and café with a covered outside seating area. There is also a large car park area on site even though we are only 10 minutes' walk from the town centre.

Importantly though, for the Dark Sky's Initiative there is a wonderful view of the nights sky on clear nights with no buildings or interruptions. I was very impressed to see the space station passing overhead a couple of weeks ago, and I often see many shooting stars when leaving after some of our late night functions.

The yellow sky glow from the old street lighting is now in the "dim" passed and I think this location would make an ideal spot for stargazing parties. The Green Frog features in the external lighting master plan as one of the measurement points for the sky quality monitoring.

In Order to increase our winter usage we ran a few events and parties in the evenings and would be more than happy to run facilities for star gazing parties if this should arise.

We at The Green Frog, fully support any initiative to promote the quality of the night sky without pollution.

Thanks for taking time to read our letter of support.

Yours sincerely

Kris Allan AKA the green frog

THE GREEN FROG | HAMMERLANDS | MOFFAT | DG10 9HU

TEL | 01683 221220

Subj: **Neil Adams added a comment to your profile on Moffat Online**
Date: 15/09/2014 11:31:46 GMT Daylight Time
From: mail@moffatonline.co.uk
Reply-to: do-not-reply@moffatonline.co.uk
To: JandDPaterson@aol.com

Neil Adams added a comment to your profile on Moffat Online

The work done with the street lighting in Moffat for the "Dark Skies Project" is truly excellent. What a difference the lights have made.

This has encouraged me to look at my own lighting at home, I have planned LED lighting for my car parking area and have just ordered LED replacement bulbs for PIR lights on my out house. I have also fitted LED lighting wherever I can inside the house.

Outside I am hoping it will help with the Dark Skies Project and I know that overall it will certainly help with my energy consumption.

To view the full comment, visit:

http://www.moffatonline.co.uk/profiles/comment/list?attachedToType=User&attachedTo=0vubk0vaskwg2&commentId=2782450%3AComment%3A74136&xgsi=1&xg_source=msg_com_profile

To reply to the comment, visit:

<http://www.moffatonline.co.uk/profile/NeilAdams?xgsi=1#com>

—

To disable email notifications for comments on your profile, go to:

http://www.moffatonline.co.uk/profile/JamesPaterson?xgsi=1&unfollowMyPage=1&xg_source=msg_com_profile

To control which emails you receive on Moffat Online, go to:

http://www.moffatonline.co.uk/?xgo=Kw7juTQHsz4Ke3essY2j0VAYxVkhDaiF/XjAHDzs4golpteQCH0dPg&xg_source=msg_com_profile

16 September 2014 AOL: JandDPaterson

Adam Anderson
Chair Moffat and District Community Council.

David Booth
17 meadow Bank,
Moffat. DG10 9LR

Re dark Sky project Moffat ..

Many Months ago now Jim Paterson, carried out a survey at my property with respect to our outside lighting and compliance with dark sky status .


I can confirm that following the survey and Jim's advice we have converted all of our outside lighting (some 8 in all) to a system compatible with the dark sky project , and took the opportunity to fit LED's. Reducing both the light spread and the power bill into the bargain.

Hopefully this letter and others will pursued the "powers that be "that the town of Moffat should be award the coveted Dark Sky Status.

I am more than happy to provide more information or be involved in whatever form to further this particular project.

Yours sincerely

David Booth



23/9/14.

James H Paterson

Appendix 1

St.Ninians Road

Project code:

Baseline

Date:

23-12-2012

Designer:

James H Paterson BA(Hons) CEng FILP MSL

The nominal values shown in this report are the result of precision calculations, based upon precisely positioned luminaires in a fixed relationship to each other and to the area under examination. In practice the values may vary due to tolerances on luminaires, luminaire positioning, reflection properties and electrical supply.

Lighting Consultancy And Design Services

Scottish Office

Rosemount House

Well Road

Moffat

DG10 9BT

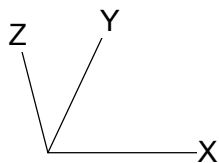
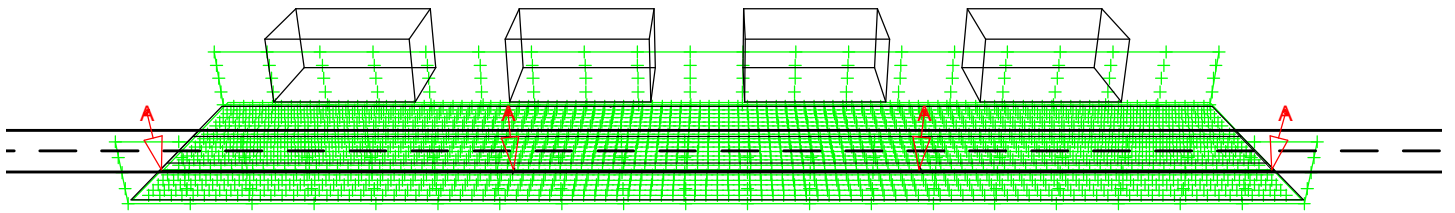
Telephone: 01683 220 299

Mobile Phone: 0777 316 0303

E-Mail: lcadsinScotland@aol.com

1. Project Description

1.1 3-D Project Overview



A  FGS104

2. Summary

2.1 General Information

The overall maintenance factor used for this project is 0.80.

2.2 Obstacle Information

Obstacle	Transparency (%)	Position		
		X (m)	Y (m)	Z (m)
house 1	0	5.00	24.00	0.00
house 2	0	30.00	24.00	0.00
house 3	0	55.00	24.00	0.00
house 4	0	80.00	24.00	0.00

2.3 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	4	FGS104	1 * SOX55W	74.0	1 * 7800

The total installed power: 0.30 (kWatt)

2.4 Calculation Results

(II)luminance Calculations:

Calculation	Type	Unit	Ave	Min	Max	Min/Ave
Public Highway	Surface Illuminance	lux	4.66	1.27	19.81	0.27
House Line 2	Surface Illuminance	lux	1.14	0.29	2.19	0.25
Garden 2	Surface Illuminance	lux	1.11	0.45	1.99	0.41
Garden 1	Surface Illuminance	lux	6.29	1.50	21.03	0.24
House Line 1	Surface Illuminance	lux	2.56	0.19	5.80	0.07

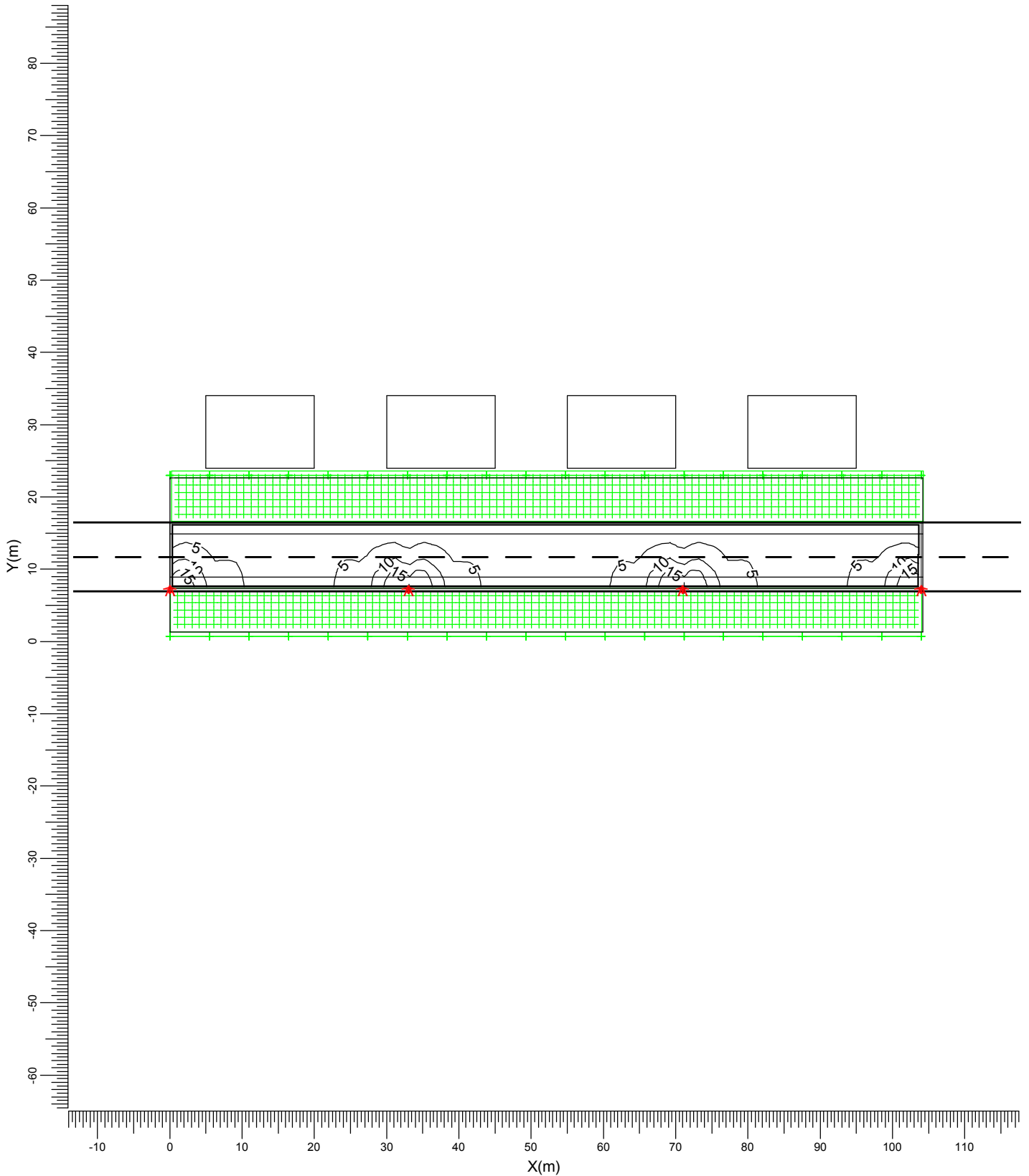
Obtrusive Light Calculations:

The upward light ratio (ULR) is 0.07.

3. Calculation Results

3.1 Public Highway: Iso Contour

Grid : Public Highway at Z = -0.00 m
Calculation : Surface Illuminance (lux)

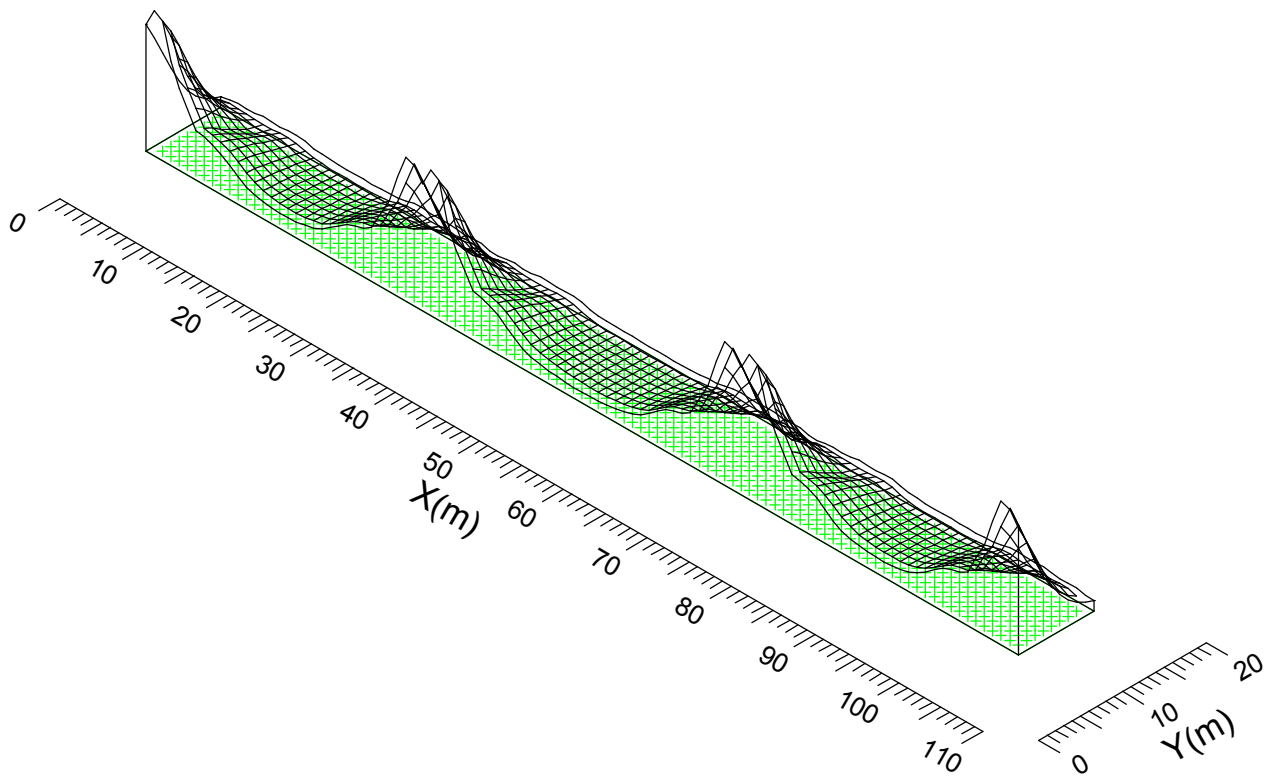


A FGS104

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
4.66	1.27	19.81	0.27	0.80	1:750

3.2 Public Highway: Mountain Plot

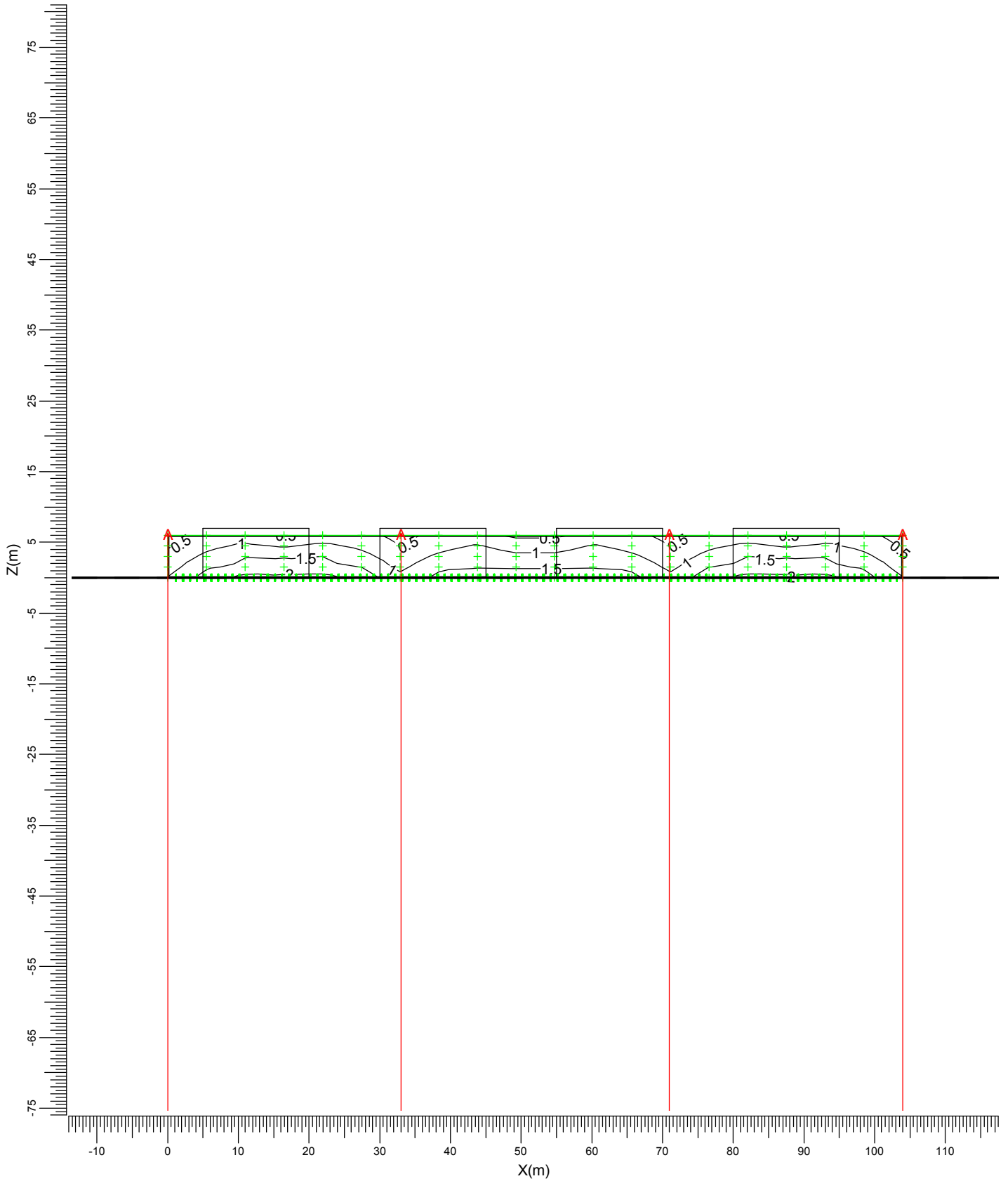
Grid : Public Highway at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
4.66	1.27	19.81	0.27	0.80

3.3 House Line 2: Iso Contour

Grid : House Line 2 at Y = 23.00 m
Calculation : Surface Illuminance (lux)



A FGS104

Average
1.14

Minimum
0.29

Maximum
2.19

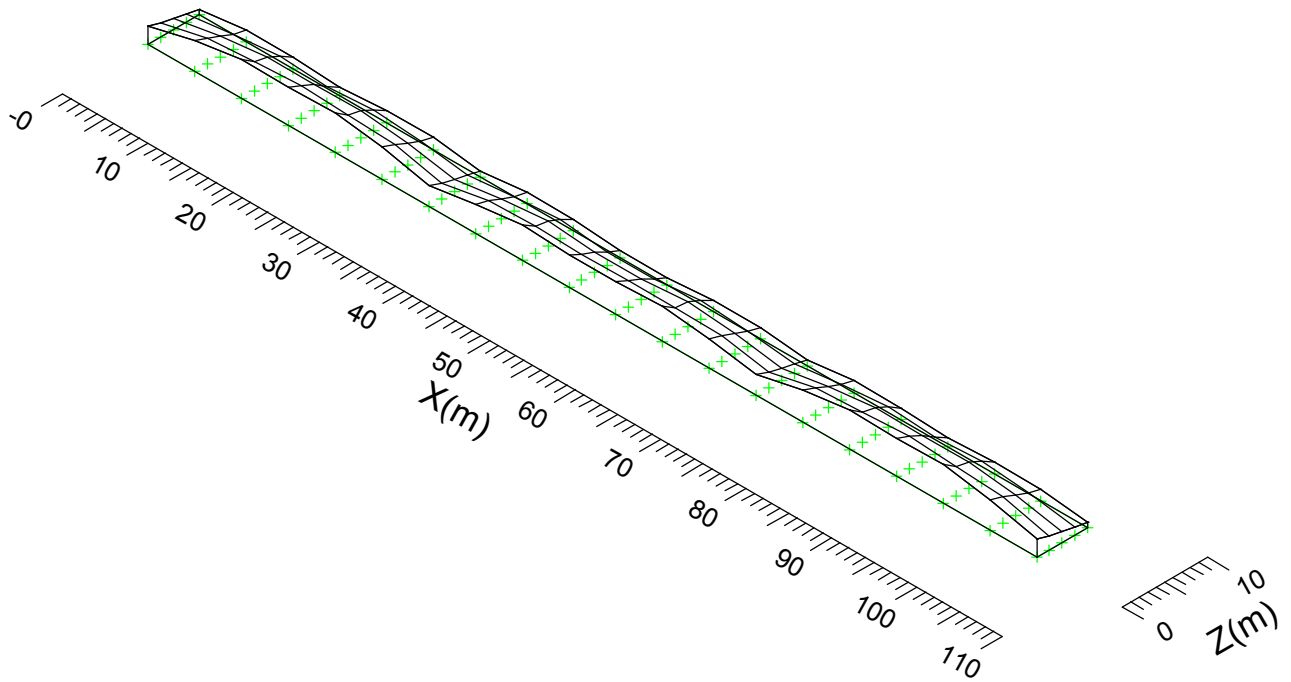
Min/Ave
0.25

Project maintenance factor
0.80

Scale
1:750

3.4 House Line 2: Mountain Plot

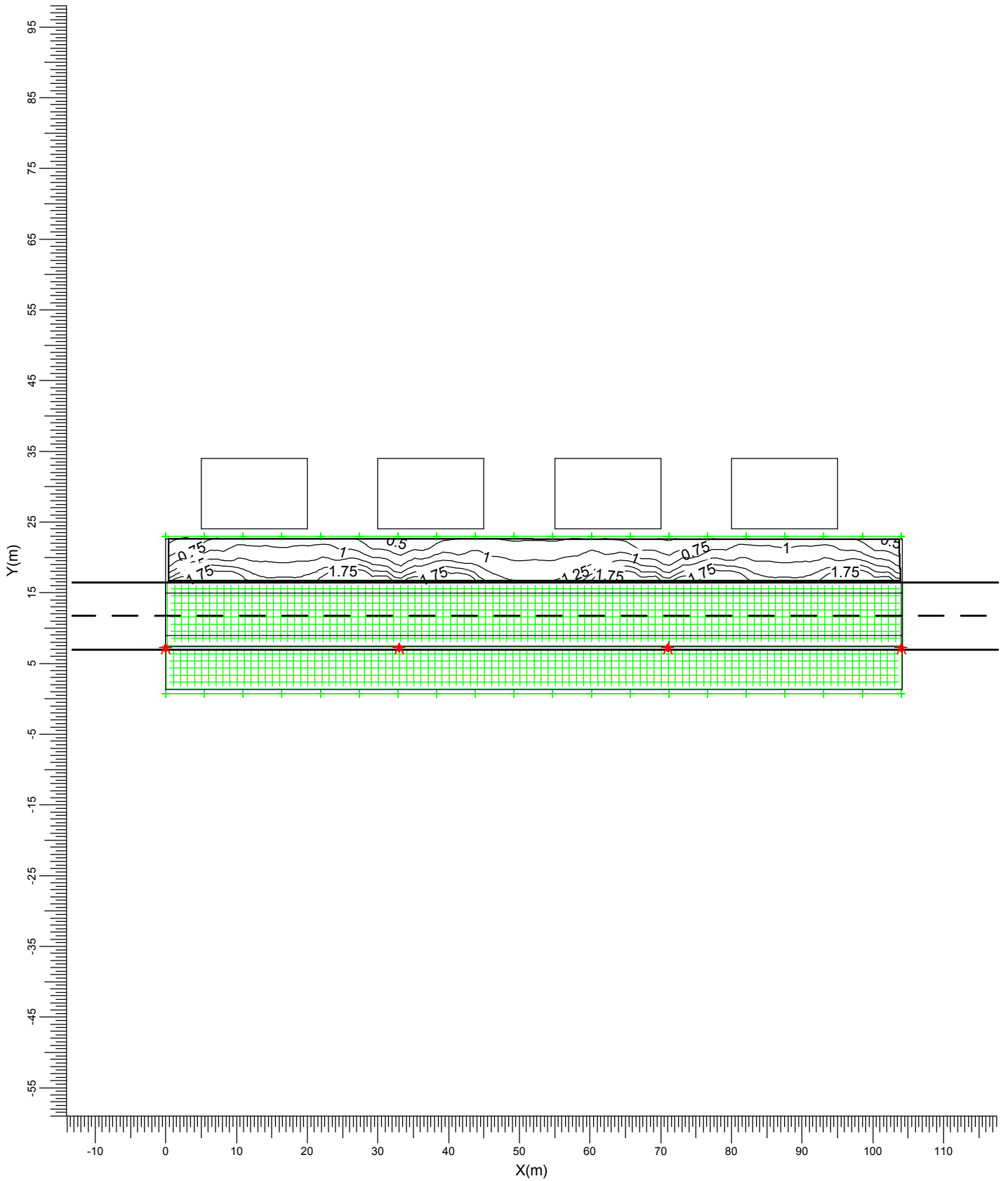
Grid : House Line 2 at Y = 23.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
1.14	0.29	2.19	0.25	0.80

3.5 Garden 2: Iso Contour

Grid : Garden 2 at Z = -0.00 m
Calculation : Surface Illuminance (lux)

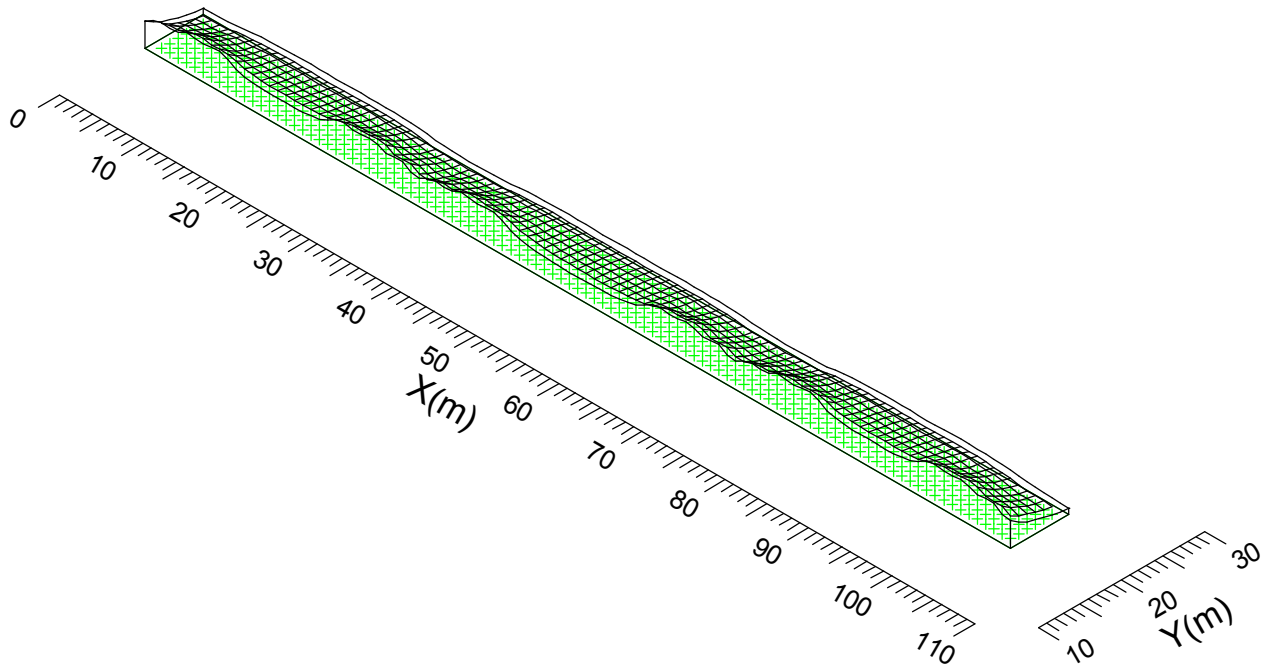


A FGS104

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
1.11	0.45	1.99	0.41	0.80	1:750

3.6 Garden 2: Mountain Plot

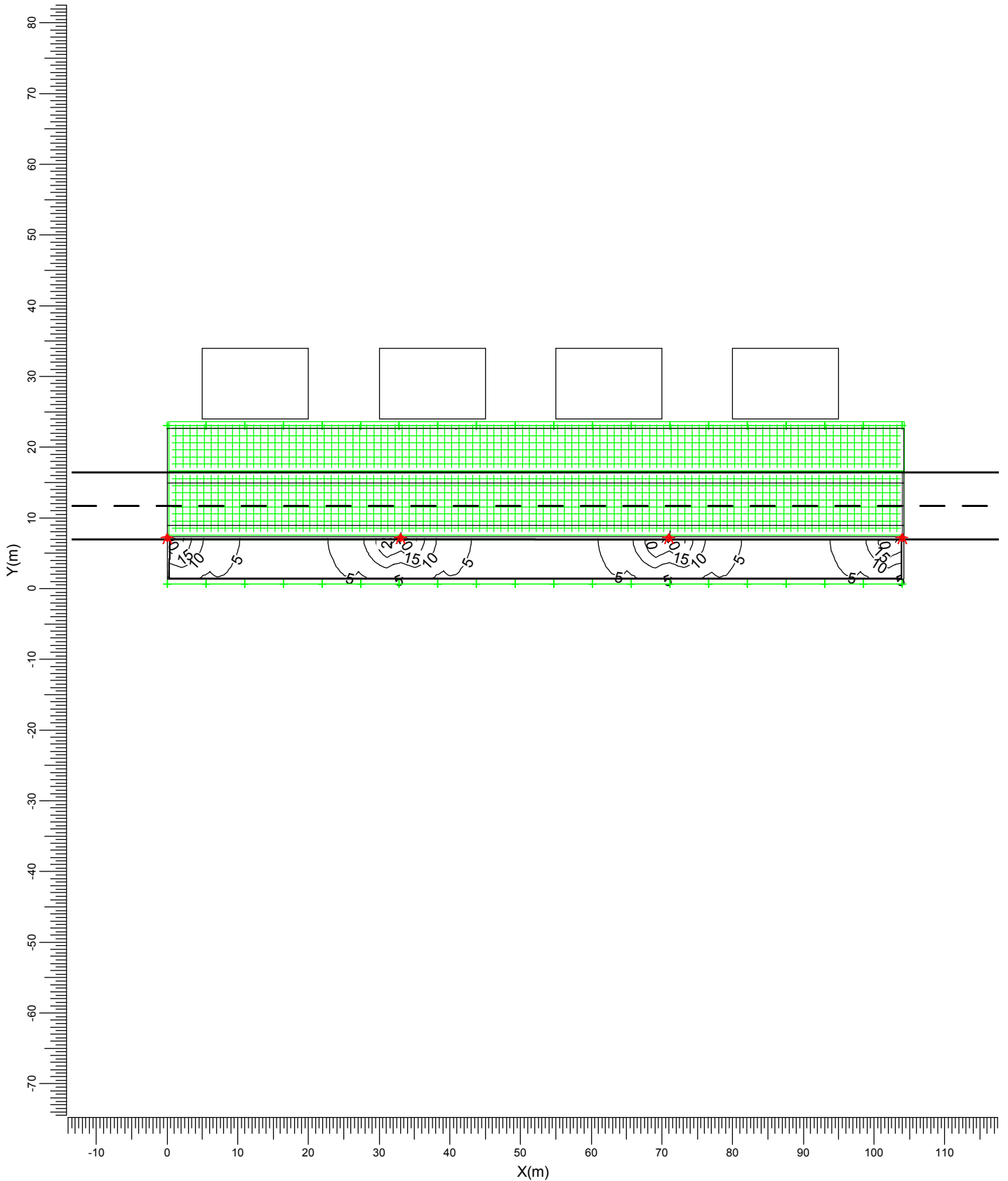
Grid : Garden 2 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
1.11	0.45	1.99	0.41	0.80

3.7 Garden 1: Iso Contour

Grid : Garden 1 at Z = -0.00 m
Calculation : Surface Illuminance (lux)

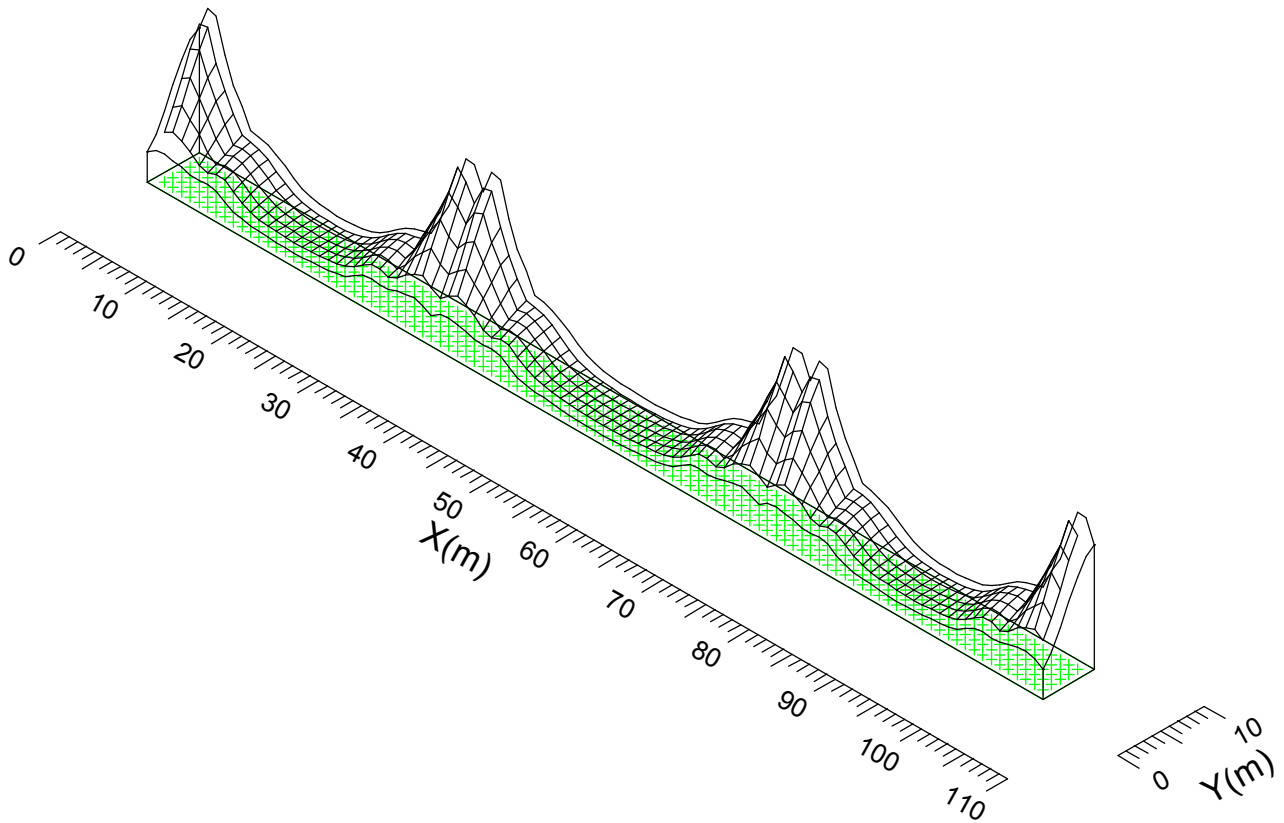


A FGS104

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
6.29	1.50	21.03	0.24	0.80	1:750

3.8 Garden 1: Mountain Plot

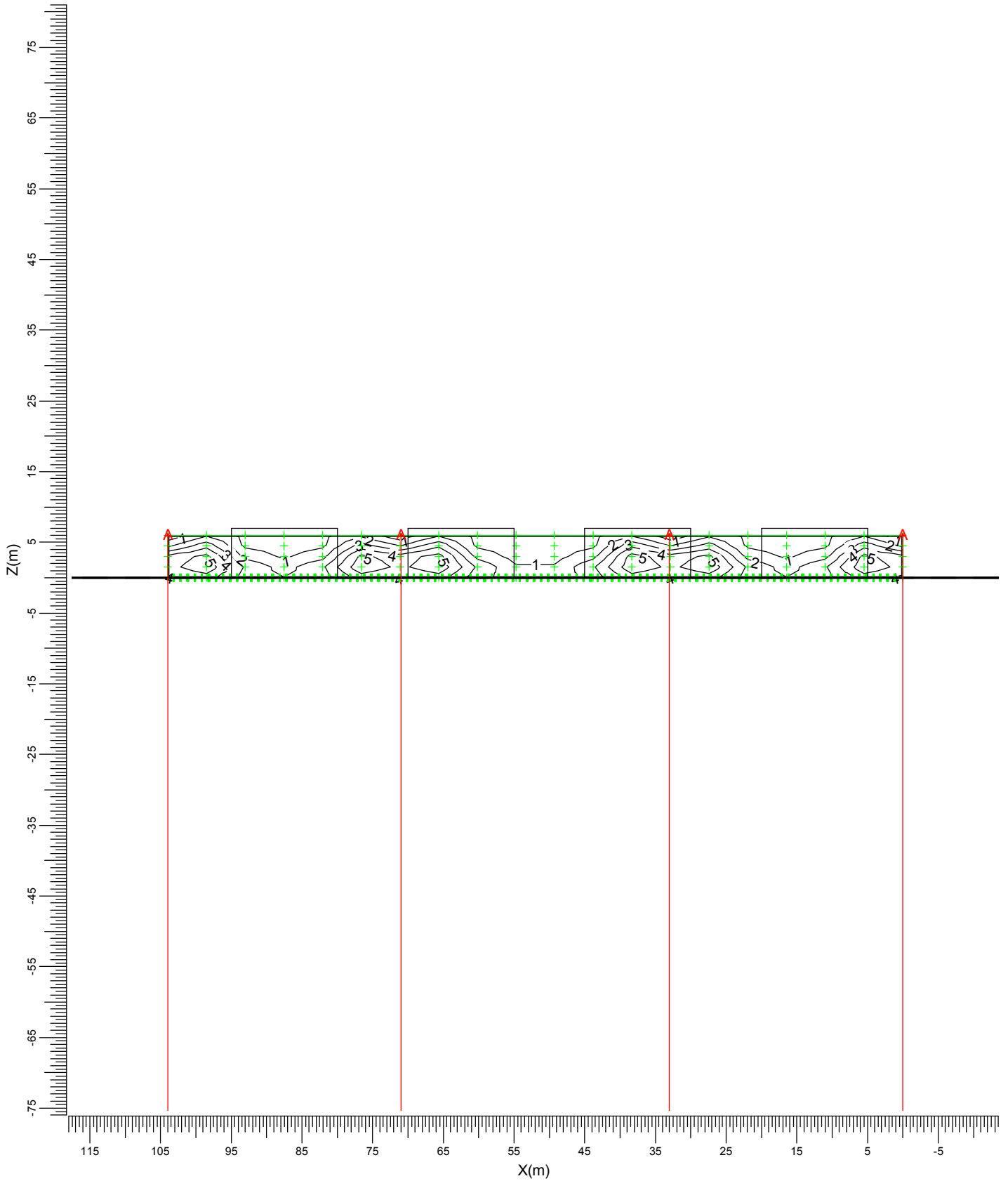
Grid : Garden 1 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
6.29	1.50	21.03	0.24	0.80

3.9 House Line 1: Iso Contour

Grid : House Line 1 at Y = 0.70 m
Calculation : Surface Illuminance (lux)

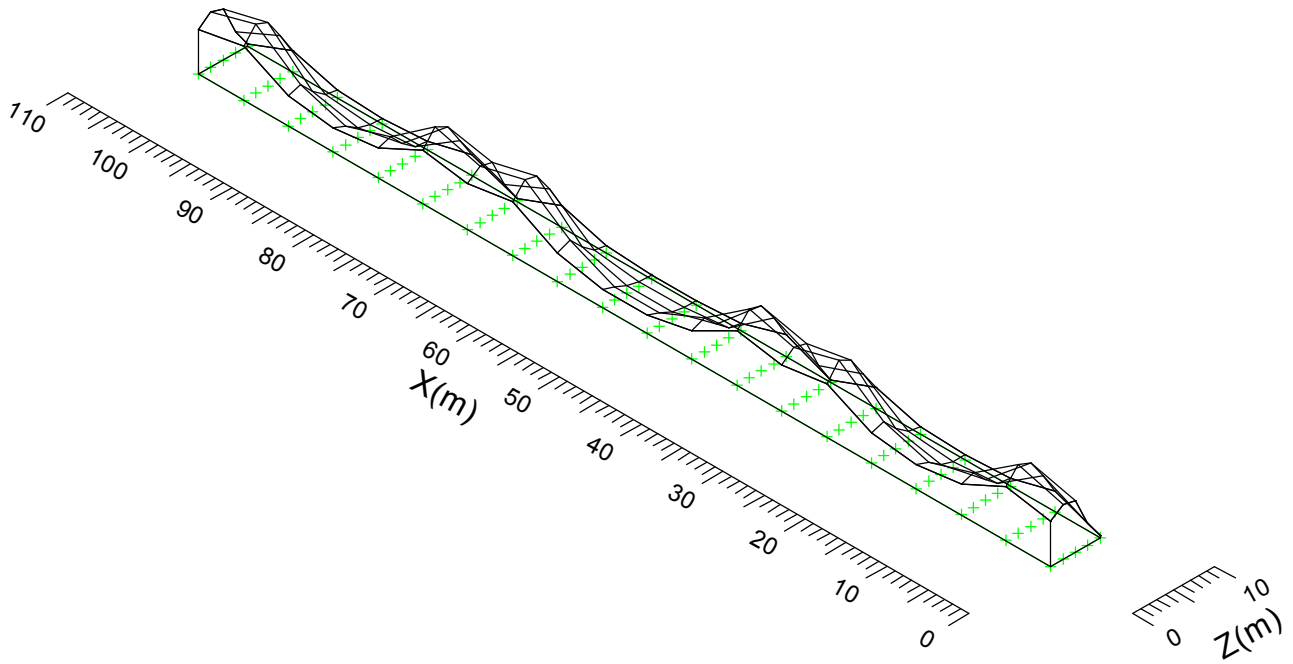


A FGS104

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
2.56	0.19	5.80	0.07	0.80	1:750

3.10 House Line 1: Mountain Plot

Grid : House Line 1 at Y = 0.70 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
2.56	0.19	5.80	0.07	0.80

Appendix 2

Pringle Court

Project code:

Sodium Baseline

Date:

16-01-2013

Designer:

James H Paterson BA(Hons) CEng FILP MSL

The nominal values shown in this report are the result of precision calculations, based upon precisely positioned luminaires in a fixed relationship to each other and to the area under examination. In practice the values may vary due to tolerances on luminaires, luminaire positioning, reflection properties and electrical supply.

Lighting Consultancy And Design Services

Scottish Office

Rosemount House

Well Road

Moffat

DG10 9BT

Telephone: 01683 220 299

Mobile Phone: 0777 316 0303

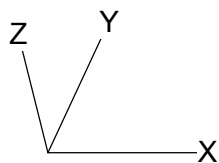
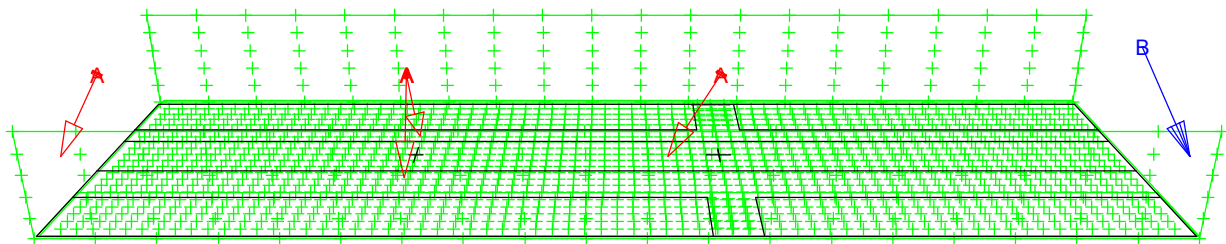
E-Mail: lcadsinScotland@aol.com

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1. Project Description

1.1 3-D Project Overview



A  FGS104

B  2695 SNN/1C *

2. Summary

2.1 General Information

The overall maintenance factor used for this project is 0.80.

2.2 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	4	FGS104	1 * SOX55W	74.0	1 * 7800
B	1	2695 SNN/1C *	1 * 1SON-T 150W	-	1 * 17500

The total installed power: - (kWatt)

2.3 Calculation Results

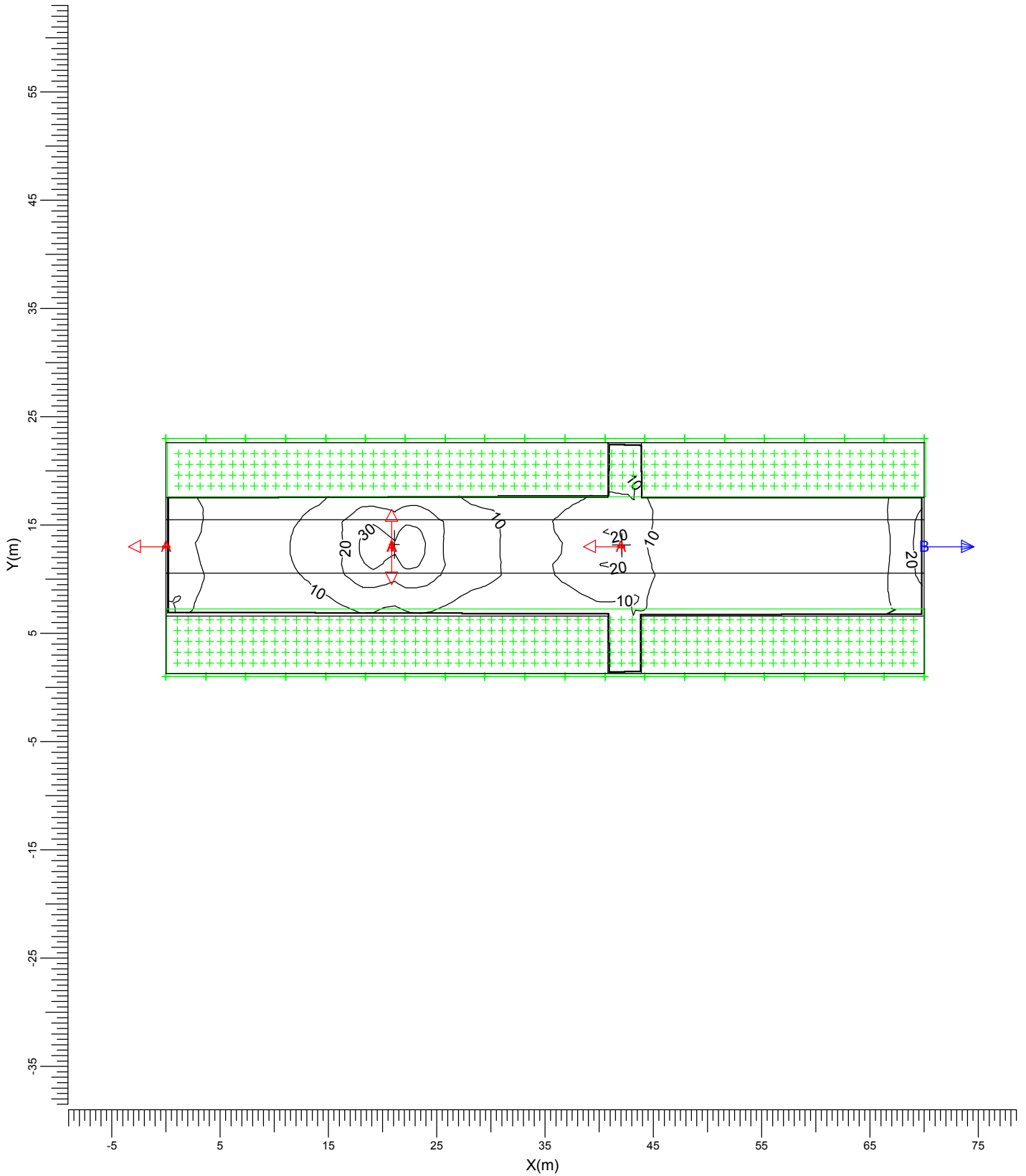
(II)luminance Calculations:

Calculation	Type	Unit	Ave	Min	Max	Min/Ave
Public Footpath	Surface Illuminance	lux	9.57	0.13	38.30	0.01
Garden 1	Surface Illuminance	lux	3.73	0.21	11.97	0.06
Garden 2	Surface Illuminance	lux	4.96	0.19	14.48	0.04
House Front 1	Surface Illuminance	lux	3.48	0.15	13.09	0.04
House 2 Front	Surface Illuminance	lux	4.35	0.14	18.93	0.03

3. Calculation Results

3.1 Public Footpath: Iso Contour

Grid : Public Footpath at Z = -0.00 m
Calculation : Surface Illuminance (lux)



A → FGS104

B → 2695 SNN/1C *

Average
9.57

Minimum
0.13

Maximum
38.30

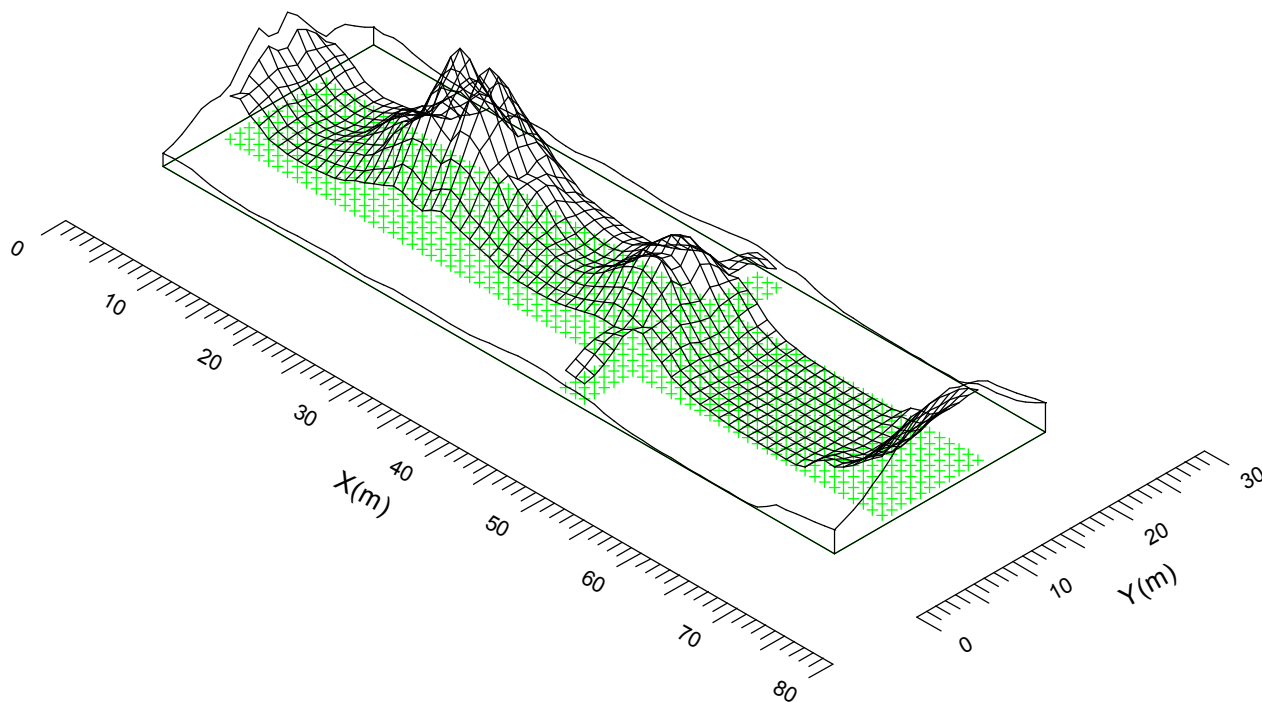
Min/Ave
0.01

Project maintenance factor
0.80

Scale
1:500

3.2 Public Footpath: Mountain Plot

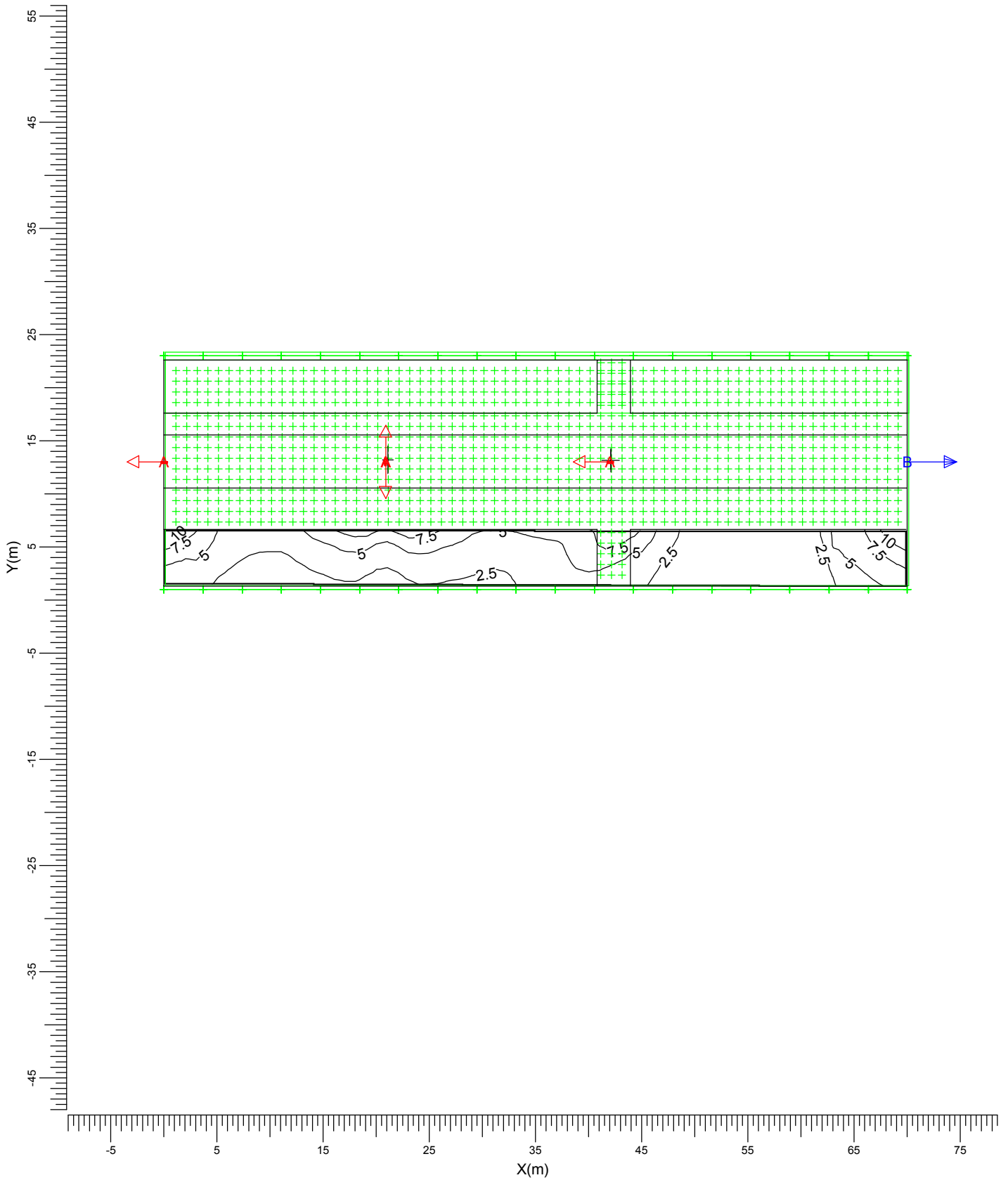
Grid : Public Footpath at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
9.57	0.13	38.30	0.01	0.80

3.3 Garden 1: Iso Contour

Grid : Garden 1 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



A

→ FGS104

B

→ 2695 SNN/1C *

Average
3.73

Minimum
0.21

Maximum
11.97

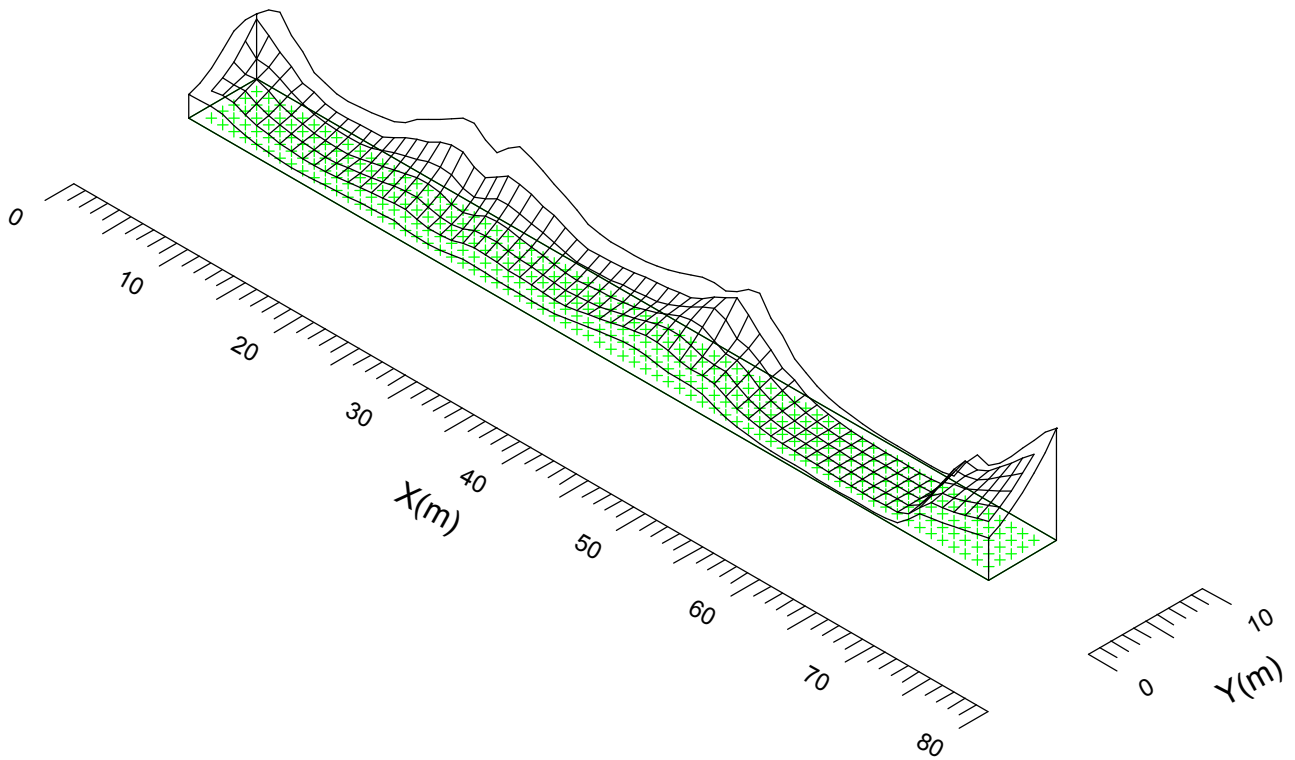
Min/Ave
0.06

Project maintenance factor
0.80

Scale
1:500

3.4 Garden 1: Mountain Plot

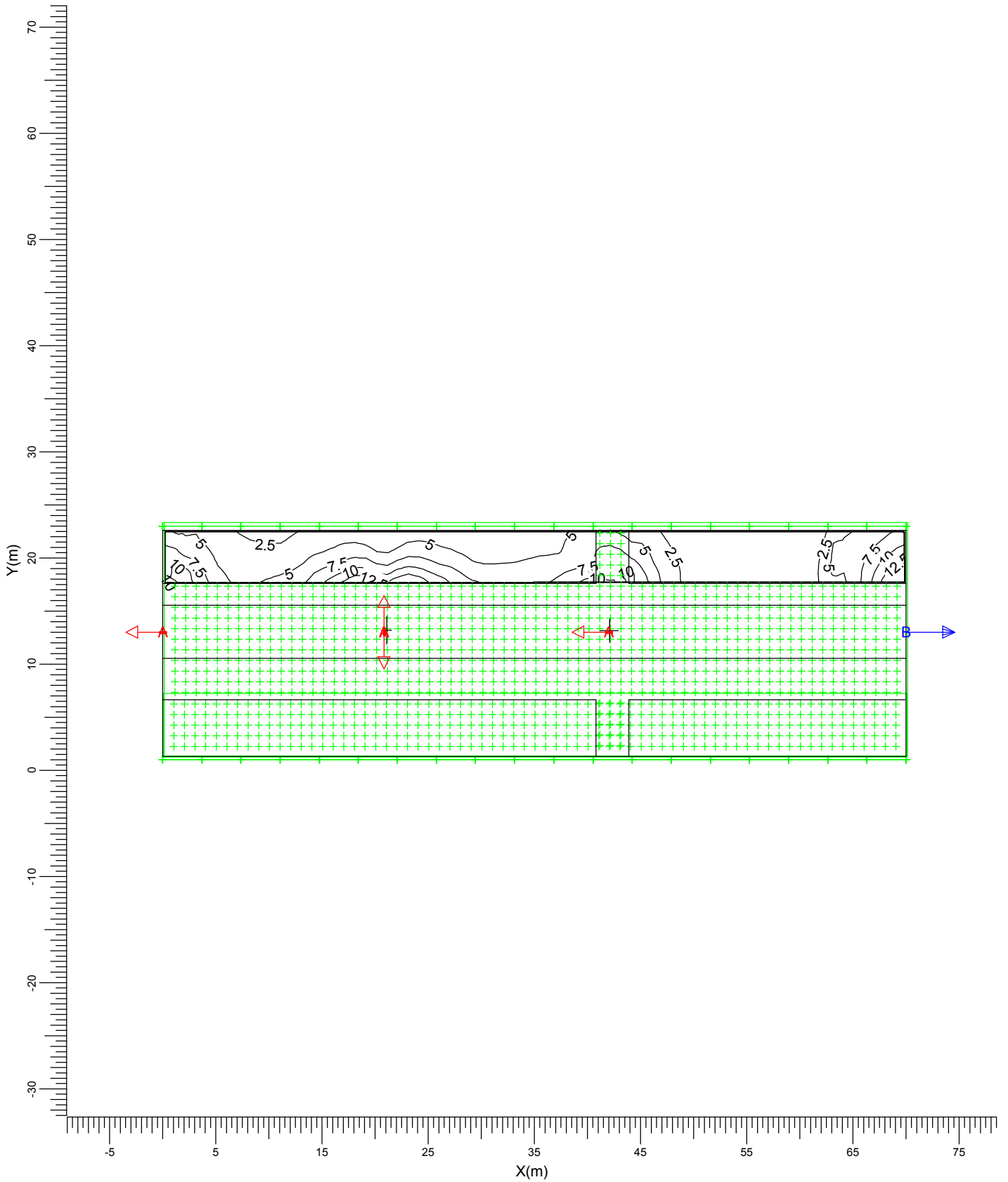
Grid : Garden 1 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
3.73	0.21	11.97	0.06	0.80

3.5 Garden 2: Iso Contour

Grid : Garden 2 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



A FGS104

B 2695 SNN/1C *

Average
4.96

Minimum
0.19

Maximum
14.48

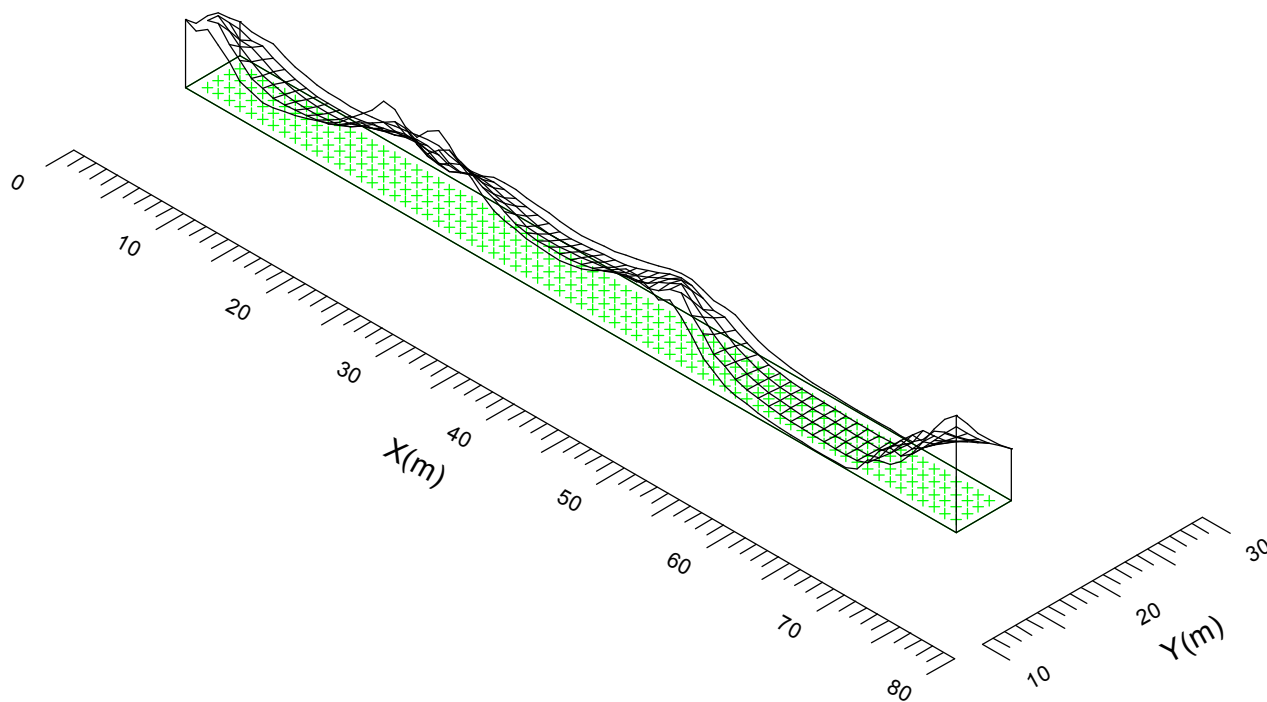
Min/Ave
0.04

Project maintenance factor
0.80

Scale
1:500

3.6 Garden 2: Mountain Plot

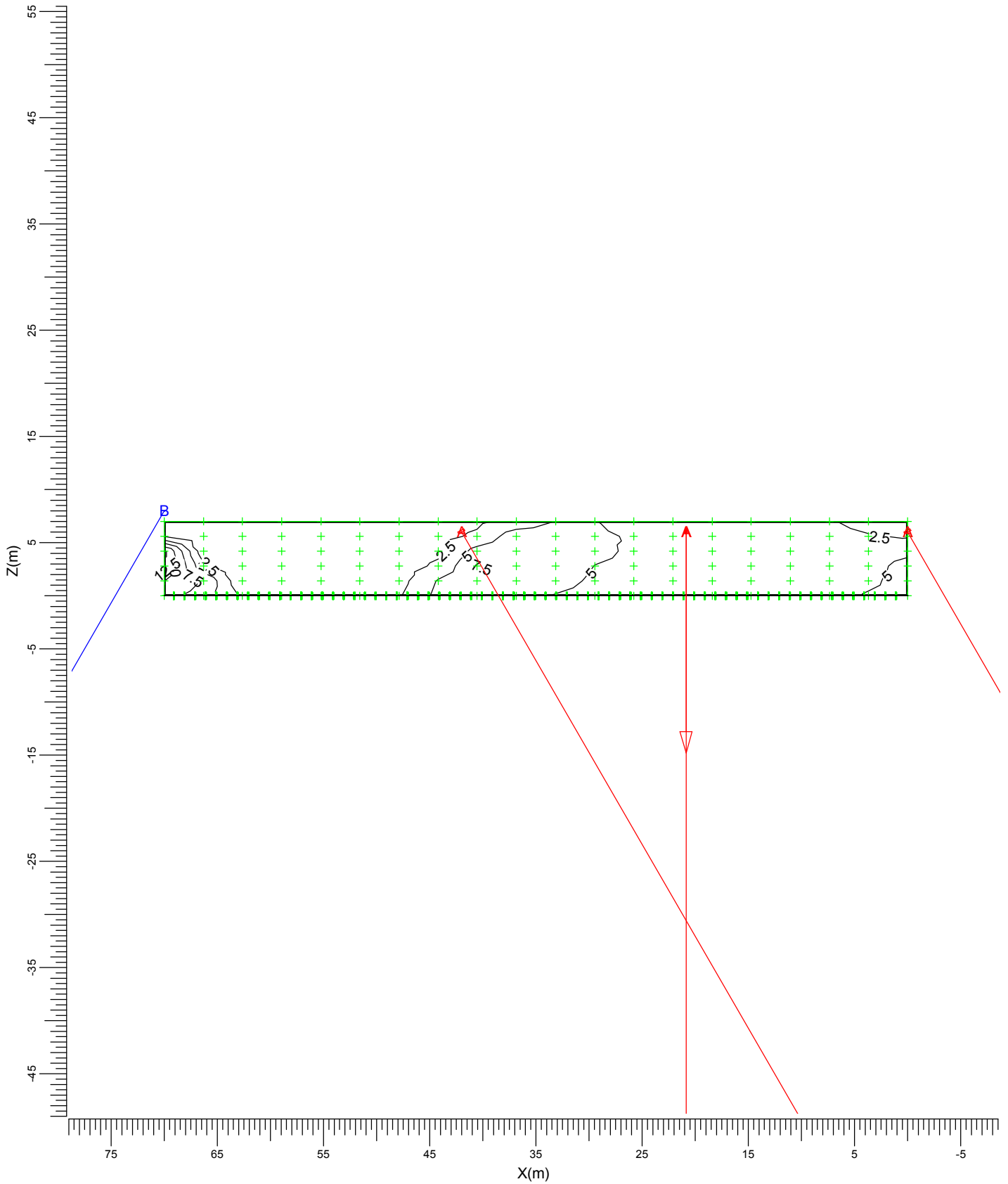
Grid : Garden 2 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
4.96	0.19	14.48	0.04	0.80

3.7 House Front 1: Iso Contour

Grid : House Front 1 at Y = 1.00 m
Calculation : Surface Illuminance (lux)

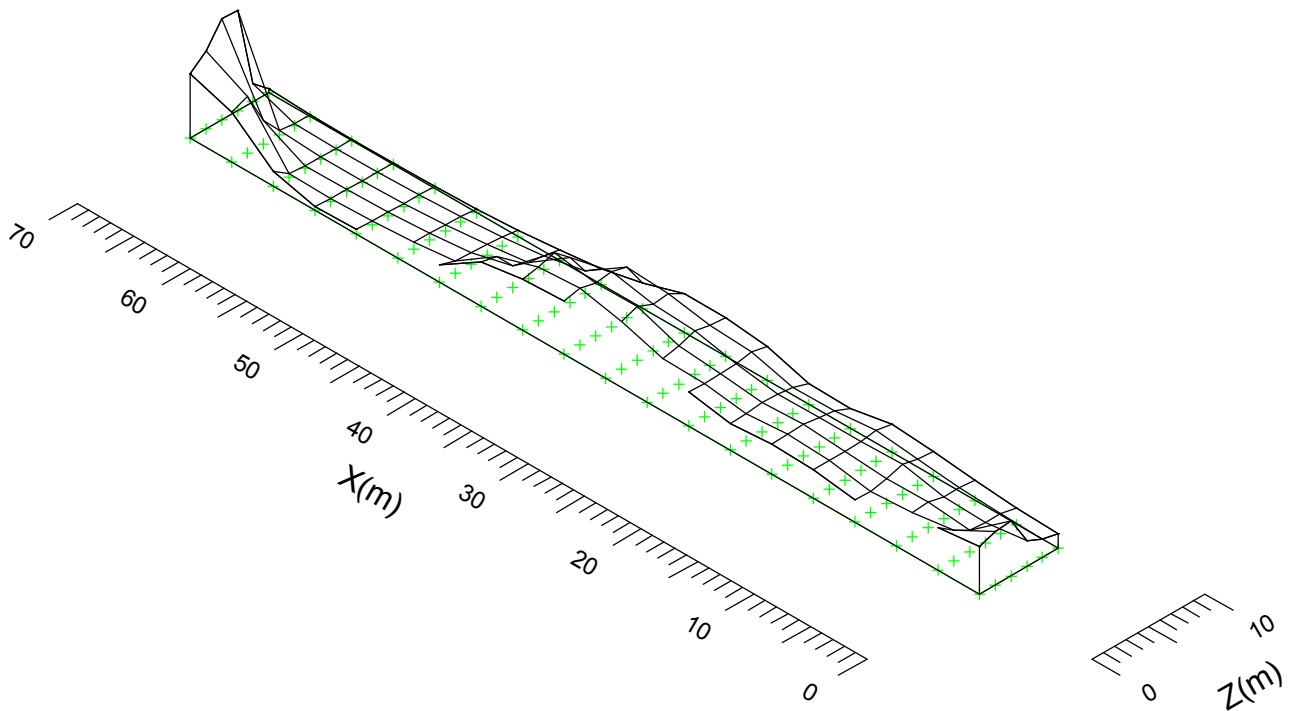


A → FGS104 B → 2695 SNN/1C *

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
3.48	0.15	13.09	0.04	0.80	1:500

3.8 House Front 1: Mountain Plot

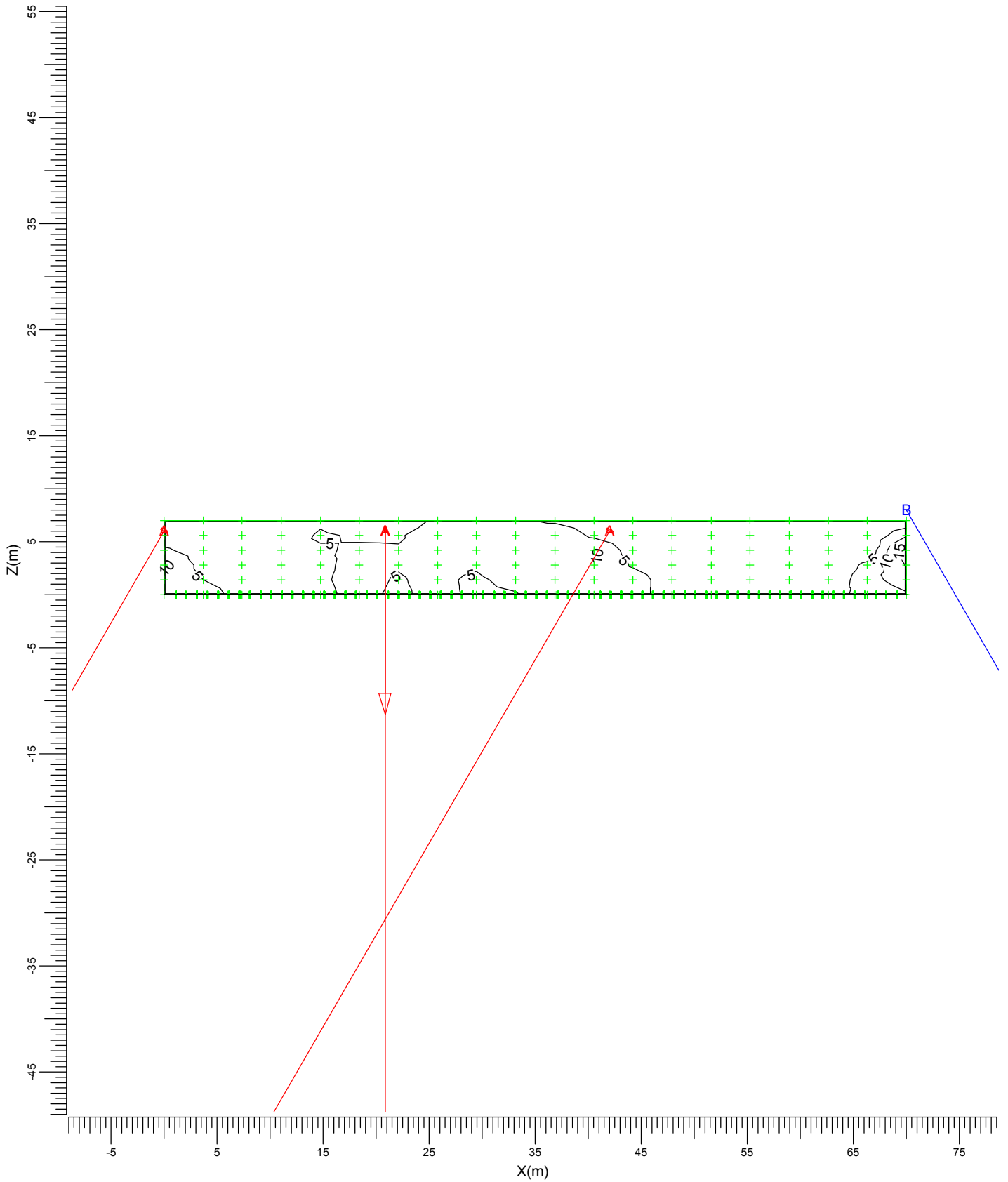
Grid : House Front 1 at Y = 1.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
3.48	0.15	13.09	0.04	0.80

3.9 House 2 Front: Iso Contour

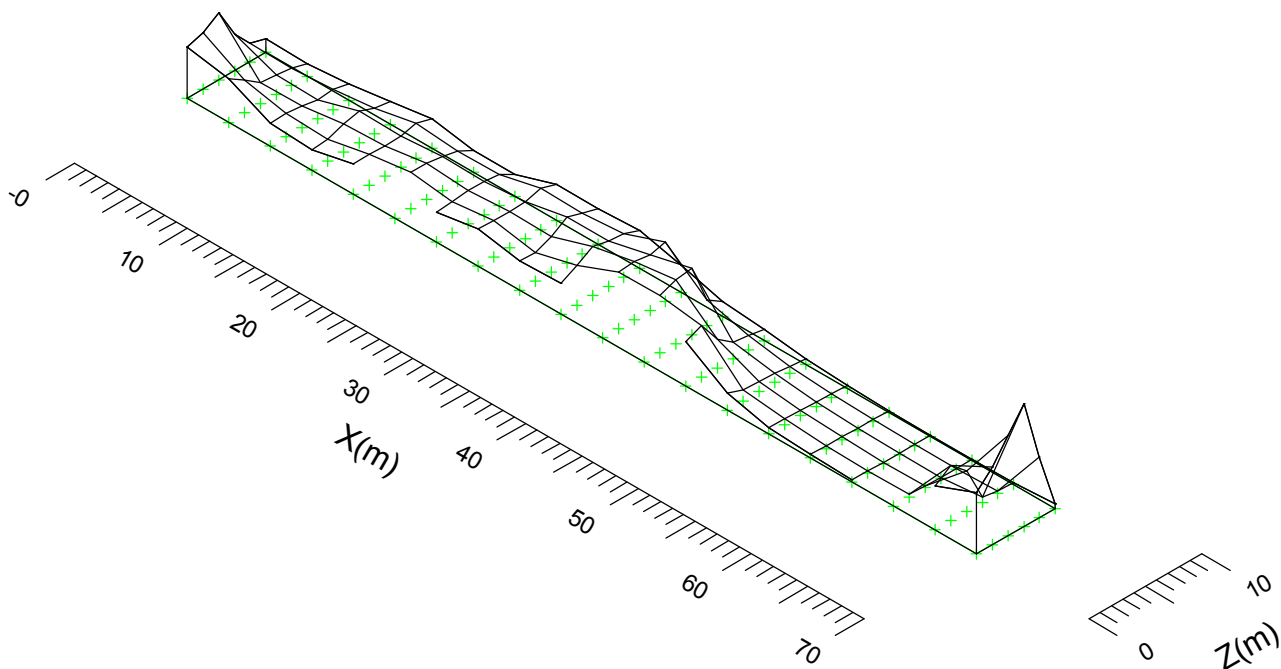
Grid : House 2 Front at Y = 23.00 m
Calculation : Surface Illuminance (lux)



A	→ FGS104	B	→ 2695 SNN/1C *		
Average 4.35	Minimum 0.14	Maximum 18.93	Min/Ave 0.03	Project maintenance factor 0.80	Scale 1:500

3.10 House 2 Front: Mountain Plot

Grid : House 2 Front at Y = 23.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
4.35	0.14	18.93	0.03	0.80

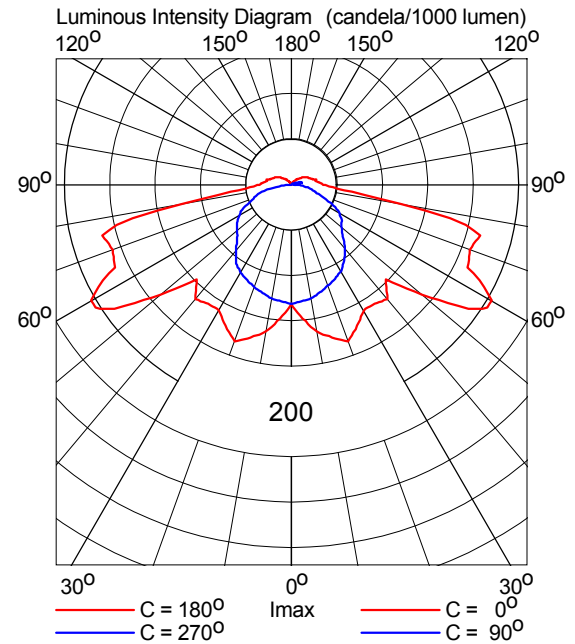
4. Luminaire Details

4.1 Project Luminaires

FGS103/104/105
FGS104 1xSOX55W



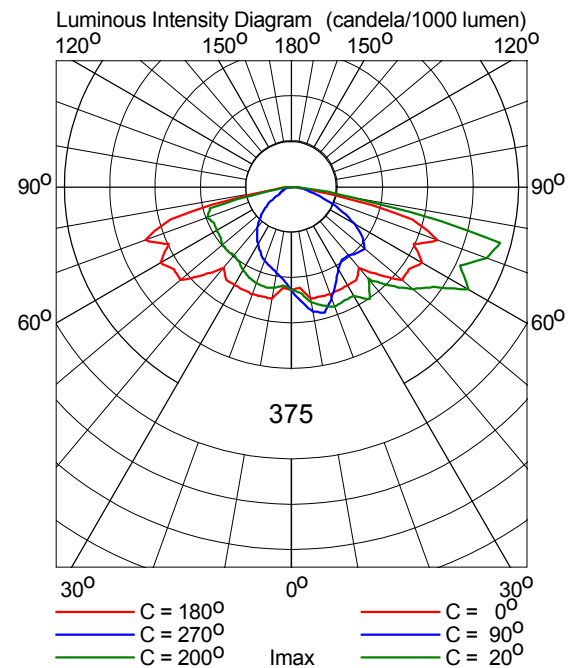
Light output ratios
 DLOR : 0.65
 ULOR : 0.05
 TLOR : 0.70
 Ballast : Conventional
 Lamp flux : 7800 lm
 Luminaire wattage : 74.0 W
 Measurement code : D507000000



2695 SNN * 1x1SON-T 150W

Light output ratios
 DLOR : 0.79
 ULOR : 0.01
 TLOR : 0.80
 Lamp flux : 17500 lm
 Measurement code : LM02191 /

Note: Luminaire data not from database.



DATE: 31 January 2013
DESIGNER: James H Paterson BA(hons) CEng MCIBSE FI
PROJECT No: Baseline Study
PROJECT NAME: Town Centre



See separate study showing building mounted floodlights producing 45% ULR

Appendix 3

LCADS Ltd
Moffat and Gloucester

PREPARED BY: Lighting Consultancy And Design Services Ltd
Rosemount House
Well Road
Moffat DG10 9BT

e-mail: lcadsinScotland@aol.com
website: www.lcads.com

Layout Report

General Data

Dimensions in Metres Angles in Degrees
 Grid Origin 78.5m x 72.4m
 Area 157.1m x 266.5m
 Sample Spacing 5.07m x 4.94m

Luminaires

Luminaire A Data

Supplier	
Type	OT150T4
Lamp(s)	150W ST
Lamp Flux (klm)	16.00
File Name	OT150T4.LDT
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	79.0, 5.0, 0.0



Luminaire B Data

Supplier	
Type	ZX3/1289/Clear Poly./135/-...
Lamp(s)	250W-SONT+
Lamp Flux (klm)	32.00
File Name	ZX3TY922268.cib
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	501.0, 195.0, 52.0



Luminaire C Data

Supplier	C U Phosco
Type	P109-OPAL
Lamp(s)	70W SON
Lamp Flux (klm)	5.60
File Name	p109-opal.cib
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	73.0, 72.0, 68.0

Luminaire D Data

Supplier	_Historic Lanterns
Type	QB2B1055.4A + QB2M
Lamp(s)	55W SOX
Lamp Flux (klm)	7.80
File Name	r0004957.cib
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	179.3, 135.2, 67.6



Luminaire E Data

Supplier	
Type	ZX3/1289/Clear Poly./120/-...
Lamp(s)	150W-SONT+
Lamp Flux (klm)	16.50
File Name	ZX3TX922306.cib
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	502.0, 42.0, 37.0

Luminaire F Data

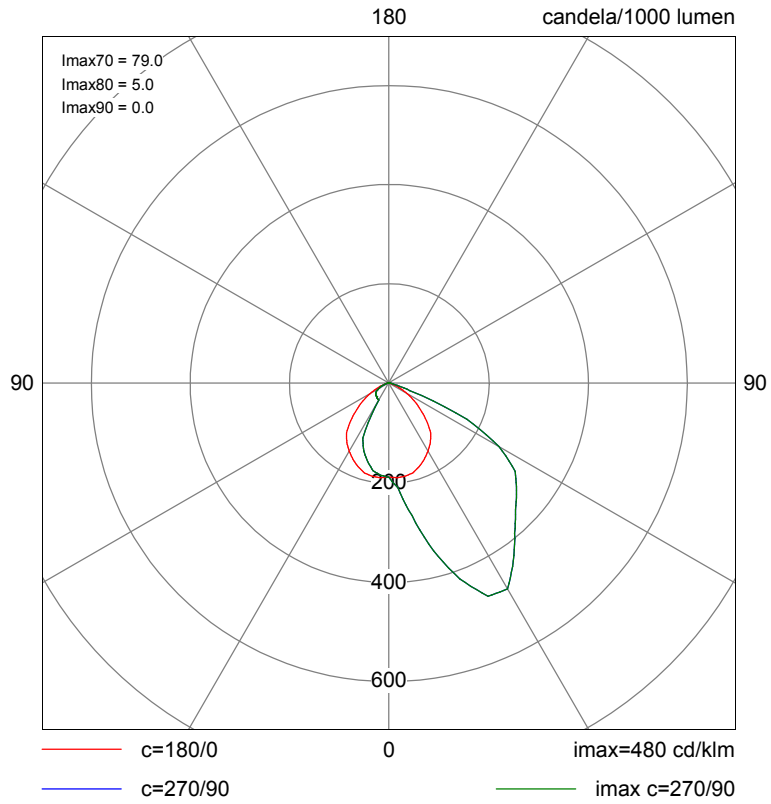
Supplier	Sugg
Type	Westminster Med cgp Refrac...
Lamp(s)	HPS 70w
Lamp Flux (klm)	5.60
File Name	S930055.ies
Maintenance Factor	0.85
Imax70,80,90(cd/klm)	82.3, 85.0, 83.3

Layout

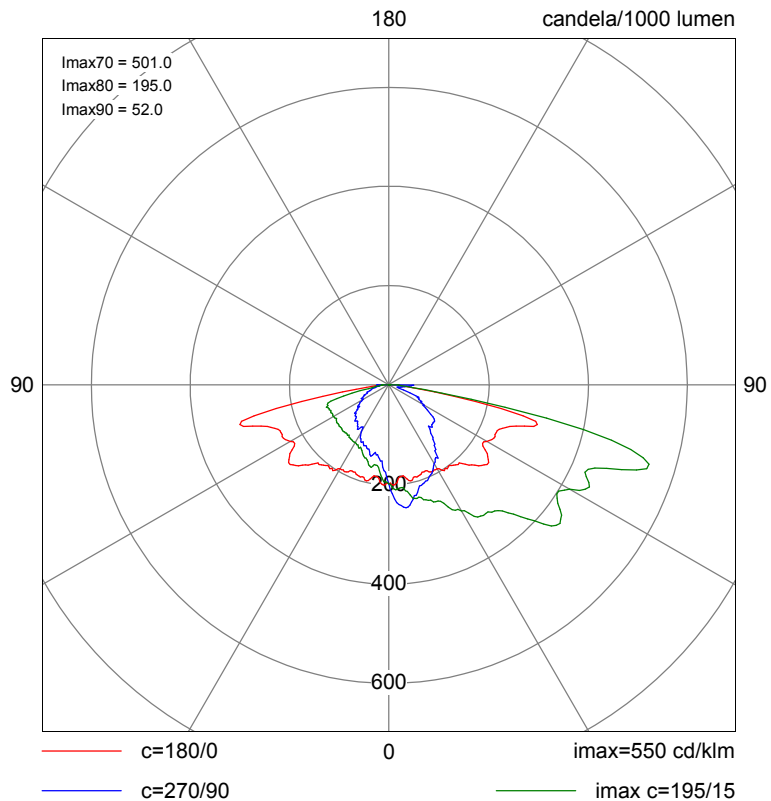
No.	Type	X	Y	Height	Angle	Tilt	Cant	Out-reach	Target X	Target Y	Target Z
1	E	218.00	69.85	8.00	20.00	5.00	0.00	1.00			
2	A	200.63	78.54	8.00	90.00	45.00	0.00	0.00			
3	A	182.81	87.84	7.00	0.00	5.00	0.00	0.00			
4	A	227.10	99.70	8.00	195.00	45.00	0.00	0.00			
5	A	180.55	115.46	8.00	10.00	45.00	0.00	0.00			
6	A	217.27	128.13	8.00	205.00	45.00	0.00	0.00			
7	D	157.31	120.79	6.00	295.00	5.00	0.00	0.50			
8	B	194.83	137.43	8.00	10.00	5.00	0.00	1.00			
9	B	194.76	137.36	8.00	190.00	5.00	0.00	1.00			
10	D	231.55	154.07	6.00	120.00	5.00	0.00	0.50			
11	D	156.16	142.35	6.00	300.00	5.00	0.00	0.50			
12	A	165.46	162.56	8.00	30.00	45.00	0.00	0.00			
13	C	180.41	172.06	6.00	0.00	0.00	0.00	0.00			
14	D	202.33	174.92	6.00	300.00	5.00	0.00	0.50			
15	A	196.45	182.36	8.00	215.00	45.00	0.00	0.00			
16	A	147.40	192.13	6.00	30.00	45.00	0.00	0.00			
17	C	165.26	200.08	6.00	20.00	0.00	0.00	0.00			
18	A	186.81	210.59	8.00	210.00	45.00	0.00	0.00			
19	C	143.36	200.22	6.00	30.00	0.00	0.00	0.00			
20	F	137.50	207.70	4.00	30.00	0.00	0.00	0.00			
21	F	129.88	221.51	4.00	0.00	0.00	0.00	0.00			
22	A	170.31	241.29	8.00	215.00	45.00	0.00	0.00			
23	B	137.73	254.70	8.00	25.00	5.00	0.00	1.00			
24	B	137.75	254.65	8.00	210.00	5.00	0.00	1.00			
25	B	123.02	282.78	8.00	35.00	5.00	0.00	1.00			
26	B	123.02	282.72	6.00	215.00	5.00	0.00	1.00			
27	B	113.86	301.53	8.00	40.00	5.00	0.00	1.00			
28	B	113.92	301.42	8.00	215.00	5.00	0.00	1.00			
29	C	122.20	238.75	6.00	30.00	0.00	0.00	0.00			
30	E	194.82	77.90	8.00	180.00	5.00	0.00	1.00			
31	E	108.32	340.36	8.00	185.00	5.00	0.00	1.00			
32	D	76.59	300.57	5.00	190.00	5.00	0.00	0.50			
33	D	195.58	213.30	6.00	300.00	5.00	0.00	0.50			

Polar Diagrams

Luminaire A OT150T4

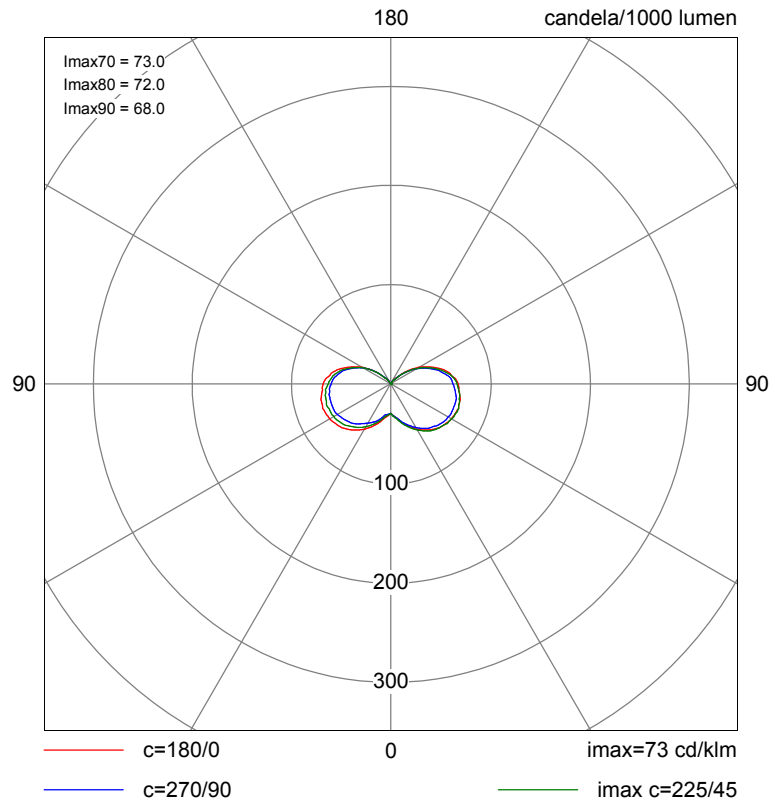


Luminaire B ZX3/1289/Clear Poly./135/-33

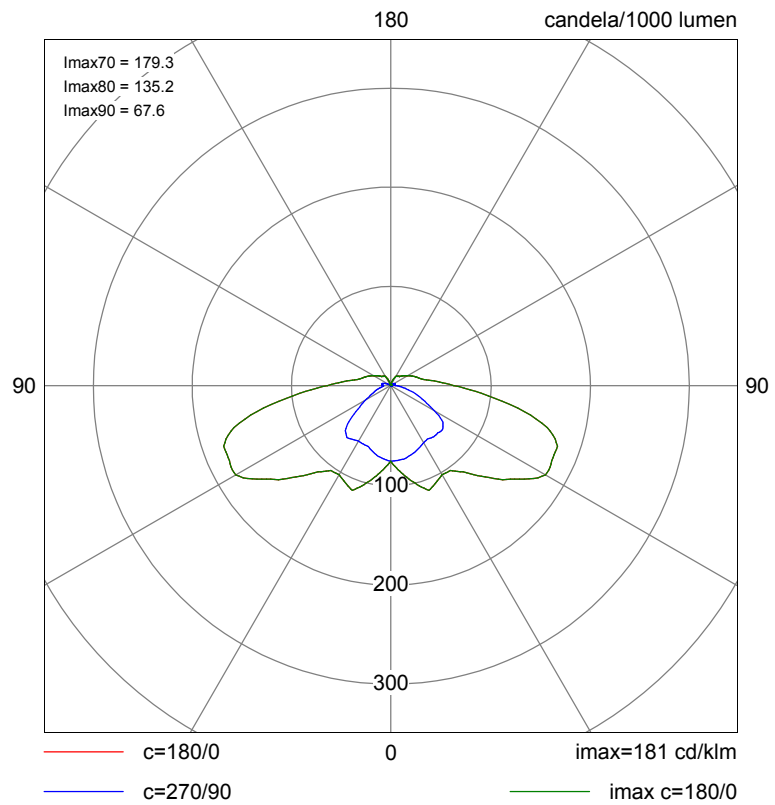


Polar Diagrams Continued

Luminaire C P109-OPAL

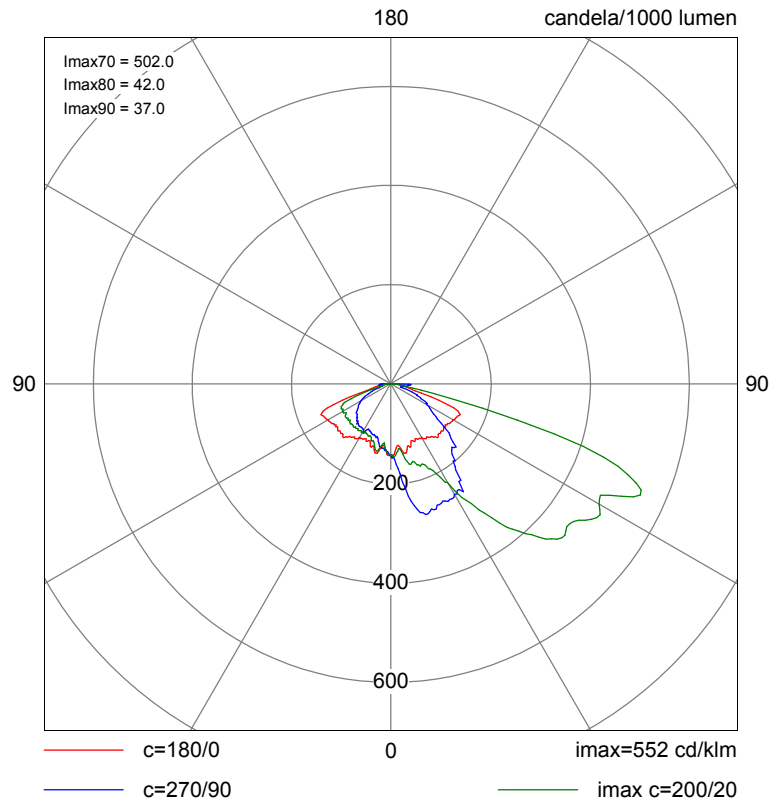


Luminaire D QB2B1055.4A + QB2M

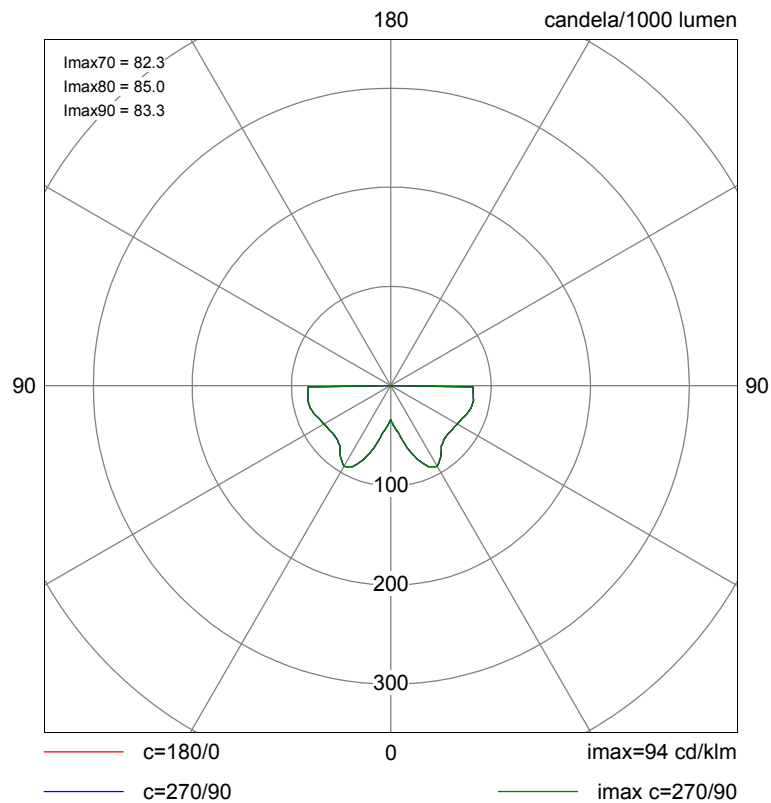


Polar Diagrams Continued

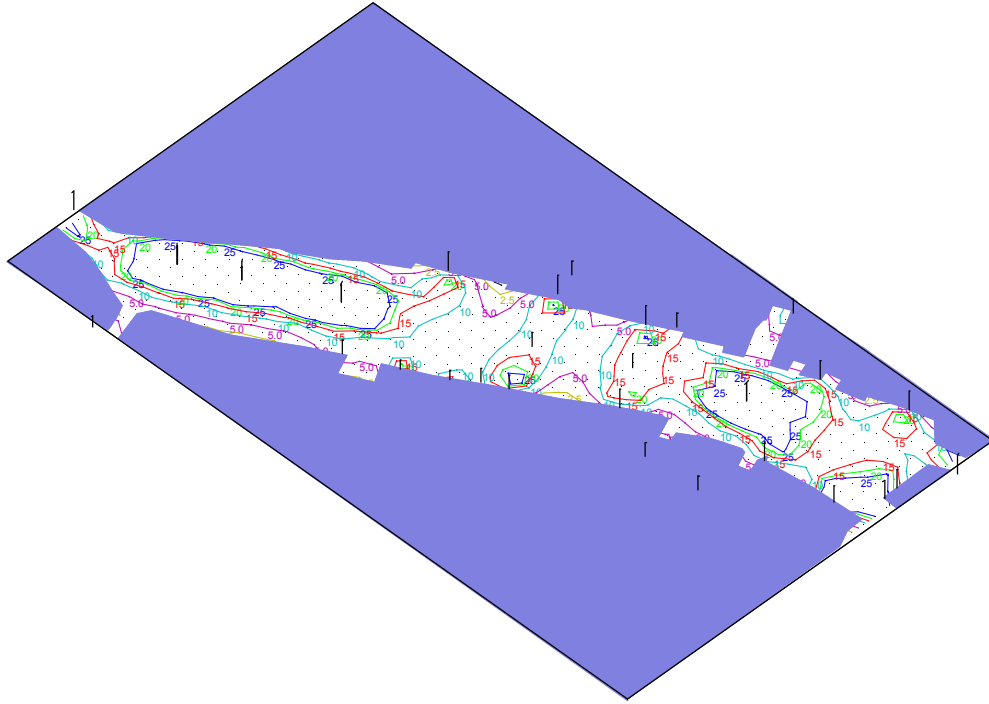
Luminaire E ZX3/1289/Clear Poly./120/-46



Luminaire F Westminster Med cgp Refractor



Horizontal Illuminance (lux)



Results

Eav	22.58
Emin	2.03
Emax	210.74
Emin/Emax	0.01
Emin/Eav	0.09

Horizontal Illuminance (lux)



Results

Eav	22.58
Emin	2.03
Emax	210.74
Emin/Emax	0.01
Emin/Eav	0.09

Horizontal Illuminance (lux)



Results

Eav	22.58
Emin	2.03
Emax	210.74
Emin/Emax	0.01
Emin/Eav	0.09

Appendix 4

St.Ninians Road

Project code:	WW Mini Iridium 5up
Date:	23-12-2012
Designer:	James H Paterson BA(Hons) CEng FILP MSL
Description:	BGS451 WSO 1xECO 35-2S 830 Warm White Optic

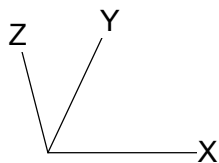
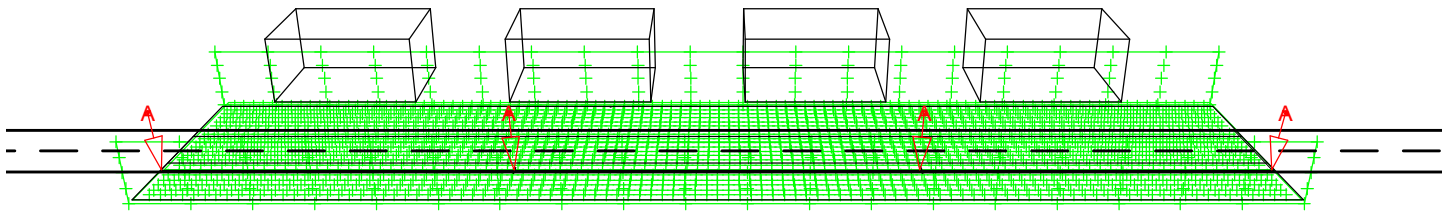
The nominal values shown in this report are the result of precision calculations, based upon precisely positioned luminaires in a fixed relationship to each other and to the area under examination. In practice the values may vary due to tolerances on luminaires, luminaire positioning, reflection properties and electrical supply.

Lighting Consultancy And Design Services

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Rosemount House
Well Road
Moffat
DG10 9BT
Telephone: 01683 220 299
Mobile Phone: 0777 316 0303
E-Mail: lcadsinScotland@aol.com

1. Project Description

1.1 3-D Project Overview



A  BGS451 WSO

2. Summary

2.1 General Information

The overall maintenance factor used for this project is 0.80.

2.2 Obstacle Information

Obstacle	Transparency (%)	Position		
		X (m)	Y (m)	Z (m)
house 1	0	5.00	24.00	0.00
house 2	0	30.00	24.00	0.00
house 3	0	55.00	24.00	0.00
house 4	0	80.00	24.00	0.00

2.3 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	4	BGS451 WSO	1 * ECO35-2S/830	41.0	1 * 3480

The total installed power: 0.16 (kWatt)

2.4 Calculation Results

(II)luminance Calculations:

Calculation	Type	Unit	Ave	Min	Max	Min/Ave
Public Highway	Surface Illuminance	lux	4.04	1.30	14.88	0.32
House Line 2	Surface Illuminance	lux	0.09	0.01	0.33	0.16
Garden 2	Surface Illuminance	lux	0.41	0.06	1.10	0.14
Garden 1	Surface Illuminance	lux	3.10	0.21	13.85	0.07
House Line 1	Surface Illuminance	lux	0.15	0.00	0.86	0.00

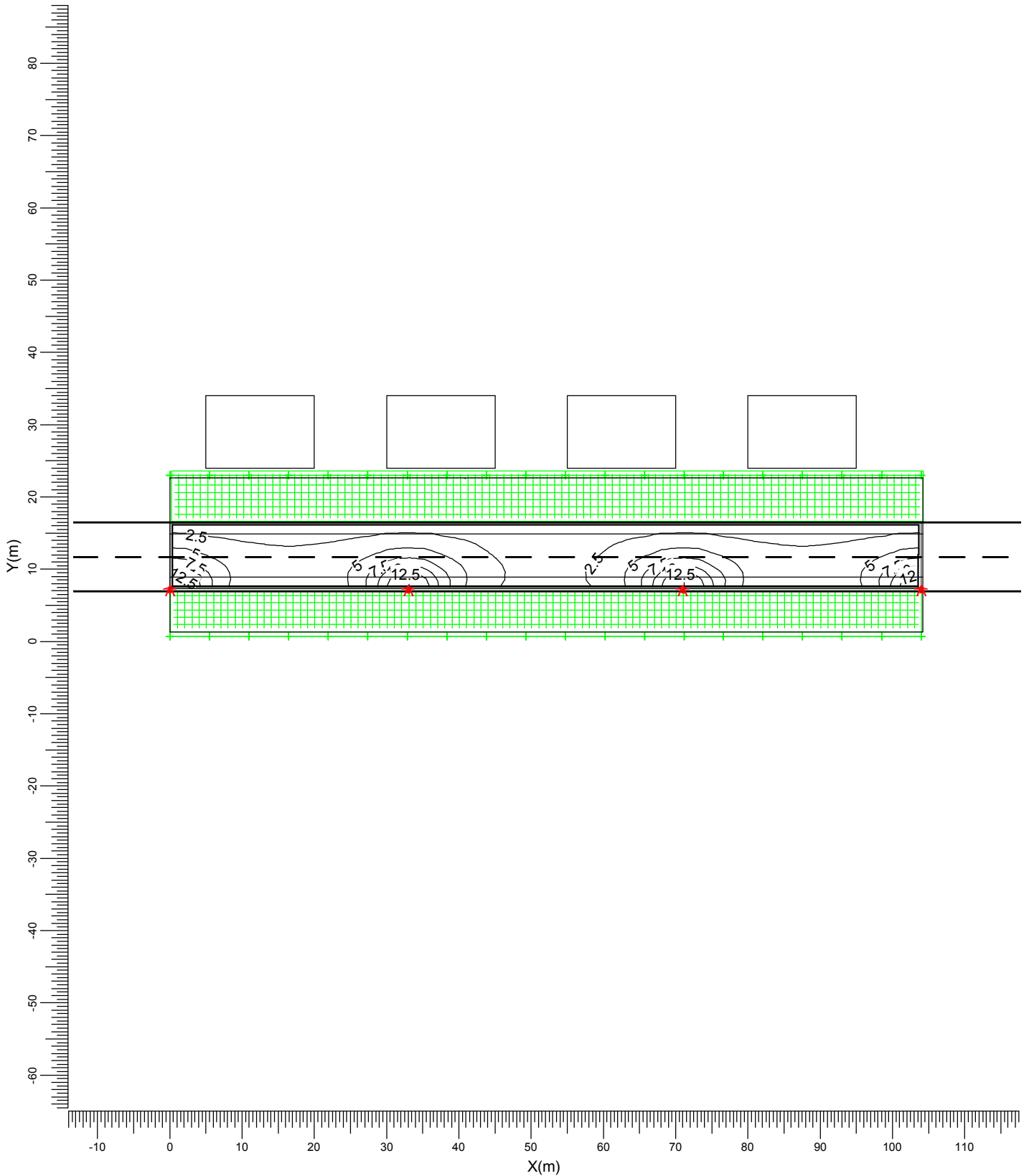
Obtrusive Light Calculations:

The upward light ratio (ULR) is 0.00.

3. Calculation Results

3.1 Public Highway: Iso Contour

Grid : Public Highway at Z = -0.00 m
 Calculation : Surface Illuminance (lux)

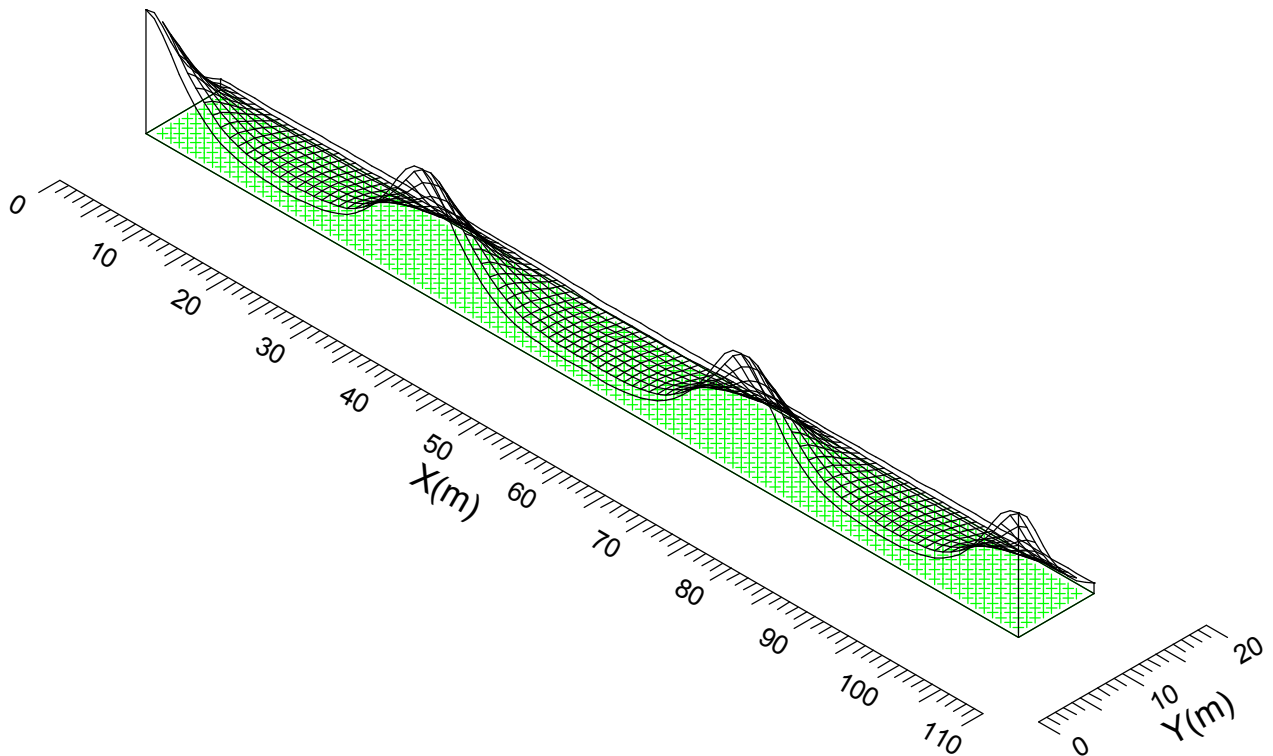


A BGS451 WSO

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
4.04	1.30	14.88	0.32	0.80	1:750

3.2 Public Highway: Mountain Plot

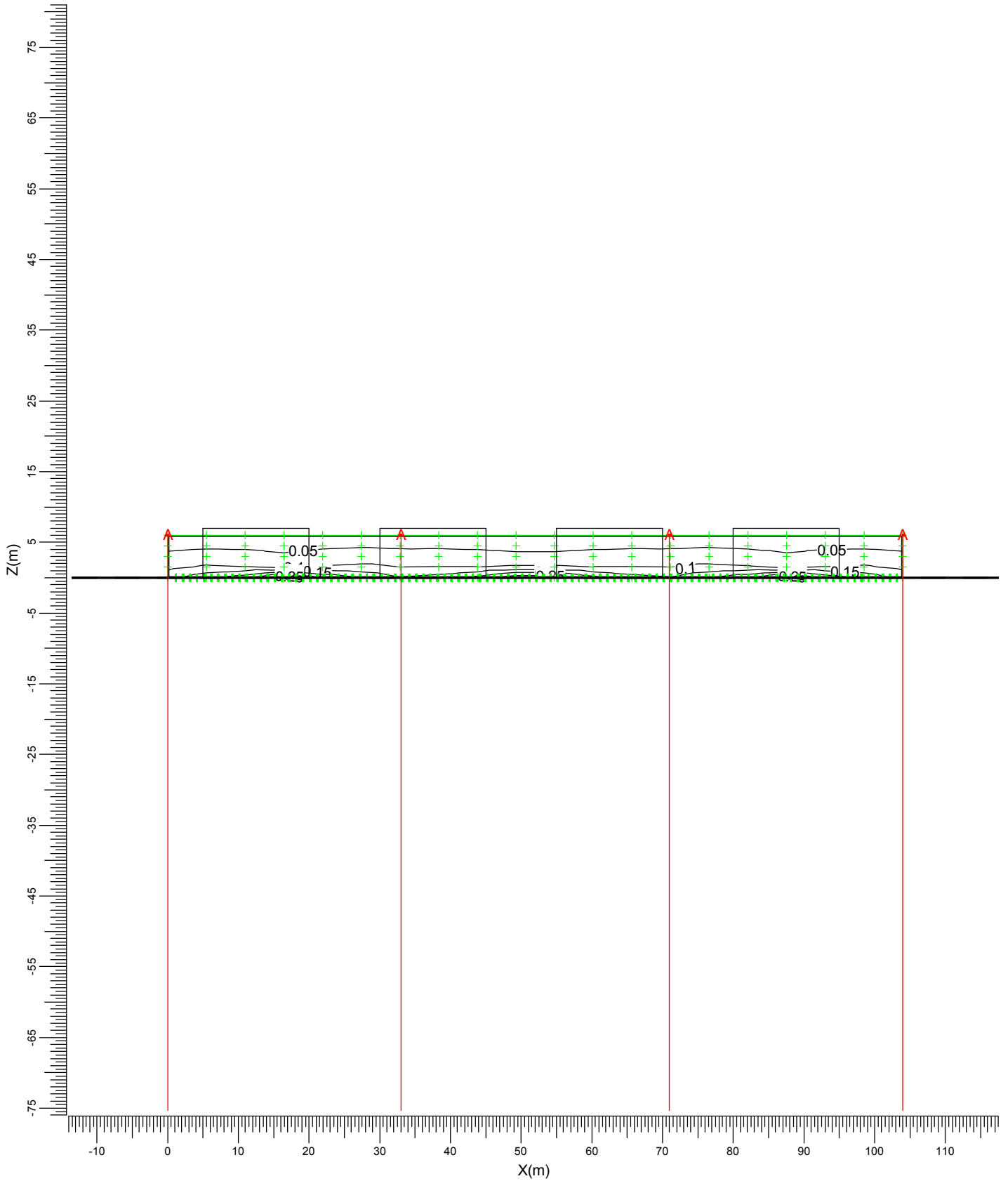
Grid : Public Highway at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
4.04	1.30	14.88	0.32	0.80

3.3 House Line 2: Iso Contour

Grid : House Line 2 at Y = 23.00 m
 Calculation : Surface Illuminance (lux)

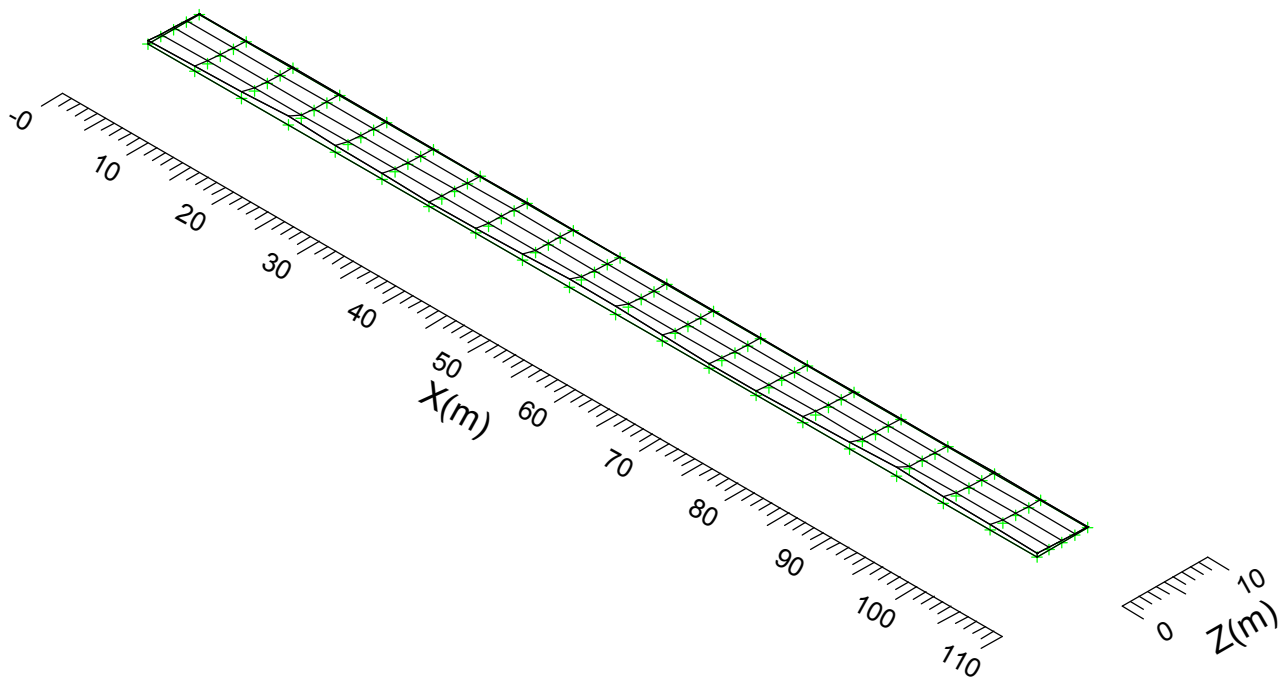


A BGS451 WSO

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
0.09	0.01	0.33	0.16	0.80	1:750

3.4 House Line 2: Mountain Plot

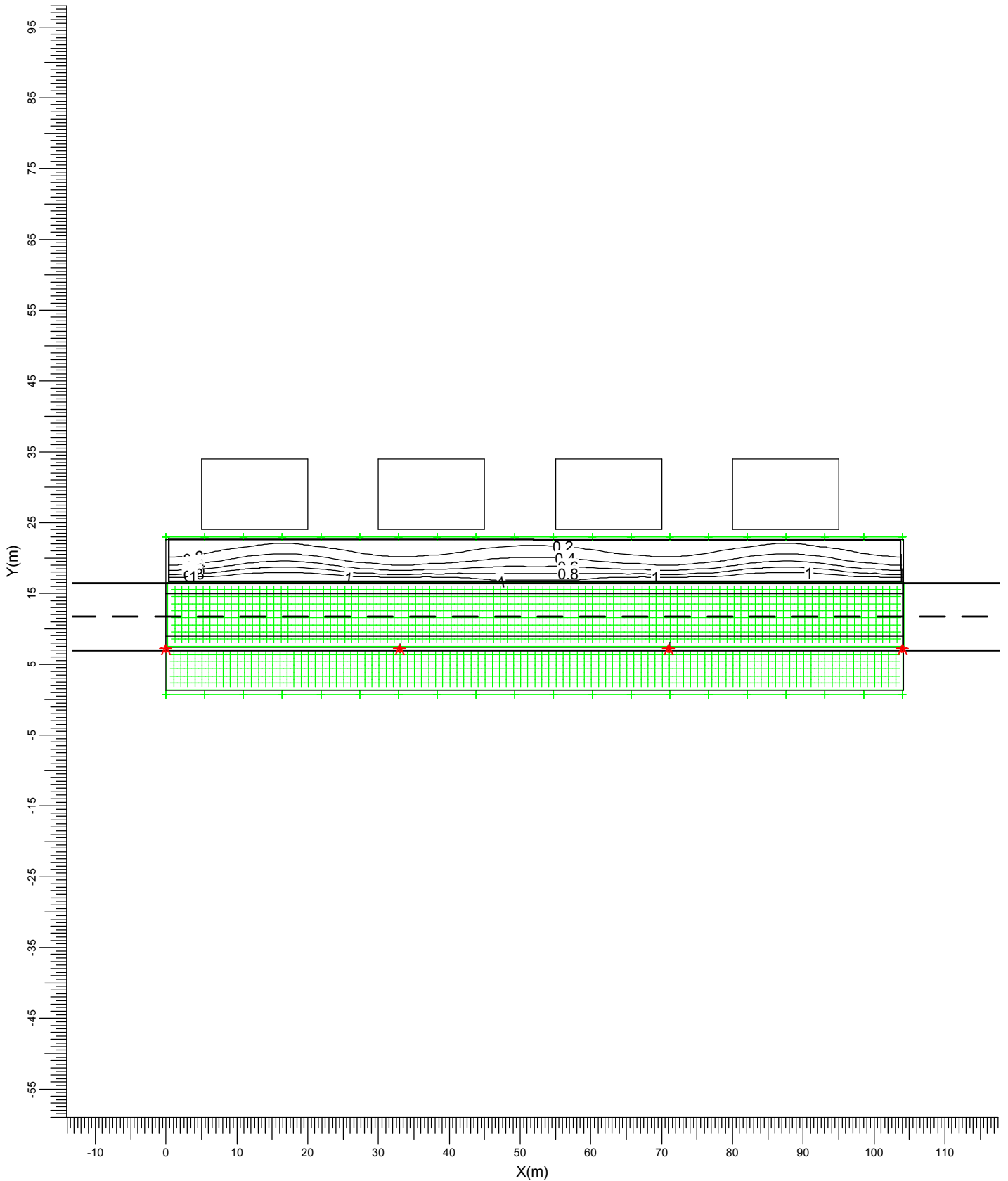
Grid : House Line 2 at Y = 23.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
0.09	0.01	0.33	0.16	0.80

3.5 Garden 2: Iso Contour

Grid : Garden 2 at Z = -0.00 m
 Calculation : Surface Illuminance (lux)

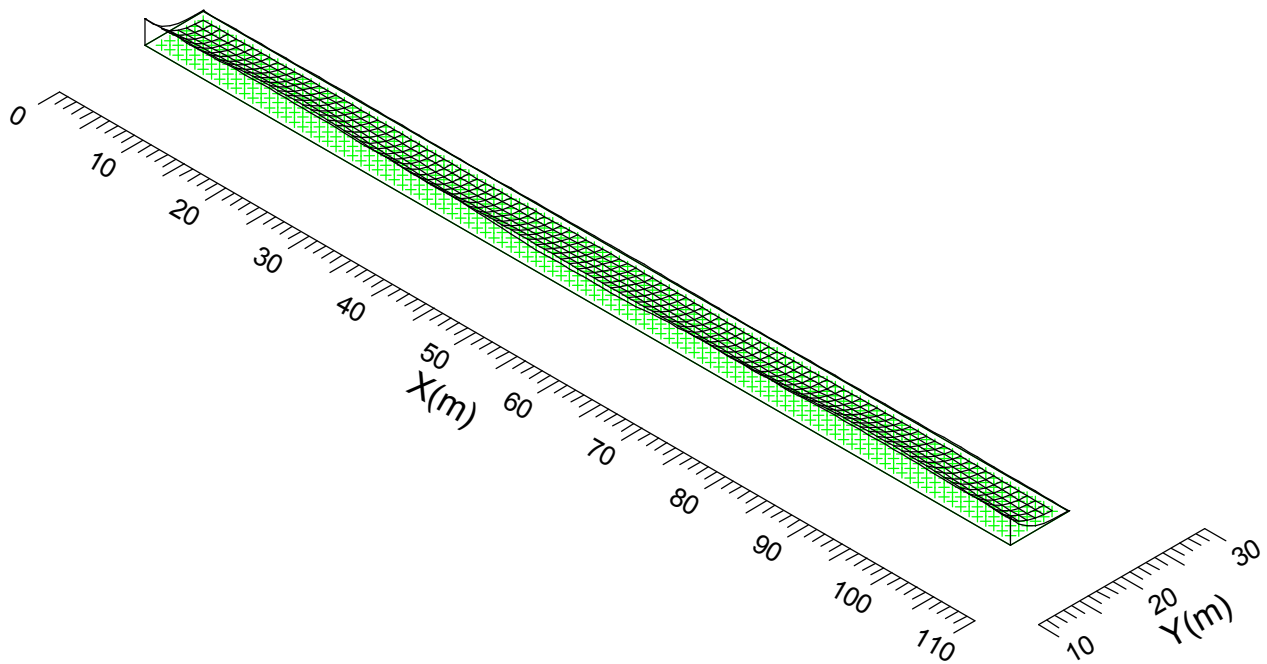


A BGS451 WSO

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
0.41	0.06	1.10	0.14	0.80	1:750

3.6 Garden 2: Mountain Plot

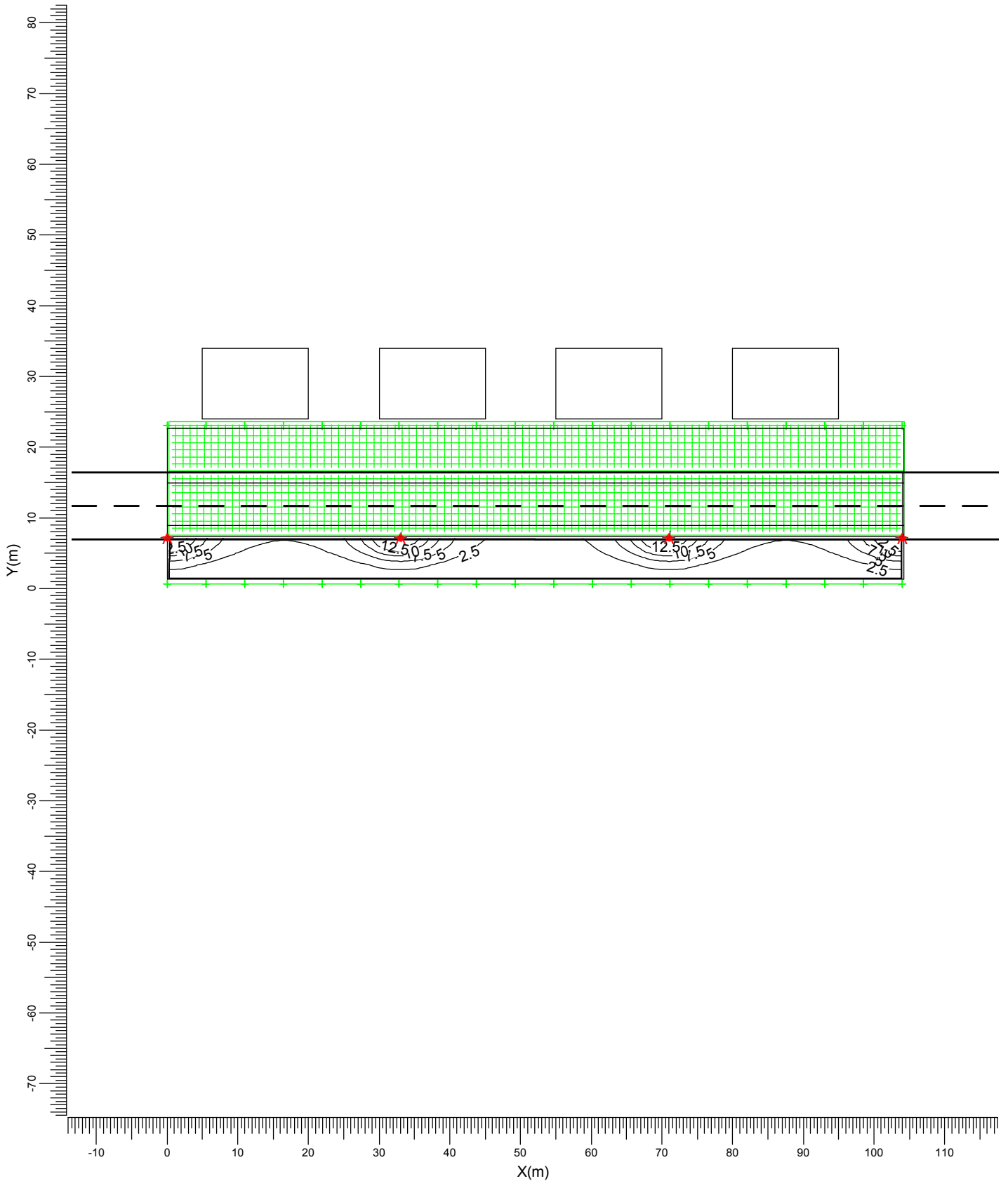
Grid : Garden 2 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
0.41	0.06	1.10	0.14	0.80

3.7 Garden 1: Iso Contour

Grid : Garden 1 at Z = -0.00 m
 Calculation : Surface Illuminance (lux)

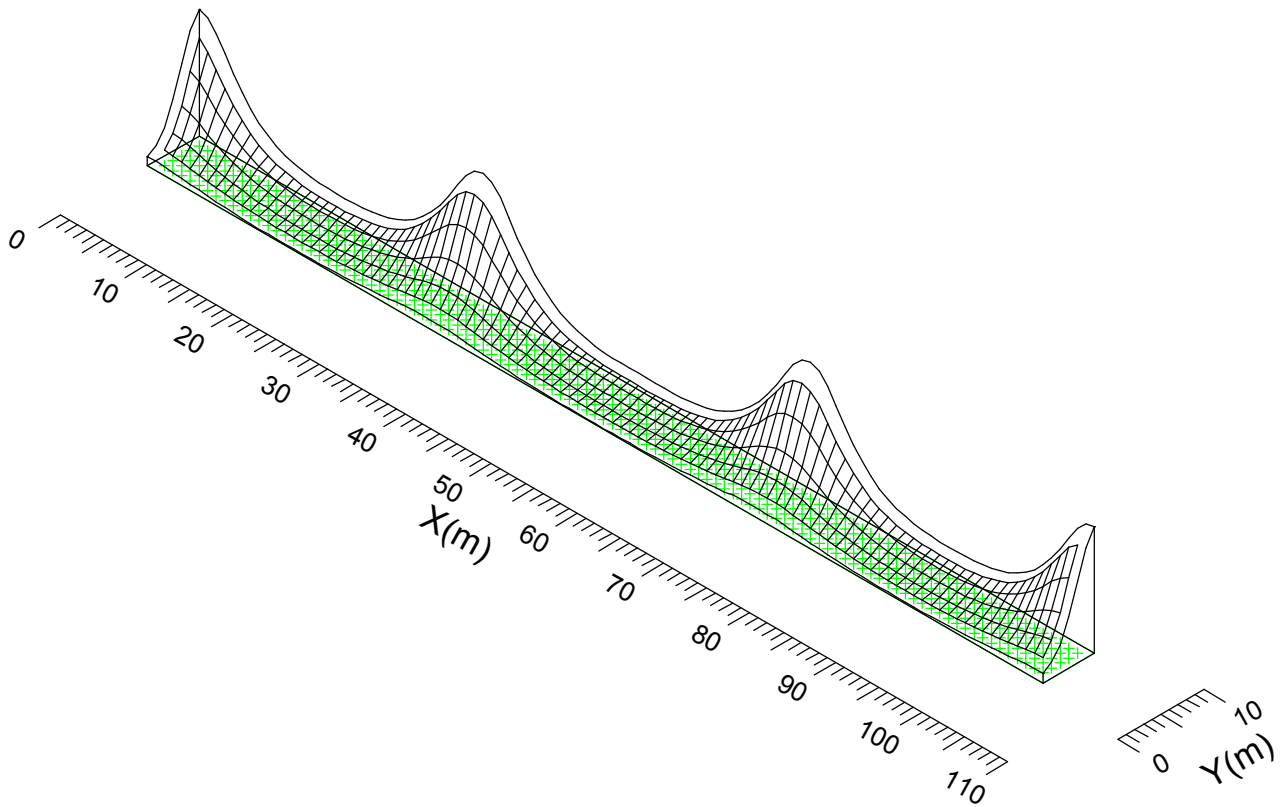


A BGS451 WSO

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
3.10	0.21	13.85	0.07	0.80	1:750

3.8 Garden 1: Mountain Plot

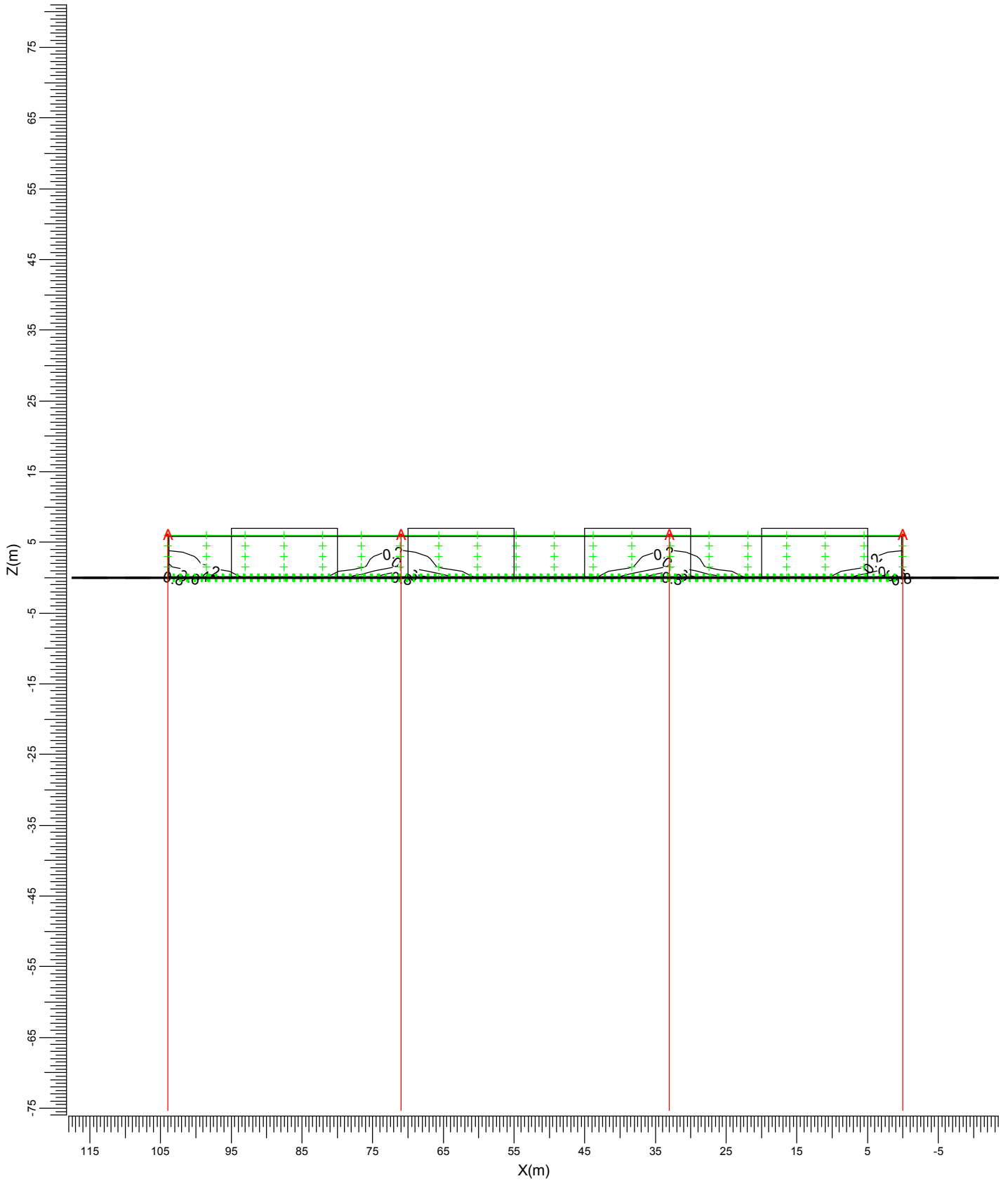
Grid : Garden 1 at Z = -0.00 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
3.10	0.21	13.85	0.07	0.80

3.9 House Line 1: Iso Contour

Grid : House Line 1 at Y = 0.70 m
 Calculation : Surface Illuminance (lux)

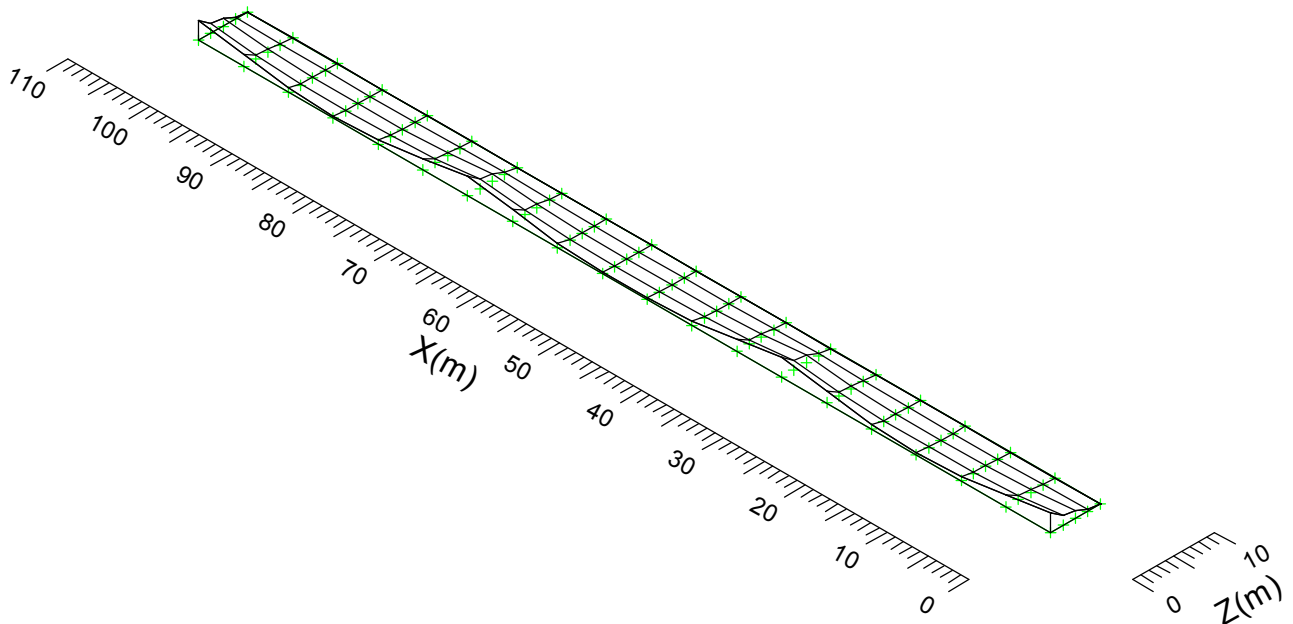


A → BGS451 WSO

Average	Minimum	Maximum	Min/Ave	Project maintenance factor	Scale
0.15	0.00	0.86	0.00	0.80	1:750

3.10 House Line 1: Mountain Plot

Grid : House Line 1 at Y = 0.70 m
Calculation : Surface Illuminance (lux)



Average	Minimum	Maximum	Min/Ave	Project maintenance factor
0.15	0.00	0.86	0.00	0.80

4. Luminaire Details

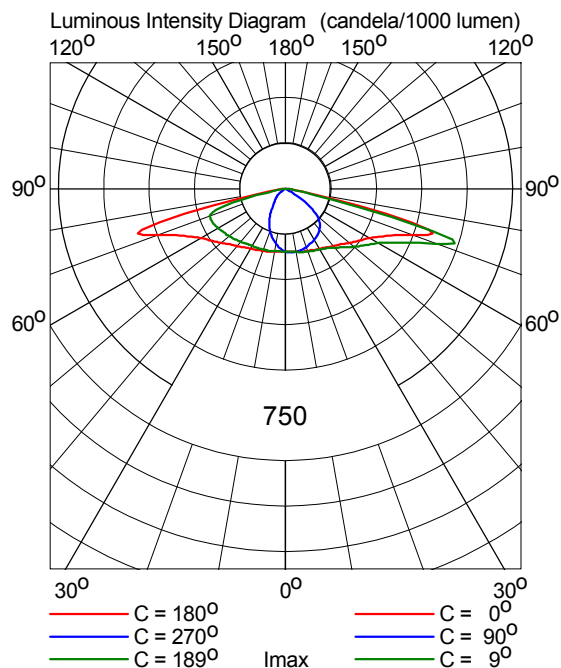
4.1 Project Luminaires

BGS451 WSO 1xECO35-2S/830/-

Light output ratios

DLOR	: 0.77
ULOR	: 0.00
TLOR	: 0.77
Lamp flux	: 3480 lm
Luminaire wattage	: 41.0 W
Measurement code	: LVMB054300

Note: Luminaire data not from database.



DATE: 7 February 2013
DESIGNER: James H Paterson BA(hons) CEng MCIBSE FI
PROJECT No: LED-CPO Study
PROJECT NAME: Town Centre



See separate study showing building mounted floodlights producing 0% ULR

Appendix 5

LCADS Ltd
Moffat and Gloucester

PREPARED BY: Lighting Consultancy And Design Services Ltd
Rosemount House
Well Road
Moffat DG10 9BT

e-mail: lcadsinScotland@aol.com
website: www.lcads.com

Layout Report

General Data

Dimensions in Metres Angles in Degrees

Grid Origin 78.5m x 72.4m

Area 157.1m x 266.5m

Sample Spacing 5.07m x 4.94m

Luminaires

Luminaire A Data

Layout

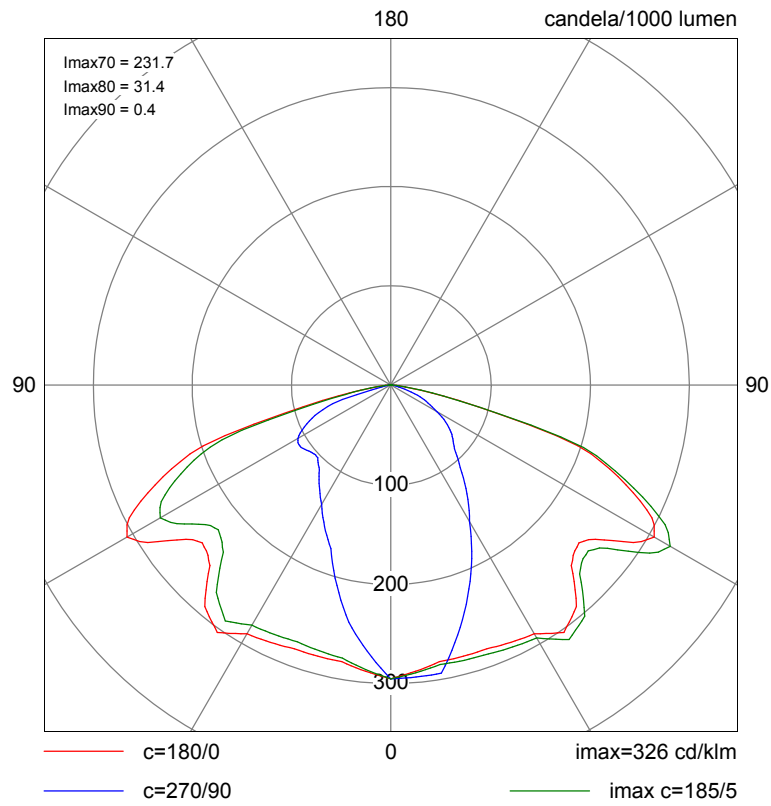
No.	Type	X	Y	Height	Angle	Tilt	Cant	Out-reach	Target X	Target Y	Target Z
1	B	218.00	69.85	8.00	20.00	5.00	0.00	1.00			
2	A	200.63	78.54	8.00	90.00	0.00	0.00	0.00			
3	A	182.81	87.84	7.00	0.00	0.00	0.00	0.00			
4	A	227.10	99.70	8.00	195.00	0.00	0.00	0.00			
5	A	180.55	115.46	8.00	10.00	0.00	0.00	0.00			
6	A	217.27	128.13	8.00	205.00	0.00	0.00	0.00			
7	C	157.31	120.79	6.00	295.00	5.00	0.00	0.50			
8	E	195.35	137.66	8.00	25.00	0.00	0.00	1.00			
9	E	195.35	137.66	8.00	210.00	0.00	0.00	1.00			
10	C	231.55	154.07	6.00	120.00	5.00	0.00	0.50			
11	C	156.16	142.35	6.00	300.00	5.00	0.00	0.50			
12	A	165.46	162.56	8.00	30.00	0.00	0.00	0.00			
13	C	180.49	171.98	6.00	25.00	0.00	0.00	0.20			
14	C	202.33	174.92	6.00	300.00	15.00	0.00	0.50			
15	A	196.45	182.36	8.00	215.00	0.00	0.00	0.00			
16	A	147.40	192.13	6.00	30.00	0.00	0.00	0.00			
17	C	165.26	200.08	6.00	20.00	0.00	0.00	0.25			
18	A	186.81	210.59	8.00	210.00	5.00	0.00	0.00			
19	C	143.36	200.22	6.00	30.00	0.00	0.00	0.25			
20	F	137.66	207.56	4.00	30.00	0.00	0.00	0.00			
21	F	129.95	221.63	4.00	30.00	0.00	0.00	0.25			
22	A	170.26	241.17	8.00	215.00	5.00	0.00	0.00			
23	E	137.81	254.63	8.00	25.00	0.00	0.00	1.00			
24	D	137.75	254.65	8.00	210.00	0.00	0.00	1.00			
25	E	123.01	282.66	8.00	35.00	0.00	0.00	1.00			
26	D	123.02	282.72	6.00	215.00	0.00	0.00	1.00			
27	E	114.17	301.38	8.00	40.00	0.00	0.00	1.00			
28	D	114.17	301.43	8.00	215.00	0.00	0.00	1.00			
29	C	122.20	238.75	6.00	30.00	0.00	0.00	0.25			
30	B	194.82	77.90	8.00	180.00	5.00	0.00	1.00			
31	B	108.32	340.36	8.00	185.00	5.00	0.00	1.00			
32	C	76.59	300.57	5.00	190.00	5.00	0.00	0.50			
33	C	195.58	213.30	6.00	300.00	5.00	0.00	0.50			
34	C	165.26	200.03	6.00	210.00	0.00	0.00	0.25			
35	C	180.42	171.98	6.00	220.00	0.00	0.00	0.25			
36	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00			

Layout Continued

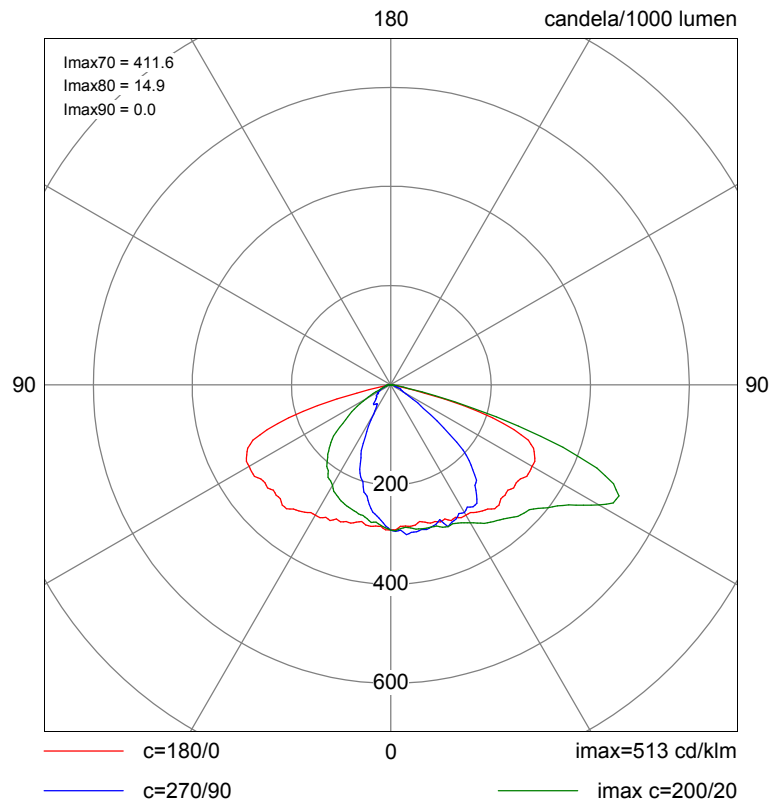
No.	Type	X	Y	Height	Angle	Tilt	Cant	Out-reach	Target X	Target Y	Target Z
37	C	163.63	61.51	4.00	115.00	0.00	0.00	1.00			
38	C	109.30	260.38	10.50	35.00	0.00	0.00	0.00			
39	C	93.64	293.96	6.00	105.00	0.00	0.00	0.25			

Polar Diagrams

Luminaire A MVP504 GC OC P5

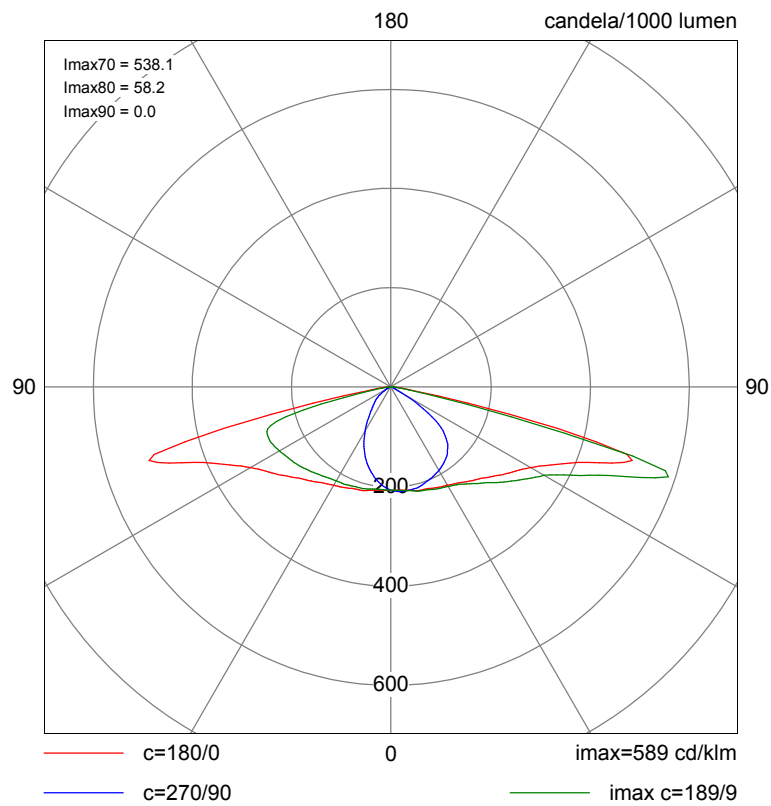


Luminaire B BGP352 T15 DC

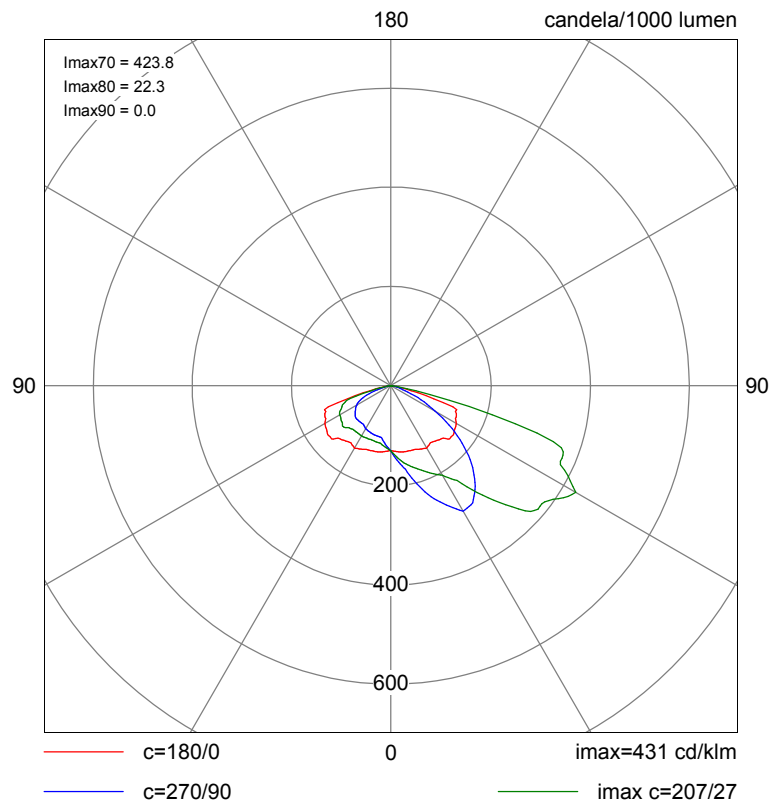


Polar Diagrams Continued

Luminaire C BGS451 WSO

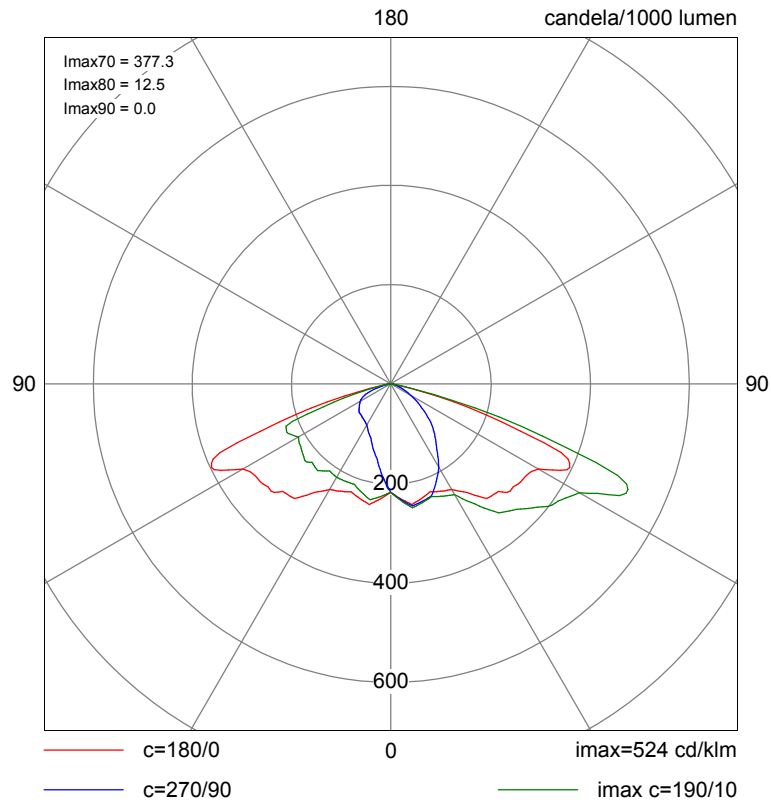


Luminaire D SGS253 FG OC P1

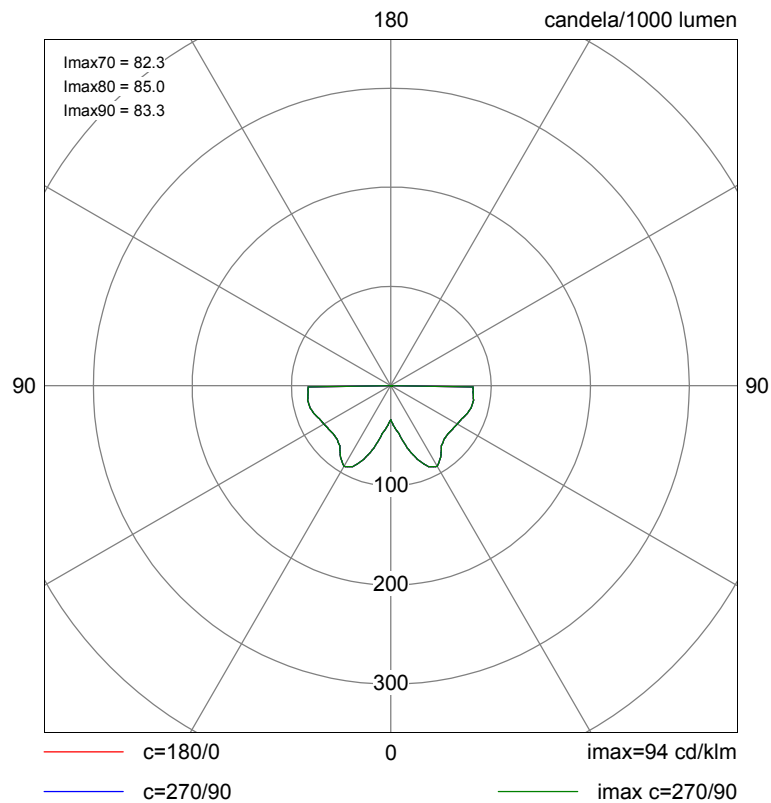


Polar Diagrams Continued

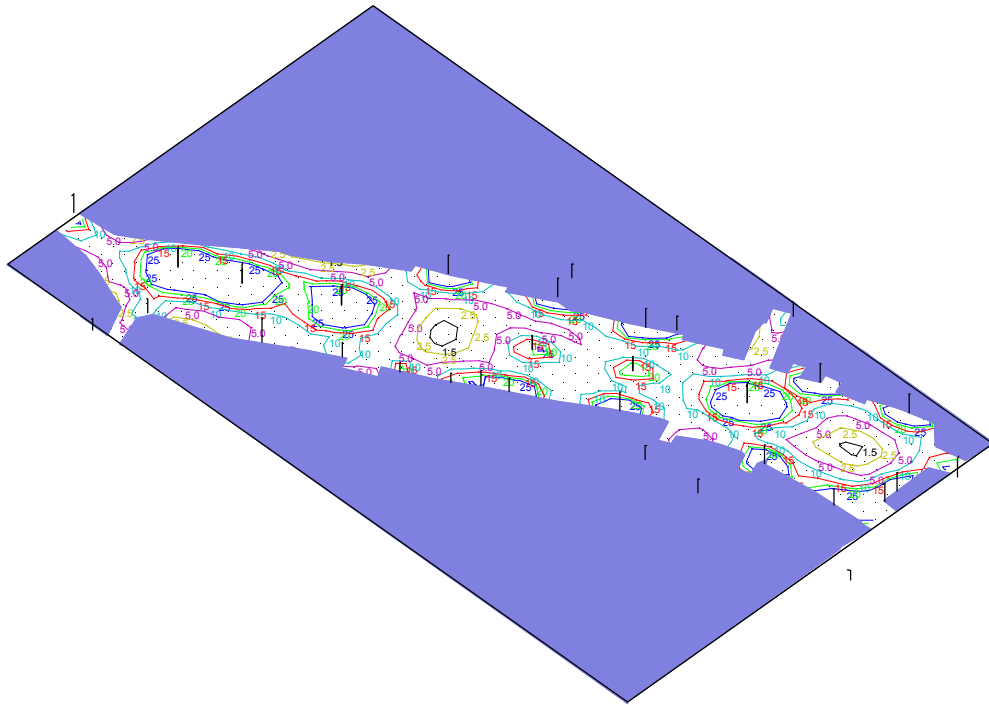
Luminaire E SGS253 FG OC P11



Luminaire F Westminster Med cgp Refractor



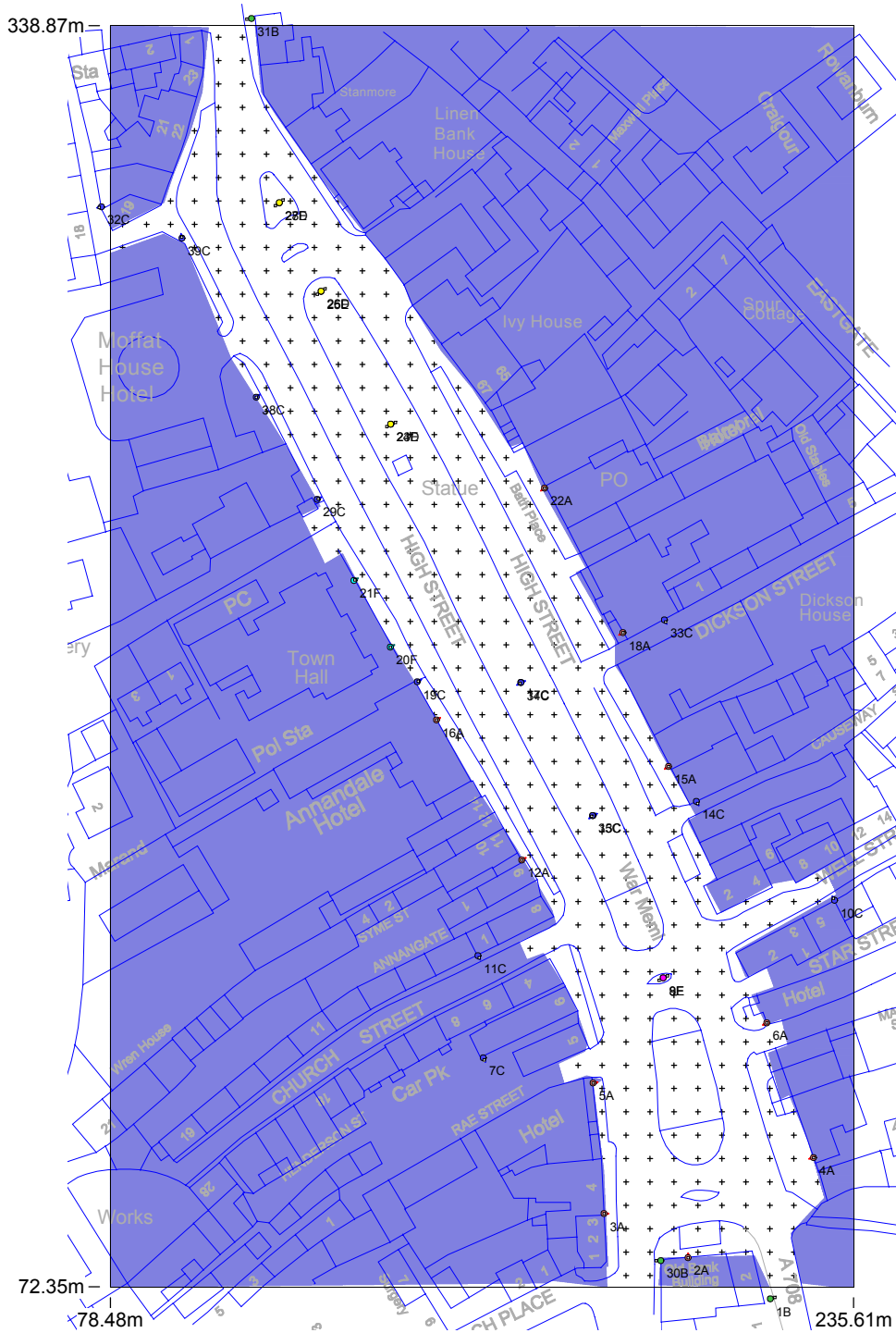
Horizontal Illuminance (lux)



Results

Eav	15.82
Emin	1.22
Emax	110.92
Emin/Emax	0.01
Emin/Eav	0.08

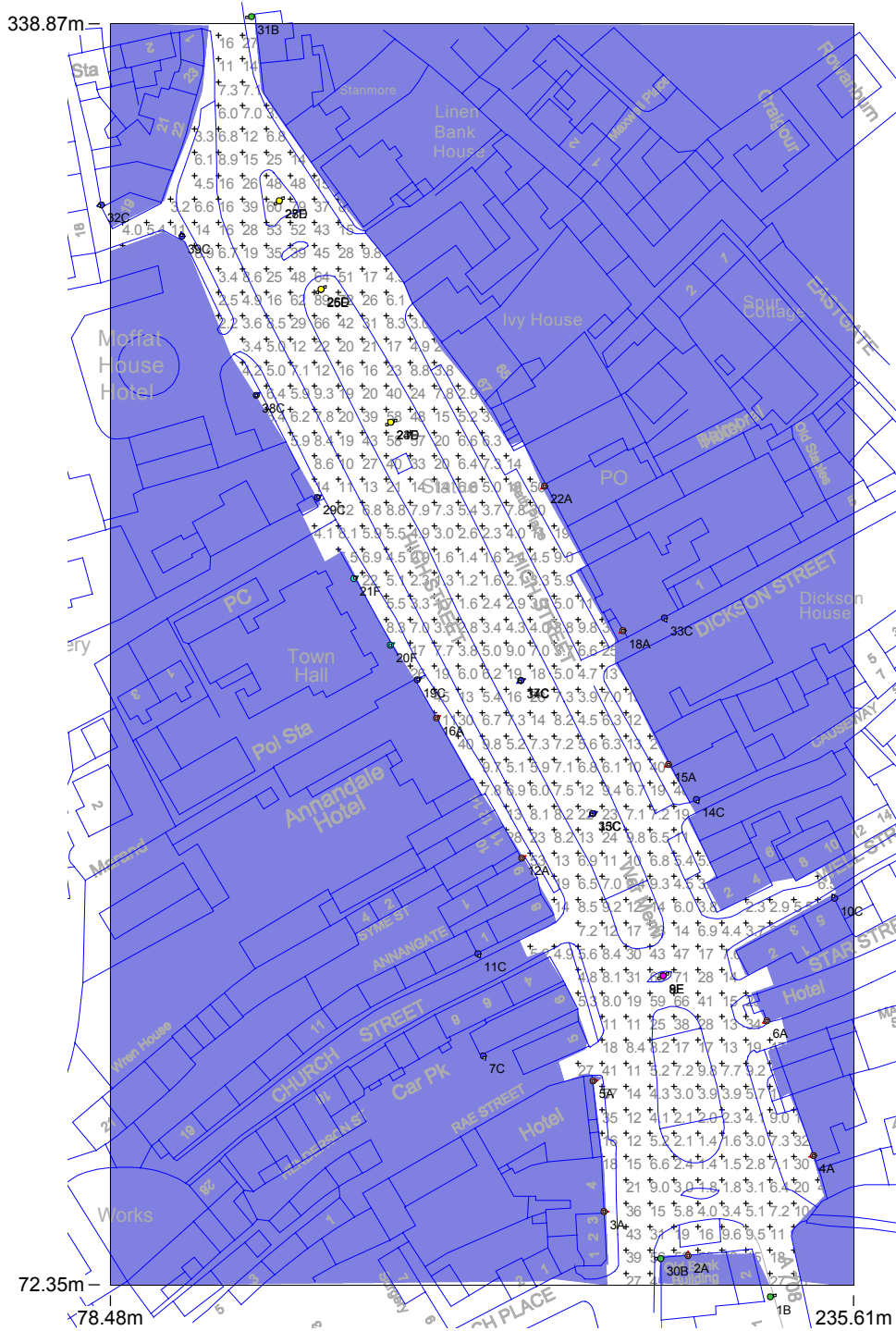
Horizontal Illuminance (lux)



Results

Eav	15.82
Emin	1.22
Emax	110.92
Emin/Emax	0.01
Emin/Eav	0.08

Horizontal Illuminance (lux)



Results

Eav	15.82
Emin	1.22
Emax	110.92
Emin/Emax	0.01
Emin/Eav	0.08

James H Paterson