Before the Independent Hearing Panel
Appointed by Environment Southland and Gore District Council

Under	the Resource Management Act 1991
In the matter of	an application by Gore District Council for resource consent to establish the Longford Bridge across the Mataura River

Statement of evidence of Stephen Christopher Butler

9 December 2020

Introduction

1 My full name is Stephen Christopher Butler.

2 I am retired. I have a New Zealand Certificate in Civil Engineering and a Diploma in Environmental Management (University of Auckland,1999. Research topic: Light Pollution). I am an amateur astronomer with a strong interest in reducing light pollution. I am not representing any organisation in this statement of evidence.

3 In my astronomy and light pollution roles I have been the leader of the Dark Skies Group of the Royal Astronomical Society of New Zealand (RASNZ) since 2003, a RASNZ Councillor since 2004, and am currently RASNZ President 2020-2022. I was elected a Fellow of RASNZ in 2017.

4 I am a member of the International Dark-Sky Association, and have been involved in the accreditation of the Aoraki Mackenzie International Dark Sky Reserve (AMIDSR) and the Rakiura Stewart Island Dark Sky Sanctuary, and have supported the Great Barrier Island Dark Sky Sanctuary and the Wai-iti Dark Sky Park (Nelson). I am currently helping several other communities in their applications. I am Chairman of the AMIDSR Board.

5 *Code of Conduct for Expert Witnesses*
While this is not a hearing before the Environment Court, I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I have complied with it in preparing this evidence and I agree to comply with it in presenting evidence at this hearing. The evidence that I give is within my area of expertise except where I state that my evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions that I express in this evidence.

6 In preparing this statement of evidence, I have considered the following documents:

(a) Resource Management Act 1991;

(b) App A - Avifauna Assessment - Longford shared pathway

(c) The Section 42A report;

(d) Lighting Reports (Various);

(e) Our Air 2018, Min for Env and StatsNZ

(f) Blue Light Aotearoa, Royal Society New Zealand

(g) National Light Pollution Guidelines for Wildlife, Australian Government
.

Scope of evidence

7 This evidence addresses:

(a) RMA: intrinsic values, in relation to ecosystems, means those aspects of ecosystems and their constituent parts which have value in their own right, including—

(ii) the essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience;

(b) Spectral qualities of artificial light and its effects on wildlife

Intrinsic values in relation to ecosystems

8 The Section 42A Report lists, in the executive summary, that the key issues of this application are: visual effects; and amenity values. There is brief mention but no discussion of Intrinsic Values of the Mataura River ecosystem. The effects of introducing lighting into this currently unlit area is likely to disrupt integrity, form, functioning and resilience of this ecosystem.

9 "International research has revealed numerous connections between light pollution and species disruption. Many species rely on natural patterns of light and dark to navigate, cue behaviours for nesting and mating, and hide from predators or forage for food." ***Our Air 2018, Min. for Environment***

10 These natural patterns of light and dark occur on daily, monthly (lunar) and seasonal scales. The daily cycle is split into bright day time, crepuscular periods at dawn and dusk, and darkness at night. Each of these periods of the day have their own adapted species. The introduction of artificial light into the Mataura river environment extends the crepuscular periods into the dark night time period. This can disrupt the functioning of insects, fish and birds both within each species and their interactions between species.

11 "Light is one of the most important abiotic factors on Earth. The illuminance from natural light sources (the sun, moon, stars, and atmospheric effects such as airglow) covers a large dynamic range of about nine orders of magnitude. During the day it ranges from a maximum of about 100,000 lx to about 800 lx at sunset. At night it reaches a maximum of about 0.3 lx at a full-moon night, decreases to about 0.001 lx at a moonless clear night (Hänel et al., 2018) and even further for cloudy conditions (Jechow & Hölker, 2019; Jechow, Hölker, & Kyba, 2019a). The light cycle between night and day, the lunar cycle, weather or seasons serve as external cues (zeitgeber) for cyclic biological processes such as reproduction and foraging (Kronfeld-Schor & Dayan, 2003; Robert, Lesku, Partecke, & Chambers, 2015). In aquatic systems, the water is an additional "optical filter" that alters the wavelength (color), direction, and polarization of the incident light (Mobley, 1994)". *How dark is a river? Artificial light at night in aquatic systems and the need for comprehensive night-time light measurements* https://onlinelibrary.wiley.com/doi/10.1002/wat2.1388

12 The lighting of the bridge and its approaches has the potential to create a barrier to aquatic life in the Mataura river. Shielding and downward direction of light on the bridge will result in light falling on the river itself. The use of curfew or reduction in levels is suggested in the design pans to minimise the timing of light on the pathways and bridge. Consideration is encouraged to use motion control to further minimise the duration of light.

13 "The results from this study should certainly encourage city planners to be cautious about installing lights near streams. Managers and scientists should work together in order to educate citizens about the potential negative impacts of artificial lights on stream ecosystems." *The effects of artificial light at night on stream ecosystems* https://d-nb.info/1034073923/34

Spectral qualities of artificial light and its effects on wildlife

14 The introduction of Light Emitting Diodes (LEDs) for outdoor lighting has seen an emergence of research into the effects of the broader spectrum of the light produced by these lights. Of concern is the high proportion of short wavelength (blue rich) light contained in their spectrum. LEDs as used in outdoor lighting are fundamentally a source of blue light. This light is absorbed by phosphor coatings on the diode and re-emitted as white light with varying levels of the original blue light remaining. This broad spectrum blue rich light is raising concerns as it introduces blue light into the night environment. Blue light, from the sun and sky, has a strong environmental influence during the day and is inappropriate at night.

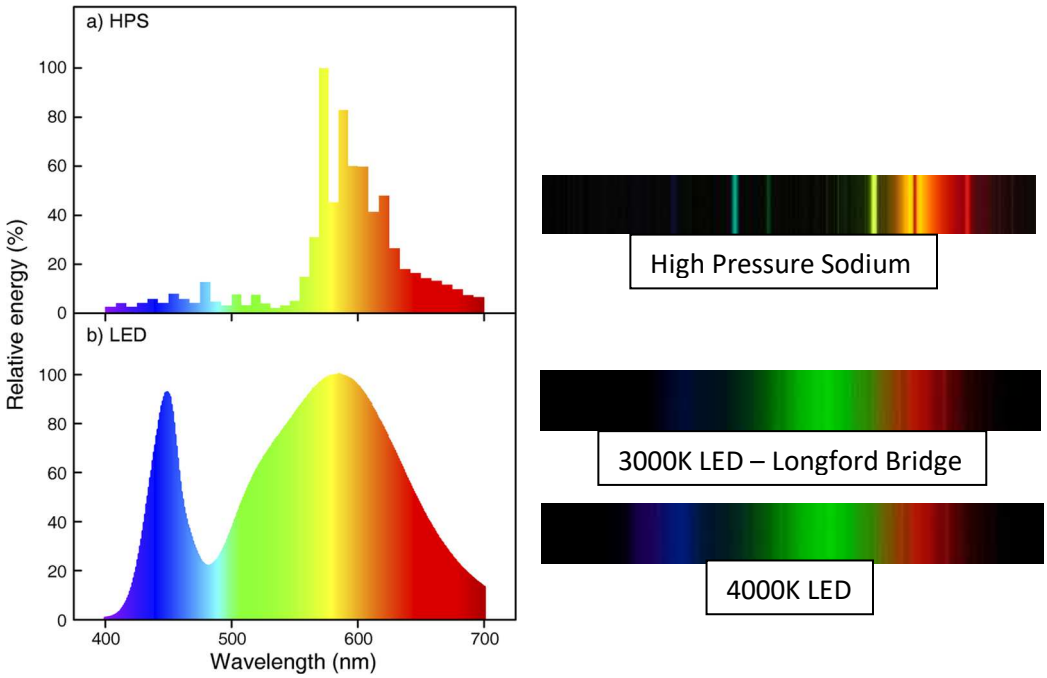

Image from: LED lighting increases the ecological impact of light pollution irrespective of color temperature https://doi.org/10.1890/14-0468.1

15 "Phosphor-coated white LED lamps have the potential to increase the impacts of light pollution dramatically. Given the strong impetus for their adoption in municipal and industrial applications, it is imperative to fully understand the potential long-term impacts of white LED lights on ecological

communities, populations, and species. A comprehensive assessment of overall impacts and knowledge about the influence of each region of the visible spectrum will allow technologists to work with ecologists to focus future developments in lighting technology that balance the needs of illumination with reduced ecological impact." *Conclusion from research by SCION, LED lighting increases the ecological impact of light pollution irrespective of color temperature* https://doi.org/10.1890/14-0468.1

16 "Currently there is a global move from yellow sodium lighting to white LED lighting, which emits different wavelengths of light. A recent study found that LED artificial light at night (ALAN) reduced the biomass of periphyton by 62% in a freshwater drainage ditch in Westhavelland Nature Park, Brandenburg, Germany." *European Commission, Science for Environment Policy, Nocturnal use of LEDs negatively affects freshwater microorganisms, Germany*
https://ec.europa.eu/environment/integration/research/newsalert/pdf/nocturnal_use_of_leds_negatively_affects_freshwater_microorganisms_germany_520na4_en.pdf

17 "Artificial light at night (ALAN) is a widespread alteration of the natural environment that can affect the functioning of ecosystems. ALAN can change the movement patterns of freshwater animals that move into the adjacent riparian and terrestrial ecosystems, but the implications for local riparian consumers that rely on these subsidies are still unexplored. …We argue that it is important to include mitigation measures into new lighting concepts in order to consider ecological impacts. This requires multidisciplinary efforts by landscape- and urban planners, lighting engineers, and terrestrial and aquatic ecologists to mitigate any effects. We suggest the installation of artificial lights directly adjacent to stream riverbanks should be designed with consideration given to riparian buffers in which movement and dispersal of aquatic and terrestrial organisms are preserved."
Artificial Light at Night Affects Organism Flux across Ecosystem Boundaries and Drives Community Structure in the Recipient Ecosystem *https://doi.org/10.3389/fenvs.2017.00061*

18 "Due to the different colour of light emitted by LED lighting from traditional yellow sodium lighting, it is expected to increase the ecological impacts of ALAN on many organisms. Impacts of LED ALAN on freshwater ecosystems are less well known, but with 80% of the world's population living within 3 km of a body of freshwater, these ecosystems are also subject to the effects of artificial light." ***European Commission, Science for Environment Policy, Nocturnal use of LEDs negatively affects freshwater microorganisms, Germany***
https://ec.europa.eu/environment/integration/research/newsalert/pdf/nocturnal_use_of_leds_negatively_affects_freshwater_microorganisms_germany_520na4_en.pdf

19 **App A - Avifauna Assessment - Longford shared pathway** provides the following advice: "To reduce the potential for bird strikes and bird attraction to the bridge structure, all lighting should be downward-facing with minimal

horizontal spill. Birds can be attracted to or disorientated by lighting. Similarly, the spiral strand cables could be made more visible to birds flying by the use of UV lights, luminous tape, or aerial markers. This is in part contradictory to guidance in the **National Light Pollution Guidelines for Wildlife, Australian Government** to "Use lights with reduced or filtered blue, violet and ultra-violet wavelengths." UV (see 21 & 22 below).
https://www.environment.gov.au/biodiversity/publications/national-light-pollution-guidelines-wildlife

20 Further assessment of the impact of spectral qualities of light suggest that green light may be of use to reduce the possible collisions with the bridge tower structure and cables. "Based on the results of the experiment presented here, it can be suggested that changing the color (spectral composition) of artificial lights for public roads and on human-built structures will significantly decrease the number of casualties among nocturnally migrating birds. Therefore, as a follow-up, the electronics company Philips experimentally developed bird-friendly light sources, low in red. It was not possible to include only blue light, even though this would seem optimal from the point of view of the birds. The problem is that humans cannot work safely under blue light. Therefore, the newly developed light source includes the green spectrum and appears greenish to human observers. …The concept of bird-friendly lighting can potentially be used everywhere, both off- and onshore, artificial night lighting affects migrating birds. ….What is needed now are systematic investigations into the impact of bird-friendly light on other organisms than birds." ***Green Light for Nocturnally Migrating Birds*** http://www.ecologyandsociety.org/vol13/iss2/art47/

21 "Under low light conditions (dark adapted vision), light is detected by cells in the eye called rods. Rods only perceive light in shades of grey (no colour). This is known as scotopic vision and it is more sensitive to shorter wavelengths of light (blue/violet) than photopic vision.
The variation in the number and types of cells in the retina means animals and humans do not perceive the same range of colours. **In animals, being 'sensitive' to light within a specific range of wavelengths means they can perceive light at that wavelength, and it is <u>likely they will respond to that light source</u>."**

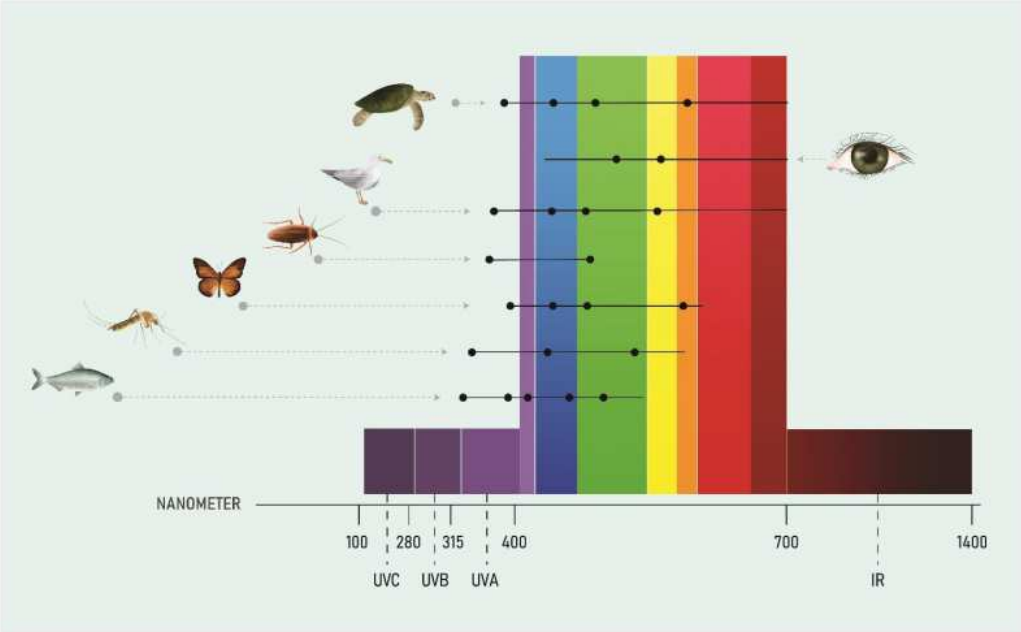

Figure 17 Ability to perceive different wavelengths of light in humans and wildlife is shown by horizontal lines. Black dots represent reported peak sensitivity. Note the common sensitivity to short wavelength light across all wildlife. Figure adapted from Campos (2017)[8].

Image from National Light Pollution Guidelines for Wildlife, Australian Government

22 National Light Pollution Guidelines for Wildlife - Appendix A – Best Practice Lighting Design recommends: "Use lights with reduced or filtered blue, violet and ultra-violet wavelengths."

23 "To reduce the potential for bird strikes and bird attraction to the bridge structure, all lighting should be downward-facing with minimal horizontal spill. Birds can be attracted to or disorientated by lighting." ***App A - Avifauna Assessment - Longford shared pathway***. Compare this with recent news from the West Coast region of Punakaiki where new LED streetlights were turned off to avoid attracting fledgling Petrels. "An NZTA spokeswoman said the Punakaiki trial was triggered by the replacement of six of 15 street lights last summer. The LEDs were more attractive to the endangered birds than the old lights. Hoods were trialled to keep the light away from the birdpaths, but that did not work." https://www.stuff.co.nz/environment/123269073/west-coast-village-going-dark-to-save-baby-seabirds-blinded-by-street-lights

24 "Using these assessment metrics, filtered yellow-green and amber LEDs are predicted to have lower effects on wildlife than high pressure sodium lamps, while blue-rich lighting (e.g., K ≥ 2200) would have greater effects. Together with control of intensity, direction, and duration, the approach can be used to predict and then minimize the adverse effects of lighting and can be tailored to individual species or taxonomic groups." ***Rapid assessment of lamp spectrum to quantify ecological effects of light at night*** **https://www.researchgate.net/profile/Travis_Longcore/publication/325724554_Rapid_assessment_of_lamp_spectrum_to_quantify_ecological_effects_of_light_at_night/**

25 NIWA scientists are researching how the colour change (of LED lighting) will affect insects which are indicators of healthy urban waterways. The project is funded through the Ministry of Business, Innovation and Employment's Endeavour Fund and undertaken in conjunction with Scion, (see 15 above) the University of Canterbury, Christchurch City Council, NZTA and LINZ. https://niwa.co.nz/news/summer-series-2018-niwa-scientist-throws-light-on-the-red-zone

26 I note in the Lighting Design reports that the lighting chosen is 3000K LED. This informs me that ecological impacts from lighting have not been considered.

Conclusion

27 "A review of the impact of artificial light at night proposed several management strategies to reduce the harmful effects on ecosystems. These strategies include avoiding use altogether, reducing the duration of use, limiting light scattering directed into unintended areas, dimming light intensities and altering the spectral composition through light source selection and filters. However, the effectiveness of many of these strategies to reduce the biological effects of blue light has not been extensively studied." ***Blue Light Aotearoa, Royal Society of New Zealand*** https://www.royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/impacts-of-artificial-blue-light-on-health-and-the-environment/

28 Given the complexities of the river and riparian ecosystems, the nature of the bridge structure with high tower and support cables and the incomplete knowledge of the impact of broad spectrum artificial light on a range of species, the strategy of "avoiding use" would appear to be the best way to protect the intrinsic values of the Mataura river.

Dated this 9th day of December 2020

Stephen Christopher Butler