BEFORE the Upper Hutt City Council

Plan Change 45 Signs Objectives, Policies and Rules, Upper Hutt District Plan

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Under	the Resource Management Act 1991 ('**RMA**')
In the matter of	a submission and further submission by the New Zealand Transport Agency (submitter number 6) on Plan Change 45: Signs Objectives, Policies and Rules, Upper Hutt District Plan

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Primary statement of evidence of Stephen (Steve) James Muir for the New Zealand Transport Agency

Dated 30 April 2019

Introduction

1. My full name is Stephen James Muir. I am a Director of ELC – Essential Lighting Consultancy Ltd an independent lighting consultancy business offering Lighting Advisory Services.

2. My qualifications include NZ Certificate Electrical Engineering (NZCE), Illumination Engineering Certificate, current Member of The Illumination Engineering Society (MIES) and a Registered Lighting Practitioner (RLP).

3. For the past two years I have worked as a director of ELC – Essential Lighting Consultancy Ltd – where I have been involved with many exterior lighting projects including assessment of obtrusive lighting effects.

4. Previously I worked for Connetics Ltd for 15 years as their Lighting Design Manager responsible for many roading and exterior lighting projects including; the Christchurch Southern Motorway, various sports floodlighting, new subdivisions, inner city precinct areas and exterior feature lighting projects such as Christchurch Cathedral and Victoria Street bridge. My past duties have included being the co-author and presenter of EECA's "Rightlight" road lighting web site, the co-author of the NZ Transport Agency's M30 specification and Christchurch City Council LED Billboard research project.

5. I have attended many International lighting conferences and manufacturing facilities throughout the world and presented a paper at the 2012 Starlight Conference in Tekapo.

6. I confirm that I have the qualifications and experience and that I have been engaged by the NZ Transport Agency to provide evidence in relation to my qualifications and experience

7. I am accompanied today by Aaron Hudson who is providing the Planning evidence for the NZ Transport Agency.

Code of Conduct

8. I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider

material facts known to me that might alter or detract from the opinions expressed. I understand that the Code of Conduct requires me to assist the Hearings Panel impartially on matters within my expertise, and not to advocate for the Transport Agency.

Background

9. Upper Hutt City Council are reviewing their district plan rules on signs. Proposed Plan Change 45 (PPC 45) to the Upper Hutt District Plan, contains no performance standards for digital or illuminated signs. It is a requirement of PPC 45 that any proposal to erect a digital sign would require a resource consent application with a full assessment of environmental effects. However, no guidance is included to steer the council decision making on consent applications for digital signs. The intent of the Transport Agency's submission is for Upper Hutt City Council to adopt good practice standards to manage the adverse effects of digital or illuminated signs.

10. As changes in technology continue it is expected to make digital signage increasingly more attractive as an information channel. This can cause natural tensions between the desire of the advertising industry for signs to be seen by a large viewing audience by attracting attention and the potential adverse effects that can arise from visually dominant signage. The intention is to quantify the visual effects (particularly about luminance and image changing) for LED signs.

11. Digital signs are becoming increasingly popular and the space on the electronic signs is marketed as being superior to that on static signs. Concerns have been raised that a digital sign which is located within proximity to key decision points such as intersections and where luminance levels are set high, can potentially attract a driver's attention to the sign, leading to safety concerns.

Scope of Evidence

12. My evidence addresses proposed Plan Change 45, particularly in relation to lighting effects including the influence of the surroundings. I discuss the following matters:

    a) Spill light and glare, direct viewing and changes in luminance;

b) Area surrounding the sign;
c) Physical features of adjacent buildings, trees and transport network systems; and
d) Possible interference on visibility of transport network users.

13. I have separated my evidence into the following sections:
    a. Surrounding environment
    b. Definition of Lighting terms
    c. Visibility
    d. Visual Effects
    e. Dwell Time
    f. Placement of signs
    g. Lighting and Brightness
    h. Best Practice Guidance

Surrounding Environment

14. Outdoor lighting while it is intended for a specific purpose it may have some detrimental effects on the environment for which it is installed within.

15. Australian/New Zealand Standard 4282 (AS/NZS 4282) *Control of the obtrusive effects of outdoor lighting*, updates the best practice technical guidance on managing the adverse effects of outdoor lighting on the environment. AS/NZS 4282 introduces and promotes varying environmental zones. Different Light Technical Parameters are recommended based on ambient conditions and surrounding Environmental Zones. These environmental zones are described in Table 3.1 within AS/NZS42 82. Various environmental zones are considered, ranging from intrinsically dark through to high brightness. This enables an Environmental Zone to be chosen based on the location where the installation is to occur. Tables 3.2 to 3.5 references light technical parameters for the various zones as an indication of potential control of obtrusive lighting effects.

16. Sky Glow is an area-wide issue that is less likely to be affected by individual sign installations. Urban sky glow is the result of stray light being scattered in the atmosphere, brightening the natural sky background level. Sky glow is variable depending on weather conditions, quantity of dust and gas in the atmosphere, amount of light directed skyward, and the direction from which it is viewed. It can be mitigated by limiting the amount of exterior lighting in the greater space

and by including the spectral and optical distribution of luminaires. Sky glow can be minimised by using luminaires that are able to provide good optical control at elevation angles at or immediately below the horizontal. High correlated colour temperature light sources (such as blue light) should be avoided as light at the blue end of the spectrum increases the scatter of light. Light sources that use warmer colour temperatures help reduce the scatter of light in the atmosphere. To protect the night sky, only luminaires with an Upward Light Ratio (ULR) of zero percent (or close to zero) and a nominal correlated colour temperature of less than 4000K are preferred.

Definition of Lighting Terms

17. Illuminance is what allows us to see items which do not emit light. **Illuminance** or "I" for incident – is the amount of light falling onto a surface or an incident ray of light striking a surface measured with an "incident meter". It is a measure of how much incident light illuminates a surface area. It is known as the amount of luminous flux (in lumens) that is received by a given area lumens/square meter (lm/m^2) or lux.

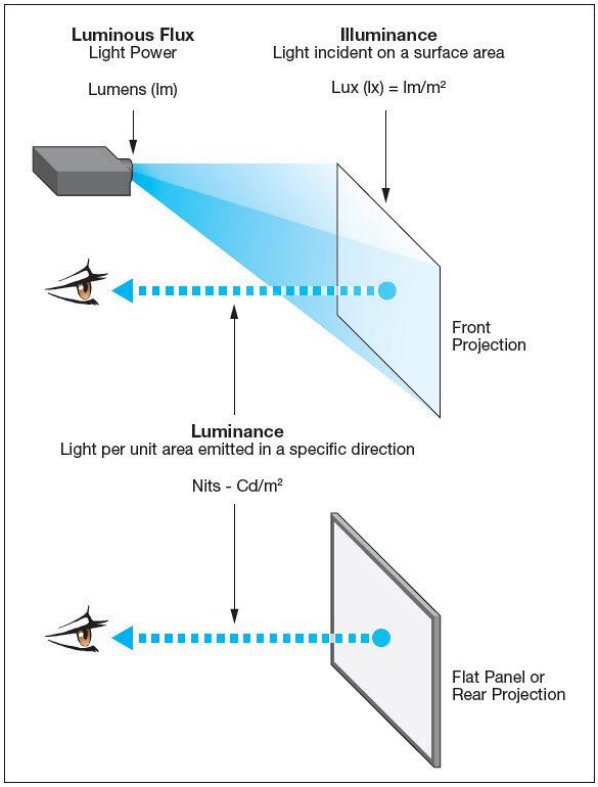
18. Illuminance (illumination) is usually measured in units of foot-candles or lux; luminance (surface brightness) is most often measured in nits or candela per square meter (cd/m2). The two definitions are indicated in Figure 1 below.

19. Typical examples of illuminance values are 400-500 lux on a desk within an office, outdoor multi-use recreational sports facility 100 -300 lux and 3-14 lux for a public outdoor carpark.

20. **Luminance** or "L" for leaving – is the amount of light "leaving" or reflected by an object and is measured as candela per square meter (cd/m2) or nits. One nit is equivalent to one cd/m2. Luminance is a key measurement when analysing surfaces which emit light, like a computer or television screen, or a digital sign. The value of luminance at a point on a surface can therefore vary depending on the observer's viewpoint. In the display industry, luminance is used to quantify the brightness of displays. It can be considered as the human perception of brightness or how bright we perceive the light to be.

21. Typical examples of luminance values are 30 – 100 cd/m2 for a desktop computer monitor, 450 – 1000 cd/m2 for a High Definition TV and 1000 – 3000 cd/m2 direct from an unshielded streetlight.

Figure 1: Definition of Illuminance and Luminance[1].



22. **Glare** – is a reduction in the ability to see and is the result of excessive amounts of luminance in the human field of view or excessive and uncontrolled brightness (luminance).

23. There are two types of glare;

    a) **Disability glare** impairs the visibility of objects without necessarily causing discomfort (reduction in visibility). Threshold Increment is a measure of disability glare expressed as a percentage increase in contrast required between an object and its background for it to be seen equally well with a source of glare present. The higher the percentage of Threshold Increment the greater the value of disability glare. Table 3.2 AS/NZS4282 limits Threshold Increment for the various Environmental Zones.

[1] Source of diagram://www.extron.com.html and Christchurch City Billboard Research document.

b) **Discomfort glare** causes discomfort without necessarily impairing the visibility of objects.

24. **Spill light** – is the illuminance falling onto an adjoining property or area that is not intended to be illuminated by a resultant light source. The permitted levels of spill light within any city can range between 1 – 25 lux depending on what environmental zone and what time the lighting installation is being used. It is also important to differentiate between specific light trespass (spill light) from signs into surrounding areas and the addition to general light pollution within cities (sky glow).

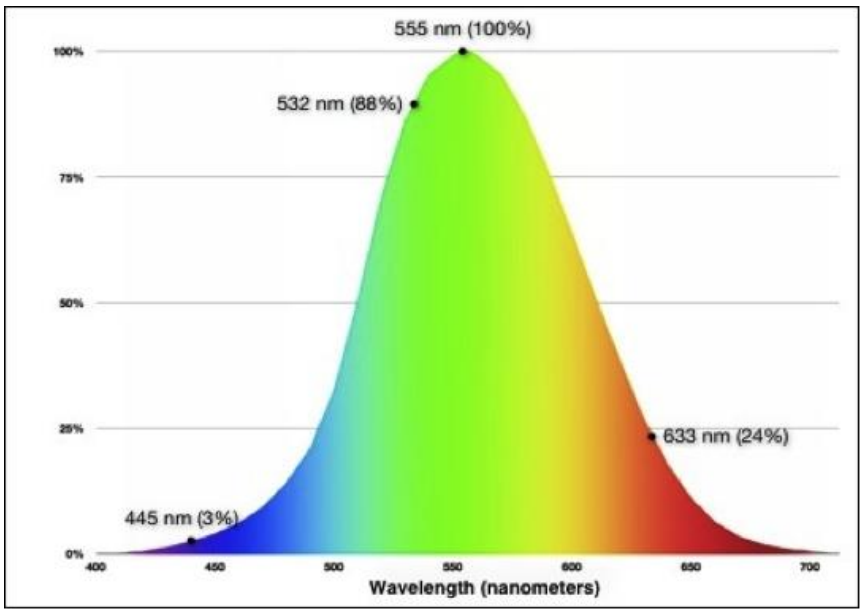
Visibility

25. Visibility – is a measure of the distance at which an object or light can be seen. During low light conditions only our eyes rod cells are in operation and in this state, it is commonly known as **Scotopic** vision (0.01 – 0.000,001 cd/m2). In this state the eye is the most sensitive to green-blue light around the 450 – 500 nm wavelength while it is insensitive to wavelengths longer than 650nm (the red colours). Therefore, blue light stands out more than any other coloured light at night and therefore AS/NZS4282 discourages the use blue light in a dark environment.

26. **Photopic** vision (5 – 100,000 cd/m2) occurs when the eyes cone cells are dominant, and humans can easily identify colour and have a high visual acuity where they can identify detail. This occurs during the day or in high light conditions and red colours appears dominant. Adaptation is also much faster in this state.

27. When rods and cones combine (or photopic and scotopic vision combine) it is known as Mesopic vision. Mesopic light levels range from luminance levels between 0.001 and 10 cd/m2. Most outdoor night time activities and road lighting scenarios are in the Mesopic range.

Figure 2: Spectrum wavelength distribution[2]



28. At night (or low light levels) the eye compensates for lower light levels by becoming more sensitive to light; it is more easily distracted, dazzled, and even disabled by an overly luminous object than the daytime eye is. It is, therefore, important to set limits for the brightness of signs for dusk and night time to avoid adverse effects. Table 3.5 AS/NZS 4282 does this plus it references an Environmental Zone describing and or limiting the intensity (brightness) in relation to the surrounding area.

Visual Effects

29. **Field of View** – is the extent of the visual field when looking straight ahead. What we see at any moment of time. Standard line of sight or relaxed line of sight can be within plus or minus 15° from 0° in front of eyes. Therefore, at a viewing distance of 100 meters a vertical sign will be within our relaxed line of sight up to an approximate height of 27m.

[2] CIE and Christchurch City Council LED Billboard Research document – Technical Review of Visual Effects

30. Visual Effect – is also related to the physical size of the sign and how long the image is within our field of view. That is dependent on viewing distance and the speed you could be travelling towards the sign. For digital signage this will give us a display time which will enable a cycle or rotation time to be established for a limited number of images.

31. All attempts should be made regarding the reduction in any likelihood of a driver seeing more than one message at a time on a digital sign. This provides guidance to avoid the visual effects arising from image change-overs. It is recommended that the message display time should be calculated using the formula:

    Maximum viewing distance (m) / speed limit (m/sec) x common factor of 1.5 = Minimum viewing time for one image.

32. The constant factor of 1.5 in the formula above is to allow for a site that has a slower speed or the vehicle is likely to be travelling slower or could even be stopped at traffic signals hence a common factor to limit display time (reduce risk of visual effect) could be 1.5 x the minimum display time.

33. **Rotational time** – is the time taken for all images to be seen including the transition time from one image to another.

34. **Transition time** should be zero or as close as possible to that so there is no time delay when changing from one image to another i.e. it should be instantaneous or a maximum time interval of half a second. This is so that an approaching driver cannot perceive any blinking of the display or have any distracting visual effect between successive displays.

35. There should be no message sequencing where a message is spread across more than one advertisement.

36. Ensure the backdrop of the sign is considered, including whether the sign breaks the skyline (i.e. is it seen against the dark sky, open sea or breaking the skyline of buildings or trees).

37. **Visual Acuity** – commonly referred to the clarity of vision or the ability to see detail. It increases and then begins to decrease as the background luminance increases. For this reason, all signs should have a fixed luminance level over the full display time so there is no increase in intensity over the images display time.

38. Another example of visual acuity is when the text sometimes moves horizontally across the sign. This is distracting one's attention and is within an observer relaxed field of view hence moving images, "drop-in" objects or moving text should be discouraged.

39. Colours and intensity of one dominant colour on any single image should be limited.

40. **Luminance Ratio** – is the ratio of the brightest to the darkest. For example, the average luminance of a sign (or inner field of vision) to the background (or outer vision) could have a high luminance ratio which is good from a display perspective but could have a detrimental effect to the visual environment. This scenario is like the working environment of a computer screen in an office situation with a background window with bright sunlight.

Dwell Time

41. Dwell Time – Is where the graphical content or colours within a signs image can change. It is recommended in Clause 3.3.5.4 AS/NZS4282 that the "dwell time" of any image is limited to 10 seconds or more and the average luminance shall change by less than 30% on any change of image.

42. The longer the dwell time the better because this means one static image is visible for longer hence less likelihood that a digital changing image sign will have an impact on a passing road user.

Placement of Signs

43. The distance to the point at which a sign can first be seen or noticed, varies significantly, depending on foreground screening and surrounding features. Signs with long sight lines are attractive to advertisers, but generally lead to higher visual effects as (depending on speed of the viewer and image dwell time) several image change overs can be experienced.

44. Recommendations regarding the placement of signs;
    a) Consider the minimum spacing between digital signs according to the environmental zone, speed limit of the road and location where they are to be located
    b) Consider viewing distances

c) Drivers should not be able to view two or more digital sign displays in their field of vision at the same time
d) Digital signs should be prohibited near locations where drivers must make critical decisions
e) Identify specific areas where digital signs are prohibited according to the environmental zone.

45. To limit the potential cumulative effect, a minimum distance between signs could be a maximum of one sign within any 100m viewing distance in urban areas (with speed ≤ 70km/h) and 200m in rural or semi-rural areas (with speed > 70km/h). This is consistent with the Transport Agency's – Traffic control devices manual and Christchurch City Council LED Billboard Research document – Technical Review of Visual Effects.

Lighting and Brightness

46. Visually prominent colours, text and images are chosen by advertising agencies to attract the viewing audience's attention. It has been observed that red and pink colours and bold text boxes stand out visually during the day, leading to higher prominence.

47. When viewed against a white building façade the appearance and prominence of white images differs significantly to when viewing it against a dark background (such as trees), the black night sky or open blue sea or sky. In areas with high ambient light, billboards stand out less than when viewed against a building and they appear visually less obtrusive than when viewed against the dark night sky. Digital signs mounted on tall masts, above the driver/viewer, appear to "hang in the sky"; at night, which leads to higher visual effects and more distraction.

48. The dimming or change of intensity within one image attracts the viewers' eye. Therefore, a constant level of brightness and transition of images without the appearance of a black image is considered appropriate to avoid sudden appearance of images that cause high visual effects.

49. It is essential to avoid glare for the safety of drivers, cyclists and pedestrians. Therefore, a reduction of brightness or intensity of LED billboards during night time hours is essential due to our eyes operating in the Mesopic or Scotopic range. For this reason, there is a strong need to restrict the luminance to a maximum luminance level as that

referenced in Table 3.5 in AS/NZS4282. This also allows for differing Environmental Zones.

Best Practice Guidance

50. All illuminated signs to comply with AS/NZS4282 *Control of the obtrusive effects of outdoor lighting.*

51. Avoid mounting of signs on slopes, river banks and bridges or at a grade to increase the viewing distance. For areas frequented by pedestrians it is necessary to consider a human scale for signs.

52. It is preferable if a sign is back dropped and not viewed against a dark background, sea or sky.

53. Avoid intersections and complex areas requiring attention from drivers. It is recommended that only one billboard should be in a driver's field of vision at any one time. Drivers should only be exposed to one advertisement in the sequence as they pass by. Longer "dwell time" (≥ 10 seconds) may be appropriate in slow speed areas, for long viewing distances or at intersections where drivers are exposed to the view of a billboard for a longer time.

54. Provide minimum distances where signs are permitted in relation to intersections and the posted speed limit of the road;
    a) Speed limit ≤ 70 km/hr no signs shall be located within 100m of an intersection, traffic signals, pedestrian crossing or regulatory / warning sign
    b) Speed limit ≥ 70 km/hr no signs shall be located within 200m of an intersection, traffic signals, pedestrian crossing or regulatory / warning sign

55. All digital signage should only be permitted to display non-animated images, incorporate; no flashing or revolving lights, no moving images, no moving shapes or text within an image.

56. Variable brightness/sensors to be fitted to automatically control the brightness of a sign in relation to the existing lighting conditions on site. Maximum average luminance of any sign shall comply with Table 3.5 AS/NZS4282.

57. Placement or location of automatic controls and light sensing devices should be carefully considered to ensure correct ambient lighting levels

are always being recorded/adjusted. If there is a fault with the automated control system described the complete screen shall default to black or switch off. The light sensor should be located on top of sign unless a good reason exists to suggest otherwise.

58. Determine an acceptable level of rotation time in conjunction with environmental zone, viewing distance, speed limit, how many image changes are permitted over what transition time.

59. Static displays only with fade or dissolve transitions, or transitions that do not have the effect of moving text or images. No image to include any scrolling, travelling, spinning or zooming in, or similar special effects that have the appearance of movement, animation, or changing in size, or get revealed sequentially rather than all at once (e.g. letters dropping into place, etc.).

60. The dwell or display time should not be less than 10 seconds to avoid drivers seeing multiple images and transition time between images should be as short as possible (less than 0.5 of a second).

Conclusion

61. I request that the hearing Commissioner's consider the requests outlined in this evidence; to reduce or evaluate the visual effects of illuminated signs on the safety of the region's transport network.

62. I will be attending the hearing on this matter and I would be happy to answer any questions on my evidence.

Stephen (Steve) James Muir
30 April 2019