



Western Ring Route – Waterview Connection



Assessment of Lighting Effects



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Quality Assurance Statement

Prepared by: Geoff Waller, Illumination Engineer and Lighting Designer (Beca)

Reviewed by: Peter Taylor, Illumination Engineer and Lighting Designer (aurecon)

Approved for Issue by: Amelia Linzey, Technical Director (Beca)

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Appendices

Appendix A - Excerpt from the Waitakere City District Plan

Appendix B - Excerpt from the Auckland City Bylaws

Appendix C - Excerpts from Road Lighting Standards AS/NZS 1158.1.2:2010, Sect. 7.3.3 & 4, Page 29.

Appendix D - Excerpt from the Australian Standard 'Control of the Obtrusive Effects of Outdoor Lighting' AS4297 (Table 2.1).

Appendix E - Samples of computer modelling and existing site spill lighting measurements.

Appendix F - Examples of light distribution from generic types of road luminaires.

Appendix G - Proposed Construction Yard plan.

1. Introduction

In 2009 the NZTA confirmed its intention that the 'Waterview Connection Project' (Project) would be lodged with the Environmental Protection Authority as a Proposal of National Significance. The Project includes works previously investigated and developed as two separate projects: being the SH16 Causeway Project and the SH20 Waterview Connection. The key elements of the Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunneled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a cycleway throughout the surface road elements of the Waterview Connection Project corridor.

This report covers the lighting effects of the Project for motorway traffic, interchanges, pedestrian/cycle ways and construction activities. Considered in the report are the after-dark effects such as spill lighting and glare. The day-time appearance of the lighting poles is considered in the Technical Report No G20, The Assessment of Visual Effects.

A description of lighting effects for this Project is provided in each sector - Sections 7-14 of this report. (reference Figure 3.1). In summary, the lighting effects of the Project are considered to be minor or less than minor.

2. Report Structure

This report is based on preliminary design concepts only and some of the finer technical details cannot be confirmed until final construction designs are in place. However, any of these details will be in accordance with the Lighting Conditions. The report provides a consolidation of information of the existing environment, the Project, and an assessment of lighting effects. A summary of contents of each section of this report is found below:

- Section 3 of this report provides a brief description of the Project.
- Section 4 describes the methodology of the lighting assessment.
- Section 5 outlines the compliance documents relevant to the lighting on this project.
- Section 6 introduces the potential adverse lighting effects.
- Sections 7 to 14 provide detailed information on the proposed lighting for Sectors 1 to 9 of this project.
- Section 15 contains the conclusion.

The lighting of motorways and roads needs to conform to different lighting standards than construction yard temporary lighting. These two types of lighting have been separated for clarity.

3. Project Description

This assessment report for lighting encompasses Sectors 1 to 9 of the Waterview Connection Project from Henderson Creek to St Lukes on SH 16 (Sectors 1-6), and the SH 20 Connection from SH 16 to the Maioro Interchange (Sectors 7-9), (refer to Figure 3.1).

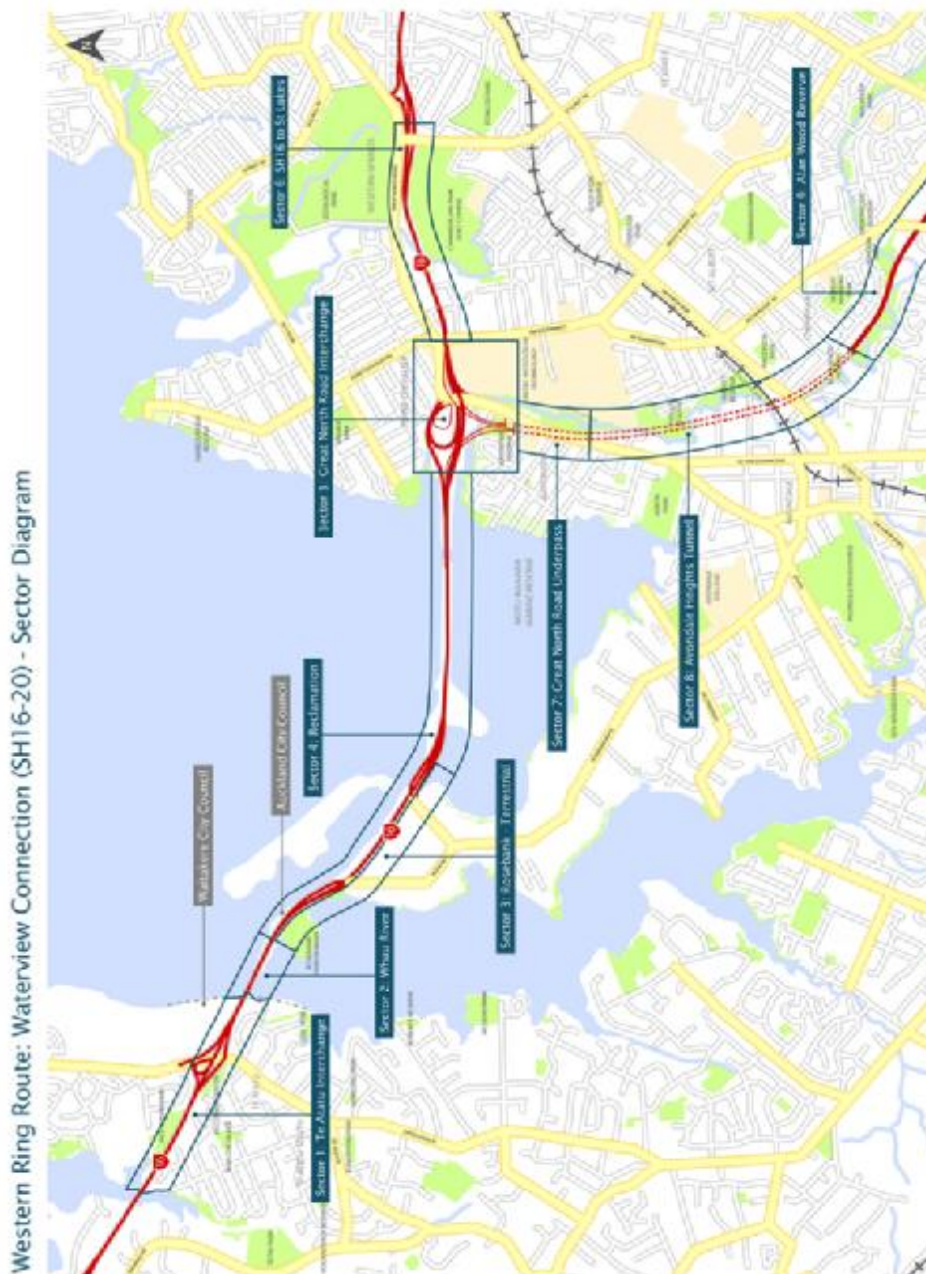


Figure 3.1: Sector Diagram

4. Methodology

For each Sector 1 through 9 the following has been completed:

- The existing lighting environment has been assessed. In selected locations, site measurements have been taken to record existing lighting conditions (Appendix E).
- The design team's lighting solution for motorway traffic, interchanges and pedestrian/cycle ways (permanent lighting) has been summarised.
- Construction activity lighting (temporary road and yard lighting) has been considered and contractors lighting obligations addressed.
- The lighting effects of the permanent lighting have been described. In selected locations, a comparison has been made with current spill lighting levels to show compliance (Table 6.1).
- The temporary and permanent lighting proposed has been assessed against the Resource Management Act, Local Bylaws and District Plans.
- The proposed mitigation methods for any adverse lighting effects have been detailed.
- The potential lighting effects to residents have been addressed.

5. Schedule of Standards, Bylaws and District Plans

Lighting has been identified as a potential effect of the Project works relevant to the Resource Management Act 1991 (RMA) and this report has been prepared to assess these effects and, where any such effects are potentially significant to identify, the measures that can be implemented to avoid, remedy, or mitigate such effects.

As a designation, the Project is not required to comply with the Waitakere City District Plan and the Auckland City (Isthmus Section) District Plan (District Plans). However, when preparing this Report, the District Plans, and the lighting standards that are referred to in those District Plans, have been considered as they provide a guide to appropriate lighting standards in the Project area. The NZTA is also required to heed Section 153(3) of the Local Government Act 2002 which states that the Crown is bound by the (??lawyer comment illegible) bylaws if non-compliance by the Crown would be "likely to have an adverse effect on public health or safety."

It is appropriate that temporary construction yard lighting conform to relevant bylaws and District Plans, as these provide lighting assessment criteria appropriate to the surrounding receiving environments.

5.1 Waitakere City District Plan

Sector 1 is located within the boundaries of the Waitakere City. Residential housing will be affected to the north and south of proposed additional motorway lanes and the upgrading of the Te Atatu Interchange. This area has a Waitakere City District Plan classification of 'Living Environment 1', in which artificial outdoor lighting is classified under Rule 14.1 (c) as a permitted activity if it:

- i.) has not more than 10 lux spill light (horizontal or vertical) measured at the site boundary of any adjoining site; and
- ii.) is shielded in such a manner that light emitted by the fixture is projected below a horizontal plane running through the lowest point of the fixture where light is emitted, or is shielded in such a manner that the lower edge of the shield is at, or below, the centre line of the light source; and
- iii.) complies with AS/NZS 1158.

There are restrictions on luminance levels for signage. However, current motorway signage is generally not artificially lit, relying on retro-reflective signage.

Refer Appendix A for a copy of Rule 14 from the Waitakere City District Plan.

5.2 Auckland City Bylaws

Sectors 2 to 9 are located within the boundaries of Auckland City. The Bylaw of relevance is Bylaw Part 13.5 - Environmental Protection (April 2008). This will affect residential areas at the Great North Road Interchange, those residential areas that overlook the Alan Wood Reserve and Hendon Park, and the new Maoro Interchange, all on the new sections of SH20.

Auckland City Bylaw Part 13.5 deals with spill lighting and glare and generally states:

- i.) No more than 100 lux (horizontal or vertical) is permitted over a residential boundary before 10pm. (13.5.1).
- ii.) No more than 10 lux (horizontal or vertical) is permitted over a residential boundary after 10pm. At night. (13.5.2).
- iii.) No more than 50 lux is permitted above a street kerbline. (13.5.3).
- iv.) Glare must be controlled, and then references AS4282:1997 (Control of the Obtrusive Effects of Outdoor Lighting). (13.5.4).
- v.) Special circumstances where it is not possible to turn off the lighting. (13.5.5).
- vi.) Exemptions: Where an authorized officer is permitted to make exceptions because of unreasonable or impractical circumstances. (13.5.6).

Refer Appendix B for copy of Part 13.5 excerpt from the Bylaw.

Brightness of signage is covered in Section 27.3.5.1 of the Bylaws. Again, the NZTA is not proposing any significant artificially lit road signage, unless(see lawyer note) there are Automatic Traffic Management Systems (ATMS) or other intermittent emergency warning lights required at the tunnel portals. (13.5.5).

5.3 Lighting Control Standard (Glare and Spill Light)

The Australian Standard AS4282:1997, "Control of the Obtrusive Effects of Outdoor Lighting" (AS4282) addresses both spill light and glare. It is referenced in the Auckland City Isthmus bylaws. This Standard specifically excludes public road lighting because it is designed for high illuminance level sports venues adjacent to residences. Road lighting is provided for overall community safety (crash prevention and pedestrian safety) and therefore a higher tolerance levels have been accepted for the associated glare and spill lighting. However, the Standard can assist should any point specific calculations be required for spill light and glare. Semi-cut off luminaires and occasionally fully cut-off luminaires, will be required in more sensitive areas, to mitigate both glare and spill light. Temporary floodlighting for construction activities will need tight

glare and spill light control where adjacent to residential areas, and AS4282 will have more relevance to these situations ¹

5.4 Luminance Control Standard

Should there be any signage lighting, it will be designed to the internationally accepted standards of the Institute of Lighting Engineers, Technical Report No.5. (TR5).

5.5 Roadlighting Standard

All motorway, other classified road lighting design and pedestrian/cycle ways, together with luminaire selection, will conform to the requirements of the current Roadlighting Standard AS/NZS 1158. This is primarily for safety reasons and is verified by computer modeling.

In New Zealand, roadlighting is divided into two sections, Type V primarily for Vehicular movement and Type P for Pedestrians mixed with low speed traffic. There are four categories of Type V and twelve categories of Type P, the latter ranging from non-arterial roads down to pedestrian footpaths and carparks.

Sectors 1 to 9 of this Project will have the motorway and ramp sections carried out to Lighting Category V3 of this Standard, which is the usual designation for New Zealand motorways where there are no pedestrians. Where the motorways intersect with arterial roads, Great North Road (and its temporarily deviation), Te Atatu Roads and Maioro Road, these interchanges will be designed to a higher illuminance level, Lighting Category V2, but always dependent on the rating of the arterial road.

Standard AS/NZS 1158 cross references the AS4282:1997 and explains that spill lighting levels from road lighting were not considered high enough to be considered as obtrusive. (AS/NZS 1158.1.2:2010, Section 7.3.3 (b). See Appendix C). However, the Standard notes that spill lighting can become obtrusive and describes methods of mitigation should it become so, typically with visors or cut-off luminaires.

In the same cross reference, the Standard mentions that glare (see below) is a possibility if the residents are in direct view of luminaires. If cut-off luminaires are used and the amount of glare as defined by a certain quantity of glare (from the Threshold Increment) is below a certain number, it is then considered adequately controlled.

¹ It should be noted that although this Australian Standard has been cross referenced in the current Roadlighting Standard 1158 (see below), it has not been adopted in New Zealand as there is some controversy amongst professional illumination engineers over some of the technical content as being too onerous and specific to only certain smaller sporting installations, like tennis courts. It was adopted in Australia because there was nothing else available, worldwide, at the time.

6. Assessment Matters - Potential Adverse Lighting Effects

6.1 Forms of Potential Adverse Lighting Effects

There are three main lighting effects that have the potential for varying degrees of intrusiveness to both vehicles and to residents adjacent to lighting installations. They are spill lighting, glare, and skyglow. Spill Lighting

If luminaires are not correctly chosen for the appropriate light distribution and not properly angled, there is a percentage of light that is not efficiently used to light its target. The result is wasted 'light spill' which can fall into areas where it is not wanted, such as residences adjacent to the Project. With the onset of computers, modern road luminaires can be more accurately designed and aimed to reduce this spill light component.

Attached in Appendix D is an excerpt from the Australian Standard 4282:1997. In column 4, it shows that 2 lux in light surroundings could be considered a maximum light level. At these low levels colour cannot be readily identified, but outline shapes can be defined. Many illumination engineers consider this stringent, so this could be considered conservative to residents. The footnote considers areas that abut Category V roads would be considered 'light' surroundings. In the context of a full moon on a clear night providing 0.5 lux, this is an exceptionally low level.

6.1.1 Glare

Glare is the brightness of a road luminaire or floodlight when compared with the brightness of the background against which they are seen. For instance, a road luminaire looks much brighter (and has higher glare) when viewed against a black sky, than when viewed in the surroundings of a brightly lit city street. There are two forms of glare; disabling glare and discomforting glare. Disabling glare is so intense it prevents adequate vision for accomplishing a task. This will be eliminated. Discomforting glare can generally be tolerated, but is more a nuisance, as it tends to draw the eye towards the light source, necessarily altering the eye's adaptation.

If the glare can be kept below the 20% maximum of Threshold Increment (T.I.) in AS/NZS 1158 and AS 4282, then glare is controlled. In computer calculated renditions for the Project, glare was in the area of 10%, and none near the 20% permitted limit. (T.I. is an assessment of contrast against its background).

6.1.2 Skyglow

Skyglow manifests itself as a glow above a road when humidity is high. This effect is difficult to mitigate, as it is light that reflects either directly or indirectly off the road surface, to illuminate water particles in the air, giving a glow effect. Skyglow can be reduced by using darker coloured surfaces (i.e. black asphalt, rather than a light coloured chipping, and dark painted or coloured concrete, rather than white). It can also be reduced by the specification of street luminaires that are able to provide good optical control.

6.2 Construction Activity Lighting

The contractors working on the upgrade of sections of the motorway will be required to use floodlights, either portable or temporary, mounted so that they do not cause glare by aiming lighting above the horizontal plane if directed towards any residential houses, or towards roads that are in use for the public traffic.

In temporary construction yards, (See Appendix G), spill and 'headlight sweep' are a common nuisance. There is little that can be done to mitigate this, short of requiring sunshade cloth visual barriers in sensitive areas. However, this is usually relatively transitional lighting, which can be reduced with careful location of site offices and equipment in relation to residentially zoned areas. There will be a 10m buffer zone between any equipment requiring light and a residential boundary. Lighting designs for construction yards will be submitted to an accredited illumination engineer for approval.

6.3 Potential Environmental Issues of Lighting

6.3.1 Types of Luminaires

Street/road luminaires come with three basic photometric types; open, semi-cut-off, and fully cut-off (or aeroscreened). See Appendix F.

The 'open' road luminaire is nearly obsolete, for although it allows the widest spacing, it also creates the greatest glare; normally well over that set by the current roadlighting standards.

The fully cut-off variety of luminaire produces no light above the horizontal plane, the lamp being well tucked up into the reflector. These are considered very 'environmentally friendly' to reduce spill lighting; however, to achieve an adequate uniformity, nearly a third more poles are required with their additional luminaires, lamps and the electricity required. Therefore they require the use of more energy and provide a less efficient long-term installation.

It is for this reason that the semi-cut off luminaire has almost universally been used throughout this country as a compromise between energy use and adequate lighting for safe driving.

The design for this motorway Project will use semi-cut off luminaires, though some fully cut-off luminaires will be used in more sensitive areas like Alan Wood Park where the motorway encroaches closer to residential house boundaries, or on the Causeway, where it prominently crosses the bay and is visible from many suburbs.

There are also the still-to-be-proved Light Emitting Diode (LED) luminaires which it may be possible to change across to before final procurement, if time shows that they are reliable. At present they are still being assessed in New Zealand by trials with the NZTA to see if they are durable and can conform to the AS/NZS 1158 Standards. As a result, being on trial, only their future is uncertain.

Any luminaires selected will conform to the photometric and material requirements of the AS/NZS 1158 Roadlighting Standard.

For nightscape appearance, please see footnote².

² *Lamp Types for Roadlighting – Nightscape Environmental Ambience.*

There are certain roadlighting situations where a white light is preferred over the normal "golden white" of the standard high pressure sodium lamp (HPS) commonly adopted on our roads. Such white luminaire installations usually have metal halide lamps and these are kept for some inner city locations; very busy intersections involving pedestrians and traffic in city centres; and also for pedestrian crossings.

The use of white light is not proposed for this Project. The colour rendition is not critical; the lamps are at least double the price, and typically have half the lamplife. Motorway lane-closures for relamping are costly. It is also inappropriate to have more prominent white lighting, when viewed against the "golden white" of surrounding streets. HPS is arguably more efficient than any sources of near-white light, even than LED, and the added advantage is that the double arc tube, which has been specified for over 15 years and is accepted to have a life in the order of 48,000 hours, thereby halving the amount of maintenance required of the commonly used single arc HPS lamps. However, LED should not be discarded at this juncture, as they may reach a standard of reliability in the future.

6.3.2 Illuminance/Luminance Levels

All the road lighting on the motorway will be carried out to Class V3 of AS/NZS 1158, which requires a luminance no less than 0.75 candela per square metre, with an overall uniformity (minimum-to-average) to be above 0.33; a longitudinal uniformity to be above 0.3; a Threshold Increment (T.I. for glare control) below 20%; and a minimum Illuminance to be above 10 lux for intersections.

At interchanges and gore areas (possible conflict points where traffic merges or leaves ramps), the illuminances are required to be no less than 7.5 lux, with a maximum-to-minimum uniformity to be less than 8. Any Category V road luminaires must have an Upward Waste Light Ratio of below 3%. This is 3.7 times the spill lighting levels mentioned in AS 4282:1997, but these are the levels required only on the road itself, and gives an indication of the tight containment of lighting within a specifically designed task area like a road.

Auckland City roads are likely to be Category V2 (especially any restoration of the Great North Road). These would require luminance levels of no less than 1 candela per square metre, with an overall uniformity (minimum-to-average) to be above 0.33; a longitudinal uniformity to be above 0.3; a Threshold Increment (T.I. for glare control) below 20%; and a minimum Illuminance to be above 10 lux for intersections.

To give an indication of the light levels, a bright full moon is 0.5 lux, Aotea Square is about 10 lux and an office is about 300 to 500 lux.

Please refer to Appendix D for spill lighting levels considered 'Less than minor' by AS4282:1997.

6.3.3 General Spill Lighting Levels

To give an indication of spill light levels, a sample of residences which are closest to the Project was selected from each of the sectors. The spill light was modelled and the table shows the results, none of which are more than minor. The distances are scaled from the design drawings and the illuminance plots in Appendix E. These are summarised in Table 6.1 below.

Table 6.1

	Distance from motorway or interchange lighting columns.	Expected vertical light level at window of residential building in lux.	Minor or less than minor effects.
SECTOR 1			
25 or 26 Marewa St (closest dwellings to western extent of SH16 and cycleway)	Approximately 15 metres	1.63 lux	Less than minor
16 or 17 Milich Terrace	Approximately 15metres	1.63 lux	Less than minor
2 or 4 Titoki Street	Approximately 30metres	1.2 lux	Less than minor
8 or 10 Alwyn Avenue	Approximately 52metres	2.26 lux	Minor
SECTOR 2			
38 Alwyn Avenue	Approximately 15metres	2.5 lux	Minor

	Distance from motorway or interchange lighting columns.	Expected vertical light level at window of residential building in lux.	Minor or less than minor effects.
SECTOR 5			
35, 27 and 39 Waterbank Cres.	Approximately 73 metres	0 lux - General Ambience	Less than minor
SECTOR 6			
12 Novah Place	Approximately 20 metres	2.74 lux	Minor
25 Parr Road South	Approximately 25metres	2.5 lux	Minor
SECTOR 7			
3 Oakley Ave	In tunnel zone	Not affected - General Ambience	Less than minor
SECTOR 9			
5 Barrymore Place	Approximately 35 meters	0 Lux - General Ambience	Less than minor
129/131 Hendon Avenue	Approximately 38 metres	0 Lux - General Ambience	Less than minor
190 Methuen Avenue or 194 (rear site)	Approximately 44 metres	0 Lux - General Ambience	Less than minor

N.B. Sectors 3,4, and 8 have not been included as there are no very close residences to the Project.

From this it can be seen that lighting effects at the nearest residences are within, or very close to, the requirements of even the unadopted Australian Standard AS 4282:1997.

6.3.4 Lighting Pole Arrangements

There are different arrangements of lighting poles to give satisfactory illumination for a road. The two common versions used on main sections of motorway are 'central median' or 'opposite sided' mounted. A 'single sided' arrangement is often used for motorway ramps. For any arterial roads, an alternate or staggered arrangement can be used. Intersections are considered as specific designs, requiring illuminance computer modelling.

For motorways, it is considered that the central median lighting is safer for errant vehicles and is the less environmentally obtrusive arrangement, there being half the number of poles, with the luminaires usually being on centrally mounted double outreach arms. When a motorway has eight or nine lanes across, the options available are limited, these being to design with the double sided opposite arrangement or high mast lighting to achieve economies of pole spacing. However, for outlying areas of small sections of the interchange (ie. the elevated ramps), it is possible to do a combination between the two. The central median arrangement is less visually obtrusive both during daylight and after dark, using fewer poles and requiring only a single supply cable along the central median. As well as reducing conflict with other civil services, as a secondary issue this reduces the quantity of construction material required and energy consumption during operation.

The median is so wide on parts of some sections, (for example, the eastern end of the Causeway in Sector 4), that the two carriageways have to be considered as separate roads. This provides an option of highmast lighting from the median, or alternatively, a line of double poles in the centre of the motorway, which from the aesthetic daytime visual aspect, would be perceived as an undesirable 'forest' of poles.² It is therefore considered preferable to provide single 20m high central median columns with cross arms in this area, rather than the standard 12 or 15m poles.

6.3.5 Height of Poles

In areas where there are multi-grade complex curved ramp interchanges, as at the Great North Road Interchange, economies can be achieved with the use of fewer, but taller poles, often referred to as “highmast” or “raise-lower” poles. These are usually at about 20-30m height and are mounted in the centre of the complexes (as per the Auckland Central Motorway Junction and at the Bombay Interchange on the Southern Motorway). They are spaced much wider and can either be fixed, with maintenance access provided by a crane/cherry picker, or have a more costly ‘crown’ of luminaires which can be lowered down the pole for maintenance. Again, the advantage is that these can replace many standard 12 or 15m smaller poles which are considered more of a visual impediment (both during daytime and after dark), than a fewer number of single higher poles³. Using fewer higher poles in such circumstances is also more optically efficient to reach open areas. The height allows for the luminaires to be aimed downwards, thereby reducing both glare and spill light

The higher poles at the Great North Road Interchange will be less obtrusive as they are located in a ‘bowl’ below the termination of the Maryland/Berridge/Alberta Streets situated on the escarpment beyond. There are certain places like the outlying SH20 to SH16 Westbound elevated ramps over the Oakley Creek, where a single sided 15m high regular arrangement has to be used, mounted off the deck, because of impractical mounting locations to the sides of these ramps.

6.3.6 Pedestrian/Cycle ways

Generally pedestrian/cycle ways will be provided along all the at-grade motorway sectors. Where these run parallel alongside motorway (typically divided by a chain link fence), lighting will be adequate from the median road lighting provided the appropriate Category P illuminance levels are achieved for the particular area. Where the pedestrian/cycle way deviates from the emergency stopping/bus lane or where there is significant planting between the motorway and the pedestrian/cycle way (which is proposed on the SH20 southern section), then separate P Class lighting will be provided. This will be to Category P3 (for Waitakere, 1.75 lux average), and for Auckland City Council (ACC. Modified P3, 3 lux average). This level of light provides a minimum average illuminance level for low activity, low crime and low prestige for outer city environs. These luminaires will generally be 6m high ‘box’ type with some form of vandal protection. They will be metal halide or LED.

³ Refer Technical report No G20, Assessment of Visual & Landscape Effects.

7. Sector 1. Te Atatu Interchange

7.1 Existing Environment

There are few residences located adjacent to the existing motorway from the Henderson Bridge to the present Te Atatu interchange. The interchange itself has residential housing on all three of the sides of the ramps. This section extends from the Whau Bridge in the East, to some 600m west of the TeAtatu interchange. At present the motorway has three lanes per carriageway east of the overbridge, and two lanes per carriageway to the west. There are emergency stopping lanes to each carriageway.

Up to the interchange, there are double sided 10m poles with 250W HPS luminaires.

Luminaires on 10m poles are regularly spaced across the interchange complex. All are 250W HPS with semi-cut off luminaires. Some houses to the south are only tens of meters from the NZTA boundaries and some have a view north over the motorway looking down onto some kilometres of the motorway causeway which is lit at night.

From the interchange, there is a double side arrangement of 12m poles with 250W HPS luminaires following down to the Whau River Bridges.

7.2 Proposed Environment During Operation

It is intended to lower the existing motorway but keep the existing overbridge. The city bound on-ramp is being reconfigured with a larger radius to conform to international motorway design.

Between the Te Atatu Interchange and the Henderson Bridge an extra lane is being added to take it from two lanes to three in each direction.

An extra lane is being added to each side of the main motorway towards the city, making three lanes and an emergency lane to the west, and four lanes and an emergency lane to the East. Houses will be taken to both the north and south of the interchange to accommodate the larger area required. Most of one side of Titoki Street will be taken. The existing pedestrian underpass, under the city bound on-ramp, will be extended.

The proposed lighting to the main area of this interchange is via an arrangement of 20m high columns with multiple 400W HPS luminaires. The outer ramps will be illuminated with single sided 12m poles. The pedestrian/cycle ways will be provided with low mounted low wattage luminaires and any pedestrian crossings with white light to enhance the crossing markings.

The 600 meter section of motorway to the west of the Te Atatu interchange, and the stretch east to the Whau Bridge will be lit with central median 20m high columns with four 400w HPS lamps typically at 120m between-

column centres. (This arrangement will be continued further west towards the Lincoln Road Interchange, as the extra lane is added).

The lighting tie-in zones to the existing council authority roads will either be cleaned and relamped or replaced to match NZTA requirements.

Construction Yards. There will be a construction area (Yard 1, Orangahina Park, See Appendix G) to the north east which will be accessed from the Te Atatu North Road. It will have site offices, construction plant, workshops and a refuelling facility. This will have temporary lighting during the construction period, and will be operational all the hours of darkness.

7.3 Description of the Lighting Effects

The new layout of the Te Atatu interchange has a larger area to illuminate and therefore requires proportionally more lighting. The existing 12m poles with 250w lamps will be replaced with 20m high columns with multiple 400w lamps directed along the carriageways. This high column solution reduces the overall quantity of lighting structures required to illuminate the interchange to the required lighting levels.

The addition of extra lanes to the motorway will involve some widening of the motorway boundary resulting in the removal of some residences. This will give other residences in Alwyn Avenue and Titoki Street a different lighting scene of SH16, than their previously lit street, but will not be significantly different for spill lighting.

Construction Yards. Any construction site will require temporary lighting and the location and aiming of this temporary lighting will need to be carefully controlled.

7.4 Assessment of the Lighting Effects

The overall lighting of the finished Project will appear similar to the existing. There will be houses exposed where previously they had been obstructed by housing now removed, which will make the viewing of this lighting from these houses different. As detailed above, the illuminated area of the interchange will be larger, but the final lighting effect will be similar to the existing. Residential properties that are adjacent to the motorway will experience a higher level of illumination, because they will be closer to the widened motorway, but will experience only minor different lighting effects as they are already familiar with the existing adjacent street lighting.

Glare for residents will be minimal as roadlighting will be carried out to the requirements of Standard AS/NZS 1158.

Construction Yards. The lighting effects will comply with all the requirements of Section 3.1 for Waitakere City District Plan (Section 5.1 of this report).

7.5 Recommended Mitigation Measures

As the roadlighting will be designed to the requirements of Standard AS/NZS 1158, no mitigation will be required as the lighting effects will be minor. However, consideration should be given to the proposed planting of trees at the residential and motorway boundaries, which may offer an additional visual barrier that could further reduce the lighting effects. There will be some noise walls varying in height between 2m-3.5m, which may also further act as lighting shielding to residents.

Construction Yards. Lighting plans for any temporary lighting for construction works or construction facilities shall be produced by the contractor, and lodged with the Auckland Council for approval and verification by an independently qualified lighting specialist, to show that they comply with the standards referenced in Section 5 of this report. Asymmetrical floodlights will be used with glass visors that are not raised more than 3 degrees above the horizontal plane when used for general area yard lighting. The installation should be carried out with the best lighting practice to minimise adverse or stray lighting effects.

8. Sector 2. The Whau River Bridges

8.1 Existing Environment

This sector has three lanes running each way with no additional emergency stopping lane on the westbound carriageway.

The pole arrangement is double sided 250W HPS luminaires on 12m poles continuing across the Whau River Bridges, with sufficient lighting for the pedestrian/cycle way which is fenced off with a low visual obstructive chain link fence.

There is only recreational navigation of the Whau Creek as the motorway bridge clearance is too low to permit any significant shipping. It is considered there will not be any change in glare issues from the existing road lighting to small motorised recreational craft that use this Creek for mooring. There is no residential housing close to the Project in this sector.

8.2 Proposed Environment During Operation

The Whau River Bridges are intended to be widened to accommodate an extra lane to each carriageway and still retain some form of pedestrian/cycle way. The lighting is proposed to be reconfigured to a central median using 20m high columns with four 400W HPS luminaires aimed along the carriageway, typically at 120m centres. No lighting structures will be mounted on the outer edges of the motorway. Centrally mounted columns are considered better for visual continuity, 'forward guidance' orientation and for safety. The columns will be mounted within protective barriers to protect them from errant vehicle collisions.

This lighting solution will be continued across the entire motorway causeway. There will be local motorway construction lighting for the bridge widening and for the added lane construction.

Construction Yards: There will be no construction and materials handling yards in this sector.

8.3 Description of the Lighting Effects

Having four luminaires on one lighting column will look little different at night from the existing lighting. The light will need to reach further across the widened carriageways and include the pedestrian/cycle way.

The columns will be higher than the existing poles, but will be less frequent. The proportions of pole height to motorway width will appear much the same.⁴

⁴ Refer Technical Report No G20, Assessment of Visual & Landscape Effects.

Carriageway construction lighting is likely to be via temporary poles mounted on readily moveable concrete blocks. This allows moving of the lighting as different lanes of traffic are diverted during the construction period. Although there will be vehicle speed restrictions the lighting will, where practical, conform to the Roadlighting Standard AS/NZ1158, during this period.

8.4 Assessment of the Lighting Effects

The western end of the Whau River Bridges is the boundary line between Waitakere City and Auckland City. The roadlighting lighting effects will be within all the requirements of AS/NZS 1158, and the standards provided in Section 5 of this report. Glare for residents will be minimal if roadlighting is carried out to the requirements of AS/NZS 1158.

There will be a wider width of lit roadway with the additional lanes. Nocturnal birds are unlikely to find this significantly different from the existing to which they are already familiar.⁵

The proposed lighting will not significantly change the existing lighting conditions for marine navigation.

8.5 Recommended Mitigation Measures

The lighting design will be designed to comply with the requirements of the Roadlighting Standard AS/NZS 1158; and in particular the Upward Waste light Ratio (UWLR) shall not exceed 3% to minimise glare and spill light. As the roadlighting will be designed to requirements of the Standard, no further mitigation will be required as there will be no residences close to the Project.

Lighting plans for any temporary lighting for road construction works will be lodged with the NZTA for approval and verification by an independently qualified lighting specialist to confirm that they comply with the standards referenced in Section 5 of this report.

Construction Yards. There will be no construction yards in this Sector requiring mitigation measures.

⁵ Refer Technical Report No G3, Assessment of Avian Ecological Effects

9. Sector 3. Rosebank Terrestrial & Rosebank Domain

9.1 Existing Environment

This sector, from the Whau River Bridges heading east past the Rosebank Park Domain and beyond, includes the end of the Rosebank Peninsula, incorporating the Patiki and Rosebank Road motorway ramp intersections. On the south side of the motorway is a service material dumping area and some factories. On the north side of the motorway is the Pollen Island (Motu Manawa Marine Reserve). The motorway lighting is, at present, a double sided arrangement on 12m poles with 250W HPS lamps until the Patiki overpass bridge. Further south, the arrangement changes to double outreach central median lighting.

9.2 Proposed Environment During Operation

The addition of two extra lanes will involve a widening to the south into the Rosebank Park Domain and the higher reclaimed mound area where there is a mini race track, and also to the north. The pedestrian/cycle way will be relocated further to the south.

The lighting is proposed to be reconfigured to a central median using 20m high columns with four 400W HPS lamps typically at 120m centres. No lighting structures will be mounted on the outer edges of the motorway. Centrally mounted columns are considered to be better visually and for safety. The columns will be mounted within protective barriers to avoid errant vehicles colliding with them and provide a clearer line-of-sight for drivers.

This lighting solution will be continued across the entire Causeway.

Construction Yards. The present dumping area adjacent to the Patiki on ramp will be re-used as the Construction Yard No. 2 (Patiki Road).

9.3 Description of the Lighting Effects

The poles and luminaires will be the same as the previous Sector. Again, there will be a wider width of lit roadway with the additional lanes. Nocturnal birds are unlikely to find this significantly different from the existing to which they are already familiar.⁶

Road construction lighting is likely to be via temporary poles mounted on readily moveable concrete blocks. This allows moving of the lighting as different lanes of traffic are diverted during the construction period. Although there will be vehicle speed restrictions the lighting will, where practical, conform to the Roadlighting Standard, during this period.

⁶ Refer Technical Report No G3, Assessment of Avian Ecological Effects

Construction Yards. The construction yard will have 24 hour temporary lighting for the construction plant and materials handling.

9.4 Assessment of the Lighting Effects

The roadlighting lighting effects will comply with all the requirements of the Roadlighting Standard AS/NZS 1158.

Construction Yard. There are no residential zones near Construction Yard No. 2. Temporary lighting during construction activities will need to be designed and aimed appropriately to minimise any glare to motorway users.

9.5 Recommended Mitigation Measures

The road lighting design will comply with the requirements of the Roadlighting Standard AS/NZS 1158; and in particular the Upward Waste light Ratio (UWLR) shall not exceed 3% to minimise glare and spill light. As the roadlighting will be designed to requirements of the Standard, no further mitigation will be required as there will be no residences close to the Project.

Carriageway construction lighting is likely to be via temporary poles mounted on readily moveable concrete blocks. This allows moving of the lighting as different lanes of traffic are diverted during the construction period. Although there will be vehicle speed restrictions the lighting will, where practical, conform to the Roadlighting Standard.

Lighting plans for any temporary lighting for road construction works will be lodged with the NZTA for approval and verification by an independently qualified lighting specialist to confirm that they comply with the standards mentioned in Section 5 of this report and safety audits.⁷

The Construction Yard. Lighting plans for any temporary lighting for construction works or construction facilities shall be produced by the contractor, and lodged with the Auckland Council for approval and verification by an independently qualified lighting specialist, to show that they comply with the Standards referenced in Section 5 of this report. Asymmetrical floodlights will be used with glass visors that are not raised more than 3 degrees above the horizontal plane when used for general area yard lighting. The installation should be carried out with the best lighting practice to minimise adverse or stray lighting effects.

⁷ *Safety audits are often requested by the NZTA to check adequacy of the roadlighting for vehicles. These are conducted by independent auditors*

10. Sector 4. Reclamation and Causeway Section

10.1 Existing Environment

The Causeway is sufficiently wide to take six lanes of traffic, two emergency stopping/bus lanes and a pedestrian/cycle way.

It is considered that the existing choice of central median lighting with single pole-double outreach arms has minimised the environmental lighting impact of the roadlighting across the Causeway, which is such a prominent straight artificial feature crossing the bay⁸. At night they produce minimal glare or spill light. The pedestrian/cycle ways are not separately lit. What spill light there is, is considered adequate for safe cycling and walking.

10.2 Proposed Environment During Operation

The intention is to raise the existing Causeway and add an extra lane to each side. A small section towards the eastern Waterview Interchange end will have an additional lane for the new ramp feed-in from the west to the south, (making nine lanes in all, if including the bus/emergency stopping lanes). The extra width in this small stretch will require some side lighting in addition to the new median lighting.

The lighting is proposed to be reconfigured to the same central median, but using 20m high columns with four 400W HPS lamps typically at 120m centres. No lighting structures will be mounted on the outer edges of the motorway. Centrally mounted columns are considered to be better for safety and visually (both visual effects and for 'forward guidance' driver orientation). The columns will be mounted within protective barriers to avoid errant vehicles colliding with them and provide this clearer line-of-sight for drivers.

This lighting solution will be continued across the entire motorway causeway, except in the wider parts of this sector, where the additional lanes will result in the light columns having typically 100m centres - instead of 120m.

10.3 Description of the Lighting Effects

The road lighting will need to reach further across the widened carriageways. Where the pedestrian/cycle way is significantly separated from the motorway it will be provided with stand-alone lighting. Where it runs parallel and immediately adjacent to the emergency stopping/bus lane with only a chain link fence between, additional lighting will not be required provided an illuminance to Category P3 is provided. (Refer Section 6.3.6 of this report).

⁸ Refer Technical Report No G20, Assessment of Visual & Landscape Effects.

Road construction lighting is likely to be via temporary poles mounted on readily moveable concrete blocks. This allows moving of the lighting as different lanes of traffic are diverted during the construction period. Although there will be vehicle speed restrictions the lighting will, where practical, conform to the Roadlighting Standard, during this period.

10.4 Assessment Of The Lighting Effects

Any longshore recreational marine activities in the Tamaki Estuary are unlikely to have different lighting effects from the existing.

There are no residential or factories zones near this area of motorway reconstruction.

The roadlighting lighting effects will be within all the requirements of AS/NZS 1158.

Temporary lighting during road construction activities will need to be designed and aimed appropriately.

10.5 Recommended Mitigation Measures

The lighting design will be carried out to the requirements of the Roadlighting Standard AS/NZS 1158; and in particular the Upward Waste light Ratio (UWLR) shall not exceed 3% to minimise glare and spill light. As the roadlighting will be designed to requirements of this Standard, no further mitigation will be required.

Lighting plans for any temporary lighting for carriageway construction works will be lodged with the NZTA for approval and verification by an independently qualified lighting specialist, to confirm they comply with the standards referenced in Section 5 of this report.

11. Sector 5. The Great North Road Interchange

11.1 Existing Environment

The Interchange lies within a slight bowl with higher land of the Point Chevalier residential zoning on a scarp to the north. The lighting is provided by a series of single-armed 12m poles with 250W HPS semi-cut off luminaires scattered across a double curved and ramped intersection. Many of residents, being above the Interchange receive minimal glare.

There are one or two residences at the end of Maryland Street at a lower level and closer to the Causeway and Tamaki shoreline, that have a view across to SH16.

At present there is no motorway connecting SH16 to SH 20, or designated pedestrian/cycle way.

11.2 Proposed Environment During Operation

This interchange will have added elevated radial ramps that will stretch across the Oakley Creek and will affect housing in Herdman Street and Waterbank Crescent further to the south (in Sector 7). They will see the new lit elevated ramps. The houses at the end of Maryland street will have a distant view of the new elevated ramps in addition to their present night time view of SH16.

The houses situated on the scarp to the north of the interchange in Point Chevalier, that used to have a view of these residences and the Creek, will now have a distant view of elevated ramps and the first section of the new SH20 interconnecting motorway that transitions to below grade into a pair of bored tunnels beneath the Great North Road. They will see the new section of the SH20 motorway at night where previously they had only seen the lights of the Great North Road.

Construction Yards: There will be two temporary contractors' construction yards in the centre of the existing interchange (Yards Nos. 3 and 4, Great North Road, See Appendix G). These will have site offices, materials storage, a laboratory and workshops that will require lighting all night.

11.3 Description of the Lighting Effects

The hub of the interchange will use 20m highmast columns with four 1kW HPS fully cut-off floodlights. Column spacing will be maximised over both the widened motorway SH16 and the new interconnecting ramps to the south. Going higher with the poles, but with a greater spacing, will be better visually both day and for uniformity of lighting at night. The height allows for the luminaires to be aimed downwards, thereby reducing both glare and spill light

The straight-through SH16 section of the motorway will continue with 20m high central median columns at 80m spans for night time visual continuity and 'forward guidance' orientation. They will be 400W full cut-off luminaires.

The lit elevated ramps will be noticeable at night, being higher than the surrounding residences.

Some of the outlying elevated ramps that connect the motorways from west to south (and vice versa) will be too far from the hub and will be lit from 250W single sided 15m curved outreach poles with luminaires that have a special reflector for delivering light along a thin strip of twin traffic lane.

Construction Yards. There will be two construction yards (Nos. 3 and 4) in this Sector, with all night lighting.

11.4 Assessment of the Lighting Effects

There will, of necessity, be an increase in lighting to serve this larger area of the centre of the Great North Road Intersection owing to the increased number of ramps, but it will not be intrusive. The vertical component to the lighting will be contained by verifying that the design has been properly aimed and commissioned. The lit area will look brighter than previously when viewed from the Point Chevalier residences. From there, in the far distance, the internally lit tunnel portals will be noticeable after dark. However, the residents will be familiar with the lighting already existing in the area, making the added lighting ambience in the area of a lesser significance.

In Sector 7, there will be residences in Hemington and Arlington Streets that will look across the Creek towards the Sector 5 Interchange, who will now see the lights of the elevated ramps in this Sector.

Lighting for the temporary carriageway for traffic will require careful monitoring.

Construction Yards: There will be more all night light here than previously. None of this light will provide spill light over residential boundaries of over 10 lux as the lighting will be within the spill light requirements of the bylaws. Lighting will be designed to be below 100 lux, however, care will be taken to avoid mis-aimed floodlights, to minimise lighting effects to both to distant residents or cars travelling through the intersection.

11.5 Recommended Mitigation Measures

The new lighting interchange design will use a lesser number of highmast 20m columns to replace the larger number of existing 12m poles.

Modern technology cut-off asymmetrical floodlights with a maximum of a three degree tilt to the horizontal plane will be used. This will mitigate adverse lighting effects and glare to those situated in Pt Chevalier.

With the special luminaires that provide light along the lanes of the ramps, any spill light will be minimised.

The lighting design will be designed to comply with the requirements of the Roadlighting Standard AS/NZS 1158; and in particular the Upward Waste light Ratio (UWLR) shall not exceed 3% to minimise glare and spill light. As the roadlighting will be designed to requirements of the Standard, no further mitigation will be required.

Lighting plans for any temporary lighting for carriageway construction works will be lodged with the NZTA for approval and verified by an independently qualified lighting specialist to confirm they comply with the standards referenced in Section 5 of this report.

Construction Yards: The construction site lighting will conform to the Auckland City Bylaw No. 13.5. The installation will be carried out with the best lighting practice available to minimise adverse or stray lighting effects. Generally no more than 100 lux will be permitted in the yards, sufficient to allow all night work, but to reduce the effect of the residents views onto these areas.

Lighting plans for any temporary lighting for construction facilities shall be produced by the contractor, and lodged with the Auckland Council for approval and verification by an independently qualified lighting specialist that they comply with Auckland City Bylaw No. 13.5.

Asymmetrical floodlights will have glass visors that are not raised more than 3 degrees above the horizontal plane when used for general construction area lighting.

12. Sector 6. Existing Motorway SH16 from the Great North Road Intersection to St Lukes Intersection

12.1 Existing Environment

The six lane (plus two new emergency stopping lanes) existing motorway, passes through both residential zones and has a boundary on the Chamberlain Park Golf Course. This Sector already has a double sided arrangement of 12m poles with 250W HPS light sources from semi-cut off luminaires.

The pedestrian/cycle way is existing, and will remain unaltered. The lighting will remain unchanged.

The current installation has been in place for some time and has been familiar to the residents and the general public.

12.2 Proposed Environment During Operation

An extra lane is being added to each side of the motorway to take the additional traffic flow from the new interchange. The NZTA intends that the lighting of this section of the motorway is to be upgraded to a central median arrangement eastwards as far as the St Lukes overpass bridge. Although the Sector continues just east of the bridge, it is not intended that the roadlighting further east, beyond the bridge, will be altered at this stage.

The lighting will be achieved with four 400W HPS luminaires, aimed along the carriageway, on 20m columns, with 80m spacing and set within a new median barrier.

During construction, a method of mounting temporary light poles on relocatable concrete blocks is likely to be used. They provide adequate light for traffic in reduced speed construction areas. This is considered a good method to reduce spill light and glare even for temporary lighting.

Construction Yard: To the north of the motorway will be a new construction yard (Contractors Yard No. 5, Meola Creek, See Appendix G) for site office and materials handling.

12.3 Description of the Lighting Effects

The changes to the motorway lighting are expected to reduce the environmental impact. Even with fewer poles, there will be improved lighting uniformity on the road. (The proposed solution will also be more economical, and environmentally and sustainably designed, halving the amount of cabling required).

Construction Yard: The present area for the construction yard is an undeveloped square of land alongside the motorway, with no lighting. It will require temporary all night lighting.

12.4 Assessment of the Lighting Effects

The effects of the motorway lighting will be similar to the existing, with which the public and residents should already be familiar, but with the advantage that they will be full cut-off.

The Construction Yard: For all-night construction lighting, it is noted that the Auckland City Bylaw No. 13.5 addresses spill lighting and glare and generally requires that no more than 100 lux (horizontal or vertical) is permitted over a residential boundary before 10pm, or 10 lux thereafter. Generally no more than 100 lux will be permitted in the yards, sufficient to allow all night work, but to reduce the effect of the residents views onto these areas.

There are residences to the east and west of this construction yard, but spill lighting will not be an issue as any equipment requiring lighting will be located 10m back from any residential boundary.

12.5 Recommended Mitigation Measures

The final motorway will conform to the permitted environmental spill light and glare levels as noted in AS/NZS 1158 and therefore no further mitigation measures will be taken.

Lighting plans for any temporary lighting for carriageway construction works will be lodged with the NZTA for approval and verification by an independently qualified lighting specialist to confirm they comply with the standards referenced in Section 5 of this report.

Consideration should be given to the proposed planting of trees at the residential and motorway boundaries, which may offer an additional visual barrier that could further reduce the lighting effects.

Construction Yard: Floodlights used in the construction yard will be appropriately aimed. Asymmetrical floodlights only will be used, and mounted so that the glass visors are not raised more than 3 degrees above the horizontal plane when used for general area lighting.

Lighting plans for any temporary lighting for this construction facility shall be produced by the contractor, and lodged with the Auckland City Council for approval and verification by an independently qualified lighting specialist, that they comply with the Auckland City Bylaw No. 13.5.

The yard installations will be carried out with the best lighting practice to minimise adverse or stray lighting effects.

There will be a 10m buffer zone between any equipment and a residential boundary to reduce lighting effects.

13. Sectors 7 and 8. Great North Road and Avondale Heights Deep Tunnel Sections

13.1 Existing Environment

At present, this is a residentially zoned area in the area of Herdman Street and Waterbank Crescent. The residents are at present somewhat shielded from the SH16 lighting by trees of Oakey Park and the heavily mangrove-covered Oakley Creek.

The Great North Road is a main arterial route that was recently improved. It has been widened, upgraded and power reticulation has been installed underground. The roadlighting is provided by 12m poles with 250w HPS luminaires on a staggered side arrangement. There are two lanes of traffic in each carriageway.

13.2 Proposed Environment During Operation

Most of this arterial Great North Road will remain unchanged as the twin bore tunnel will be passing beneath it. There will be a temporary deviation for a small section to circumvent the construction operations at the northern tunnel portal, but the road will be reinstated as previously, with the same lighting.

There will be land take in this area and houses in the Cowley Street area will be moved or demolished to make way for the northern portal of the proposed tunnels.

Construction Yards: There will also be an expanse of residential land taken up for the site offices, equipment and materials handling for the tunnel boring in the Cowley Street area. During the construction phase a considerable amount of temporary construction yard lighting will be required both at Waterview Park, (Yard No. 6), and also especially near the tunnel entrance, (Construction Yard No. 7 Oakley Creek Reserve). This will be for tunnel construction equipment, site offices, workshops, a refuelling facility, materials, handling plant, tunnel spoil, and a concrete batching plant. It will be in use all hours of darkness.

There will also be some permanent plant buildings for pumps and transformers in the vicinity of the intersection of Herdman and the Great North Road. Also a fire tunnel ventilation shaft at 36 Craddock Street, along the line of the tunnel, that will require some minimal external security lighting, and will also require some area lighting during construction.

Where the deep tunnel continues underground to the south, there will be few lighting effects visible in the permanent installation. However, there will be some requirements for pedestrian/cycle way lighting as it is the intention to link the pedestrian/cycle way with those to the recently completed SH20 motorway beyond Sector 9.

13.3 Description of the Lighting Effects

Except for the Yards Nos. 6 and 7 construction/site office zones mentioned above, there will be little change to existing lighting effects. There will be additional light where the SH20 new motorway enters the tunnels from the Waterview interchange and there will also be a requirement for some additional lighting for some access road lighting to the tunnel vent, and the pedestrian/cycle way.

Construction Yards: Care will be taken so that the small tunnel vent construction zone, even if seemingly remote from the main activity of the tunnel portals, will conform to the Auckland City Bylaw lighting requirements, especially if there is any all night construction. Again, there may be some plant that requires a level higher than 100 lux, but provided this is only sparingly used in specific small task areas, (ie. reading meters or dials), and if checked by a qualified illumination engineer, there will not be any appreciable spill light or glare.

The fire vent construction site will be close to residences, so care must be taken to minimise the effects of any temporary spill light or glare.

Any public pedestrian/cycle ways lighting will conform to the 'P3' (ACC modified) Category of the Roadlighting Standard 1158.

For all-night construction yard lighting, it is noted that the Auckland City Bylaw, Section 13.5, deals with spill lighting and glare. There may be some plant in the construction yards that require a level higher than 100 lux, but provided this is contained to within specific task areas; this will not be a concern.

The residences near Yards Nos. 6 & 7, are set well back from this area. Also as any equipment will be located 10m back from residential boundaries, there will not be a spill lighting issue.

13.4 Recommended Mitigation Measures

Before the motorway passes underground, it will conform to the permitted environmental spill light and glare levels as noted in AS/NZS 1158 and therefore no further mitigation measures will be required.

Lighting plans for any temporary lighting for carriageway construction works will be lodged with the NZTA for approval and verification by an independently qualified lighting specialist, to confirm they comply with the Auckland City Bylaw No. 13.5

The pedestrian/cycle way lighting will use fully cut-off luminaires to minimise spill light.

Construction Yards: Any of the construction areas that are 24 hour operation, will have appropriately shielded lighting to prevent spill lighting or glare to residents. Lighting plans for any temporary lighting for this construction facility shall be produced by the contractor, and lodged with the Auckland City Council for approval and verification by an independently qualified lighting specialist, that they comply with the Auckland City Bylaw No. 13.5

The installation will be carried out with the best lighting practice to minimise adverse or stray lighting effects. Asymmetrical floodlights will be used with glass visors that are not raised more than 3 degrees above the horizontal plane when used for general area lighting.

There will be a 10m buffer zone between any equipment and a residential boundary to reduce lighting effects. However, consideration should be given to the proposed planting of trees at the residential and construction yard boundaries, which may offer an additional visual barrier that could further reduce the lighting effects. Therefore no further mitigation methods will be required.

14. Sector 9. Alan Wood Reserve

14.1 Existing Environment

At present, there is no road passing through this section. It is the Allan Wood and Valonia Reserves and is encompassed by parts of Bollard Avenue and Methuen Road to the west, and Hendon Avenue to the east. There is a slight natural depression formed by the Oakley Creek over which some of the residents look. The present environment is relatively dark with some amenity lighting at the reserve access parking areas.

This Sector finishes at the Maioro Bridge with a 'tongue' of the main motorway construction continuing under the proposed bridge to connect with the existing newly completed SH 20 motorway.

Half of this Maioro interchange and the linking section of the SH20 motorway has been the subject of an earlier lighting Assessment Environmental Effects report for the Outline Plan of Works for the half diamond and continuing south to the present Sandringham Rd roundabout. (Dated 23 December 2009, Geoff Waller, Beca Ref. ZN1-2505066.). This section has already been designed in preparation for the imminent construction of the new Maioro Bridge.

At present there is a temporary double sided lighting pole arrangement of 250W HPS luminaires on 12m poles south of the Maioro Intersection. It will be changed to a single sided arrangement up the new ramp. Much of the land in the immediate area has already been cleared in preparation for the motorway to continue north. There are sections just south of Richardson Road that are bordered to the east by factories.

14.2 Proposed Environment During Operation

The new motorway will exit the tunnels at a portal just south of the intersecting Stewart Road, beyond Hendon Avenue. It will pass through the Allan Woods Reserve and on southwards to the Maioro Intersection. Here the motorway will be lit with central median lighting from 20m single columns with cut-off luminaires aimed along the carriageways. Near the tunnel portal, where the median is very wide, there will be a single staggered pole arrangement with one 1x400W luminaires mounted within the median area. As the median narrows, the arrangement will revert to the standard 20m single column arrangement with two x 400 HPS luminaires.

South of the Maioro Bridge (being a visual break), the arrangement will change again to an existing opposite side pole arrangement to be visually the same, for the continuity of the SH20 motorway southwards.

There will be a pedestrian/cycle way to the west side of the new motorway which will be provided with its own amenity lighting, where it separates from the side of the motorway, with planting between.

Construction Yards: During the construction phase there will be a number of lit construction yards. (Construction Yards Nos. 8, to 9 and 10)

The most significant (Yard 9) will be off Hendon Avenue at the extension of Stewart Road and Olympus Street, comprising of a site office, workshop, refuelling facility, materials handling plant, tunnel spoil, and a concrete batching plant for the southern boring of the twin tunnels.

Other temporary construction yards will be off Hendon Avenue at an opening at Barrymore Road (Construction Yard No. 11) and the last, (Construction Yard No. 12) accessed off Valonia Street.

Most of these construction areas do not back directly onto residential properties. However, for Construction Yard No. 11, which is accessed from Barrymore Rd, there are residential properties directly against the construction boundary.

All the construction sites will have all-night operation lighting for a period of six months and at the least, minimal security lighting.

14.3 Description of the Lighting Effects

This sector has potential significant sensitivity to environmental issues for it is where the motorway surfaces from the Waterview tunnel. At night this is, at present, a relatively dark area and there will be a visual environmental impact for residents looking out towards the future motorway both during the day, seeing a line of lighting columns, and at night, where previously there was minimal lighting. The new motorway will cut through a green park alongside the upper reaches of the Oakley Creek.

More distant residences on both sides of the motorway will be able to see the roadlighting. However, it will be seen as an illuminated object and will not impinge on their properties as spill light. It is still important to minimise any lighting effects. Some houses located high up on the Three Kings volcanic cone may be able to see the lit motorway after dark, though it will be a distant view.

The nearer residences will look down onto the motorway from either side and they will see the lit carriageway.

Construction Yards: Care will be taken so that even the smallest construction zones, even if seemingly remote from the main activity of the motorway construction, are conforming to the Auckland City Bylaw No. 13.5 lighting requirements, especially if there is all night construction. Again, there may be some construction plant that requires a level higher than 100 lux, but provided this is only sparingly used in small specific task areas, (ie. reading meters or dials), and if checked by a qualified illumination engineer, there will not be any appreciable spill light or glare.

14.4 Recommended Mitigation Measures

This is an area where fully-cut off luminaires will be used. As these allow no light above the horizontal plane, they therefore require nearly a third more luminaires than semi-cut-off equivalents to achieve the required uniformity. This solution will continue as a median centrally mounted 20m lighting column arrangement with standard twin 400W luminaires per pole to the north side of the Maioro Bridge.

Going higher with the poles, but with a greater spacing, will be better visually for both day and night. The height allows for the luminaires to be aimed downwards, thereby reducing both glare and spill light. With such a design, where some of the residences are located a little above the motorway, any spill light or glare would be negligible. There will also be some acoustic barriers of 2m - 4m height which could also be will also be visual light barriers.

This cut-off lighting design will be used to reduce the environmental unwanted lighting effects and therefore no further mitigation is required. However, consideration should be given to the proposed planting of trees at the residential and motorway boundaries, which may offer an additional visual barrier that could further reduce the lighting effects.

Lighting plans for the motorway lighting will be lodged with the NZTA for approval and verification by an independently qualified lighting engineer, to confirm they comply with the standards mentioned in Section 5 of this report.

Construction Yards: Lighting plans for any temporary lighting for these construction facilities shall be produced by the contractor, and lodged with the Auckland Council for approval and verification by an independently qualified lighting engineer, so that they comply with the Auckland City Bylaw No. 13.5.

This is especially so for Construction Yard No. 11, which has access from Barrimore Rd where there are residential properties directly against the northern construction boundary. Spill lighting is not expected to be an issue as any equipment requiring lighting will be located beyond a buffer zone, 10m back from the boundary, to reduce the possible adverse lighting effects.

Asymmetrical floodlights will be used with glass visors that are not raised more than 3 degrees above the horizontal plane when used for general yard area lighting.

There are also residences close to one side of each of Construction Yards No. 6, 8, and 12, which will require to be similarly addressed.

If these issues are addressed no further lighting mitigation will be required.

The pedestrian/cycle ways will require a similar plan and all are to be verified as complying to AS/NZS 1158 (with any Auckland City amendments), by an independently qualified lighting engineer. The luminaires will be of the fully cut-off variety with horizontal glass and stone guards to minimise vandalism.

15. Conclusion

This report has addressed the areas of potential adverse lighting effects, namely spill light, glare and skyglow as described in section 6 of this report.

Roadlighting is a compromise between the provision of adequate safety lighting for road users and the minimization of adverse lighting effects on non road users. With recently computer-designed luminaires that project light *efficiently* to only the areas where needed, any spill light or glare issues for modern roadlighting are generally minimised, as a matter of course.

Many of the motorway sectors, where lanes are to be added, already have adequate roadlighting appropriate for their present width and category. The public and adjacent residential house owners are already familiar with the lighting, especially those adjacent to SH16.

There will be some visual differences to residents due to the increased light levels and coverage. However, the new lighting proposed is required to consider the safety of the road users and so is required to meet minimum standards.

If the roadlighting and construction yard lighting design and installation are carried out in accordance with this Assessment of Lighting Effects Report, the spill lighting effects will be confined to those stated in this Report.

Also, it is considered that the lighting effects will be 'minor or less than minor' as shown in Table 1.1 and within the requirements of the relevant District Plans and Bylaw. There is no reason why all the final motorway lighting should not conform to the local councils' relevant District Plans or Bylaw, and the AS/NZS 1158 Standard for Roadlighting.