ASSESSMENT OF LIGHTING EFFECTS

Christchurch Southern Motorway
Stages 2 (CSM2) & 3 (MSRFL)
Road Lighting
Environmental Impact Report

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This Technical Report has been produced in support of the Assessment of Environmental Effects (AEE) for the Main South Road Four Laning and Christchurch Southern Motorway Stage 2 Project. It is one of 20 Technical Reports produced (listed below), which form Volume 3 of the lodgement document. Technical information contained in the AEE is drawn from these Technical Reports, and cross-references to the relevant reports are provided in the AEE where appropriate.

A Construction Environmental Management Plan (CEMP) has been prepared to provide the framework, methods and tools for avoiding, remedying or mitigating environmental effects of the construction phase of the Project. The CEMP is supported by Specialised Environmental Management Plans (SEMPs), which are attached as appendices to the CEMP. These SEMPs are listed against the relevant Technical Reports in the table below. This Technical Report is highlighted in grey in the table below. For a complete understanding of the project all Technical Reports need to be read in full along with the AEE itself; however where certain other Technical Reports are closely linked with this one they are shown in bold.
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For further information on the structure of the lodgement documentation, refer to the ‘Guide to the lodgement documentation’ document issued with the AEE in Volume 1.
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Executive Summary

The lighting design for Christchurch Southern Motorway Stage 2 (CSM2) and Main South Road Four Laning (MSRFL) project (the Project) will use a combination of full cut-off (Type 3) and semi cut-off (Type 2) luminaires throughout. More sensitive areas where the motorway/expressway encroaches closer to residential house boundaries or in areas where changes in topography might adversely impact on the environment (i.e. on or off ramps) full cut-off (Type 3) luminaires will be installed. This provides an economical solution, while also restricting the effects of the lighting on the environment.

All luminaires selected will conform to the photometric and material requirements of the AS/NZS 1158 Road Lighting Standard.

The use of future, newer technology such as light emitting diodes (LEDs) is not precluded at this stage because this technology is still developing at a rapid rate.

For this Project, the road lighting will be designed to meet full compliance with Australian/New Zealand Standard AS/NZS 1158 Road Lighting, subcategory V3. This Standard requires a Threshold Increment (glare control) below 20% and Upward Waste Light Ratio (UWLR) shall not exceed 3%. Because of these factors, and the use of semi cut-off (Type 2) and full cut-off (Type 3) luminaires, the effects of glare, spill light and upward waste on the environment are considered to be minimal.

For the main motorway carriageway (CSM2), no lighting is required from approximately 1400 chainage to approximately 4200 chainage (2.8km).

No carriageway lighting is required on MSRFL from approximately 3900 chainage to approximately 5800 chainage (1.9km). Isolated intersection lighting (flag lighting) is required on Berketts Road.

Where underpass or overpass lighting is required for the motorway or local roads that have significant pedestrian use (i.e. Curraghs Road overpass and Halswell Junction Road underpass), it is intended to use surface mounted luminaires with flat glass (Type 3 full cut-off) optic.

The lighting column arrangement for the main carriageway will be designed as ‘Dual Staggered’ to be consistent with the Christchurch Southern Motorway Stage 1 (CSM1) lighting. Lighting column heights throughout will have a luminaire mounting height of 11.3m to 12.6m. Light fixtures are to be directed onto the carriageway, aimed away from houses to reduce direct view of luminaires to create less glare and spill light. The lighting columns will all be frangible galvanised sectional steel (unpainted).

All cycleway lighting will be designed to comply with AS/NZS 1158 subcategory P3 using environmentally friendly full cut-off (Type 3) luminaires.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. Along the majority the Project, there are buffer distances between the road and the adjacent properties, and this will assist in mitigating any effect of headlights.

Because the concept lighting design complies with AS/NZS 1158, the effects of operational lighting for the Project will be no more than minor, and therefore no mitigation is required. Any additional landscape planting and acoustic fences indicated in other technical reports will offer additional visual barriers that will further reduce the lighting effects.
1.0 Introduction

1.1 Introduction

Christchurch Southern Motorway Stage 2 (CSM2) will link to CSM1 and consists of a four-lane median separated motorway, from Halswell Junction Road to join SH1 near Robinsons Road.

This will then lead onto SH1, where the Main South Road Four-Laning (MSRFL) part of the Project will involve four laning the existing two-lane State Highway 1 (SH1) from Robinsons Road to near Rolleston. Together, CSM2 and MSRFL are referred to as the Project.

This report provides an assessment of the potential effects from the lighting proposed for the Project for motorway traffic, interchanges, under passes, over bridges and pedestrian/cycle ways and for construction activities. This report takes into consideration the night time effects of lighting such as spill light, glare and upward waste light.

Lighting can be viewed from two perspectives. First, ensuring that the proposed motorway/expressway is safely lit for the users, and secondly, managing the effects of that lighting on the surrounding environment. The lighting of motorways and roads conform to different lighting standards than those applicable to pedestrian and cycle ways. Different lighting standards apply to temporary lighting for construction activities.

This report is based on and recommends final preliminary design concepts only. The finer technical details will be developed once final construction designs are in place.

1.2 Report Structure

This report is structured as follows:
- Section 2 outlines the Project description;
- Section 3 outlines the relevant lighting standards and district plan provisions;
- Section 4 explains the different types of lighting effects and road lighting luminaires;
- Section 5 outlines the proposed lighting for the Project;
- Section 6 provides an assessment of the possible lighting effects of the Project;
- Section 7 is a summary of recommended mitigation measures; and
- Section 8 contains the conclusions.
2.0 Project Description

The NZ Transport Agency (NZTA) seeks to improve access for people and freight to and from the south of Christchurch via State highway 1 (SH1) to the Christchurch City centre and Lyttelton Port by constructing, operating and maintaining the Christchurch Southern Corridor. The Government has identified the Christchurch motorway projects, including the Christchurch Southern Corridor, as a road of national significance (RoNS).

The proposal forms part of the Christchurch Southern Corridor and is made up of two sections: Main South Road Four Laning (MSRFL) involves the widening and upgrading of Main South Road (MSR), also referred to as SH1, to provide for a four-lane median separated expressway; and the construction of the Christchurch Southern Motorway Stage 2 (CSM2) as a four-lane median separated motorway. The proposed construction, operation and maintenance of MSRFL and CSM2, together with ancillary local road improvements, are referred to hereafter as ‘the Project’.

MSRFL

Main South Road will be increased in width to four lanes from its intersection with Park Lane north of Rolleston, for approximately 4.5 km to the connection with CSM2 at Robinsons Road. MSRFL will be an expressway consisting of two lanes in each direction, a median with barrier separating oncoming traffic, and sealed shoulders. An interchange at Weedons Road will provide full access on and off the expressway. MSRFL will connect with CSM2 via an interchange near Robinsons Road, and SH1 will continue on its current alignment towards Templeton.

Rear access for properties fronting the western side of MSRFL will be provided via a new road running parallel to the immediate east of the Main Trunk rail corridor from Weedons Ross Road to just north of Curraghs Road. For properties fronting the eastern side of MSRFL, rear access is to be provided via an extension of Berketts Drive and private rights of way.

The full length of MSRFL is located within the Selwyn District.

CSM2

CSM2 will extend from its link with SH1/MSRFL at Robinsons Road for approximately 8.4 km to link with Christchurch Southern Motorway Stage 1(CSM1, currently under construction) at Halswell Junction Road. The road will be constructed to a motorway standard comprising four lanes, with two lanes in each direction, with a median and barrier to separate oncoming traffic and provide for safety.1 Access to CSM2 will be limited to an interchange at Shands Road, and a half-interchange with eastward facing ramps at Halswell Junction Road. At four places along the motorway, underpasses (local road over the motorway) will be used to enable connectivity for local roads, and at Robinsons / Curraghs Roads, an overpass (local road under the motorway) will be provided. CSM2

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1 CSM2 will not become a motorway until the Governor-General declares it to be a motorway upon request from the NZTA under section 71 of the Government Roading Powers Act 1989 (GRPA). However, for the purposes of this report, the term “motorway” may be used to describe the CSM2 section of the Project.
will largely be constructed at grade, with a number of underpasses where elevated structures provide for intersecting roads to pass above the proposed alignment.

CSM2 crosses the Selwyn District and Christchurch City Council boundary at Marshs Road, with approximately 6 km of the CSM2 section within the Selwyn District and the remaining 2.4 km within the Christchurch City limits.

Key design features

The key design features and changes to the existing road network (from south to north) proposed are:

- a new full grade separated partial cloverleaf interchange at Weedons Road;
- a new roundabout at Weedons Ross / Jones Road;
- a realignment and intersection upgrade at Weedons / Levi Road;
- a new local road running to the immediate east of the rail corridor, to the west of Main South Road, between Weedons Ross Road and Curraghs Road;
- alterations and partial closure of Larcombs Road intersection with Main South Road to left in only;
- alterations to Berketts Road intersection with Main South Road to left in and left out only;
- a new accessway running to the east of Main South Road, between Berketts Road and Robinsons Road;
- an overpass at Robinsons and Curraghs Roads (the local roads will link under the motorway);
- construction of a grade separated y-junction (interchange) with Main South Road near Robinsons Road;
- a link road connecting SH1 with Robinsons Road;
- a short new access road north of Curraghs Road, adjacent to the rail line;
- a new roundabout at SH1 / Dawsons Road / Waterholes Road;
- an underpass at Waterholes Road (the local road will pass over the motorway);
- an underpass at Trents Road (the local road will pass over the motorway);
- the closure of Blakes Road and conversion to two cul-de-sacs where it is severed by CSM2;
- a new full grade separated diamond interchange at Shands Road;
- an underpass at Marshs Road (the local road will pass over the motorway);
- providing a new walking and cycling path linking the Little River Rail Trail at Marshs Road to the shared use path being constructed as part of CSM1;
- an underpass at Springs Road (the local road will pass over the motorway);
- a new grade separated half interchange at Halswell Junction Road with east facing on and off ramps linking Halswell Junction Road to CSM1; and
- closure of John Paterson Drive at Springs Road and eastern extension of John Paterson Drive to connect with the CSM1 off-ramp via Halswell Junction Road roundabout (east of CSM2).

The proposed alignment is illustrated in Figure 1 and encompasses the MSRFL and CSM2 alignments between Rolleston and Halswell Junction Road.
Figure 1 Proposal location map

Legend:
- CSM2 Proposal
- MSRFL Proposal
- Local Authority Boundary
- State Highways
- Road stopping location
- Railway Line

NZ Transport Agency
CSM2 & MSRFL

Final 4 Assessment of Lighting Effects
3.0 Standards and District Plan provisions

3.1 Lighting Standards

There are a number of lighting standards that are relevant to the Project, as follows:

- AS/NZS 1158.0:2005 Lighting for Roads and Public Spaces Part 0 – Introduction;
- AS/NZS 1158.0:2005 Lighting for Roads and Public Spaces Part 3.1 - Pedestrian Area (Category P) Lighting – Performance and Installation Design Requirements; and

3.2 AS/NZS 1158 - Road Lighting Standards

For this Project, all motorway/expressway, other local road lighting design and pedestrian/cycle ways, together with the type of luminaires proposed, will conform to the requirements of the current Australian/New Zealand Standard AS/NZS 1158 Road Lighting (AS/NZS 1158). AS/NZS 1158 ensures safe vehicle and pedestrian movement and the timely identification of objects and pedestrians by the motorist’s eye, while travelling at speed during the darkness hours.

AS/NZS 1158 series of standards is considered to be an acceptable standard for lighting roads in New Zealand because it provides design requirements and recommendations prepared by committees and experts from industry, government bodies, road users and other sectors. These standards reflect the latest in scientific and industry experience.

Under AS/NZS 1158, road lighting is separated into two categories:

- ‘Category V’ primarily for vehicular traffic; and
- ‘Category P’ which is for pedestrians, mixed with low speed traffic.

There are four subcategories of Type V and twelve subcategories of Type P, the latter ranging from non-arterial roads to pedestrian footpaths and car parks.

3.3 AS/NZS 1158 Part 0 and 1.1 - Road Lighting

Standard AS/NZS 1158 addresses both spill light and glare restraints\(^2\) and references the following issues:

- Upward light content;
- Sideways spill light content;
- Direct viewing of the luminaire (or lamp source);
- Colour of the light.

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\(^2\) AS/NZS 1158.1.2 Section 7.3.3 (b)
As road lighting is provided for overall community safety (crash prevention and pedestrian safety), a higher tolerance level has been accepted for the associated glare and spill lighting. AS/NZS1158 contains limitations on glare, spill light and upward waste light.

Within these sections, AS/NZS 1158 cross-references AS 4282 and explains that the spill lighting levels from road lighting is not considered high enough to be obtrusive, but glare from the road lantern may be of annoyance to adjacent residences. AS/NZS 1158 discusses mitigation measures, such as shielding or the use of cut-off (Type 3) luminaires. An explanation of the three different types of luminaires is provided below in Section 4.6 of this report.

In the same cross reference, AS 4282 notes that glare 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 (20% as set out in AS/NZS 1158), it is then considered to be adequately controlled. The Threshold Increment (Glare) expected from using full cut-off (Type 3) and semi cut-off (Type 2) luminaires will be 7.05% and 16.51% respectively. Hence, both types of luminaire are compliant with AS/NZS 1158.

3.4 AS 4282:1997 - Control of the Obtrusive Effects of Outdoor Lighting

The Australian Standard AS 4282:1997 “Control of the Obtrusive Effects of Outdoor Lighting” (AS 4282) addresses both spill light and glare. While AS 4282 has been cross-referenced in AS/NZS 1158, it has not been adopted in New Zealand. There is controversy amongst professional illumination engineers in New Zealand over the technical content of this standard, which is considered to be too onerous and not specific enough for general use for all exterior lighting applications.

It should also be noted that AS 4282 specifically excludes public road lighting and was originally intended for evaluating lighting of tennis courts (and similar high illuminance areas) located within residential areas. The use of AS 4282 is not appropriate for road lighting, as the illumination levels for road lighting are relatively low, and the functionality of the lighting for safety of pedestrian and vehicular movement has a higher priority than sources of other potentially obtrusive light.

AS 4282 does however, provide some guidance on what spill light and glare effects are acceptable and assists in evaluating spill light and glare when viewed from a specific location, such as a residential property. To this end, a 10 lux illumination level has been taken as the appropriate cut-off level to determine whether the lighting from the road, cycleway or walkway can be deemed obtrusive and present a nuisance to residents (in accordance with AS 4282). This level (10 lux) of spill light is considered acceptable as a proven criteria from existing installations in lieu of any specific requirement within AS/NZS1158 and has also been used on other State highway projects throughout New Zealand as a suggested target level; for example, CSM1 and MacKays to Peka Peka Expressway.

3.5 Luminance Control Standard

There is no signage lighting proposed for the Project. If signage lighting is added at a later stage, it should be considered separately as outdoor lighting to comply with AS 4282.
3.6 Christchurch City Plan

As notices of requirement for designations are being sought, it is not essential that the Project comply with rules relating to lighting in Christchurch City Plan. However, when designing the Project lighting and preparing this report, any relevant Christchurch City Plan provisions and the lighting standards discussed above have been considered, as they provide some guidance as to the appropriate lighting for this Project.

Section 5 (see Figure 3 below) is located within the jurisdiction of Christchurch City Council.

Few residential properties will be affected through this section as the majority of affected land is commercial property or rural farmland.

This area is zoned Rural Zone 2 (RU2) or Business Zone 5 (B5) in the Christchurch City Plan. In these zones, the development standards concerns glare (Note: glare terminology is misused in this standard and it is meant to mean spill light). Under Volume 3 Part 11 Clause 2.3.2 and Clause 2.3.4 glare Standards, an activity which results in greater than 4 lux light spill in a rural zone and 20 lux in a business zone is a discretionary activity. The explanation for this glare standard is to control the “adverse effects caused by illumination from properties, but not from street lighting.” While this development standard is not strictly relevant to the Project because it relates to illumination from properties, it does provide some guidance on controlling a level of spill light that is acceptable.

Notwithstanding this, all endeavours will be made to ensure the direction of light is adequately controlled at source to minimise any unnecessary spread over adjoining properties or into the atmosphere.

3.7 Selwyn District Plan

As notices of requirement for designations are being sought, it is not essential that the Project comply with rules relating to lighting in Selwyn District Plan. However, when designing the Project lighting and preparing this report, any relevant Selwyn District Plan provisions and the lighting standards discussed above have been considered, as they provide some guidance as to the appropriate lighting for this Project.

Sections 1 to 4 of the Project (see Figure 3 below) are located within the jurisdiction of Selwyn District Council.

Few residential properties will be affected by the Project lighting throughout this section as the majority of affected land is commercial property or rural farmland. There is a significant length of the alignment roadway (4.7km) that will not be illuminated.

Rule 9.18 in the Rural Volume of the Selwyn District Plan relates to spill light from activities. Under Rule 9.18.1.2, any lighting that does not have a lux spill of more than 3 (vertical or horizontal) onto any part of any adjoining properties is a permitted activity. If the exterior lighting is not directed away from adjacent properties or roads, or the lux spill is greater than 3, discretionary activity resource consent would be required.

As noted above, because notices of requirement for designations are being sought, compliance with these rules is not essential, but light spill effects of the Project have been assessed. All endeavours will be made to ensure the direction of light is adequately controlled at source to minimise any unnecessary spread over adjoining properties or into the atmosphere.
4.0 Lighting Effects and types of luminaires

4.1 Types of Adverse Lighting Effects

There are four main types of lighting effects that have the potential for varying degrees of intrusiveness to both vehicles and residents living near lighting installations. They are:

- spill light;
- glare;
- sky glow (upward light); and
- head light sweep.

These effects are illustrated in Figure 2 below and explained in more detail in this section of the report.

4.2 Spill Lighting

Spill lighting or “Light Trespass” can be described as the effects of light or illuminance that strays from its intended purpose. On a roadway lighting system, it is desirable to have all the light directed onto the roadway and not on the adjacent area. Spill light effects cannot be totally avoided but it can be reduced through luminaire selection, mounting height and tilt angle.

An example of how spill light will be controlled based on the concept lighting design for the Project is provided in Appendix A to this report. This calculation shows spill light will not be an issue (more than 10 lux) on any property located further than approximately 20m from the lighting columns proposed for the Project.

Two “worst case examples” at the Shands Road / Marshs Road intersection and CSM2 / MSRFL Junction have been modelled in Appendix B to this report, to indicate that spill light compliance is achievable (i.e. less than 10 lux at an approximate distance of 20m from the lighting columns).
4.3 Glare

Glare is the brightness of a luminaire 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.

Probably the most annoying and safety related aspect of light pollution is glare. It is defined by the Illumination Engineering Society (IES) as the sensation produced by luminance in the visual field that is sufficiently greater than the luminance to which the eye has adapted to cause annoyance, discomfort, or loss of visual performance and visibility.\(^3\) The three types are as follows:

- **Blinding glare** - describes effects such as that caused by staring into the sun. It is completely blinding and leaves temporary or permanent vision deficiencies.
- **Disability glare** - describes effects such as being blinded by oncoming car lights, or light scattering in fog or in the eye, reducing contrast, as well as reflections from print and other dark areas that render them bright, with significant reduction in sight capabilities.
- **Discomfort glare** - does not typically cause a dangerous situation in itself, though it is annoying and irritating at best. It can potentially cause fatigue if experienced over extended periods.

Under AS/NZS 1158, if glare can be kept below the 20% maximum of Threshold Increment, AS/NZS 1158 indicates that glare is controlled. In computer calculated renditions for the Project, glare will be assessed at the detailed design stage, and will be compliant with AS/NZS 1158 in all areas. Two example calculations are provided in Appendix C to this report, which shows a Threshold Increment (Glare) of 7.05% and 16.51%, which is well below the requirements of 20% permitted in AS/NZS 1158.

4.4 Sky Glow

Urban sky glow is the result of stray light being scattered in the atmosphere brightening the natural sky background level. This effect is extremely detrimental to astronomers as well as annoying to many people in the general public. The overall impact of sky glow throughout this project has been limited by not providing any road lighting for approximately 4.7km through the rural environment.

This effect is difficult to mitigate, as it is light that reflects either directly or indirectly off the road surface. Sky glow 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 will also be reduced by the specification of street luminaires that are able to provide good optical control.

Any road luminaire must limit its Upward Waste Light Ratio (UWLR) below 3% (of the total light output). This is to minimise the direct light content to the night sky environment. The two example calculations provided in Appendix C indicate an UWLR value of 0.03% and 1.62%. This means light from the luminaire is being directed where the light is required.

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\(^3\) Light Pollution Environmental Effects of Roadway Lighting Technical Paper prepared for CIVL 582 Transportation Engineering Impacts. Dr G Brown, University of British Columbia.
4.5 Headlight Sweep

Effects from headlights are most likely to affect residents when headlights are directed toward a dwelling; requiring the following combination of circumstances to occur:

- Where a proposed motorway is elevated, with no planting mitigation taller than the pavement height;
- Where a proposed motorway curves resulting in headlights being directed off the alignment of the road and where residences are close to the carriageway;

The aiming and intensity of vehicle headlights forms part of the vehicle’s Warrant of Fitness examination. The requirement is for the lights to be aimed downwards and slightly to the left of centre.

Where headlights are visible from ‘side on’ i.e. passing traffic with headlights oriented at right angles to the view, the effects would be less than if headlights were directed toward the viewpoint/dwelling.

4.6 Types of Luminaires

Road lighting luminaires are designed around three basic design functions:

- Type 1: open – these luminaires are nearly obsolete. They allow for the widest spacing but create the greatest glare, exceeding that set by AS/NZS 1158. For this reason, open luminaires will not be used on the Project;
- Type 2: semi cut-off - these luminaires are widely used for most road lighting projects throughout New Zealand as a compromise between energy consumption and adequate lighting for safe driving.
- Type 3: full cut-off (or aero screen/flat glass). These luminaires have a completely flat visor, which produce zero upward light above the horizontal plane. The lamp is housed in the upper part of the internal optical housing, which helps to minimise any adverse effects of glare. They are considered to be very ‘environmentally friendly’ because they reduce spill light. However, when compared to the other two types of luminaires, a greater number of luminaires are typically required to achieve the required lighting parameters.

Diagrams of each type of luminaire are shown below:
Type 1 - Open luminaire characteristic with unrestricted upward light content above horizontal plane. This type of luminaire will not be used anywhere on this Project.

Type 2 - Semi cut-off luminaire characteristic upward light content restricted to 10 degree above horizontal plane. This type of luminaire is being used on the flat section of the main carriageway only.

Type 3 - Full cut-off luminaire characteristic upward light content restricted to below horizontal plane. This type of luminaire is proposed on all on/off ramps at any interchange and on any raised section of roadway leading to an over bridge.
5.0 Proposed Lighting for the Project

5.1 Introduction

As the Project is located in a rural area, and for road safety reasons, only the intersections and high conflict areas are to be illuminated. A concept lighting design is shown on the drawings within the Plan set contained within Volume 5.

No carriageway lighting is required on SH1 MSRFL from approximately 3900 chainage to approximately 5800 chainage. Isolated intersection lighting (flag lighting) is required on Berketts Road.

Any area of CSM2 and MSRFL that has a resultant gap with no lighting cannot be less than 300m in length. This distance is required to give the human eye a chance to adapt to the different light levels.

For the main CSM2 carriageway, no lighting is required from approximately 1400 chainage to approximately 4200 chainage (2.8km).

No lighting is proposed for the new rear access roads west and east of the Main South Road.

The design for this Project will use Type 2 luminaires, throughout the main carriageway. Type 3 luminaires will be used in more sensitive areas where the Project encroaches closer to residential boundaries, or in areas where changes in topography might adversely impact on the environment (i.e. on or off ramps and over bridges).

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

The use of future, new technology control systems or light emitting diodes (LEDs) is not included in the current lighting design. It is recommended that at the detailed design stage, the NZTA gives further consideration to the use of LEDs. The introduction of LED technology is changing very quickly. Any proposal to change to LED luminaires would not have any additional adverse effect on the environment when compared to full cut–off (Type 3) luminaires, because they are similar in performance.

Figure 3 below shows the Project alignment divided into sections that are used to assess potential lighting effects, which will be discussed in the next section of this report.

Figure 3
5.2 Luminance and Illuminance Levels

For this Project, the road lighting on the State highway carriageway will be designed to meet full compliance with AS/NZS 1158, subcategory V3. This will require luminance levels of 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 7.5 lux for intersections.

At interchanges and gore areas (which are possible conflict points where traffic merges or leaves ramps), the illuminance is required to be no less than 7.5 lux, with a maximum-to-minimum uniformity to be less than 8.

Any Category V road luminaire must have an Upward Waste Light Ratio (UWLR) of below 3%. This gives an indication of the tight containment of lighting within a specifically designed task area like a road. By using a full cut-off (Type 3) luminaire, it is anticipated the UWLR will be 0.03%, and a semi cut-off (Type 2) luminaire will have an UWLR of 1.62%, which therefore complies with Category V of AS/NZS 1158.

As explained in the previous section, any area of CSM2 and MSRFL that has a resultant gap with no lighting cannot be less than 300m in length.

For MSRFL from Rolleston to approximately 3900 chainage, including all intersections, interchanges, roundabouts, over bridges and under bridges will be designed to comply with subcategory V3.

Under AS/NZS 1158, the lighting for the following local roads in Selwyn District must comply with the relevant subcategory: Weedons Road (V4), Levi Road (V4), Jones Road (V4) and an unnamed industrial road adjacent to railway line (P3).

No carriageway lighting is required on SH1 MSRFL from approximately 3900 chainage to approximately 5800 chainage. Isolated intersection lighting (flag lighting) is required on Berketts Road.

Where CSM2 joins SH1 MSRFL (approximate chainage 0 to 1400), including all on and off ramps, interchanges, over bridges, under bridges and intersections, lighting will be designed to comply with subcategory V3. All lighting on and within Robinsons Road and Curraghs Road intersection and under bridge will be designed to comply with subcategory V3.

For the main CSM2 carriageway, no lighting is required from approximately 1400 chainage to approximately 4200 chainage (2.8km).

Intersection lighting is required on SH1 Main South Road and Waterholes Road and will be designed to comply with subcategory V3.

No lighting is required on the Hamptons Road or Trent’s Road over bridge, other than provisional allowance of cable duct or conduit for lighting to be added in the future.

The intersection of Waterholes Road and Hamptons Road can be considered an isolated intersection where the lighting must comply with partial subcategory V4.

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4 Subcategory V3 applies to motorways/roads that are mainly for vehicle use with no or few pedestrians.
Lighting for the following Christchurch City local roads needs to comply with the relevant subcategory as follows: Marsh’s Road (V3), Shands Road (V3), Springs Road (V3), Halswell Junction Road V3 and new link road to John Paterson Drive (P3).

5.3 Underpass and Overpass Lighting

Where underpass or overpass lighting is required for the local roads that have significant pedestrian use, it is intended that surface mounted Type 3 flat glass luminaires will be installed to minimise the effects of obtrusive light.

The locations where this form of lighting is proposed are Weedons Road over bridge, Main South Road underpass, Shands Road, Springs Road, Curraghs Road underpass, and Halswell Junction Road underpass.

5.4 Lighting Column Arrangements

To maintain continuity with the existing roadway lighting for CSM1, the lighting column arrangement for the main carriageway will be designed as ‘Dual Staggered’.5

As there is a 3m central median throughout the extent of the main carriageway, the other likely arrangements to meet the required classification would be ‘Dual Opposite’ or ‘Dual Central’. The Dual Staggered approach was selected as the preferred arrangement as there was a 30% reduction in the total number of columns required when compared to the Dual Opposite arrangement. The Dual Central arrangement was not selected because of difficult maintenance issues and a request from the NZTA not to pursue this option via the principal’s requirements for the CSM1 project.

At the interchanges, intersections, roundabouts, and where there is no central median, the column arrangements will alter between staggered or single sided. Column locations will be identified at positions that best suit the road layout, while minimising the impact on road users and residents.

5.5 Lighting Column Heights

To maintain continuity with the existing roadway lighting in CSM1, and to provide an optimal solution, the lighting column heights for the main carriageway will have a luminaire mounting height ranging between 11.3m and 12.6m.

The lighting columns will all be frangible galvanised sectional steel design with a ground planted base section.

Any columns requiring attachment to over bridges will have a purpose built bracket attached to the bridge structure and all cabling will be concealed within the bridge. This has been avoided wherever possible, but where the excessive spacing between columns cannot be avoided e.g. SH1 on ramp over CSM2, a purpose built bracket will be engineered.

5.6 Pedestrian and Cycleway Lighting

All cycleway lighting will be designed to comply with AS/NZS 1158.3.1 subcategory P3.

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5 ‘Dual staggered’ arrangement means two rows of lighting columns offset from each other either side of the carriageway.
Generally pedestrian/cycle way lighting will be provided along all the at-grade motorway sections from the motorway luminaires provided the cycleway is located within approximately 10m from the carriageway edge.

Where cycleway lighting is otherwise required, dedicated cycleway lighting will be attached to 7.4m steel columns incorporating full cut-off (Type 3) luminaires. It is recommended that LED style luminaires be considered in this location during the detailed design phase.

5.7 Construction Lighting

5.7.1 Construction Activity or Security Lighting

It is appropriate that all temporary storage areas or construction sites with exterior lighting conform to the appropriate rules of the District Plans.

Temporary lighting for construction activities or security lighting for construction sites will need glare and spill light control compliant with AS 4282. This lighting has not yet been designed, it will be designed under the Construction Environmental Management Plan (CEMP), and the lighting will be fully compliant with the requirements of the District Plans for obtrusive light, and/or the relevant clauses of AS4282.

In temporary construction sites, spill lighting, glare and “headlight sweep” can cause a detrimental effect. Mitigation of these effects can be controlled with full cut-off luminaires, sunshade screening and buffer zones. Construction and security lighting is usually of a temporary nature and will be reduced with careful location of site offices and equipment in relation to surrounding properties. It is recommended there be a minimum 10m buffer zone between any equipment or area requiring construction or security lighting and an adjoining property.

Lighting for these areas should be designed or reviewed by an accredited Illumination Engineer as part of the CEMP.

No construction activity lighting or security lighting will be supplied via a stand-by generator that would have an adverse noise effect.

5.7.2 Temporary Road Lighting

For any existing roadway that is to be diverted modified or re-routed to allow the construction of any new works, existing lighting levels must be maintained or improved on during the works. If existing luminaires must be disconnected or removed before adjacent new lighting has been commissioned, then temporary lighting shall be provided. The nature of this new temporary lighting, including any new luminaires and columns will be compliant with AS/NZS 1158. This lighting has not yet been designed, but will be designed under the CEMP, and be fully compliant with the requirements of AS/NZS 1158.

Mitigation of any lighting effects will be controlled via the use of Type 2 semi cut-off luminaires or Type 3 full cut-off luminaires (being the same or similar to those proposed in the concept lighting design for this Project).

Lighting for these areas should be designed or reviewed by an accredited Illumination Engineer as part of the CEMP.
No temporary lighting will be supplied via a stand-by generator that will have a detrimental noise effect.

5.8 Light Spill Levels

A typical illuminance plot for a straight section of the Project is shown in Appendix A to this report. This analysis shows no significant spill light at a distance of 20m or further from the carriageway.

Table 1 below depicts the expected spill light at three locations as an example of the amount of spill light that can be expected for properties located close to the Project. Those locations are shown on Figure 4 below. The results shown in Table 1 below indicate that the effects from spill light on properties are less than minor or have no effect.

<table>
<thead>
<tr>
<th>Approximate Location (Refer to Figure 4 below)</th>
<th>Approximate Distance away</th>
<th>Expected vertical light level in lux.</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area A</td>
<td>50m</td>
<td>0.4 Lux</td>
<td>less than minor</td>
</tr>
<tr>
<td>Area B</td>
<td>170m</td>
<td>0 Lux</td>
<td>no effect</td>
</tr>
<tr>
<td>Area C</td>
<td>140m</td>
<td>0 Lux</td>
<td>no effect</td>
</tr>
</tbody>
</table>
6.0 **Assessment of Lighting Effects**

In this section of the report, the following assessment is provided for each section of the Project, Sections 1 through 5 (as shown in Figure 3 above):

- The existing environment;
- The proposed lighting solution for motorway traffic, interchanges, underpass / overpass and pedestrian / cycle ways;
- An assessment of potential lighting effects of the permanent lighting against the relevant lighting standards; and
- Any proposed mitigation measures.

6.1 **Section One: Weedons Road Interchange**

6.1.1 **Existing Environment**

The makeup of the general area for this section is typically rural, with some existing lifestyle residential properties.

The alignment from Main South Road Junction leading up to Weedons Road follows the existing Main South Road or runs through ‘green fields’ land. There is no existing road lighting throughout this section.

6.1.2 **Proposed Environment during Operation**

The main carriageway will be divided into four lanes, with two lanes in either direction, separated by a 3m raised median throughout until it connects with SH1 near Rolleston.

There will be a two lane overpass for north/south bound traffic along Weedons Road, which will connect to the on/off ramps either side of the motorway.

The intersection of Weedons Ross Road and Jones Road will be modified to incorporate a new roundabout, on the north side of the existing railway line.

The intersection of Weedons Road and Levi Road will be modified so that traffic can follow a new sweeping bend connecting the two roads. Weedons Road will continue south after the new modified intersection. This alteration occurs over “green field” land, with the existing overhead flag lighting becoming obsolete.

The proposed motorway road lighting for the main carriageway will incorporate luminaires with a semi cut-off (Type 2) optic installed on 12.6m columns throughout in a Dual Staggered arrangement.

All lighting for the SH1 interchanges, and lighting on the raised overpass will utilise a full cut-off (Type 3) optic installed on 11.3m steel columns. This is to minimise the effect of spill light and upward waste light into the night sky environment.
6.1.3 Description of Lighting Effects

The new road lighting layout will require areas such as conflict points and intersections to have an increased level of illumination from the main carriageway, to meet compliance with AS/NZS 1158.1.1 subcategory V3.

Lighting columns located in and around curves in the roadway must comply with reduced spacing for carriageway curves as explained within AS/NZS 1158.1.1 clause 3.3.

6.1.4 Assessment of Lighting Effects

The overall lighting of this area will appear significantly different to what is there now because there is currently no lighting or minimal “flag lighting” over the whole area.

There will be residential houses, farm land and commercial properties in the immediate area exposed to lighting effects where previously they had none. Spill light, glare and upward light will be controlled by using full cut-off (Type 3) optic installed on steel columns. An example calculation provided in Appendix C indicates an UWLR value of 0.03%. This means light from the luminaire is being directed downwards onto the carriageway where light is required.

An example of how spill light will be controlled is indicated in Appendix A. This calculation shows spill light will not be an issue (more than 10 lux) on any property located further than approximately 20m from the lighting columns.

The illuminated area of the interchange will be larger, but the final lighting effect will be acceptable by the extensive use of flat glass luminaires. This is confirmed by the modelling examples done for the Main South / CSM2 interchange and Shands Road Interchange indicated in Appendix B. It is also reconfirmed by the example calculations set out in Appendices A and C for Spill Light, Glare and Upward Waste Light.

Residential properties that are adjacent to the motorway will experience a higher level of illumination, because they will be closer to the widened motorway and currently there is no road lighting. These effects will be limited by the use of semi cut-off (Type 2) luminaires, which control spill light, glare and upward waste light (refer to Appendices A and C).

Glare will be minimised by the use of full cut-off (Type 3) and semi cut-off (Type 2) luminaires and the completed design will be compliant (i.e. below) the maximum Threshold Increment (20%) outlined within AS/NZS 1158. The example calculations in Appendix C show a Threshold Increment (Glare) of 7.05% and 16.51%, which is well below the requirements of 20%.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. In the majority of this section of the Project, there are buffer distances between the road and the adjacent properties and this will assist in mitigating any effect of headlights. Landscape planting would further mitigate any effect from headlights.
6.1.5 Recommended Mitigation Measures

As the road lighting will be designed to the requirements of the Standard AS/NZS 1158 for glare, spill light and upward waste light, the lighting effects will not be obtrusive. Therefore, no mitigation will be required.

6.2 Section Two: CSM2/Main South Road Junction, Waterholes Roundabout

6.2.1 Existing Environment

The makeup of the general area for this section is typically semi-rural with some existing residential properties and a number of commercial properties.

There are a reasonable number of existing lighting points illuminating the existing intersection of the Main South Road and Curraghs Road/Robinsons Road intersection. Residents living nearby will be used to some lighting in their immediate vicinity. This existing lighting will either be removed/relocated or incorporated into the new layout so any lighting effects will not be cumulative.

The path of the Project from Hamptons Road leading up to Robinsons Road is through ‘green fields’ land. There is no existing road lighting through this section.

6.2.2 Proposed Environment during Operation

The main carriageway will be divided into four lanes, with two lanes in either direction, separated by a 3m raised median throughout.

There will be a two lane overpass for south bound traffic from State Highway 1 (SH1) which will connect to the modified intersection of Robinsons Road and connect with Curraghs Road via a new underpass beneath the motorway.

The proposed road lighting for the main carriageway will incorporate luminaires with a semi cut-off (Type 2) optic installed on 12.6m columns throughout in a Dual Staggered arrangement.

The width of the SH1 road lanes reduces to 6m (single lane) where it diverts from the motorway, and increases to 10m (two lanes) for traffic converging onto the overpass.

All lighting for the SH1 interchanges (at Curraghs Road overpass, SH1 link under-pass) and lighting on the raised overpass will utilise a full cut-off (Type 3) optic installed 11.3m steel columns. This is to minimise the effect of glare, spill light and upward waste light into the night sky environment. An example calculation provided in Appendix C indicates an UWLR value of 0.03%. This means light from the luminaire is being directed downwards onto the carriageway where the light is required.

Lighting on the Robinsons Road and Curraghs underpass will also utilise full cut-off (Type 3) luminaires.
6.2.3 Description of Lighting Effects

The new road lighting layout will require areas such as conflict points and intersections to have an increased level of illumination from the main carriageway, to meet compliance with AS/NZS 1158.1.1 subcategory V3.

Lighting columns located in and around curves in the roadway must comply with reduced spacing for carriageway curves as explained within AS/NZS 1158.1.1:2005 clause 3.3.

6.2.4 Assessment of Lighting Effects

This area has also been extensively modelled to indicate the effect of lighting within the immediate vicinity. Refer to Appendix B to this report.

The overall level of illumination for this section of CSM2 will be similar to the existing levels for the main carriageway on existing SH1 near the intersection with Curraghs Road. The inclusion of the new on/off ramps and an increase in general lighting will also result in an increase in the level of spill light to the adjoining property boundaries. Luminaire selection of full cut-off (Type 3) will be used for these areas to limit the level of spill light over the road reserve boundary, as detailed on the lighting concept design drawings within the Plan set contained within Volume 5.

Because Robinsons Road / Curraghs Road is an underpass at a different grade to the main carriageway the new lighting effect will be no worse than it is now in fact it is likely to be improved (reduced) due to luminaire select of full cut-off (Type 3) and or installed tilt angle of luminaires. The existing lighting on this intersection will either be removed/relocated or incorporated into the new layout so any lighting effects will not be cumulative to what is there now.

Glare will be minimised by the use of full cut-off (Type 3) luminaires and the completed design will be compliant (below) the maximum Threshold Increment (20%) outlined within the Road Lighting Standard AS/NZS1158. Two example calculations are provided in Appendix C, which show a Threshold Increment (Glare) of 7.05% from a full cut-off (Type 3) luminaire and 16.51% from a semi cut-off (Type 2) luminaire.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. In the majority of this section of the Project, there are buffer distances between the road and the adjacent properties, and this will assist in mitigating any effect of headlights.

6.2.5 Recommended Mitigation Measures

As the road lighting will be designed to the requirements of Standard AS/NZS 1158 for glare, spill light and upward waste light, plus full cut-off (Type 3) luminaires will be used on any raised section of roadway, the lighting effects will not be obtrusive. Therefore, no mitigation will be required.
6.3 Section Three: Waterholes Road Underpass

6.3.1 Existing Environment

This section of the motorway is in a rural setting with several lifestyle residential properties nearby.

The path of the motorway from Shands Road leading up to Waterholes Road is through ‘green fields’ land. There is no existing road lighting throughout this section.

The existing intersection of Waterholes Road and Hamptons Road has existing “Flag lighting”.

6.3.2 Proposed Environment during Operation

There will be a two lane overpass where CSM2 intersects with Waterholes Road, which will be a through road for west / east bound traffic towards Hamptons Road.

The existing intersection of Waterholes Road and Hamptons Road will be modified to suit the new road layout. The modifications for Waterholes Road will start approximately 200m from the existing intersection and divert north-east in a curve where it will eventually meet with Hamptons Road.

6.3.3 Description of Lighting Effects

There is no requirement for road lighting throughout the motorway on this section of the Project. There is also no lighting proposed for the Waterholes Road underpass hence there will be no lighting effects on the environment.

The Hamptons Road and Waterholes Road intersection will require road lighting to provide illumination to satisfy the requirements of AS/NZS 1158.1.1 subcategory V4 for isolated intersections.

6.3.4 Assessment of Lighting Effects

As there is only “flag lighting” proposed for the new intersection of Waterholes Road and Hamptons Road, the effect from the lighting is considered to be minor and will be similar in nature to the existing “flag lighting” on the existing intersection.

Glare will be minimised by the use of full cut-off (Type 3) luminaires and the completed design will be compliant (i.e. below) the maximum Threshold Increment (20%) outlined within AS/NZS 1158.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. In the majority of this section of the Project, there are buffer distances between the road and the adjacent properties, and this will assist in mitigating any effect of headlights.

6.3.5 Recommended Mitigation Measures

As the road lighting for the new intersection of Waterholes Road and Hamptons Road will be designed to the requirements of Standard AS/NZS 1158 for glare, spill light and upward waste light, plus full cut-off (Type 3) luminaires will be used, lighting effects will be minor. Therefore no mitigation will be required.
6.4 Section Four: Shands Road Interchange

6.4.1 Existing Environment

The makeup of the general area of the Shands Road Interchange is typically semi-rural with some existing residential and commercial/industrial properties nearby.

The path of the motorway from Springs Road leading up to Shands Road is through “Green Field” land. There is no existing road lighting through this section.

Existing lighting on the Shands Road/Marshs Road intersection has been installed on existing overhead distribution poles. It is envisaged that these luminaires will be upgraded and or replaced to allow for the modified road geometry.

6.4.2 Proposed Environment during Operation

The main carriageway is divided into four lanes, with two lanes in either direction, separated by a 3m raised median throughout.

There will be an overpass where CSM2 intersects with both Marshs Road and Shands Road, which will be a through road for north and south bound traffic.

Traffic can either enter or exit the motorway at these points via two single lane on/off ramps on either side of the main carriageway.

Shands Road and Marshs Road intersections will be controlled by traffic signal lights.

The proposed road lighting for the main carriageway will incorporate luminaires with a semi cut-off (Type 2) optic installed on 12.6m columns throughout, in a Dual Staggered arrangement.

The lighting for Marshs Road and Shands Road interchanges, plus any lighting installed on the raised overpasses will utilise a full cut-off (Type 3) optic installed on steel columns. This is to minimise the effect of spill light and upward waste light into the night sky environment. An example calculation provided in Appendix C indicates an UWLR value of 0.03%. This is below the permitted 3% and means that light from the luminaire is being directed downwards onto the carriageway where the light is required.

Lighting columns located near the on/off ramps will be installed on the outside curves facing back towards the main carriageway, to minimise the effects of glare and spill lighting due to the direction of the light source.

6.4.3 Description of Lighting Effects

The new road lighting layout will require areas, such as conflict points and intersections, to have an increased level of illumination from the main carriageway, to meet compliance with AS/NZS 1158.1.1 subcategory V3. This will be achieved by reduced spacing between columns in these locations.

Lighting columns located in and around curves in the roadway must comply with AS/NZS 1158.1.1 clause 3.3 reduced spacing for curves.
6.4.4 Assessment of Lighting Effects

This area has also been extensively modelled to indicate the effect of lighting within the immediate vicinity. Refer to Appendix B to this report.

The level of illumination for this section of CSM2 will be similar to the existing levels for the main carriageway of CSM1. Luminaire selection of full cut-off (Type 3) and semi cut-off (Type 2) will be used for these areas to limit the level of spill light over the road reserve boundary, as detailed on the lighting concept design drawings. An example of how spill light will be controlled is indicated in Appendices A and B. These calculations indicate that the task lighting is concentrated within the road reserve area and will be less than 10 lux on any property located further than approximately 20m from the lighting columns.

Glare will be minimised by the use of full cut-off (Type 3) luminaires on any raised section of roadway and the complete design will be compliant (below) the maximum Threshold Increment (20%) outlined within AS/NZS 1158. An example calculation is provided in Appendix C, which shows a Threshold Increment (Glare) of 7.05% from a full cut-off (Type 3) luminaire and 16.52% from a semi cut-off (Type 2) luminaire is below the requirements of 20%.

Any road luminaire must limit its Upward Waste Light Ratio (UWLR) to be below 3% (of the total light output). This is to minimise the upward waste light to the night sky environment. The example calculation provided in Appendix C indicates an UWLR value of 0.03% and 1.62% for Type 3 and Type 2 luminaires. This means light from the luminaire is being directed where the light is required.

Lighting columns located near the on/off ramps will be installed on the outside curves facing back towards the main carriageway, to reduce the immediate effects from the direction of the light source.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. In the majority of this section of the Project, there are buffer distances between the road and the adjacent properties, and this will assist in mitigating any effect of headlights. Landscape planting would further mitigate any effect from car headlights because the direct view would be obstructed.

6.4.5 Recommended Mitigation Measures

As the road lighting will be designed to the requirements of the Standard AS/NZS 1158 for glare, spill light and upward waste light and the full cut-off (Type 3) luminaires will be used on any raised section of roadway. Therefore, no mitigation will be required as the lighting effects will be minor.
6.5  **Section Five: Springs Road and Halswell Road Underpass, John Paterson Drive**

6.5.1  **Existing Environment**

The makeup of the general area where CSM2 continues on from CMS1 is typically semi-rural with some existing residential and commercial / industrial properties.

The roadway lighting (for CSM1 when it is completed) comprises 12.6m sectional steel lighting columns with 250W HPS Sylvania Roadster, semi cut-off (Type 2) luminaires. The columns are installed in a Dual Staggered arrangement.

6.5.2  **Proposed Environment during Operation**

The merging of CSM2 will detour from the existing route of CSM1 towards the west closer to John Paterson Drive.

The main carriageway will be divided into four lanes, with two lanes in either direction, separated by a 3m raised median throughout.

One of the existing roundabouts on Halswell Junction Road and CSM1 will be removed as part of the new motorway design.

There will be an underpass where CSM2 intersects with Halswell Junction Road, which will be a through road for west and east bound traffic on Halswell Junction Road.

There is also a proposed on ramp from Halswell Junction Road/Wilmers Road roundabout to enable traffic to join onto CSM1.

A new roundabout on Halswell Junction Road will be constructed to allow north – south traffic flow over the motorway along Halswell Junction Road. This roundabout will also provide a new access road to John Paterson Drive. New lighting in this road will be provided on lower mounting height columns (7.4m) with semi cut-off (Type 2) luminaires to provide sufficient illumination to comply with AS/NZS1158.3.1 subcategory P3.

Springs Road south from Halswell Junction Road roundabout will have an underpass at the intersection of CSM2 this will enable traffic to flow independent of the motorway in a north/south direction on Springs Road.

The proposed road lighting for the main carriageway will incorporate luminaires with a semi cut-off (Type 2) optic installed on 12.6m columns throughout in a Dual Staggered arrangement to continue on from CSM1 road lighting.

The lighting for Springs Road and Halswell Junction Road may include luminaires with reduced wattage (lumen output) and/or will be utilising a full cut-off (Type 3) optic installed 11.3m steel columns because of the need to control obtrusive light into the surrounding area.
A new cycleway link is proposed parallel with the side of this section of the carriageway to link CSM1 and Little River Rail Trail to the CSM2 cycleway. Where the cycleway runs parallel to the new CSM1 / CSM2 carriageway, no new additional lighting is required. Where cycleway lighting is otherwise required, dedicated cycleway lighting will be attached to 7.4m steel columns incorporating fully cut-off (Type 3) luminaires. All care will be taken in locating these columns and the direction of view towards the luminaire to ensure minimal effect on the surrounding environment. It is recommended that LED style luminaires be considered in this location during the detailed design phase.

6.5.3 Description of Lighting Effects

The new road lighting layout will require areas, such as conflict points and intersections, to have an increased level of illumination from the main carriageway, to meet compliance with AS/NZS 1158.1.1 subcategory V3.

Existing lighting columns and luminaires identified to be removed or relocated will be re-used as part of the new lighting design. Relocated lighting columns may require new base sections.

The underside of the underpasses will require new luminaires installed to provide illumination for the main carriageway. The luminaires will be fully cut-off (Type 3) to minimise disability glare for road users.

Lighting columns located near the on/ off ramps will be installed on the outside curves facing back towards the main carriageway, to minimise the effects of spill lighting.

6.5.4 Assessment of Lighting Effects

The level of illumination for this section of CSM2 will be similar to the existing levels for the main carriageway of CSM1. Luminaire selection of full cut-off (Type 3) and semi cut-off (Type 2) will be used for these areas to limit the level of spill light over the road reserve boundary, as detailed on the lighting concept design drawings. An example of how spill light will be controlled is indicated in Appendices A and B. These calculations indicate that the lighting is concentrated within the road reserve area and will be less than 10 lux on any property located further than approximately 20m from the lighting columns.

Glare will be minimised by the use of full cut-off (Type 3) luminaires on Springs Road and Halswell Junction Road overpasses and the completed design will be compliant (i.e. below) the maximum Threshold Increment (20%) outlined within the Road Lighting Standard AS/NZS 1158. An example calculation is provided in Appendix C which shows a Threshold Increment (Glare) of 7.05% from a full cut-off (Type 3) luminaire and 16.52% for the semi cut-off (Type 2) luminaire, which are both below the requirements of 20%.

Any road luminaire must limit its Upward Waste Light Ratio (UWLR) to be below 3% (of the total light output). This is to minimise the upward waste light to the night sky environment. Two example calculations are provided in Appendix C indicating an UWLR value of 0.03% and 1.62%. This means light from the luminaires is being directed where the light is required.

Any effects from headlights are considered to be minimal because the vehicles will not generally be moving directly towards residential properties. In the majority of this section of the Project, there are buffer distances between the road and the adjacent properties and this will assist in mitigating any effect of headlights.
6.5.5 Recommended Mitigation Measures

As the road lighting will be designed to the requirements of the Standard AS/NZS 1158 for glare, spill and upward waste light, plus compliant luminaires will be used, no mitigation will be required as the lighting effects will be minor.
7.0 Summary of Recommended Mitigation

Glare will be minimised by the use of full cut-off (Type 3) and semi cut-off (Type 2) luminaires and the completed design will be compliant (below) the maximum Threshold Increment (20%) outlined within AS/NZS 1158.

The example calculations provided in Appendix C demonstrate that the luminaires used will produce an Upward Waste Light Ratio (UWLR) below 3% (of the total light output), therefore complying with AS/NZS 1158. This means light from the two types of luminaire being used is directed where the light is required.

A typical illuminance plot for a straight section of road is indicated in Appendix A. This shows no significant spill light at a distance of 20m or further from the carriageway.

Two areas of the Project that have raised sections of road for an over bridge have been modelled as the “worst case” situation, to indicate the amount of spill light that can be expected from the proposed concept lighting. The amount of light is shown in Appendix A, which shows no horizontal or vertical spill light (higher than 10 lux) occurring at a distance greater than 20m from the carriageway. Given these areas have the highest concentration of light, in other locations with less light; any effects would be less obtrusive.

Because of the method(s) of controlling glare and spill light described above, the effects of sky glow are considered to be minimal.

No further mitigation will be required as the lighting effects are considered to be acceptable. However, consideration could be given to possible planting of trees at any residential and motorway boundaries, which may offer an additional visual barrier that, could further reduce the lighting effects.
8.0 Conclusion

This report has assessed the potential adverse operational and construction lighting effects of the Project, namely spill light, glare and upward waste light.

Road lighting is a compromise between the provision of adequate safety lighting for road users and the minimisation 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 road lighting are generally minimised, as a matter of course.

There will be some visual differences to residents due to the increased light levels and dark surrounds. However, the new lighting proposed is required for the safety of the road users and is required to meet minimum standards. If the final road lighting design and installation is carried out in accordance with this Assessment of Lighting Effects Report, the spill lighting effects will be confined to those stated in this Report.

It is considered that the lighting effects of the Project will be ‘less than minor’ as shown in Table 1, the example calculations in Appendices A and C, plus the modelling calculations for the over bridge area shown in Appendix B. The light modelling simulations indicate the anticipated extent of the spill lighting on specific areas and confirm that the lighting will be designed to an acceptable level.

All exterior lighting for any construction activity or security lighting will be designed to comply with the District Plans, along with the recommendations and requirements of AS4282. Any temporary road lighting required for realignment or construction reasons will be adequately designed to comply with AS/NZS 1158. Hence any spill light, glare and upward waste light issues will be controlled. The details of these lighting requirements will be outlined in the CEMP and will be completed by an accredited Illumination Engineer.

The requirements of the relevant lighting standards are met by the concept lighting design, and therefore, the final lighting design for the Project will be able to comply with Road Lighting Standard AS/NZS 1158.

It should be noted that the effect of sky glow is the combined result of thousands of road light fittings, combined with the general exterior lighting installed in residential and commercial properties. The additional lighting proposed for the Project will not add to the existing sky glow effect by any significant amount. The effects of sky glow from the Project will be limited by the use of full cut-off (Type 3) and semi cut-off (Type 2) luminaires which restrict the amount of upward light. Therefore, the potential lighting effects of the Project are considered to be negligible.
APPENDIX A: Examples of Spill Lighting Computer Analysis

Expected Horizontal illuminance with Type 2 optical distribution
APPENDIX B: Section 2 CSM2 / MSRFL Interchange
APPENDIX C: Section 4 Shands Road / Marshs Road Interchange
### RESULTS FOR RUNNING SAASTAN WITH NOMINATED SPACINGS  
[NEW ZEALAND MODE]

**Job name:** CSM2 - MAIN CARRIAGEWAY

**Luminaire Table:** G:\Design_Engineering\Lighting Design\Table\Sylvania\Roadster\CIE\98354.CIE

**Luminaire Description:** 98354 SLA Roadster S250C

**Lamp Wattage & Type:** 250W HPS STD 12.6M STEEL 3M ARM

**Light Source:** HPS

**Stores Code:**

**Luminous Flux:** 33.2 KIms

**Upcast Angle:** 5 Degrees

**Arrangement:** 5s Dual-Staggered

**Lane Width:** 5.5 m

**Total Carriageway Width:** 11 m

**Maintenance factor:** 0.77

**Median Width:** 3 m

**Overhang 1st Row:** 1.9 m

**Overhang 2nd Row:** 1.9 m

**Traffic Flow:** One Way -->

**Lighting Category:** V3

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**APPENDIX E: Sample Straight Road Lighting Calculations**

*Type 3 Full cut-off Luminaire*

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**RESULTS FOR RUNNING SAASTAN WITH NOMINATED SPACINGS [NEW ZEALAND MODE]**

**Job name: CSM2 - MAIN CARRIAGeway**

- **Luminaire I-table:** G:\Design_Engineering\Lighting Design\I-Table\Kaos\KAOS Photometric Files new\250w Flat Glass\Kaos 2 250w HPS T P3 AEC00570.cie
- **Luminaire Description:** Kaos 2 250w HPS T P3
- **Lamp Wattage & Type:** 250W HPS 12.6M 3M A3M P-3
- **Light Source:** HPS
- **Stores Code:** Luminous Flux: 33.2 Klms
- **Upcast Angle:** 5 Degrees
- **Lane Width:** 5.5 m
- **Mounting Height:** 12.6 m
- **Maintenance factor:** 0.77
- **Overhang 1st Row:** 1.9 m
- **Overhang 2nd Row:** 1.9 m
- **Traffic Flow:** One Way
- **Lighting Category:** V3

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PleVcat - Vers 5.05 (Built: 18/10/11) Run: 13/7/2012 at 08:39:12
APPENDIX F: Road Lighting Concept Design Drawings

Refer to Road Lighting Concept Design drawings (16-001630) within the Plan set contained within Volume 5.