

# NAGA and AGL Sustainable Public Lighting Initiative

## Demonstration Project



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## 1. Executive Summary

**This report provides information on trials that were carried out by AGL in the Northern Alliance for Greenhouse Action (NAGA) Council areas in the North of Melbourne from 2004 to 2007.**

**NAGA's founding members are the Cities of Banyule, Darebin, Hume, Moreland, Whittlesea, Nillumbik Shire Council and the Moreland Energy Foundation Limited (MEFL); in early 2006, the Cities of Manningham, Melbourne and Yarra joined NAGA.**

**The maintenance, construction arm of AGL was Agility. In 2004 AGL owned and Agility maintained the majority of the lights in the NAGA area. Agility was sold in 2005 to Alinta. Just as this report was being finalised Alinta has been sold to SP-Ausnet.**

**In 2004 NAGA and AGL were successful in gaining funding for a sustainable public lighting program from the Victorian Government. The program installed 120 trial lights across five NAGA Councils (not including Manningham, Yarra and Melbourne who joined in 2006 and Nillumbik because it was not in AGL's distribution area) and Maribyrnong Council in existing suburbs where streetlighting had been provided for many decades.**

**The trials were aimed at testing the field performance of energy efficient lights that can replace the existing 80 watt (W) Mercury Vapour (MV) technology. The trial lights were:**

- **Pierlite Greenstreet 2x14W T5**
- **Sylvania Urban 50W High Pressure Sodium (HPS)**
- **Sylvania Suburban 42W Compact Fluorescent (CFL)**

**The report provides specific detail on the field performance of the different luminaires. This Executive Summary details the recommendations that arise from this trial for the application of each of the technologies within the Victorian Public Lighting industry.**

### **Pierlite Greenstreet 2x14W T5**

Based on the results of these trials we recommend the use of the T5 as a standard direct replacement for the 80W Mercury Vapour. The T5 luminaire has an International Protection (IP) rating similar to other accepted luminaires. Maintenance is slightly increased which results in increased maintenance cost, because of two lamps and electronic control gear that may require periodic replacement.



*2x14W T5*

Benefits include better uniformity of light across and along the street, better colour rendering and visibility, best current technology in terms energy performance, less lumen depreciation and lamp failure rate.

### **Sylvania Urban 50WHPS**

Based on the results of these trials we do not recommend the use of the 50W HPS as a standard direct replacement for the 80W MV because of the reduced colour rendition and poor visibility to the human eye.

### **Sylvania Suburban 42W CFL**

Based on the results of these trials we recommend the use of the 42W CFL as a direct replacement for the 80W MV only where 2x14W T5 cannot be used (e.g. some decorative streetlights).



*42W CFL*

## 1.1. Comparison of Energy and Greenhouse Savings

**TABLE. 1: Energy and Greenhouse Savings**

Annual savings if replacing 80W MV	Energy Savings per 1000 units (kWh <sup>1</sup> )	Greenhouse savings per 1000 units <sup>2</sup> (tCO <sub>2</sub> -e <sup>3</sup> )
2x14W T5	274,097	363
50W HPS	150,270	199
42W CFL	209,035	277

## 1.2. Comparison of Maintenance Issues

Table 2 below compares the maintenance issues for the different luminaires when compared to the B2224 80W MV from Sylvania. Since 1989 the B2224 has been the standard streetlight installed in residential streets. This light is no longer installed as standard and was superseded in around 2002 by the Urban 80W MV.

The four areas listed are the main areas for concern in terms of maintenance for a given luminaire.

**TABLE. 2: Maintenance Issues**

	Lamp	Control gear	Luminaire	Other maintenance issues	Photo-electric (PE) cell
B2224 80W MV	4 year bulk changes. Up to 12% failures between bulk changes.	Iron Core ballast lasts the life of the fitting	International Protection <sup>4</sup> (IP) rating 54.	Control gear cover detaches easily.	Standard D2
2x14W T5	Reduced failures. Same as 80W MV otherwise.	Replacement may be required <sup>5</sup>	IP 65. Better rating.		Standard D2
50W HPS	Reduced failures. Same as 80W MV otherwise.	As per 80W MV	IP 64. Better rating.		Standard D2
42W CFL	Increased failures. Same as 80W MV otherwise.	Replacement may be required <sup>2</sup>	IP 64. Better rating.	Lamps falling out. Current model seeks to improve on this.	Standard D2

<sup>1</sup> Kilowatt-hours

<sup>2</sup> Based on greenhouse factor of 1.325 tCO<sub>2</sub>-e per kWh and 4250 hours on per year. Note this does not include increased energy consumption from day-burning or inefficient PE cells.

<sup>3</sup> Tonnes of Carbon Dioxide equivalents

<sup>4</sup> The International Protection rating refers to protection from ingress into the luminaire. In the case of the first figure the rating refers to protection against solids (e.g. a 5 rating gives protection from quantities of dust that could interfere with a satisfactory operation, a 6 rating gives complete protection against dust). Thus the higher the rating the longer the light will maintain satisfactory light output. The second figure refers to liquids and the higher the figure the better the protection from liquid ingress.

<sup>5</sup> The electronic control gear for the 2x14W T5 and 42W CFL is sensitive to temperature. If peak temperatures at the ballast "cool spot" are under 60°C then the control gear will not require replacement. Testing over the Summer in 2007/8 will clarify peak temperatures for this component and allow whether replacement cycles are required.

### 1.3. Spacing to meet Australian Standards

The table below (copy of Table 4 on page 14 of this report) shows the spacing requirements of the luminaires installed on existing electricity distribution poles (Category P5 in the Australian Standards). The 80W Mercury B2224 is the standard streetlight in most lighting installations in Victoria.

Spacing is a critical issue for distribution businesses as it is the way in which new designs are determined and also is a critical determinant for whether the trial lights can be used as a direct replacement for the existing lights.

Spacing characteristics are effected by a combination of the lamp type, reflector and luminaire design, mounting height and road reserve width. The spacing figure is representative of the amount of light on the ground for pedestrians and road users.

Light type	15m road reserve	20m road reserve
	7.5m light height Max.pole spacing	7.5m light height Max.pole spacing
80W Mercury Urban	81.5m	77.5m
80W Mercury B2224	77.5m	73.3m
T5 2 X 14W FI	83.3m	81.6m
T5 2 X 24W FI	91.8m	91.1m
32W CFL	76.9m	75.6m
42W CFL	84.2m	83.5m
50W HPS	80.8m	78.5m

As you can see from the table all of the trial luminaires have improved spacing characteristics compared to the existing 80W Mercury B2224. This means that any of these lights could be used as a direct replacement for the existing 80W Mercury B2224 and still meet (in fact better) the requirements of the Australian Standards in terms of the light output on the ground.

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### 3. Glossary of lighting terminology

<b>Illuminance</b>	The amount of light arriving at a surface divided by the area of that surface. Measured in Lux.
<b>Illumination</b>	A general expression for the quality of light arriving at a surface.
<b>Luminance</b>	The brightness of a surface
<b>Light output</b>	The total luminous flux emitted by a light source measured in Lumens
<b>Efficacy</b>	The lamp output efficiency
<b>Lamp</b>	A generic term for a man made source of light. Often referred to as a globe or bulb.
<b>Luminaire</b>	The light fitting which houses the lamp and directs the lighting in desired directions. It includes items for fixing, operating and protecting the lamp
<b>Colour temperature</b>	The physical measure of 'yellowness' or 'blueness' in the colour appearance of a light source. The higher the temperature of the source, the bluer or less yellow it will appear to the human eye.
<b>Lumen depreciation</b>	The loss of light time as the lamp ages and luminaire optical surfaces deteriorate and collect dust.
<b>Ingress Protection</b>	Also known as 'IP rating'. A two digit code to indicate resistance to the penetration of solids and liquids. The first number refers solids and the second to liquids. An IP rating of IP55 for example, would give protection against dust and low pressure water jets from all directions. Higher numbers would give improved protection.
<b>High Pressure Sodium Lamps (HPS)</b>	Light sources with a yellow appearance.(Normally used on main roads and freeways)
<b>Fluorescent Lamps</b>	Light sources with a white appearance.
<b>Mercury Vapour Lamps</b>	Light sources with a blue/white appearance.

### About the authors

This report was written by Ray Simms and Kevin Poulton and Associates. Layout and content assistance was provided by Paul Brown of Ironbark Sustainability. Proof reading was completed by various Council officers from NAGA including Michelle Bennett, Clayton Simpson and Stuart Nesbitt.

Ray and Kevin have been involved in Public Lighting for several decades. Ray within AGL Electricity (and previously the SECV) and Kevin as a specialist lighting consultant.

## 4. Background

In early 2004, Banyule City Council began a partnership with the Australian Gas Light Company (AGL) to improve energy efficiency in street lights.

The first stage of the trial for the new technologies was in Macleod Parade, Macleod where 10 twin 14 Watt T5 fluorescent luminaires were installed. These were replacements for the existing 80W Mercury Vapour lights which are still used throughout Victoria in residential streets. The new lights immediately cut energy consumption by two thirds from 96 Watts to 30.5 Watts. This equates to a saving of almost half a tonne of greenhouse gas per year per light.



*One of the lights that were replaced,  
a Sylvania 80W MV B2224, manufactured in 1991*

A survey of Macleod Parade's residents after installation of the new lights gave broad support and approval for the trial.

This program was extended throughout the northern region of Melbourne through the expansion of the AGL program with the Northern Alliance for Greenhouse Action (NAGA) and Maribyrnong City Council. These installations were assisted by funding from the State Governments Sustainable Public Lighting Initiative. All the installations across the NAGA region were completed and surveys sent to all residents in the nearby streets. The survey results for the NAGA region are detailed in Appendix 1. The project ultimately won the United Nations of Australia World Environment Day award for the best specific environmental initiative for local government in Australia for 2005.

Following this success, a partnership was formed between Sustainability Victoria, AGL and Banyule City Council (on behalf of NAGA) to extend the trials to other councils in the northern regions of Melbourne. The trials were restricted to those councils serviced by AGL

In the latter months of 2004, 3 different types of low energy lights were installed in these councils replacing the existing mercury street lights.

Each council was able to install a total of 20 lights of their choosing making a total of 120 street lights on trial.

**TABLE. 3: Trial locations**

<b>Municipality</b>	<b>Street and location</b>	<b>Light Type</b>	<b>No. of units</b>
Banyule	Macleod Parade, Macleod	Twin 14W T5	10
	Somerset Dv, Viewbank	Twin 14W T5	10
Moreland	Richmond St, Hadfield	Twin 14W T5	2
	Richard St, Hadfield	Twin 14W T5	3
	Gowrie St, Glenroy	42W CFL	5
	Guilfoyle St, Coburg North	50W HPS	5
Darebin	Shorts Rd, Coburg North	Twin 14W T5	5
	Roseberry St, Preston	Twin 14W T5	10
	Townhall Av, Preston	Twin 14W T5	10
Hume	Jackson St, Sunbury	Twin 14W T5	4
	Brook St, Sunbury	Twin 14W T5	6
	Barkly St, Sunbury	50W HPS	7
	Timins St, Sunbury	50W HPS	2
	Cnr Brooks St & Barkly St	Twin 24W T5	1
Whittlesea	Industrial Ave, Thomastown	50W HPS	3
	Trawalla Ave, Thomastown	Twin 14W T5	10
	Trawalla Ave, Thomastown	50W HPS	3
Maribyrnong	Indwe St, West Footscray	Twin 14W T5	10
	Indwe St, West Footscray	50W HPS	5
	Roberts St, West Footscray	50W HPS	5

Nillumbik is not serviced by AGL and therefore could not participate in these trials.

## 5. Trial Methodology and Results

The trial involved in-field monitoring, laboratory testing and technical analysis of the different luminaires. The in-field testing was designed to determine the lumen depreciation over time and any maintenance issues arising during the trial period. Maintenance issues were reported to Agility for repair or replacement. The laboratory testing used an environment chamber to determine the sensitivity of the luminaires to voltage and temperature variations. Further analysis of the technical parameters of each light was carried by reviewing information supplied by the manufacturers/suppliers and analysing this information using the requirements of the Australian Standards.

### 5.1. In-field Monitoring

All lights routinely were audited to confirm correct operation and measure illuminance (lux) changes over time.

Measurements were taken using a Hagner digital luxmeter E4-X from directly below the luminaire at road level for all lights to provide uniformity and repeatability for the same recording position. The date, time and temperature were recorded for every reading.

#### 5.1.1. In-Field lumen depreciation

The following section details the change in illuminance in each street over the trial period. It is worth noting that the figures in-field will only approximate laboratory tests because of the inability to avoid some variation due to natural phenomenon such as temperature variability, cloud cover etc. The illuminance figures are an average of the illuminance under each light for a given street. Specific graphs for each street in the trial are shown in **Appendix.2: In-field Illuminance Records**.

**TABLE. 4: Lumen depreciation**

	<b>Average Depreciation</b>
<b>2x14W T5</b>	<b>11.7%</b>
<b>42W CFL</b>	<b>42.2%</b>
<b>50W HPS</b>	<b>12.9%</b>

The results of the in-field illuminance trial demonstrates that the 2x14W T5 fluorescent and 50W High Pressure Sodium Luminaires are operating close to the figure of 10% depreciation provided by lamp manufacturers.

The 42W compact figure is questionable and is almost certainly due to the small sample size of 5 lights. The lamp manufacturer figure is 18% depreciation for the 3 year period of the trials. The 80W Mercury lamp used at present would have a lumen depreciation of more than 20% for this period according to the data supplied by manufacturers

### 5.1.2. Maintenance issues of trial lights

Table 5 below provides detail of the maintenance issues from the different lights during the trial. Further information will be provided in an addendum to this report when more data becomes available.

The table below is a reasonable guide given the expected failures in 80W MV of 10-12% for lamps over 4 years. Given the expectations due to the 80W MV the maintenance issues for the trial lights have been lower than expected.

**TABLE. 5: Maintenance record**

	Numbers of lights	PE cell fails	Lamp Fails	Ballast fails
<b>2x14W T5</b>	80	2	5	1
<b>42W CFL</b>	5			
<b>50W HPS</b>	31	3		

## 5.2. Laboratory Testing

### Factors Affecting Light Output:

The major technical factors affecting light output of a residential street lighting luminaire include:

- supply voltage
- ambient and lamp chamber temperature
- lamp lumen depreciation
- and the lamp orientation
- the accumulation of dirt or moisture on the luminaire

The laboratory testing was designed to investigate the impact of varying voltage and temperature on the test luminaires. Further technical analysis investigated the issue of inevitable lamp lumen depreciation and its impact on luminaire spacing tables.

### **5.2.1. Effects of Supply Voltage Variation:**

A previous study completed by the authors of this report<sup>6</sup> has shown the effect of voltage variation on some luminaires is quite dramatic, while on others it is quite negligible. The results of these tests are duplicated here to illustrate this point.

The only variable was the supply voltage which was varied in 10 volt steps from 200V to 260V. Light output readings were taken at one minute intervals from initial start up time to 30 minutes, and the test results are shown below.

The graphs shown in **Appendix 4. Effect of Voltage Variation on Light Output** demonstrate that lights with ‘electronic control gear’ such as the T5 and CFL luminaires are largely unaffected by voltage variation. Whereas lights with iron core ballasts, such as the 80W MV and the 50W HPS are greatly affected.

It is not unusual for voltages to as low as 220V or as high as 260V anywhere on the Victorian Electricity Distribution System. Voltage on the system reduces when demand for electricity is high and voltage rises when demand is low. This means that after 9pm at night voltage on the system generally increases. Whilst during peak demand from 5pm-8pm voltage will reduce.

According to the testing program the 80W MV varied in light output by around 30% between 220V and 260V and the 50W HPS by around 60-70%.

### **5.2.2. Effects of Temperature on Lamp Performance:**

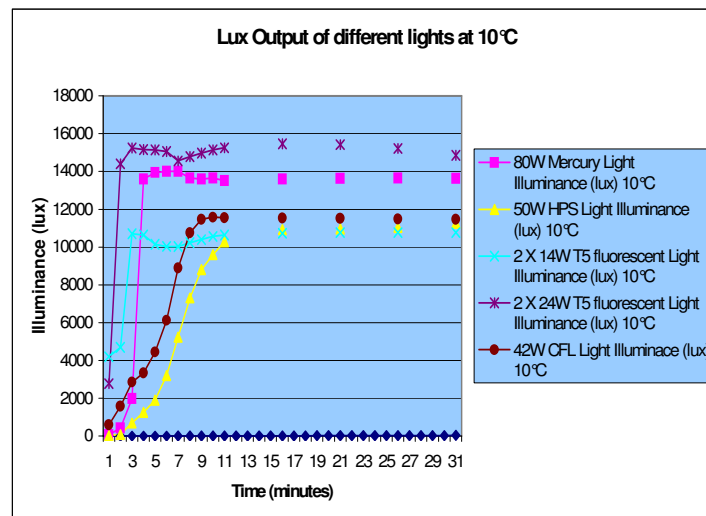
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<sup>6</sup> “Sustainable Public Lighting Initiative”, Agility, Sustainable Energy Authority of Victoria, 2006

As a general statement, High Intensity Discharge Lamps (HID), such as MV or HPS types can operate within a very wide range of ambient temperatures. Some Manufacturers claim that their HPS lamps will satisfactorily operate within a range of - 40 to + 100°C.

Fluorescent lamps however are much more temperature dependent. Similarly compact fluorescent lamps (CFL) show several critical temperature points, and appropriate Manufacturers’ data sheets should be consulted on this matter. It is not expected that in Australia this will be a significant issue. During the test of lamp illuminance in the aforementioned “Sustainable Public Lighting Initiative” (SPLI) study all the lamps under consideration started even at -5°C. There would be very few situations where temperatures anywhere in Australia would be lower than this when the lights are started on dusk each night.

The results of the SPLI study quoted in the voltage section above are again replicated below to illustrate the effects of an ambient temperature of 10°C (typical for normal starting time of a Melbourne winters night) on the starting for each of the five luminaires under consideration in that study.



As this graph indicates, once the initial starting period is over and the luminaires reach a steady state temperature condition, there is very little between them.

Even with ambient temperatures down to 5°C there was little effect on the light output. The critical factor in this situation is any possible degree of air and dust leakage through the seals of the luminaire. If there is no leakage then the luminaire chamber then it appears to maintain its steady state temperature. This is dependent on the International Protection (IP rating) of the luminaire in question.

The on-site measurements of our trial areas of 2x14W T5 luminaires over the past three years have shown that there has been no significant difference between Summer and Winter illuminance readings once the luminaires have fully warmed up.

### 5.2.3. Lumen Depreciation:

The terms Lumen Depreciation and Lumen Maintenance are interchangeable and really mean the same thing. All of the lamps under consideration in this study use some form of luminous materials to produce light.

Because of the chemical changes which take place in these materials over the lifetimes of these lamps, the luminous fluxes from the lamps gradually decline, thus reducing the light output from the lamp. In general the newer tri-phosphor coated lamps decline at a much lower rate than do the older style phosphor lamps.

Table. 6 overleaf, shows the initial light output (efficacy values of the lumen per watt (lm/w)) for each lamp, and also a calculated efficacy (lm/w) after 4 years or 17000 hours. In these calculations we have taken the total circuit watts which include the ballast losses. These light outputs at four years can be used to determine spacing tables for the lights at different heights and road reserves widths. The Spacing tables then are used in lighting designs.

**5.2.4. Effects of Maintenance Factor on Spacing Tables:**

There can be considerable error in calculating the Spacing Tables if the calculation is based on the incorrect Maintenance Factor being used. The Maintenance Factor is a component in the illuminance calculations of the Spacing Tables. Values of 0.7 for an IP5X luminaire and 0.8 for an IP6X luminaire are currently used.

Table. 6 shows calculated Maintenance Factors for the types of luminaires in this study, based on the Luminaire Maintenance Factors shown in Table F1 of AS1158.3.1 assuming that there is a cleaning interval of 48 months and a medium pollution category.

The Maintenance Factor is the product of a Luminaire Maintenance Factor (LMF) and a Light Loss Factor (LLF). The LLF is also known as the Lamp Lumen Depreciation Factor:

$$\text{Therefore MF} = \text{LMF} \times \text{LLF}$$

The Lamp Lumen Depreciation Factors used in these calculations have been interpolated from Lumen Depreciation Curves supplied by the various Lamp Manufacturers.

**TABLE. 6: Light output and depreciation factors for designing spacing tables**

	Initial lumens	Energy use (W)	Initial lm/W	4 year lm/W	Lumen Depreciation factor	4 year luminaire maintenance factor	4 Year Maintenance factor
<b>50W HPS</b>	3300	61.7	53.5	38.5	90%	0.84	0.76
<b>80W MV – Urban</b>	3800	96	39.6	26.1	66%	0.84	0.55
<b>80W MV - B2224</b>	3800	96	39.6	26.1	66%	0.76	0.50
<b>42W CFL</b>	3200	44	72.7	58.2	80%	0.84	0.67
<b>32W CFL</b>	2400	37	64.9	51.9	80%	0.84	0.67
<b>2x14W T5</b>	2400	30.5	78.7	70.8	90%	0.84	0.76
<b>2x24W T5</b>	4000	47	85.1	76.6	90%	0.84	0.76

If a Maintenance Factor of 0.8 is used for an IP6X rated luminaire (note all the luminaires above except the B2224 are IP 6X rated), then the spacing will be over estimated for all lights after four

years. If a 0.7 Maintenance Factor is used for the B2224 this again will result in an over-estimation of the luminaire spacing.

**TABLE 7: P5 Lighting Spacing Table<sup>7</sup>**

Light type	15m road reserve	20m road reserve
	7.5m light height Max.pole spacing	7.5m light height Max.pole spacing
80W Mercury Urban	81.5m	77.5m
80W Mercury B2224	77.5m	73.3m
T5 2 X 14W FI	83.3m	81.6m
T5 2 X 24W FI	91.8m	91.1m
32W CFL	76.9m	75.6m
42W CFL	84.2m	83.5m
50W HPS	80.8m	78.5m

**Subcategory P5 applies to the replacement of existing luminaires installed on existing electricity distribution poles.**

Two 80W luminaires are shown in Table 7. The B2224 version is an older model and is the most common type on distribution poles. It has a lower Ingress Protection rating than the newer Urban model and because of this, has a reduced pole spacing distance.

**Table 8. P4 Lighting Spacing Table**

Light type	P4 Category Lighting			
	15m road reserve		20m road reserve	
	5.5m light height Max.pole spacing	7.5m light height Max.pole spacing	5.5m light height Max.pole spacing	7.5m light height Max.pole spacing
80W Mercury Urban	55.0m	65.7m	46.3m	59.0m
T5 2 X 14W FI	58.2m	67.7m	33.5m	59.5m
T5 2 X 24W FI	65.5m	75.8m	63.9m	73.1m
32W CFL	54.3m	60.8m	46.3m	51.1m
42W CFL	59.9m	70.2m	53.1m	64.9m
50W HPS	55.7m	65.8m	47.6m	59.9m

**Subcategory P4 applies to new designs for installations in housing estates or existing residential streets**

<sup>7</sup> The light spacing tables are based on the data from TABLE.6 and are in accordance with the requirements of AS/NZS 1158.3.1:2005 Pedestrian area (Category P) Spacing is based on a 4 year lamp replacement cycle. Subcategory P4 is used for residential streets and applies to the whole road reserve. Lights are mounted at 5.5m for new housing estates with underground cabling and poles are up to 60 metres apart. Lights are mounted at 7.5m when mounted on electricity distribution poles with overhead conductors. The lights are usually mounted on every 2<sup>nd</sup> pole to give approximately 78m between lights.

### 5.2.5. International Protection (IP) Ratings:

#### AS1158 – Part 6, Section 2.2.2

This Clause requires a minimum degree of protection for the lamp chamber of the luminaire to be IP54.

**TABLE. 9: Luminaire IP ratings**

Luminaire	IP Rating
50w HPS - Urban	IP64
80w MV - Urban	IP64
80w MV - B2224	IP 54
1 x 42w CFL - Suburban	IP64
2 x 14w & 2x24W T5 - Greenstreet	IP65

### 5.2.6. Visibility Under Residential Street Lighting:

Does the colour of the light source used in residential street lighting have an influence on visibility and the perception of brightness? This is a question which has been debated for many years among lighting professionals. In some places, such as in Coffs Harbour, NSW, HPS lamps have been extensively used, whereas other regions, such as Victoria, have widely used MV lamps.

During the past decade there has been much experimentation in the UK, USA, and Europe regarding the spectrum of a light source, brightness perception, and visual performance in the pedestrian environment. The general consensus seems to be that the whiter light is better in these aspects but the magnitude of the difference depends on the type of task being performed.

However there is reasonable evidence that under a blue-white light source a wider range of colours will appear to be more saturated and hence brighter, whereas under a yellow-red light source many colours will “read black or dark brown” or at least will appear to be less bright. This is particularly so if the target is in an off axis direction.

Thus in residential streets a blue-white light is preferred for the reason that colour rendition and definition are clearer under these conditions – thus enhancing the perceived levels of safety of passers-by. Additionally that HPS (a yellow light) is not preferred for residential applications.

## 6. Conclusion

The AGL and NAGA trials tested the field and laboratory performance of energy efficient lights that can replace the existing 80 watt (W) Mercury Vapour (MV) technologies. The trial lights were:

- Pierlite Greenstreet 2x14W T5
- Sylvania Urban 50W High Pressure Sodium (HPS)
- Sylvania Suburban 42W Compact Fluorescent (CFL)

### Pierlite Greenstreet 2x14W T5

Based on the results of these trials we recommend the use of the T5 as a standard direct replacement for the 80W Mercury Vapour. The T5 luminaire has an International Protection (IP) rating similar to other accepted luminaires. Maintenance is slightly increased which results in increased maintenance cost, because of two lamps and electronic control gear that may require periodic replacement.

Although unit cost is slightly increased in terms of maintenance and purchase the benefits of better uniformity of light across and along the street, better colour rendering and visibility, best current technology in terms energy performance, less lumen depreciation and lamp failure rate far outweigh the costs.

### Sylvania Urban 50WHPS

Based on the results of these trials we do not recommend the use of the 50W HPS as a standard direct replacement for the 80W MV because of the reduced colour rendition and poor visibility to the human eye.

### Sylvania Suburban 42W CFL

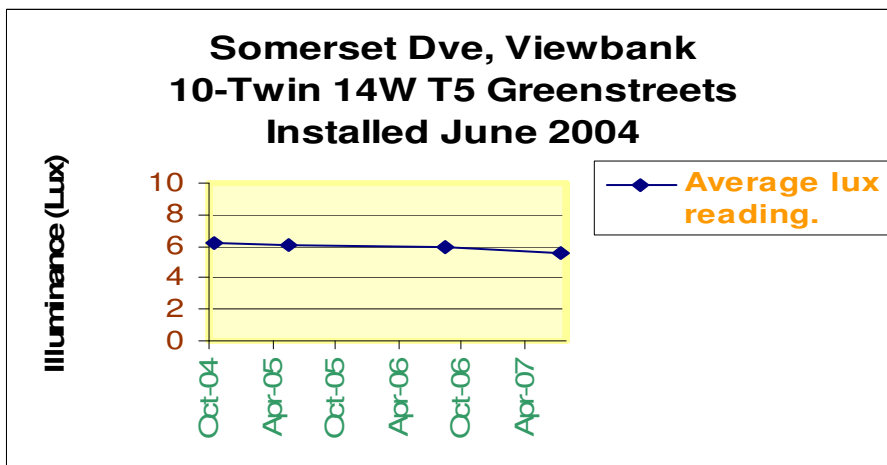
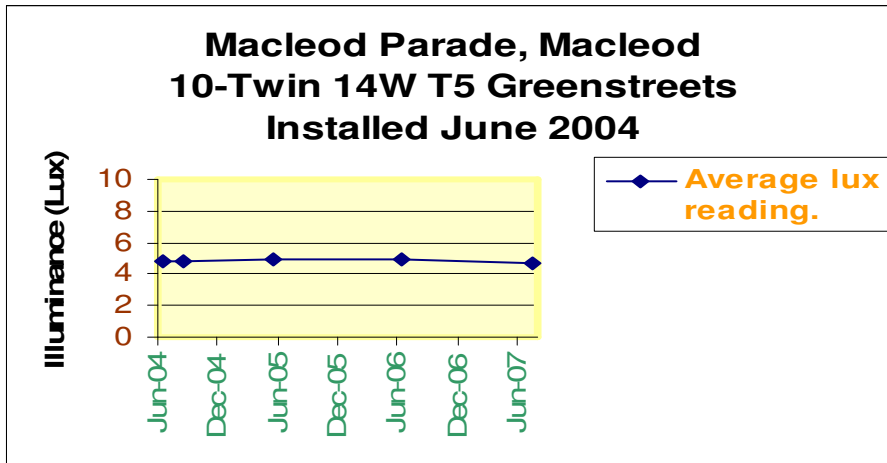
Based on the results of these trials we recommend the use of the 42W CFL as a direct replacement for the 80W MV only where 2x14W T5 cannot be used (e.g. some decorative streetlights).

## **APPENDIX.1: Results of the Residential Survey**

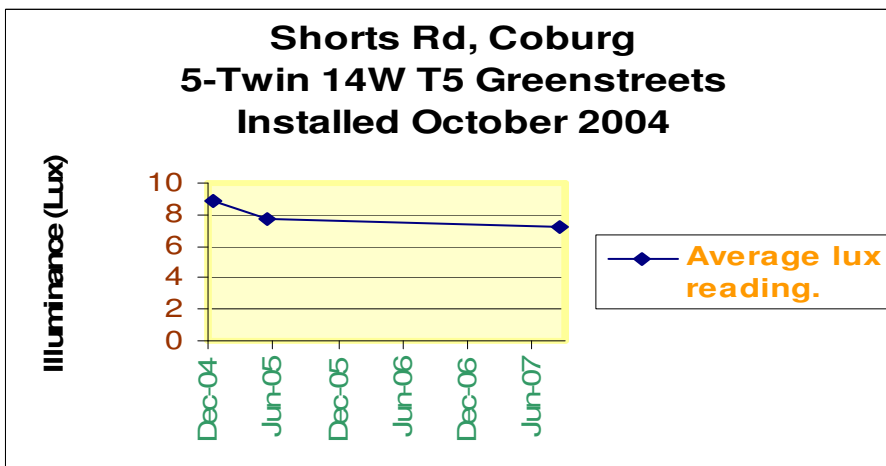
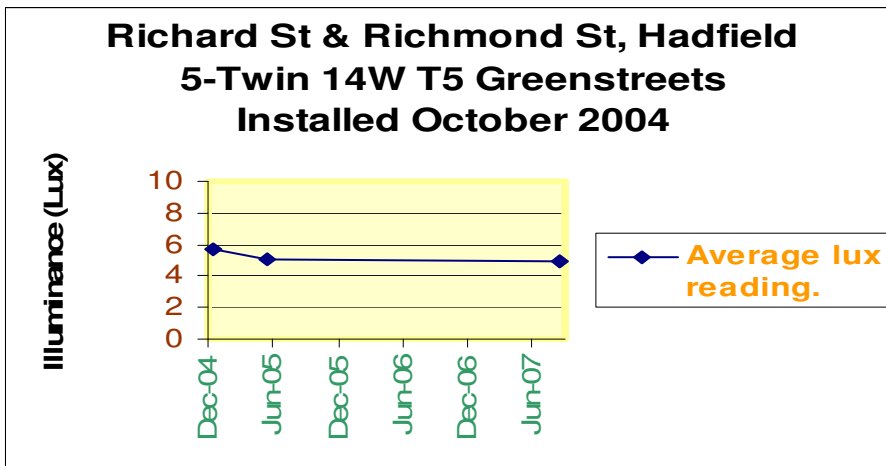
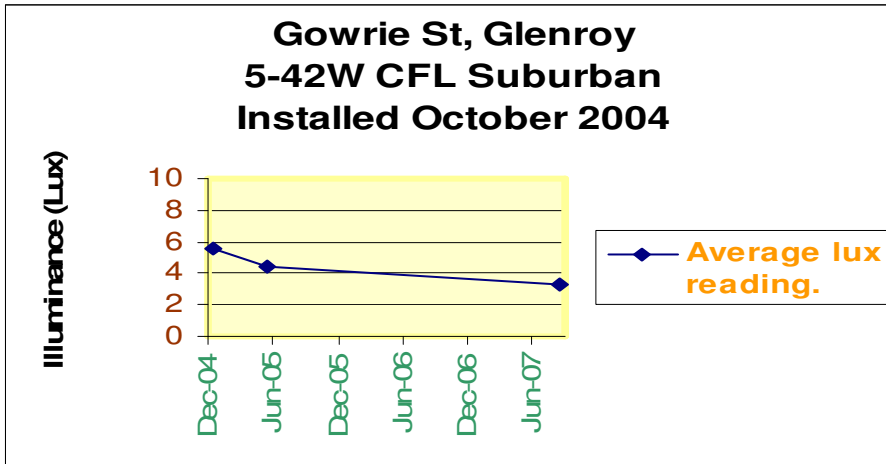
Note in the software version of the report Appendix 1 is attached as a separate file.

## APPENDIX 2: In-field Illuminance Records

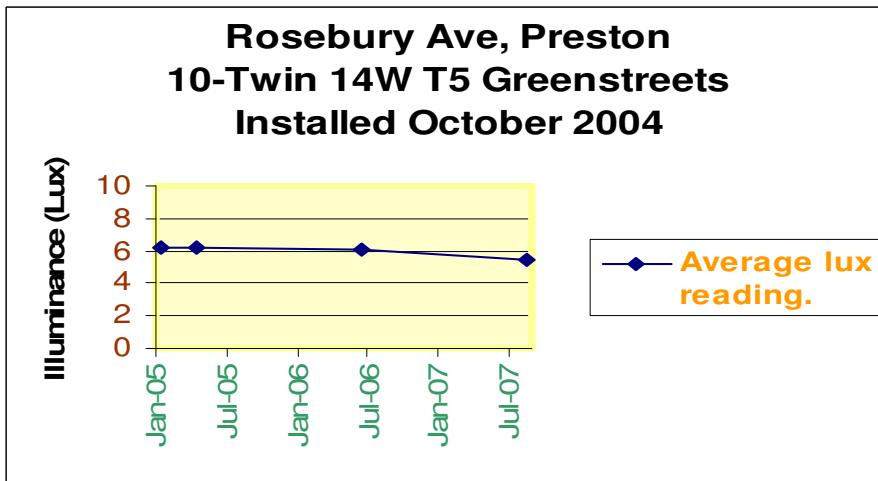
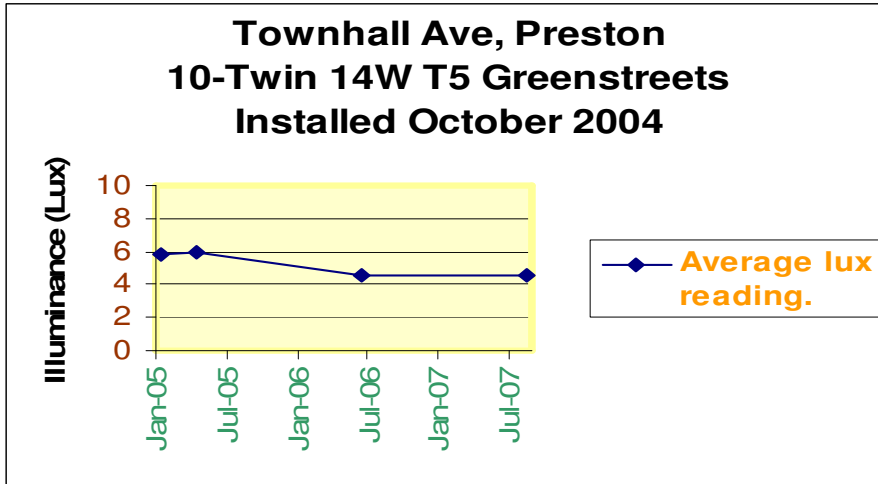
### Banyule City Council



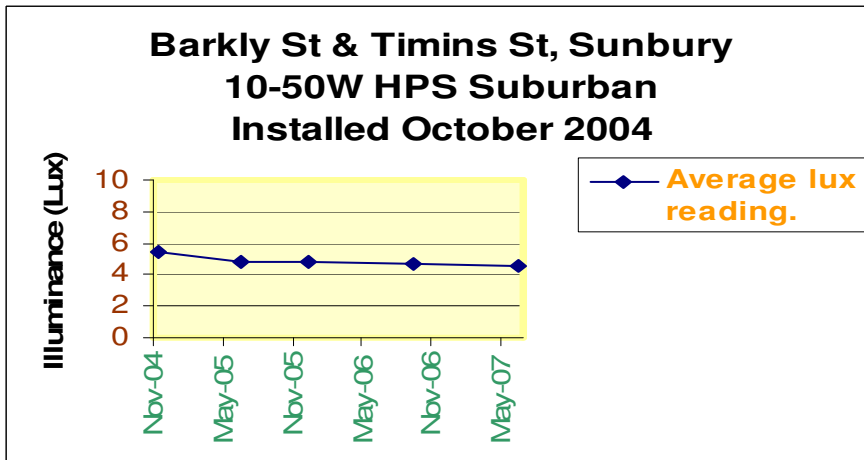
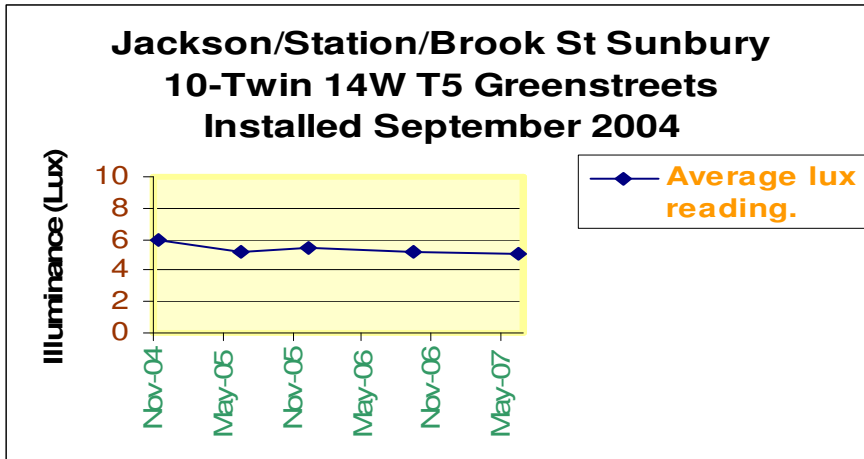
Moreland



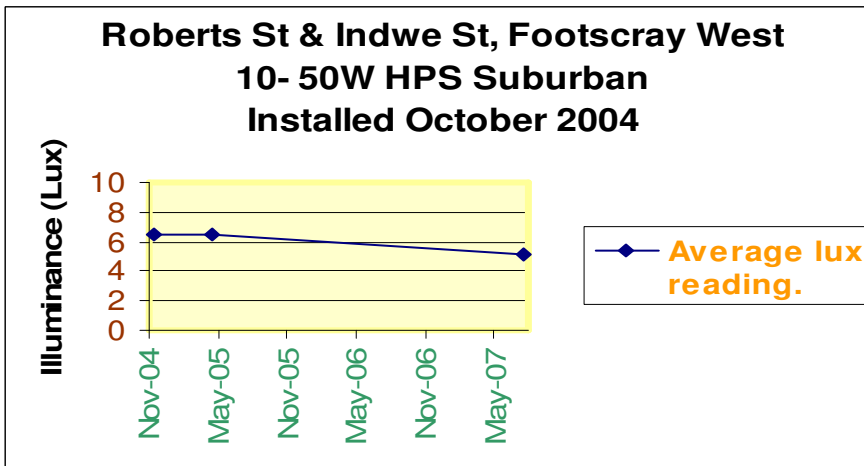
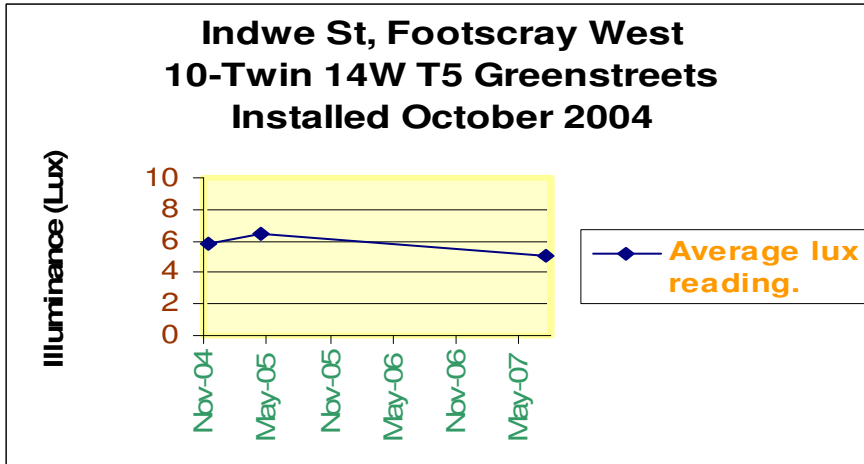
Darebin



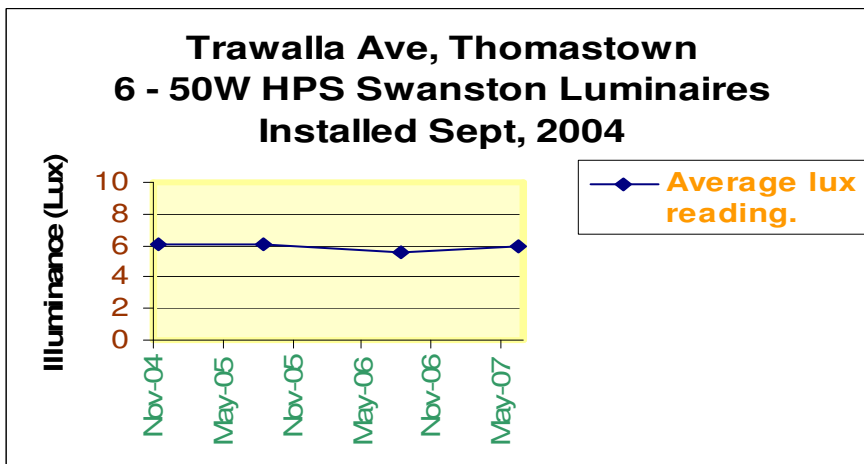
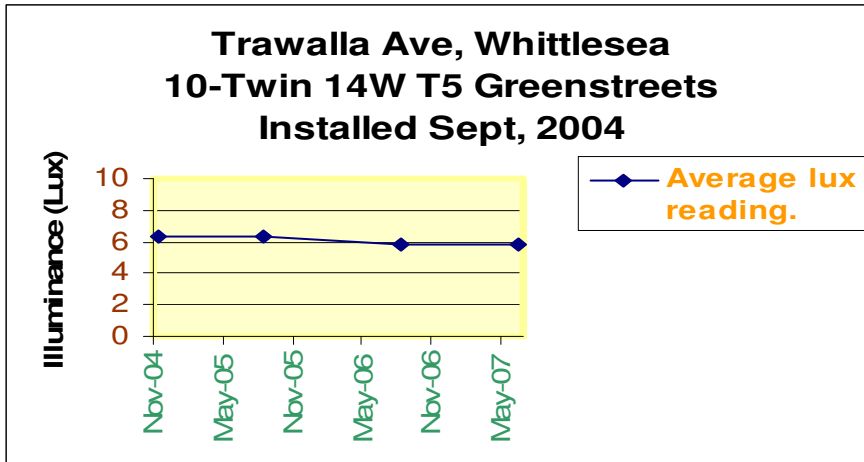
Hume



Maribyrnong



Whittlesea



## APPENDIX. 3: Maintenance issues for trial lights

### Banyule

25/06/2004,

Macleod Pde, Macleod, Cnr of Dwyer St.

Light not working. Fault crew replaced T5 with standard 80 W mercury and repaired T5 in workshop.

Cause of fault, lamp failure, lantern kept as replacement for future faults

6/12/2006, outside No. 13

Light not working. Fault crew replaced lamps and PE cell.

1/04/2005

Somerset Dve, Viewbank, opposite No 35.

Overhead conductors and T5 lantern brought down in severe storm.

T5 replaced with standard 80 W mercury when supply restored.

### Moreland

20/10/2004

9 Guilfoyle St, Coburg Nth

50W HPS lantern on continuously. Fault crew replaced PE cell

PE cells fail in the on position, known as fail safe.

Many of the brand used in this trial failed prematurely and were banned for future use.

13/08/2007

Guilfoyle St, Coburg Nth

50W HPS lantern not working, reported to Alinta

13/08/2007

77 Gowrie St Glenroy

42W CFL not working, reported to Alinta

### Darebin

15/05/2004

21 Rosebury St, Preston, Fault crews replaced lamps

13/08/2007

59A Rosebury St, Preston

Fault crews replaced lamps and PE cell

13/09/2005

52 Townhall Ave, Preston

Fault crews replaced lamps

9/01/2007

14 Townhall Ave, Preston  
Fault crews replaced lamps and PE cell

## Hume

20/10/2004  
46 Jackson St, Sunbury  
T5 lantern on continuously. Fault crew replaced PE cell

38 Barkly St, Sunbury  
50W HPS on continuously. Fault crew replaced PE cell  
1/06/2005

Barkly St cnr Timins  
50W HPS causing radio interference to resident.  
Lantern replaced with standard 80 W mercury.  
An inspection back at the office revealed that suppressors were not fitted and the lantern was sent back to Sylvania for assessment.

28/02/2006  
Barkly St cnr Terence  
50W HPS on continuously. Fault crew replaced PE cell

## Maribyrnong

23/11/2004  
op 44 Indwe St Footscray West  
T5 failed to operate after replacing lamps  
Lantern remove was sent to supplier for assessment  
Electronic ballast fuse blown, believed to be caused by power surge. When repaired it was installed back in its original position  
Surge suppression was not fitted in the first models. They are now standard equipment for T5's and 42W CFL.

22/04/2005  
Op. 34 Indwe St Footscray West  
Pole found to be defective and replaced. T5 went AWOL and was replaced with standard 80 W mercury.

13/08/2007  
Op. 50 Indwe St, Footscray West  
T5 not working, reported to Alinta

Op. 26 Indwe St, Footscray West  
T5 not working, reported to Alinta

23 Roberts St, Footscray West  
50W HPS not working, reported to Alinta

## **Whittlesea**

Op. 33 Trawalla Ave, Thomastown  
T5 not working, reported to Alinta

Op. 47 Trawalla Ave, Thomastown  
T5 not working, reported to Alinta

# APPENDIX 4. Effects of Voltage Variation On Light Output

