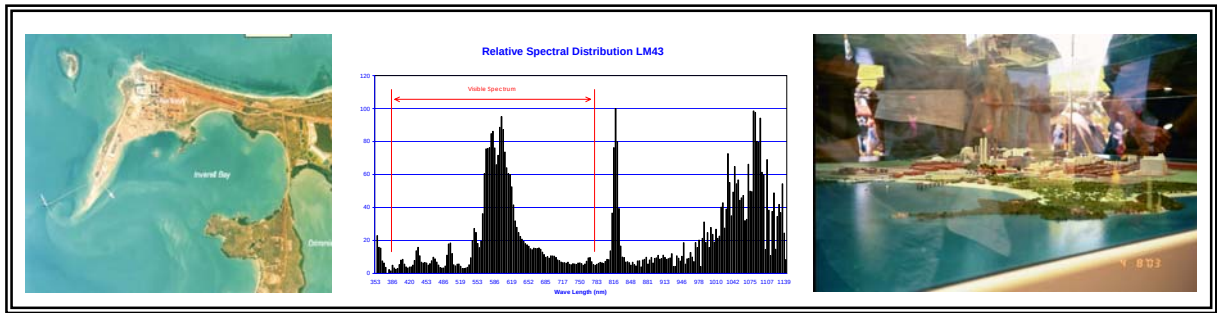




LIGHTING IMPACT ASSESSMENT GOVE ALUMINA REFINERY

Prepared For:
URS
240 Queen Street
BRISBANE QLD 4000

Prepared By:



Bassett Consulting Engineers
Level 12
132 Arthur Street
NORTH SYDNEY NSW 2060
www.bassett.com.au

Prepared By	Verified	Authorised for Issue	Date
T. Shotbolt			26 August, 2003

LIGHTING IMPACT ASSESSMENT GOVE ALUMINA REFINERY

TABLE OF CONTENTS

GOVE ALUMINA REFINERY	2
TABLE OF CONTENTS	2
GOVE ALUMINA REFINERY	4
1.0 PURPOSE	4
2.0 BACKGROUND.....	4
3.0 METHOD.....	4
3.1 PHASE 1	4
3.2 PHASE 2	4
4.0 STANDARDS.....	5
4.1 CRITERIA FOR PEOPLE.....	5
4.2 CRITERIA FOR ANIMALS.....	5
5.0 EXISTING LIGHTING INSTALLATION.....	5
5.1 LIGHTING HARDWARE.....	5
5.1.1 <i>Light Sources.</i>	5
5.1.2 <i>Luminaires.</i>	6
5.1.3 <i>Luminaire Application.</i>	6
5.2 NIGHT-TIME SURVEYS.....	7
5.2.1 <i>Generally</i>	7
5.2.2 <i>Methodology.</i>	8
5.2.3 <i>Results</i>	8
5.3 SUMMARY.	10
6.0 PROPOSED STAGE 3 EXPANSION.....	10
6.1 GENERAL UNDERSTANDING	10
6.2 COMMENTS.	11
6.3 RECOMMENDATIONS	12

TABLE 1 Existing Light Sources at Gove Alumina Refinery August 2003

TABLE 2 Gove Refinery Illuminance and Spectral Survey – July/August 2003

APPENDIX A – MANUFACTURERS LAMP DATA

APPENDIX B – SPECTRAL ANALYSIS RESULTS

APPENDIX C – PHOTOGRAPHS – GOVE ALUMINA REFINERY

APPENDIX D – MEASURING INSTRUMENT DETAILS

APPENDIX E – STAGE 3 IMPACT MODELLING

LIGHTING IMPACT ASSESSMENT

GOVE ALUMINA REFINERY

1.0 PURPOSE

The purpose of this report is to provide information on the likely impact of lighting associated with the stage 3 expansion plans.

2.0 BACKGROUND

The Gove alumina refinery operates 24 hours per day. There is considerable external lighting as would be expected on any industrial project of this type. There is lighting for general circulation, lighting to view various processes, lighting for personnel to move around the industrial plant in safety and lighting for emergency. The lighting involves a number of different types of luminaires and different types of light sources suited to different applications.

A proposed stage 3 expansion will involve lighting and the impact will depend on the industrial plant structures.

3.0 METHOD

The method of arriving at the predicted lighting impact of the proposed Stage 3 Expansion involves two phases.

3.1 PHASE 1

Investigate the existing installation and its environmental lighting impact. This involved a number of actions:

- Day-time inspection of the types of luminaires used in the various parts of the refinery.
- Night-time inspection and measurement at the perimeter of the refinery complex and adjacent areas on land. This involved both illuminance measurements and spectral measurements.
- Night-time inspection and measurement of adjacent areas on the water. This involved a patterned illuminance survey and some spectral measurement.
- Day-time photographic survey of areas considered too dangerous to investigate at night.
- Verify observations against company standards and lighting manufacturers data.

3.2 PHASE 2

- Obtain information on the proposal – plans, model etc.
- Observations of the local terrain relative to the locations of the various items of plant.
- Relate the proposed plant to existing plant and the implications of the proposed expansion.

4.0 STANDARDS

4.1 CRITERIA FOR PEOPLE

The relevant Australian Standard for light spill and glare is

AS 4282 – 1997 Control of the obtrusive effects of outdoor lighting

This standard provides guidance for development relative to property boundaries of existing buildings and to the potential location of buildings within vacant properties. There are no specific provisions for nomadic movement or temporary settlements.

The standard sets out criteria related to the human experience of light and provides criteria for both pre-curfew and post-curfew. Obviously the criteria for late night (post-curfew) is considerably more restrictive. Post-curfew the lighting criteria is measured at window locations or at the minimum setbacks from the boundary. The strict application of this standard only applies to settlement areas or known future settlement areas.

4.2 CRITERIA FOR ANIMALS

There is no information on quantities of electromagnetic radiation that form threshold criteria for different species and different life functions.

For example, water transmits wavelengths best in the range 425 to 600nm with a peak at 475 nm. It is surmised¹ that marine animals will therefore be most sensitive to these wavelengths. The threshold value of light onto a beach that may interfere with the natural progression of turtle hatchlings from the nest towards the sea is not known. Bright moonlight produces 0.25 lux on the horizontal in the visible spectrum so the assumption could be that there should be less light spill than this value. However, the more important criteria with respect to the travel of hatchlings towards the sea is believed to be the 'brightness' of light sources², that is, the horizon and the moon. The moon has a luminance of 2500 cd/m².

5.0 EXISTING LIGHTING INSTALLATION

5.1 LIGHTING HARDWARE

There are three important criteria, viz, the light source, the luminaire and how the luminaire has been applied.

5.1.1 Light Sources.

The characteristics of a light source (colour temperature (degrees Kelvin K), colour rendering (R_a) capability and lumen package (quantity of visible light – lm)) have implications both to the human visual system and the effectiveness of seeing and for native fauna.

Colour temperature is the 'whiteness' of the light with low colour temperatures being very yellow orange and high colour temperature being 'blueish white'. On site the following light sources were observed:

¹ CSIRO Australia – P Hicks and M Caccetta – Spectral Measurement of Illumination Sources at Thevenard Island

² www.turtletime.org/lighting/problems. Beach lighting: Light pollution Problems on Sea Turtle Nesting Beaches.

Light Source	Appearance	K	R _a
Low pressure sodium	orange	1700	-
High pressure sodium	Yellowish	2100	25
Mercury vapour	white	4100	40
Metal halide	White	4200 5500	65 92
Fluorescent colour 54	White	6200	72
Fluorescent colour 86	White	6300	77
Fluorescent colour 33	White	4100	63
Fluorescent green	green	-	-

Table 1.

Existing Light Sources At Gove Alumina Refinery August 2003

The actual type of lamp, that is the type of metal halide for instance and the manufacture of the lamp can vary, the characteristics (K, R_a, and spectral composition) will be sufficiently close to the above table for the purpose of this report. The on-site observations correlate with the 'Gove Standards Manual – GSM-ENG-4184-900 and 4184-901 with two exceptions. Those exceptions being the absence of tungsten halogen and the presence of low pressure sodium. Appendix A shows the typical spectral composition of the light sources as supplied by the manufacturers. Some light sources concentrate their output in the yellow part of the spectrum and others spread more into the blue green end of the visible spectrum.

As noted in the 'Gove Standards Manual', different light sources have different purposes and where the ability to discriminate colour is important metal halide, fluorescent and tungsten halogen lamps are appropriate. The 'brightness' of the lamp is related to the wattage and that is determined by the area and nature of the task being lit.

5.1.2 Luminaires.

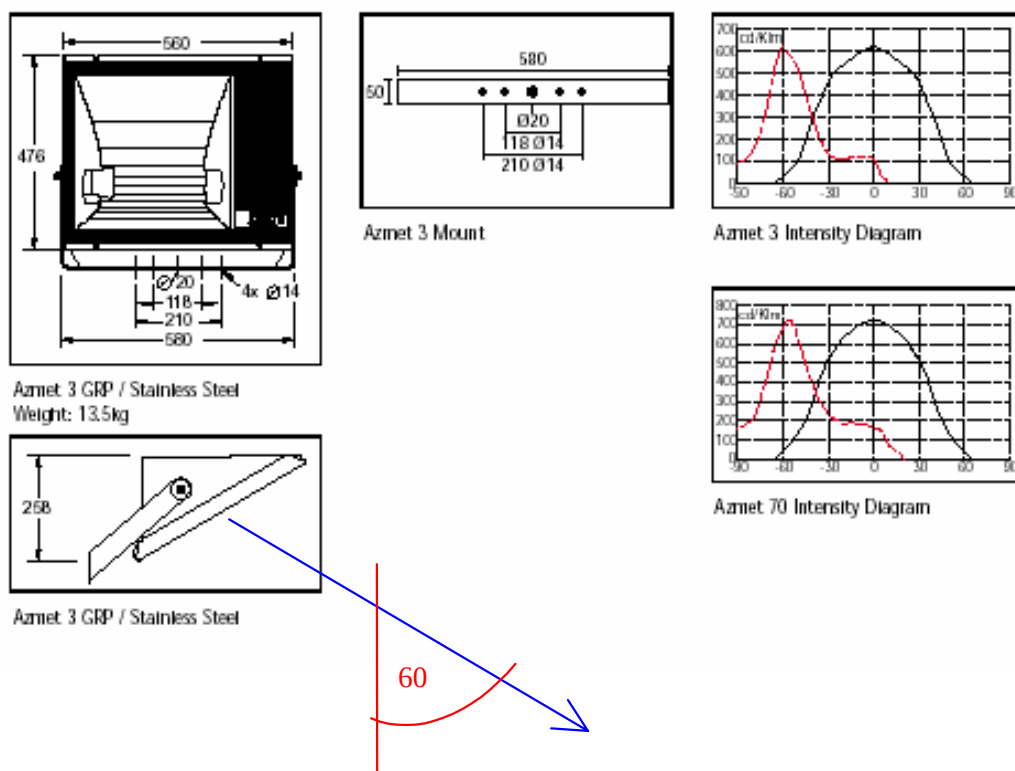
A luminaire by definition includes the lamp, the reflector, the diffuser and the control gear. The luminaire determines the distribution of light and this is primarily by the diffuser and the reflector. Asymmetric type distributions are usually the most effective at limiting light spill whilst lighting the task and this luminaire type is used on the site (Photo 1). Use of these luminaires is application specific and in some instances a more general distribution is appropriate for the task and personnel safety, eg bulkheads and weatherproof fluorescent (Photo 2).

Elsewhere, mercury vapour and mercury vapour reflector lamps are used for a variety of engineering reasons as well as economy and simplicity (Photos 3 & 4) and general road lighting (Photos 5 & 6). The range of luminaires possible is limited by the aggressive nature of the environment and the effects that that has on the luminaire housings and components versus the product available in the market.

5.1.3 Luminaire Application.

Asymmetric distribution luminaires such as the EYE Azmet floodlight are generally used appropriately around the site with the top of the floodlight

being horizontal and the peak intensity being at 60 degrees up from the nadir (downward vertical) minimising unnecessary light spill. There are some instances such as that shown (Photo 7) where the floodlight is aimed upwards a further 30 degrees (refer diagram 1) which means the peak intensity is aimed horizontally and this luminaire is quite noticeable in Melville Bay (Photo 8). With a 250W metal halide lamp this one luminaire aimed incorrectly will provide illuminance light spill in the vertical plane of 0.1 lux at 1km distance.



5.1.3.1.1.1 Diagram 1.

EYE Azmet floodlight details illustrating that with the top of the floodlight horizontal the peak intensity is at 60 degrees to the nadir.

Luminaires located close to settlements like Galupa (Photo 9) could be reviewed. On the pumping station (Photo 10), high pressure sodium bulkhead type luminaires appear quite bright and these burn throughout the night. Measurement of the luminance towards the Galupa settlement shows a reading of 1584 cd/m². This reading is approximate as an absolute reading requires the 1/3 rd degree acceptance angle of the luminance meter to be fully flashed as the meter averages everything within that zone. If by size of the luminaire and distance, the luminaire does not fill the acceptance angle an inaccurately low reading is obtained. This reading is sufficiently high to be of concern although by itself does not breach the maximum tolerable value expressed in Table 2.1 of AS 4282 – 1997. These luminaires are on a horizontal line of sight and close by the Galupa settlement (Photo 11).

5.2 NIGHT-TIME SURVEYS

5.2.1 Generally

Night time surveys were conducted at various locations. It was considered too dangerous to conduct surveys along the shoreline north and west of the

refinery. Measurements were made close to the refinery boundaries as noted in Table 2 and shown on plots on drawing S5330-E001. Measurements were made on board a boat from as close to shore as possible and shown on the items referenced above. Some measurements were also made from West Woody island (Photo 12). Measurements were made on the spit at Dundas Point and around the shore on the south side of the refinery. Areas further afield were also investigated such as Dhamitjinya (East Woody – Photo 13), and the settlement of Gunyanara on Drimmie Peninsula.

5.2.2 Methodology.

Within the restraints imposed by factors such as consideration for personal safety, access and limitations of equipment, a number of measurements were made both close to the refinery and further afield.

A GPS (satellite navigator) was used to locate each observation point. A network of points (Land Mark (LM)) was established sufficient to analyse the performance of the refinery in operation. At any one point a decision was made as to the practicality and usefulness of conducting a spectral analysis. Similarly decisions were made about illuminance measurements and photography.

5.2.3 Results.

The decisions and recorded results at each of the observation points are shown in Table 2. There are two main types of information. Illuminance measurements and spectral measurements. Illuminance measurement are adjusted to the standard CIE (Commission Internationale de L'Eclairage) human eye response curve (V_{λ}) which shows peak sensitivity at 555nm and very little at either 400 or 750 nm (low blue and high red end of the visible spectrum) with nothing in the ultraviolet or the near infra-red. Spectral measurements show all of the electromagnetic energy at the different frequencies without any bias towards the human response curve and this information can be useful for animal (marine, land based), bird and insect as well as plant life.

5.2.3.1 Illuminance.

Illuminance can be measured in the horizontal plane and as such measurements are independent of the direction of that light so long as it is above the horizontal. Illuminance in the vertical plane is dependent on direction and for obtrusive light investigations this is usually a matter of orienting the illuminance meter to obtain the maximum reading unless specific boundary planes are the reference criteria for the specific issue.

Both horizontal and vertical illuminance results have been recorded as appropriate at each point and this is shown in Table 2. The vertical illuminances (E_v) towards the refinery are plotted on drawing S5330-E001 and isolux lines interpolated and plotted based on those measurements. The results show the pattern of the light spill and that coincides with height of structures and the external lighting associated with specific processes.

Illuminance measurements were not made along the north and west beaches as noted above. Some horizontal illuminance (E_h) measurements were made inside the refinery complex near the perimeter as documented in Table 2. The horizontal illuminance values along the beaches at locations adjacent those measured inside the refinery complex are likely to be of the same order of magnitude if there are no obstructions. The likely change in value could be estimated by the inverse square rule if it was a flat area with no difference in topography and no change due to obstructions such as trees and various

built structures. The horizontal illuminance on West Woody island was 0.01 lux (LM34) whereas it was 0.02 lux at location LM19. At LM34 more luminaires were visible (Photo 15) but the distance to the luminaires was greater whereas at LM19 (Photo 16) the distance is much less but far fewer number of luminaires affected that location.

5.2.3.2 Spectral Analysis.

With the spectrometer, measurements were recorded at a number of locations as noted in Table 2. Locations found to provide unsatisfactory (too much background instrument noise compared to the light – that is the intensity of the light too low) results in the field were rejected and not recorded. Results that looked reasonable in the raw data format had to be corrected for the characteristics of the fibre optic cable part of the spectrometer. The fibre optic being less efficient in the ultraviolet and infra-red spectrum. This calibration provided correction factors that had to be applied to the raw data with the result that some further raw data was rejected on the basis of meaningfulness of the result. Despite this, a number of meaningful results were obtained and are shown in Appendix B.

In the first instance it is useful to verify the spectral signature of some of the light sources as actual lamp details were not available on-site. The spectral peak of 586nm on relative spectral distribution LM06 is indicative of low pressure sodium and coincides with spectral performance of such a light source and observations on-site. The spectral data is not pure data due to the other varieties of light sources in the adjacent areas. The signatures at LM09 and LM11 are very strongly EYE mercury vapour with the peaks at 405/408, 436, 546 and 577/579nm plus contributions from the fluorescent coating on the outer bulb in the spectrum above 600nm. At LM18 the predominant light source is mercury vapour but there is a small amount of high pressure sodium (Photo 17) as indicated by the change in signature between 550 and 650 nm. The spectral signature at LM05 is predominantly EYE standard high pressure sodium with a small amount of low pressure sodium from the adjacent conveyor lighting.

At LM43 there is a predominance of EYE standard high pressure sodium with a much lower amount of EYE mercury vapour and a minor amount of fluorescent triphosphour colour 84. Typical of a high pressure sodium lamp there is a large quantity of electromagnetic radiation in the infra-red.

At LM47 (Photo 18) the spectral signature is that of a high colour rendering metal halide lamp.

LM17 indicates the mix of high pressure sodium and fluorescent lighting on the cooling towers as well as the mercury vapour on the overhead conveyor system (Photos 19, 20 & 21).

At LM24 (similar to Photo 22 where this photograph was actually taken at position LM21) the spectral signature is weak against the background noise but the shape of the high pressure sodium lamp is still visible as are the mercury vapour spectra.

At LM49 the signal strength is not high but there are indications of EYE standard high pressure sodium and EYE standard metal halide (Photo 8). With marine animals being more sensitive to the blue/green section of the spectrum, mercury vapour, metal halide and fluorescent lamps present the greatest possibility of being disruptive to marine life. Areas such as

Wargarpunda Point are exposed to white light but other areas of the coastline, whilst having the strongest spectra in the orange/red part of the spectrum (due to the concentration of high pressure sodium light sources) also are exposed to extra spectra in the blue green area. The relative amounts at any one point vary depending on which light sources are screened and which are visible.

The light sources that are going to be visible can be shown by day-time photographs (Photo 23 to 32 inclusive) taken from various locations along the shoreline (as noted in Table 2) adjacent the refinery. From any particular point the photograph(s) show which part of which structures are visible and consequently the likelihood of exposure to direct light spill.

5.2.3.3 Comments

With respect to AS 4282 – 1997 compliance there is only one area that can be assessed relative to the criteria in the Standard and that is Galupa settlement. All other settlements are too distant from the refinery to provide measurable meaningful data. At Galupa the measured vertical illuminances were below the post-curfew criteria of the standard.

5.2.3.4 Other Observations.

Whilst it is possible to see the refinery from locations such as Dhamitjinya (East Woody island – Photo 13), illuminance measurement would not register which means it is below 0.005 lux and the 1/3 degree acceptance angle of the luminance meter would include large areas of non-light source providing a meaningless result. The concept of luminous intensity is independent of distance and therefore does not change regardless of the distance but the angular size of the light source (minutes of arc) does and once that size falls below a threshold relating to the surrounding field it ceases to be a glare source but none-the-less remains conspicuous.

5.3 SUMMARY.

The Gove Alumina Refinery operates throughout the night and is lit by a variety of light sources but primarily the light source is high pressure sodium. There are some pockets of concentrated mercury vapour lighting adjacent Wargarpunda Point and low pressure sodium along the conveyor out to the bulk cargo wharf. Otherwise, there is a mix of high pressure sodium, mercury vapour, metal halide and fluorescent, the relative strength of any particular one source depending on the observation point relative to the lit refinery plant.

The greater vertical illuminance spill impact is towards the north and the south as shown by the plotted results in drawing S5330-E001. The shoreline to the north and west being affected to varying degrees as noted in the body of the report above.

Some minor issues could be improved as noted previously.

6.0 PROPOSED STAGE 3 EXPANSION

6.1 GENERAL UNDERSTANDING

The expansion proposal is to increase production from the plant by approximately 75 percent. This means expanding plant and consequently the amount of lighting on the site. The impact of that lighting at any particular point will depend on the nature of the built structures, the processes and proximity of the new structures relative to the point(s) of concern.

Drawing URS 12373-021-559 Fig. 5 shows the areas where development is proposed and photographs 47 to 50 inclusive show a 3D model of the proposal. Whilst the process of development and design means that some details may change, the relative heights of the structures and the volume of the expansion can be appreciated from the photographs of the model. The proposed structures associated with the stage 3 expansion are shown in white. The different views in the photographs reveal the potential for the expansion proposal to impact the surroundings.

Photographs 37 to 46 inclusive show the type of lighting that can be expected on different structures.

The expansion of the precipitators is likely to be a duplication of the existing complete with lighting at high level along the top of the structures. The expansion of the calcination area is likely to involve a vertical calciner rather than a horizontal unit. This means a high structure complete with access lighting similar to the other vertical calciner structure (Photos 41 & 42). Expansion of the hydrate area will mean more lighting similar to that shown in photograph 44.

Expansion of the power station is not expected to significantly add to the light spill contribution from the site.

Expansion of the evaporation area is likely to be a duplication of the existing and the associated lighting similar to that shown in photograph 1.

Expansion to the ferro laydown area show large high structures in photograph 48. Depending on the lighting requirements for this processing plant it may impact Galupa and the northern shoreline (Biritjimi Beach).

Expansion in the red side workshops area shows a number of structures, some of them quite tall.

6.2 COMMENTS.

The photographs along the north shoreline (Photos 23 to 30 inclusive – locations shown on drawing S5330-E003) and the south east shoreline (Photo 22 - near Crocodile Creek) show the exposure to the existing structures. Inspection of photographs of the model (Photos 47 to 50 inclusive) of the proposed expansion indicate that these areas will be directly impacted.

In general terms assuming the new structures to be similar to the existing, the increase in light spill would be directly proportional, but that will only hold true for observation points at some distance from the refinery. For observation points immediately adjacent, the increase is likely to be much more substantial due to the inverse square law of illuminance when considering the proximity of the proposed structures. Illuminance is inversely proportional to the square of the distance, that is, if the distance to a light source is doubled the illuminance falls to 25 percent of the original reading. The reverse is also true. To halve the distance increases the original illuminance value 4 fold. Added to this is the likelihood that closer proximity exposes the observation point more directly to the aimed direction of specific luminaires which further increases illuminance values.

There will be areas along the north and north-west shorelines where the increase in light spill may be between 2 and 4 times the current level. The areas of potential increased impact are shown in drawing S5330-E004.

Very simple modelling of the Stage 3 expansion impact is included in Appendix E. That modelling involved a number of assumptions as noted in the Appendix. When the results of that modelling are added to the surveyed values the general picture will be as shown in S5330-E004.

With respect to AS 4282 – 1997 compliance there is only one area that can be assessed relative to the criteria in the Standard with any meaningfulness and that is Galupa settlement. The critical criteria is the post-curfew (that is the time of night that the local authority (usually the Municipal Council) determines as applicable eg 2200 or 2300 hours). The proposed tall structures in the ferro laydown area may impact the Galupa settlement. At Galupa, any one of the post-curfew criteria could be argued because the settlement abuts a 'commercial' area and AS4282 provides for 4 lux maximum vertical illuminance at a minimum setback from the property boundary. However, from Galupa, currently it is not possible to see direct views of the main refinery. It could be argued therefore that the most relevant criteria is that specified for residential in 'light surrounds', that is 2 lux. Without the influence of the street light at Galupa the environment visible from this settlement cannot be described as light surrounds. For the criteria of residential with 'dark surrounds' the potential is for vertical illuminance to exceed the curfew criteria (1 lux). At the present time there is a streetlight (photo 9) providing light in Galupa. During our inspection the residents requested additional lighting so the above discussion may be academic. The luminance of luminaires is most likely to be an issue (2500 to 500cd/m²). Care needs to be exercised in lighting of the various structures at this location to ensure that the requirements of AS 4282 are adhered to.

6.3 RECOMMENDATIONS

There are a number of actions that could be taken to minimise the overall impact of spill light from the stage 3 expansion proposal.

1. Investigate and adopt luminaires and or accessories that more strictly limit light spill. Those choices are not to affect work safety or the purpose of the lighting.
2. Reflector lamps generally provide broad light distributions with little control of spill. A stainless steel shroud could be applied in many instances particularly where the lamp has the potential to affect a large area of the surroundings such as above the precipices.
3. Floodlights with horizontal front glasses be used in instances once again where they are mounted at some height and likely to have a large area of impact. The Azmet glass is at approximately 30 degrees when the peak intensity is close to 60 degrees. The advantage of the Azmet floodlight is that the body is made from GRP and therefore relatively light weight and resistant to marine environments and to small concentrations of caustic. However, just as with the body of the many bulkhead luminaires and reflector lamp luminaires used around the site a floodlight body could also be marine quality aluminium which could be chromate and epoxy treated to resist caustic as typically used on other alumina processing plant both in Australia and around the world. The advantage of this is a greatly reduced light spill and reduced brightness.
4. To reduce the overall net affect of the addition of stage 3 expansion, some of the existing areas could be retrofitted with the kinds of measures indicated above.

Table 2. Gove Refinery Illuminance and Spectra Survey - July/August 2003

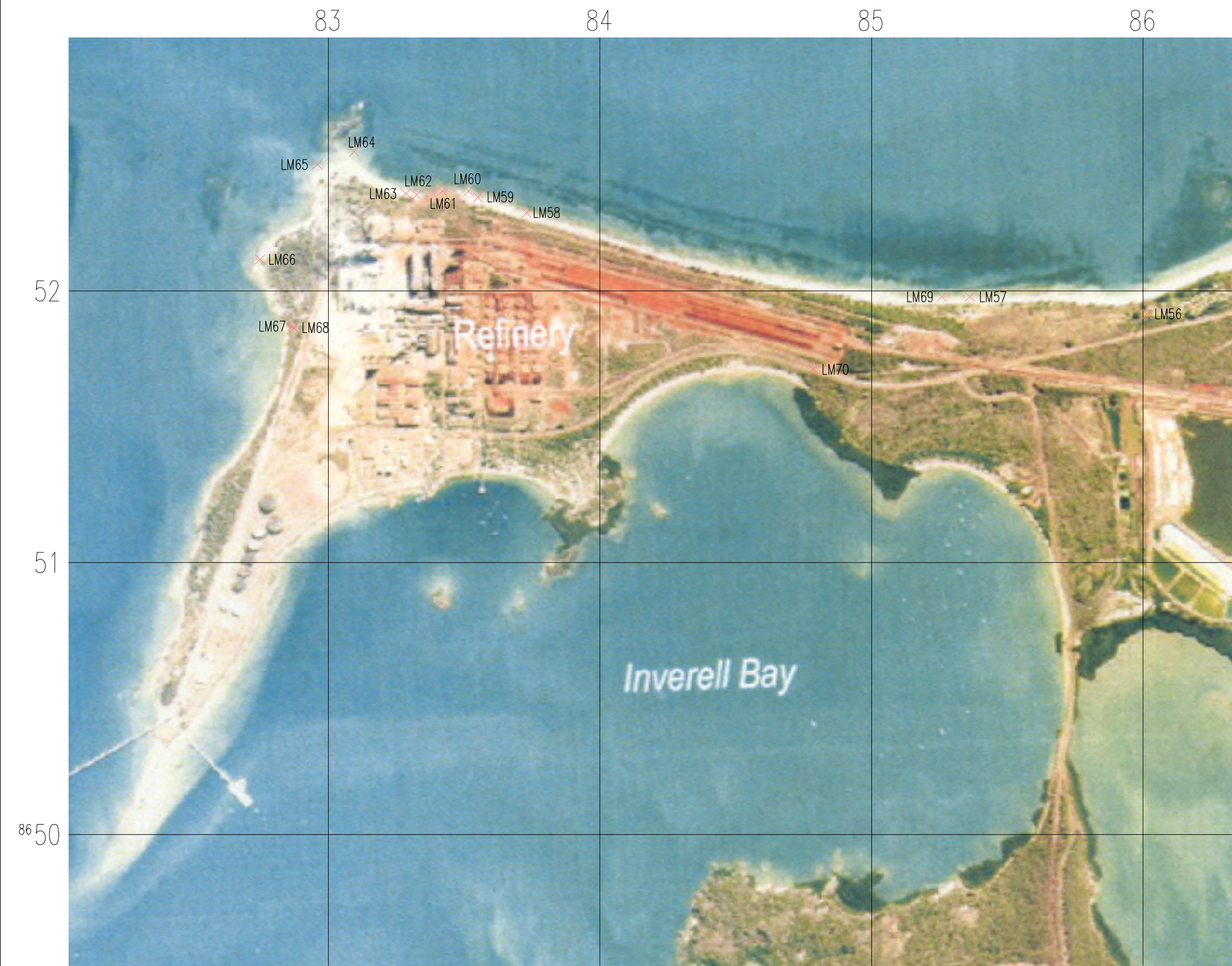
Land Mark	Description	Date	Latitude (Aust Map Grid)	Longitude (Aust Map Grid)	Illuminance			Spectrometer Reading	Luminance		Notes
					Ev (lux)	Direction	Eh (lux)		(cd/m ²)	Luminaires	
LM01	Across bay between Drimmie Peninsula and yacht club	28/07/03	12° 11' 54" S (8657651N) ???	136° 42' 27" E (53 682379E) ??	0.06	Towards refinery	0.01	yes	166 1.2	floodlights lights on conveyors	Integration 2000ms - spectra is suspect as black reference similar to measurement
LM02	Yacht club boat ramp	28/07/03	12° 11' 43" S (8651268N)	136° 42' 22" E (53 685616E)	0.02	Towards refinery		no	51.4 0.4	floodlights lights on conveyors	Only Ev as Eh will include lights from club
LM03	End of spit - Dundas Point	29/07/03	12° 12' 24" S (8650025N)	136° 40' 33" E (53 682323E)	0.08 0.03 0.10	Cargo Wharf Bulk Cargo Wharf Refinery	0.01	no	742 152 22	floodlight Cargo Wharf HPS floodlight Bulk Cargo Wharf LPS on top of conveyor BC Wharf	
LM04	Beginning of spit west side near Bulk Cargo Wharf	29/07/03	12° 12' 14" S (8650336N)	136° 40' 35" E (53 682375E)	0.08 0.40	Towards Wharf Towards conveyor	0.09	no	1131 4629 8858 222	Mercury Streetlight HPS floodlight on transfer station HPS floodlight on transfer station LPS on top of conveyor BC Wharf	
LM05	Transfer Station Bulk Cargo Wharf	29/07/03	12° 12' 11" S (8650411N)	136° 40' 37" E (53 682444E)	n/a		n/a	yes		Primarily HPS some Merc Vap	spectra reference check
LM06	Beginning of conveyor Bulk Cargo Wharf	29/07/03	12° 12' 12" S (8650391N)	136° 40' 35" E (53 682383E)	n/a		n/a	yes		Primarily LPS	spectra reference check
LM07	Beginning of Cargo Wharf	29/07/03	12° 12' 12" S (86 50379N)	136° 40' 37" E (536 82426E)	n/a		n/a	yes		Primarily metal halide at end of Wharf	spectra reference check
LM08	On Cargo Wharf	29/07/03	12° 12' 16" S (86 50279N)	136° 40' 42" E (536 82601E)	n/a		n/a	yes		Primarily metal halide at end of Wharf	spectra reference check
LM09	Beginning of Cargo Wharf	29/07/03	12° 12' 11" S (8650412N)	136° 40' 38" E (53 682466E)	n/a		n/a	yes		Under mercury vapour streetlight	spectra reference check
LM10	Carpark adjacent main office	29/07/03	12° 11' 33" S (8651570N)	136° 41' 12" E (53 683494E)	n/a		n/a	yes		Primarily metal halide	spectra reference check
LM11	Adjacent main gate	29/07/03	12° 11' 33" S (8651583N)	136° 41' 11" E (53 683473E)	n/a		n/a	yes		Merc vap, fluoro, HPS	spectra reference check
LM12	Side gate at end of road lighting	29/07/03	12° 11' 35" S (8651526N)	136° 41' 23" E (53 683839E)	n/a		n/a	yes		Mainly HPS some merc vap, fluoro	spectra reference check
LM13	Gunyanara settlement	30/07/03	12° XX' XX" S (86 51526N)	136° XX' XX" E (536 83837E)	0.01	Towards refinery	0	no	79.2 11.5	Cargo Wharf floodlight Bulk Cargo Wharf	
LM14	Galupa settlement	30/07/03	12° 11' 39" S (8651380N)	136° 41' 18" E (53 683679E)	0.13 0.31	Pump station Towards refinery	n/a	no	1584 87 1421 52	Pump station bulkhead Pump station Merc vap on pole HPS on top of refinery	Eh not measured because was not possible to eliminate local settlement mercury vapour pole mounted light influence
LM15	Back of refinery along fence	30/07/03	12° 11' 11" S (8652263N)	136° 41' 23" E (53 683825E)	1.82	Towards refinery	0.13	yes	6569 2519 83	Metal halide floodlight HPS floodlights Fluoros	
LM16	Back of refinery eastward along fence	30/07/03	12° 11' 22" S (8651900N)	136° 42' 07" E (53 685177E)	0.01	Towards refinery	n/a	no			no direct view of lights
LM17	Near silo and cooling tower	30/07/03	12° 11' 09" S (86 52319N)	136° 41' 06" E (536 83328E)	3.27	Towards refinery	0.88	yes	22370 556	HPS floodlight Green fluoro	
LM18	Near fuel farm at fence line	30/07/03	12° 11' 37" S (8651463N)	136° 40' 49" E (53 682792E)	0.83	Towards refinery	0.21	yes	8904 208	400w merc vap streetlight HPS	
LM19	NW corner fence line - Wargarpunda Point	30/07/03	12° 11' 05" S (8652446N)	136° 40' 57" E (53 683064E)	0.05	Towards refinery	0.02	yes	98.5	Mercury vapour on top of silo	no direct view of lights
LM20	Arafura sea - north of refinery	31/07/03	12° XX' XX" S (N)	136° XX' XX" E (E)	0.13	Towards refinery	n/a	no			Illuminance and spectra mapping by boat. GPS reading over written.
LM21	Arafura sea - north of refinery	31/07/03	12° 11' 09" S (8652326N)	136° 41' 35" E (53 684210E)	0.11	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM22	Arafura sea - north of refinery	31/07/03	12° 11' 06" S (86 52401N)	136° 41' 27" E (536 83969E)	0.37	Towards refinery	n/a	no			Illuminance and spectra mapping by boat. Check reference out to sea Ev = 0.01
LM23	Arafura sea - north of refinery	31/07/03	12° 11' 03" S (8652505N)	136° 41' 19" E (53 683736E)	0.32	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM24	Arafura sea - north of refinery	31/07/03	12° 11' 01" S (8652578N)	136° 41' 14" E (53 683575E)	0.34	Towards refinery	n/a	yes			Illuminance and spectra mapping by boat
LM25	Arafura sea - north of refinery	31/07/03	12° 10' 48" S (8652962N)	136° 41' 07" E (53 683349E)	0.13	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM26	Arafura sea - north of refinery	31/07/03	12° 10' 52" S (8652841N)	136° 41' 19" E (53 683731E)	0.24	Towards refinery	n/a n/a	no	432 61	Metal halide floodlight HPS generally	Illuminance and spectra mapping by boat

Table 2. Gove Refinery Illuminance and Spectra Survey - July/August 2003

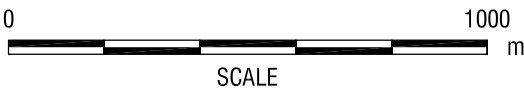
LM27	Arafura sea - north of refinery	31/07/03	12° 10' 55" S (8652739N)	136° 41' 35" E (53 684197E)	0.25	Towards refinery	n/a	no	4.3	Mercury vapour on top of silo	Illuminance and spectra mapping by boat
LM28	Arafura sea - north of refinery	31/07/03	12° 10' 59" S (8652606N)	136° 41' 47" E (53 684570N)	0.18	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM29	Arafura sea - north of refinery	31/07/03	12° 10' 32" S (8653464N)	136° 42' 01" E (53 684993E)	0.06	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM30	Arafura sea - north of refinery	31/07/03	12° 10' 28" S (8653576N)	136° 41' 50" E (53 684653E)	0.08	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM31	Arafura sea - north of refinery	31/07/03	12° 10' 27" S (8653604N)	136° 41' 34" E (53 684179E)	0.08	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM32	Arafura sea - north of refinery	31/07/03	12° 10' 24" S (8653703N)	136° 41' 19" E (53 683735E)	0.06	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM33	Arafura sea - north of refinery	31/07/03	12° 10' 21" S (8653785N)	136° 41' 05" E (53 683293E)	0.05	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM34	Arafura sea - north of refinery - West Woody	31/07/03	12° 11' 09" S (8652333N)	136° 40' 22" E (53 681988E)	0.04	Towards refinery	0.01	no	41.2 26 19	White floodlight HPS generally White lights	Measurements taken on West Woody island. Illuminance and spectra mapping by boat
LM35	not used							no			
LM36	Arafura sea - west of refinery	31/07/03	12° 11' 16" S (8652117N)	136° 40' 19" E (53 681913E)	0.04	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM37	Arafura sea - west of refinery	31/07/03	12° 11' 22" S (8651943N)	136° 40' 39" E (53 682513E)	0.08	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM38	Arafura sea - west of refinery	31/07/03	12° 11' 35" S (86 51547N)	136° 40' 36" E (536 82412E)	0.09	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM39	Arafura sea - west of refinery	31/07/03	12° 11' 46" S (8651190N)	136° 40' 30" E (53 682233E)	0.07	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM40	Arafura sea - west of refinery	31/07/03	12° 11' 58" S (8650840N)	136° 40' 26" E (53 682118E)	0.06 0.02	Towards refinery Bulk Cargo Wharf	n/a n/a	no			Illuminance and spectra mapping by boat
LM41	Arafura sea - Bulk cargo wharf North end	31/07/03	12° 12' 19" S (8650170N)	136° 40' 01" E (53 681345E)	0.78	Bulk Cargo Wharf	n/a	no			Illuminance and spectra mapping by boat
LM42	Arafura sea - Bulk cargo wharf	31/07/03	12° 12' 33" S (8649767N)	136° 40' 09" E (53 681594E)	5.21	Bulk Cargo Wharf	1.02	no			Illuminance and spectra mapping by boat
LM43	Arafura sea - Bulk cargo wharf South end	31/07/03	12° 12' 28" S (8649892N)	136° 40' 08" E (53 681557E)	n/a		n/a	yes (2 off)			Spectra mapping by boat. LM43PS spectra looking north, LM43PSS looking south.
LM44	Gove Harbour and Inverell Bay	31/07/03	12° 12' 38" S (8649585N)	136° 40' 25" E (53 682061E)	0.10 0.05	Bulk Cargo Wharf Towards refinery	n/a n/a	no			Illuminance and spectra mapping by boat
LM45	Gove Harbour and Inverell Bay	31/07/03	12° 12' 29" S (8649879N)	136° 40' 34" E (53 682351E)	0.04 0.09	Bulk Cargo Wharf Towards refinery	n/a n/a	no			Illuminance and spectra mapping by boat
LM46	Gove Harbour and Inverell Bay	31/07/03	12° 12' 19" S (8650170N)	136° 40' 43" E (53 682604E)	0.23 0.11	Cargo Wharf Transfer station	n/a n/a	no			Illuminance and spectra mapping by boat
LM47	Gove Harbour and Inverell Bay	31/07/03	12° 12' 20" S (8650134N)	136° 40' 45" E (53 682676E)	3.27	Cargo Wharf	0.68	yes	16100	Metal halide floodlight	Illuminance and spectra mapping by boat. 3 floodlights facing into bay and two facing back towards refinery.
LM48	Gove Harbour and Inverell Bay	31/07/03	12° 12' 06" S (8650568N)	136° 40' 51" E (536 82873E)	0.17	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM49	Gove Harbour and Inverell Bay	31/07/03	12° 11' 53" S (86 50967N)	136° 41' 00" E (53 683132E)	0.33	Towards refinery	n/a	yes			Illuminance and spectra mapping by boat
LM50	Gove Harbour and Inverell Bay	31/07/03	12° 11' 46" S (8651193N)	136° 41' 12" E (53 683515E)	0.56	Towards refinery	n/a n/a n/a	no	2994 1179 196	Metal halide floodlight - carpark HPS on wharf HPS multiple on pole	Illuminance and spectra mapping by boat
LM51	Gove Harbour and Inverell Bay	31/07/03	12° 12' 01" S (8650720N)	136° 41' 36" E (53 684221E)	0.20	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM52	Gove Harbour and Inverell Bay	31/07/03	12° 11' 43" S (8651261N)	136° 41' 51" E (53 684675E)	0.21	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM53	Gove Harbour and Inverell Bay	31/07/03	12° 11' 35" S (8651512N)	136° 41' 46" E (53 684517E)	0.24	Towards refinery	n/a	no			Illuminance and spectra mapping by boat
LM54	Gove Harbour and Inverell Bay	31/07/03	12° 12' 12" S (8650380N)	136° 41' 15" E (53 683594E)	0.15	Towards refinery	n/a	no			Illuminance and spectra mapping by boat

Table 2. Gove Refinery Illuminance and Spectra Survey - July/August 2003

LM55	Gove Harbour and Inverell Bay	31/07/03	12° 12' 21" S (8650117N)	136° 41' 03" E (53 683214E)	0.11	Towards refinery	n/a	no		Illuminance and spectra mapping by boat
LM56	Wallaby settlement - west end	31/07/03	12° 11' 20" S (8651978N)	136° 42' 37" E (53 686080E)	0.01	Towards refinery	n/a	no		
LM57	Daytime photo - beach north of refinery	01/08/03	12° 11' 10" S (8651978N)	136° 41' 24" E (53 686079E)	n/a		n/a	n/a		
LM58	Daytime photo - beach north of refinery	01/08/03	12° 11' 08" S (8652351N)	136° 41' 20" E (53 683749E)	n/a		n/a	n/a		
LM59	Daytime photo - beach north of refinery	01/08/03	12° 11' 07" S (8652385N)	136° 41' 14" E (53 683565E)	n/a		n/a	n/a		Highly likely to be affected by stage 3
LM60	Daytime photo - beach north of refinery	01/08/03	12° 11' 06" S (8652409N)	136° 41' 13" E (53 683531E)	n/a		n/a	n/a		
LM61	Daytime photo - beach north of refinery	01/08/03	12° 11' 06" S (8652409N)	136° 41' 10" E (53 683434E)	n/a		n/a	n/a		
LM62	Daytime photo - beach north of refinery	01/08/03	12° 11' 07" S (8652395N)	136° 41' 06" E (53 683339E)	n/a		n/a	n/a		
LM63	Daytime photo - beach north of refinery	01/08/03	12° 11' 07" S (8652399N)	136° 41' 05" E (53 683300E)	n/a		n/a	n/a		
LM64	Daytime photo - beach north of refinery	01/08/03	12° 11' 03" S (8652512N)	136° 40' 58" E (53 683095E)	n/a		n/a	n/a		
LM65	Daytime photo - beach north of refinery	01/08/03	12° 11' 04" S (8652465N)	136° 40' 54" E (53 682960E)	n/a		n/a	n/a		
LM66	Daytime photo - beach north of refinery	01/08/03	12° 11' 16" S (8652116N)	136° 40' 47" E (53 682749E)	n/a		n/a	n/a		
LM67	Daytime photo - beach west of refinery	01/08/03	12° 11' 24" S (8651870N)	136° 40' 51" E (53 682869E)	n/a		n/a	n/a		
LM68	Daytime photo - beach west of refinery	01/08/03	12° 11' 36" S (8651865N)	136° 40' 47" E (53 682872E)	n/a		n/a	n/a		
LM69	Daytime photo - beach west of refinery	01/08/03	12° 11' 19" S (86 52006N)	136° 42' 10" E (536 85259E)	n/a		n/a	n/a		
LM70	Daytime photo - croc creek, mangroves	01/08/03	12° 11' 29" S (8651711N)	136° 41' 54" E (53 684786E)	n/a		n/a	n/a		
LM71	Daytime photo - Dhamitjinya (off East Woody)	01/08/03	12° 09' 47" S (86 54792N)	136° 45' 01" E (536 90458E)	n/a		n/a	n/a		
LM72	Additional points along bay	02/08/03	12° 11' 59" S (8650802N)	136° 40' 47" E (53 682741E)	0.12	Towards refinery	0.02	no		
					0.01	Towards the bay			As a check against environment	
LM73	not used							n/a		
LM74	Additional points along bay	02/08/03	12° 11' 51" S (8651035N)	136° 40' 49" E (53 682807E)	0.12	Towards refinery	0.02	no		
LM75	Additional points along bay - adjacent channel	02/08/03	12° 11' 44" S (8651258N)	136° 40' 59" E (53 683112E)	0.37	Towards refinery	0.04	no	Influenced by one HPS floodlight close by	
LM76	Additional points along bay	02/08/03	12° 11' 42" S (8651319N)	136° 41' 07" E (53 683360E)	1.20	Towards refinery	0.22	no	Eh affected by wharf light - not indicative	



Rev	Date	Amendment Description	By	Chk
01		PRELIMINARY DRAWING		



Consulting Engineer
12th Floor
132 Arthur Street
North Sydney
New South Wales 2060
Telephone: +61 2 9957 5577
Facsimile: +61 2 9954 0677
Email: sydney@bassett.com.au
www.bassett.com.au

W.E. Bassett and Partners Pty Ltd
ABN 22 004 873 634



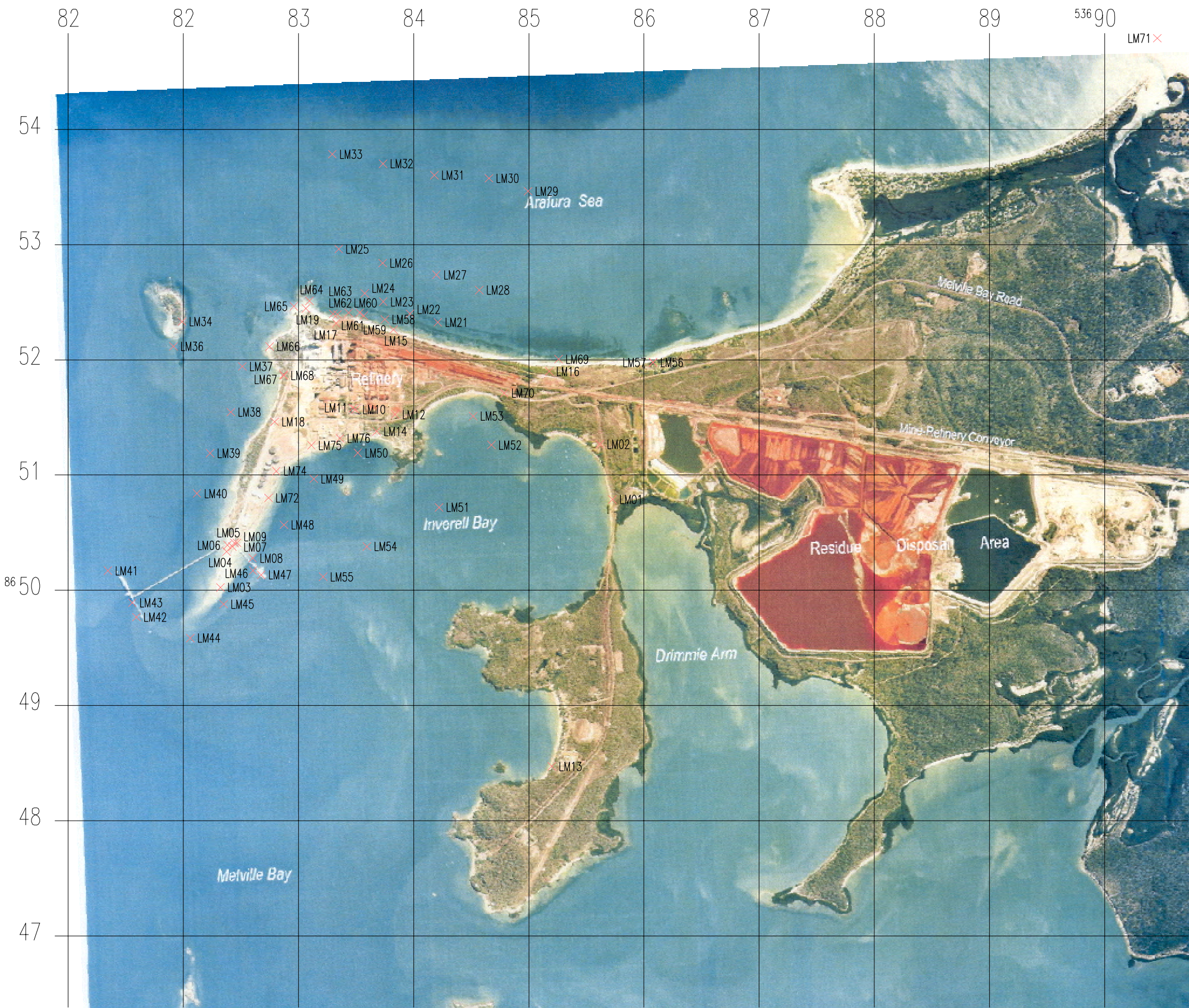
Project
**ALCAN ALUMINA
REFINERY - GOVE
LIGHTING ASSESSMENT**

Drawing Title

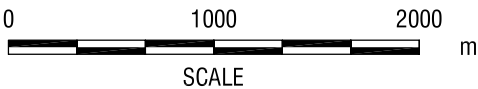
**DAY-TIME PHOTOGRAPHIC SURVEY
ALONG SHORELINES.**

Scale @ A3	N.T.S.	Checked
Date	Aug' 03	Approved
Drawn	MJK	Verified

Drawing No. S5330-E003	
Revision 01	
Sheet No. 3 of 4	



Rev	Date	Amendment Description	By	Chk
01		PRELIMINARY DRAWING		



Consulting Engineer
12th Floor
132 Arthur Street
North Sydney
New South Wales 2060
Telephone: +61 2 9957 5577
Facsimile: +61 2 9954 0677
Email: sydney@bassett.com.au
www.bassett.com.au

W.E. Bassett and Partners Pty Ltd
ABN 22 004 873 634



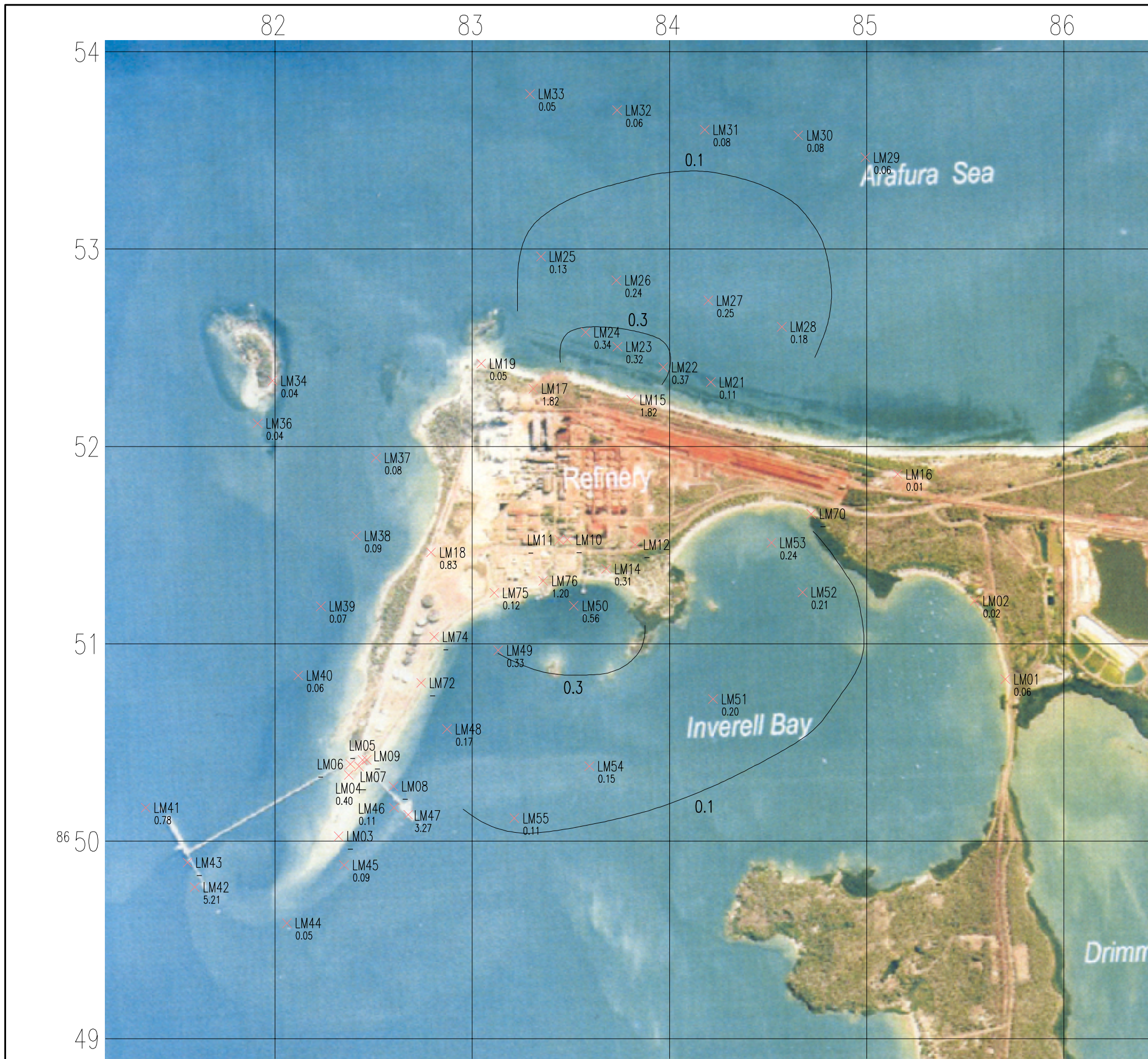
Project
**ALCAN ALUMINA
REFINERY - GOVE
LIGHTING ASSESSMENT**

Drawing Title

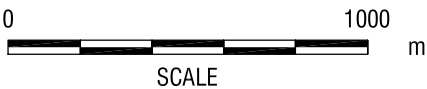
ALL SURVEY POINTS

Scale @ A3	N.T.S.	Checked
Date	Aug' 03	Approved
Drawn	MJK	Verified

Drawing No. S5330-E002	 Revision 01
Sheet No. 2 of 4	



Rev	Date	Amendment Description	By	Chk
01		PRELIMINARY DRAWING		



Consulting Engineer
12th Floor
132 Arthur Street
North Sydney
New South Wales 2060
Telephone: +61 2 9957 5577
Facsimile: +61 2 9954 0677
Email: sydney@bassett.com.au
www.bassett.com.au

W.E. Bassett and Partners Pty Ltd
ABN 22 004 873 634



Project
**ALCAN ALUMINA
REFINERY - GOVE
LIGHTING ASSESSMENT**

Drawing Title
**NIGHT-TIME SURVEYS SHOWING
LOCATIONS & Ev TOWARDS REFINERY.**

Scale @ A3	N.T.S.	Checked
Date	Aug' 03	Approved
Drawn	MJK	Verified

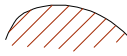
Drawing No. S5330-E001	
Sheet No. 1 of 4	
	Revision 01



Rev	Date	Amendment Description	By	Chk
01		PRELIMINARY DRAWING		



SCALE

-  HIGHEST ANTICIPATED ILLUMINANCE
-  VERTICAL ISOLUX LINE.

Consulting Engineer
12th Floor
132 Arthur Street
North Sydney
New South Wales 2060
Telephone: +61 2 9957 5577
Facsimile: +61 2 9954 0677
Email: sydney@bassett.com.au
www.bassett.com.au

W.E. Bassett and Partners Pty Ltd
ABN 22 004 873 634

Bassett

Project
**ALCAN ALUMINA
REFINERY - GOVE
LIGHTING ASSESSMENT**

Drawing Title
**PROPOSED STAGE 3 EXPANSION-
INCREASED LIGHT SPILL IMPACT.**

Scale @ A3	N.T.S.	Checked
Date	Aug' 03	Approved
Drawn	MJK	Verified

Drawing No.
S5330-E004



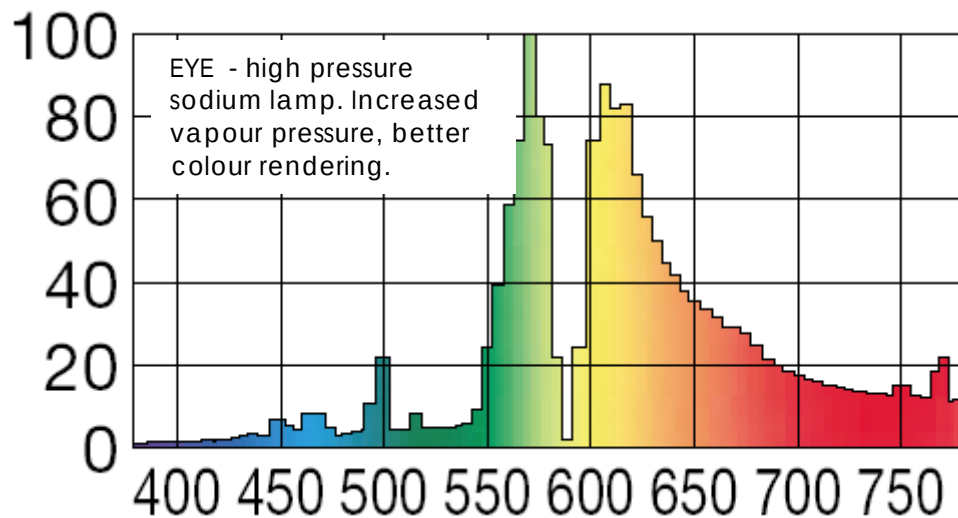
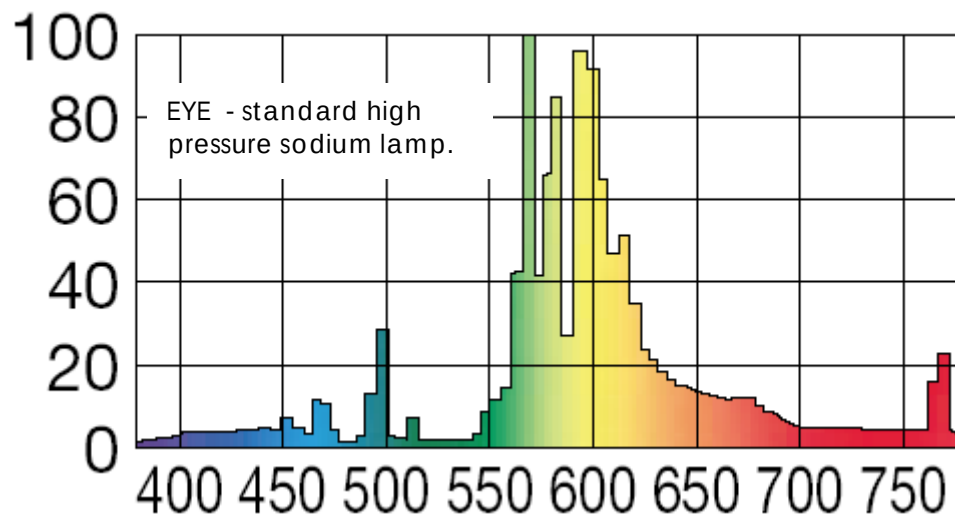
Revision
01

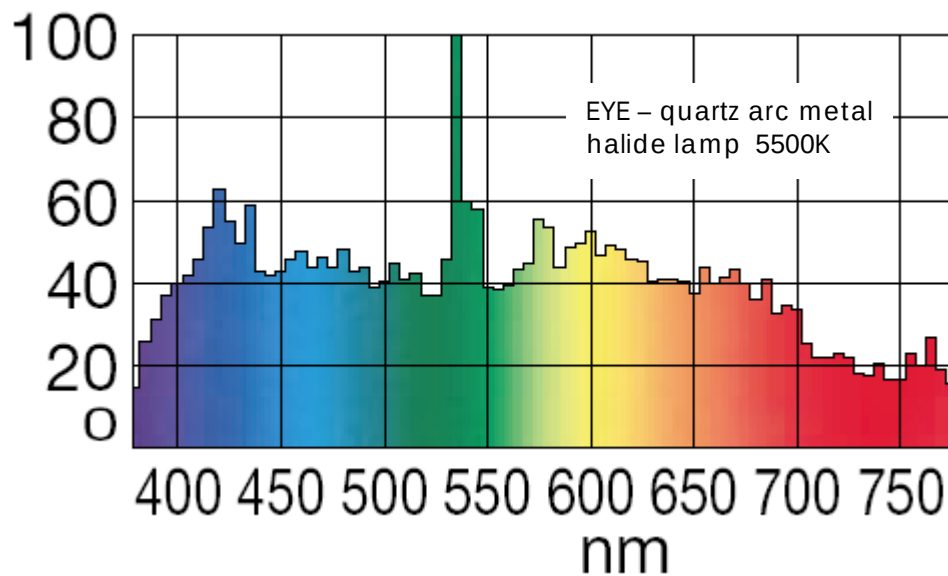
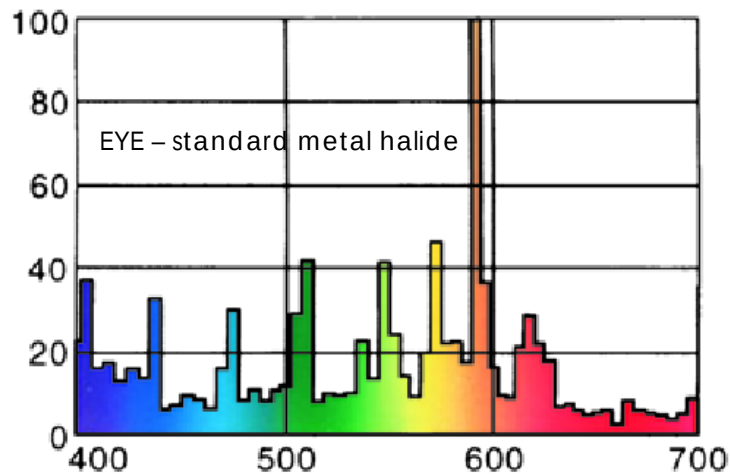
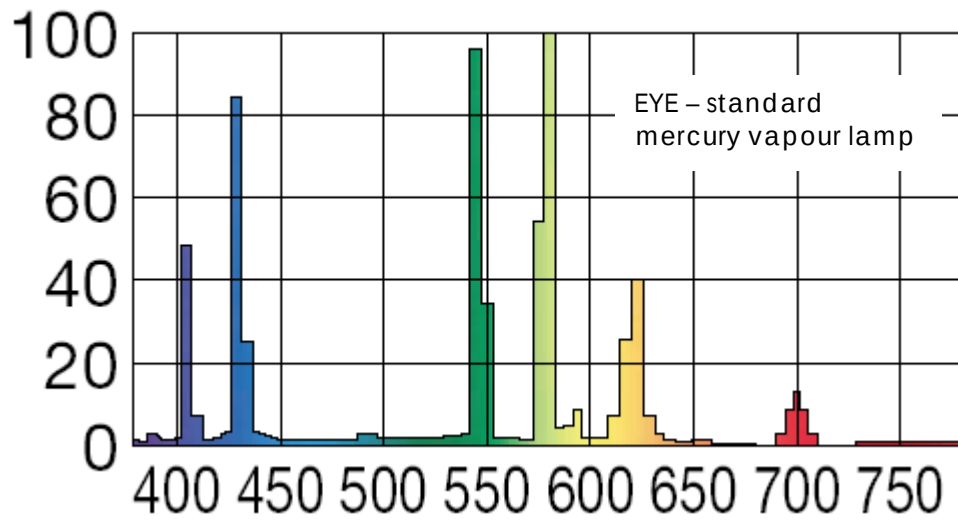
Sheet No. 4 of 4

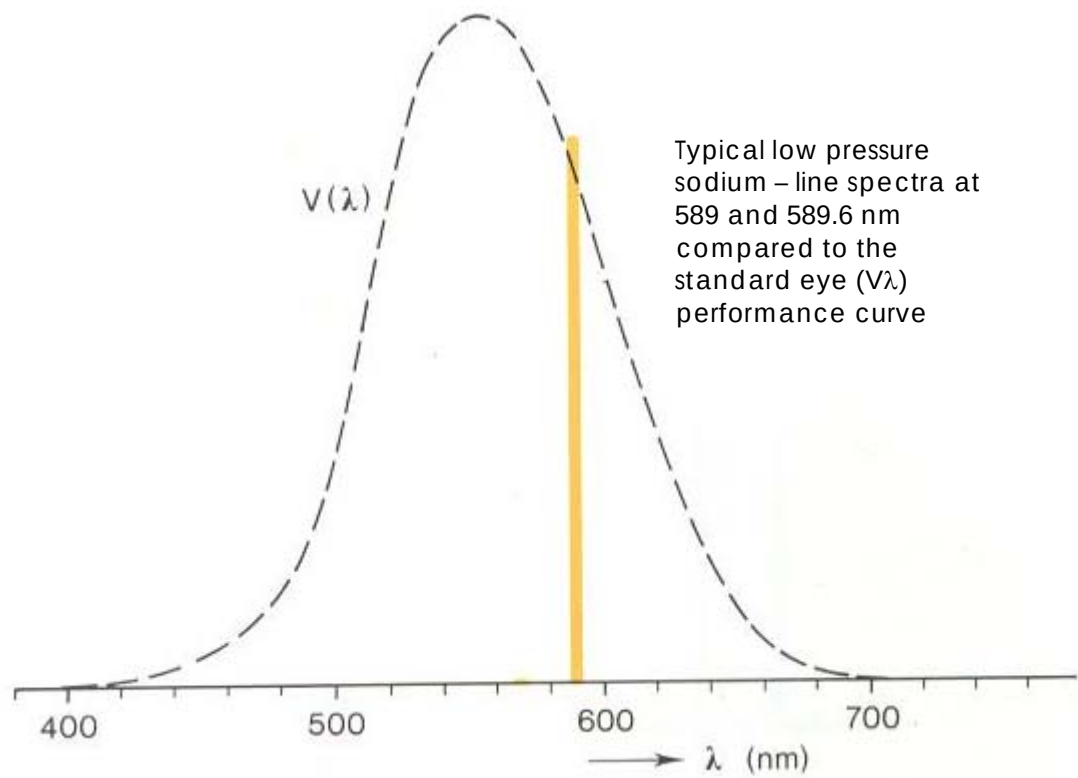
APPENDIX A

Manufactures Lamp Data

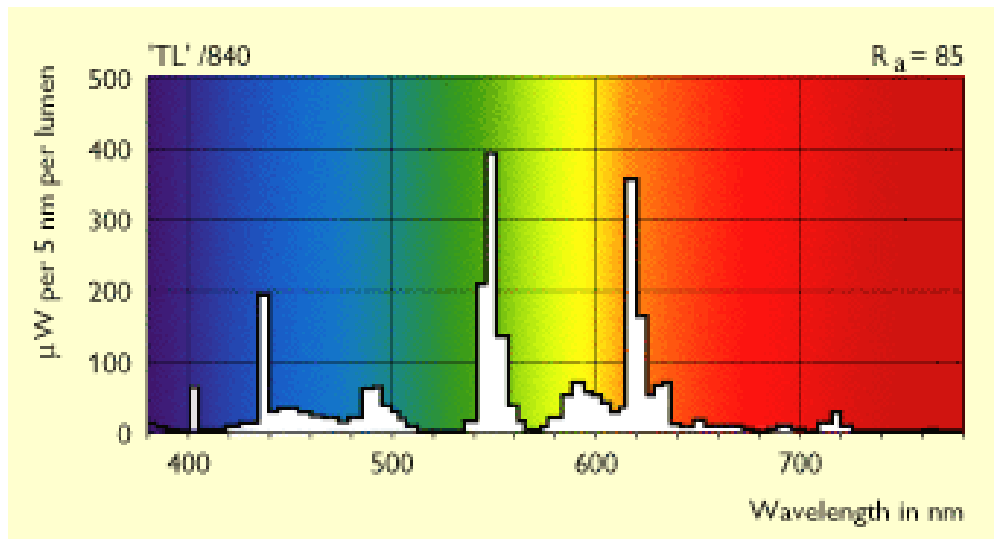
Relative Spectral Energy Distribution of Various Discharge Lamps



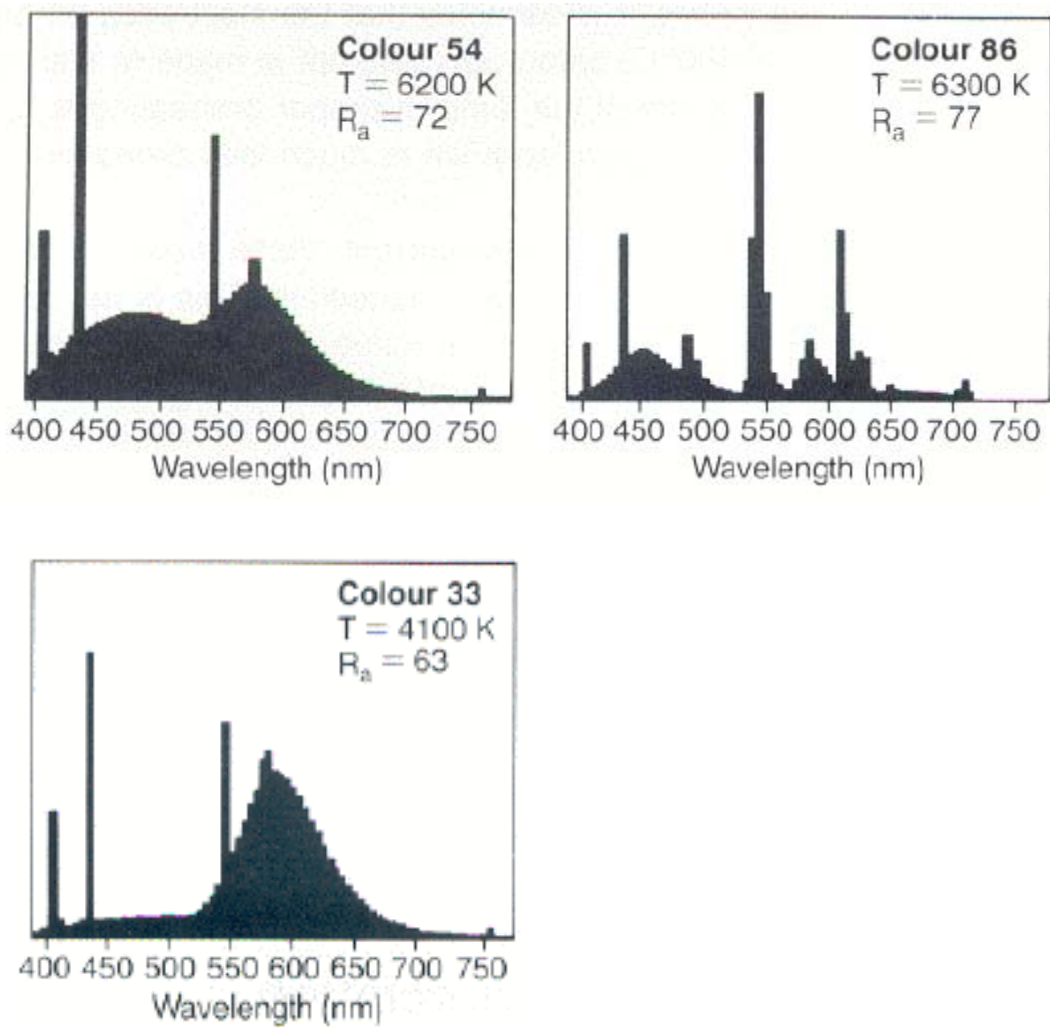




Light colour 840, $R_a = 85$

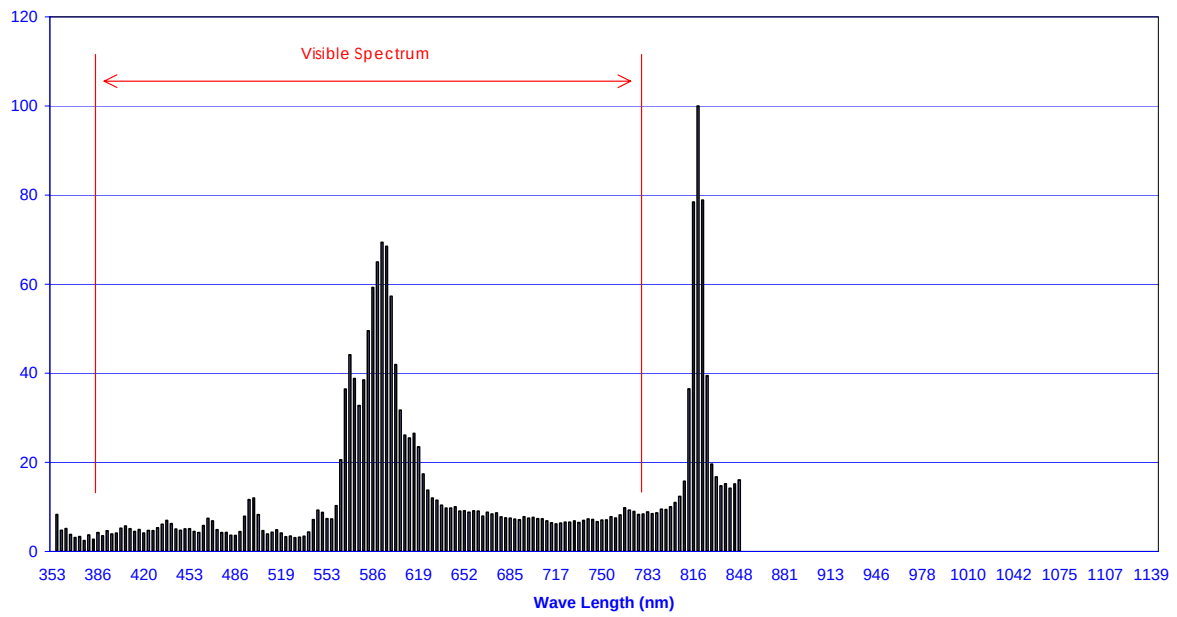
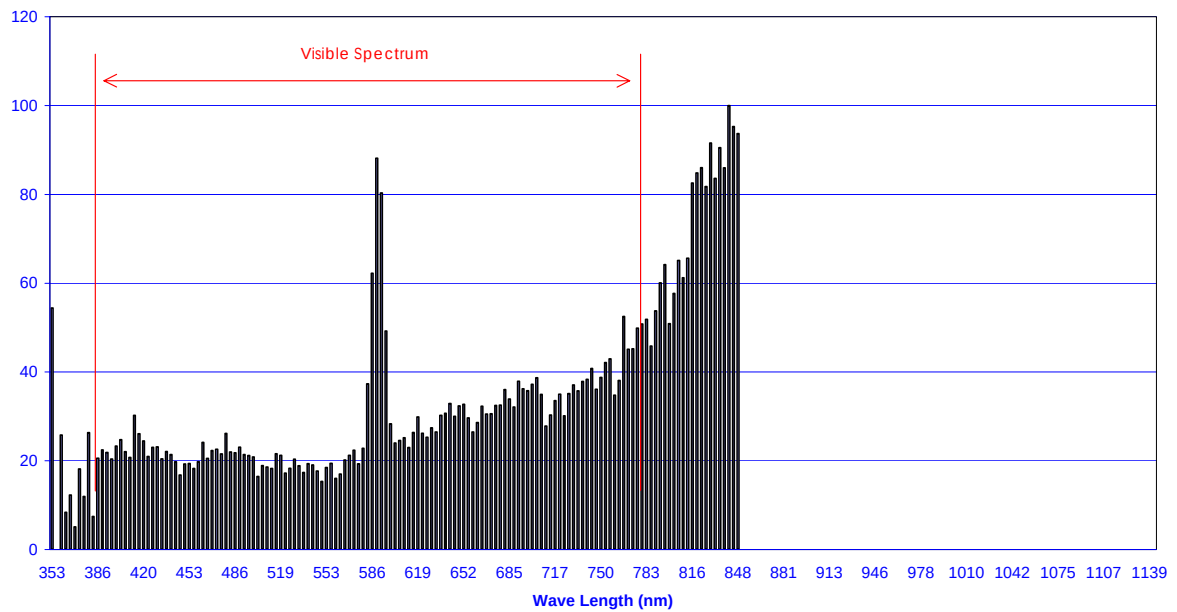


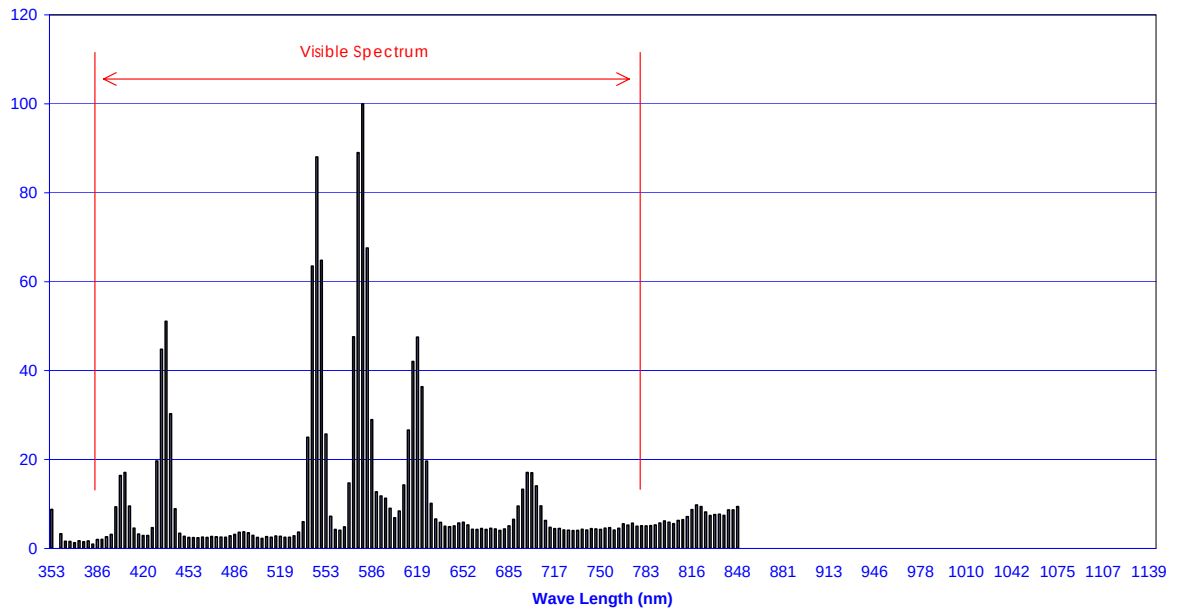
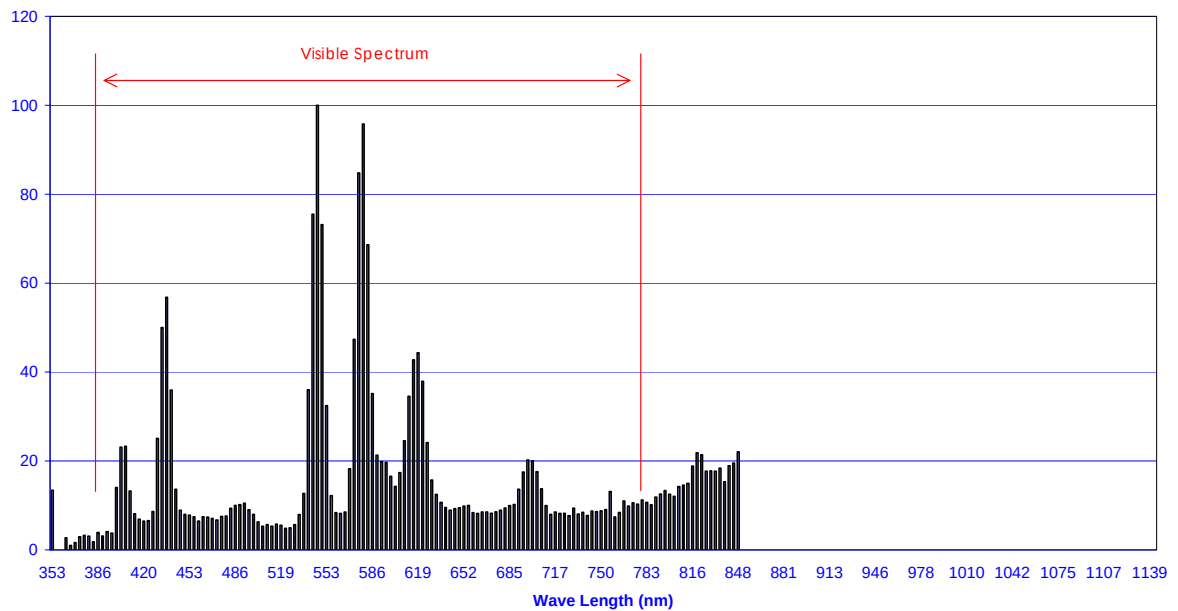
PHILIPS – Fluorescent lamps.

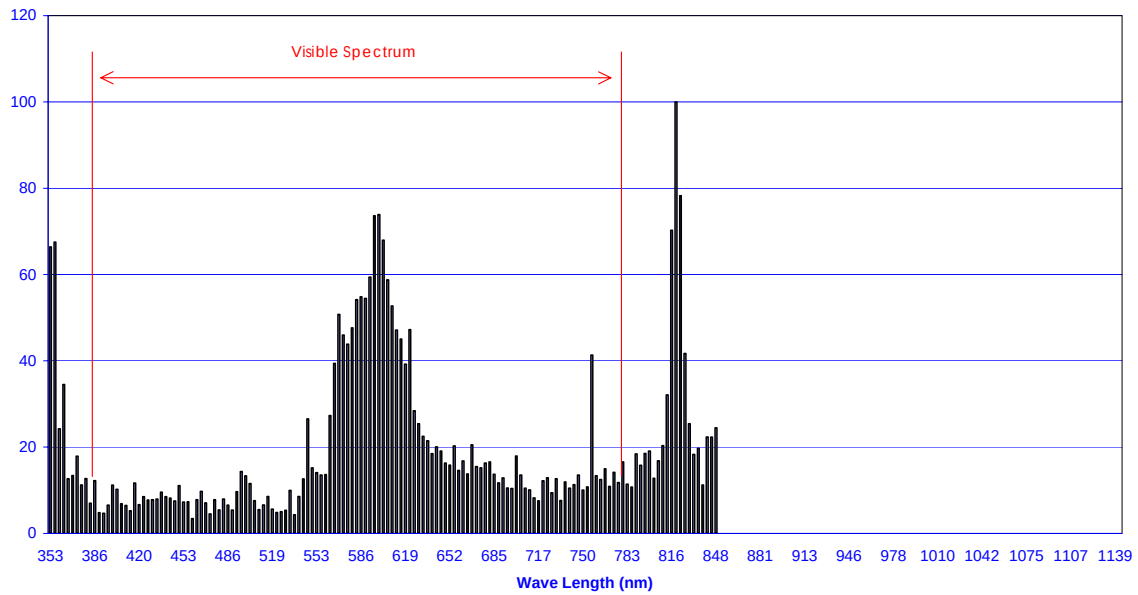
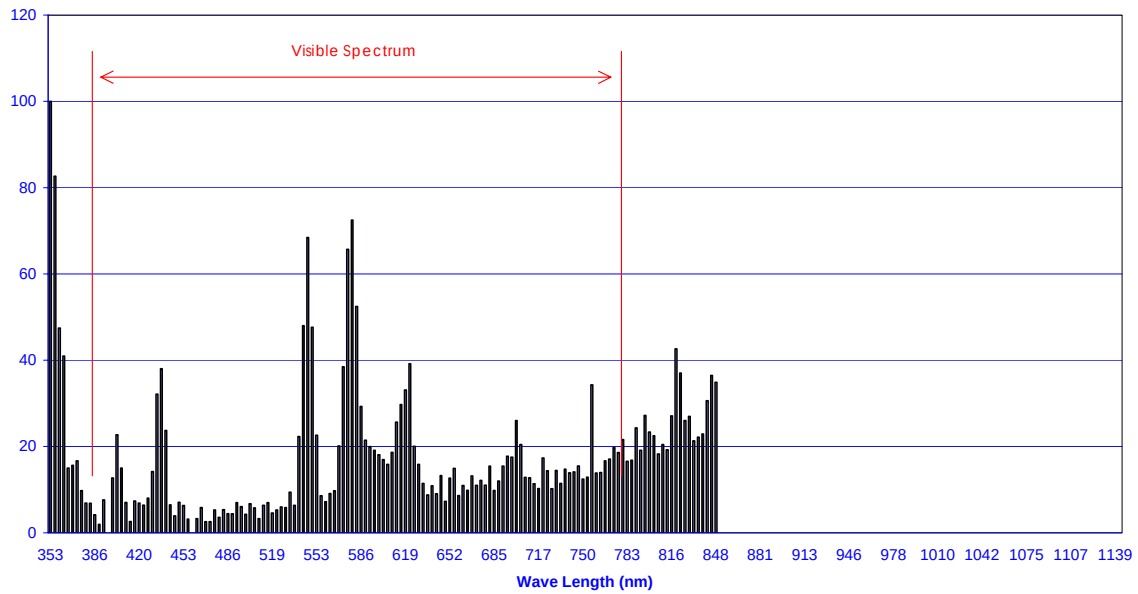


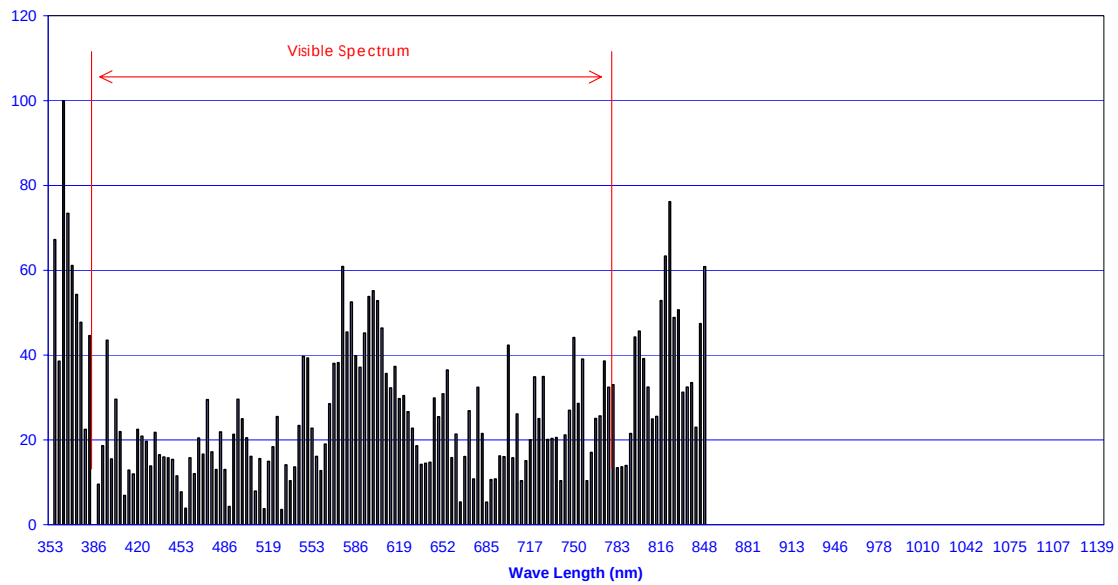
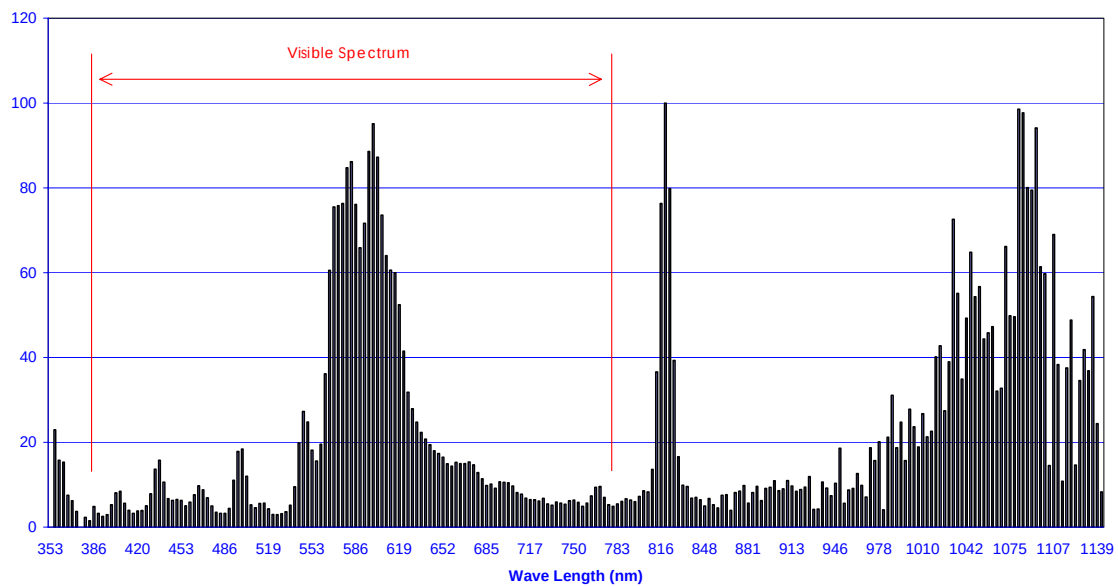
APPENDIX B

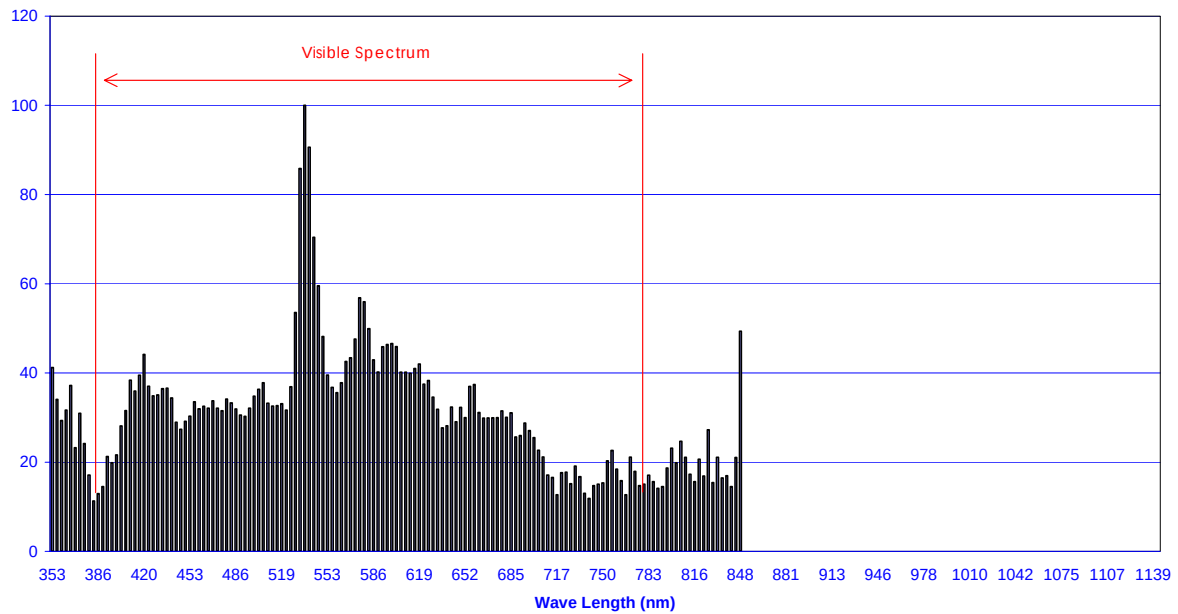
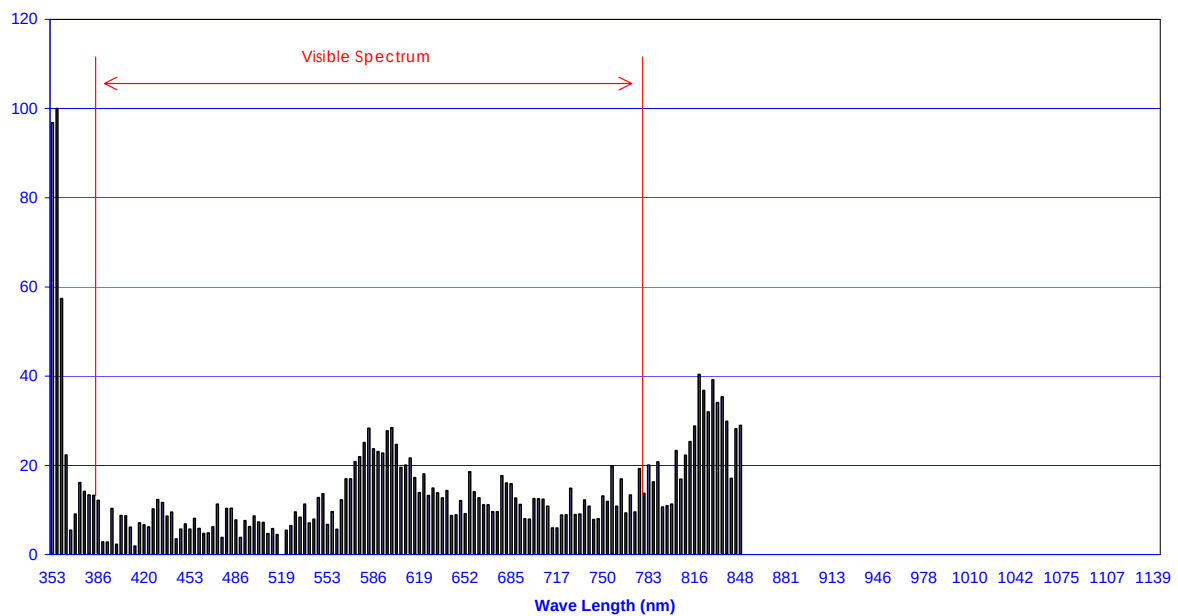
Spectral Analysis Results

Relative Spectral Distribution LM05**Relative Spectral Distribution LM06**

Relative Spectral Distribution LM09**Relative Spectral Distribution LM11**

Relative Spectral Distribution LM17s**Relative Spectral Distribution LM18**

Relative Spectral Distribution LM24**Relative Spectral Distribution LM43**

Relative Spectral Distribution LM47**Relative Spectral Distribution LM49**

APPENDIX C

Photographs – Gove Alumina Refinery

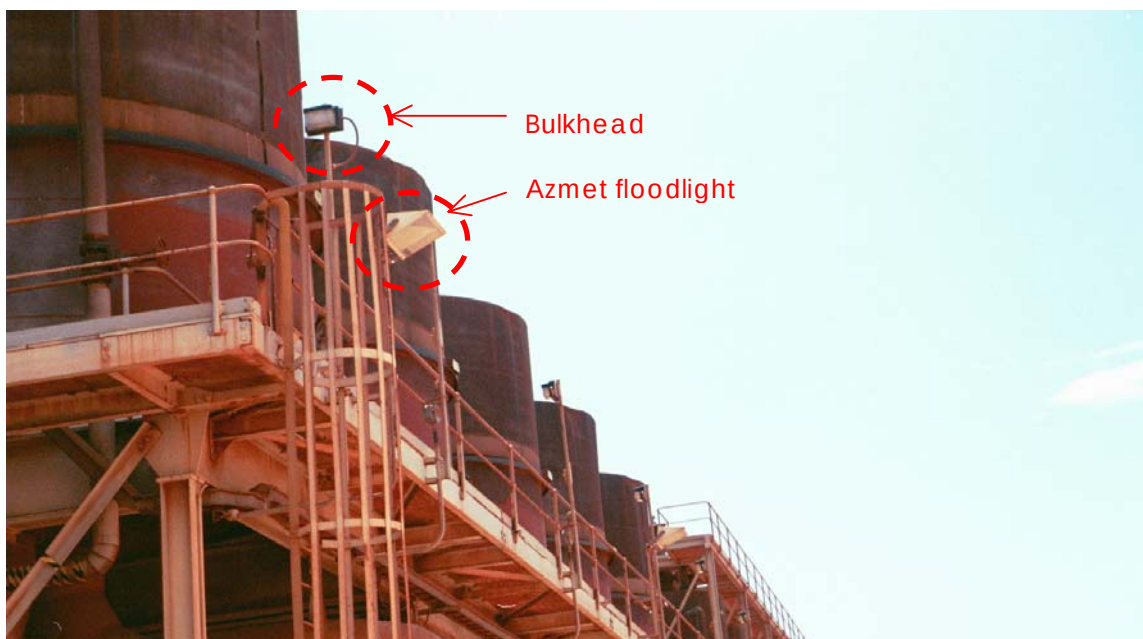


Photo 1. Evaporation area typical lighting. Azmet floodlight and bulkhead luminaires.

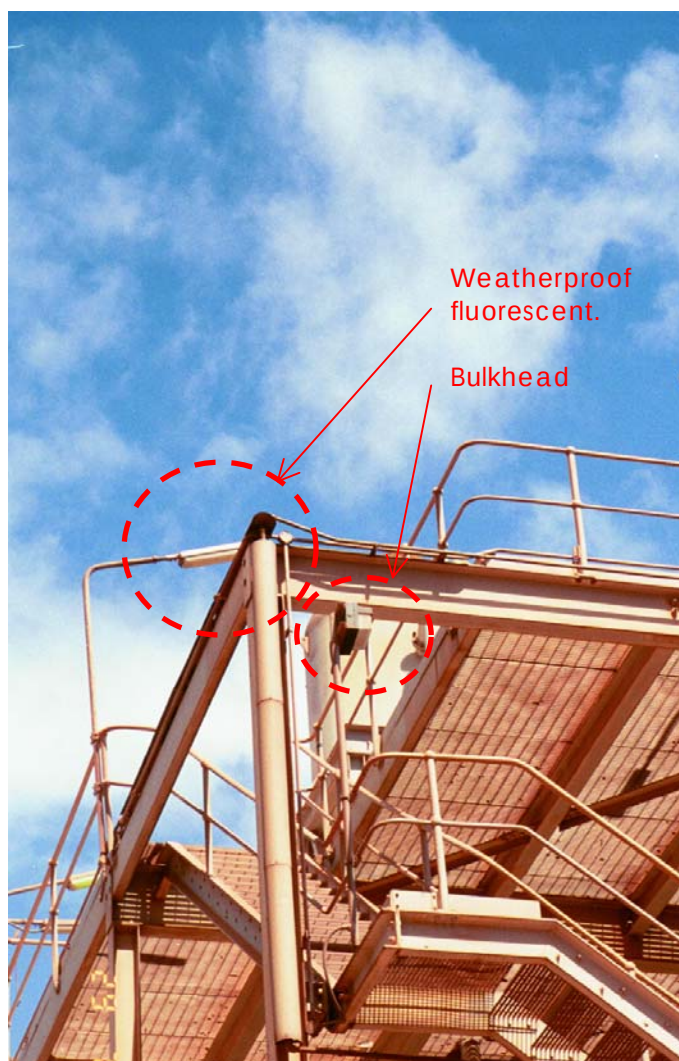


Photo 2. Hydration area typical lighting. Weather proof fluorescent and bulkhead luminaires

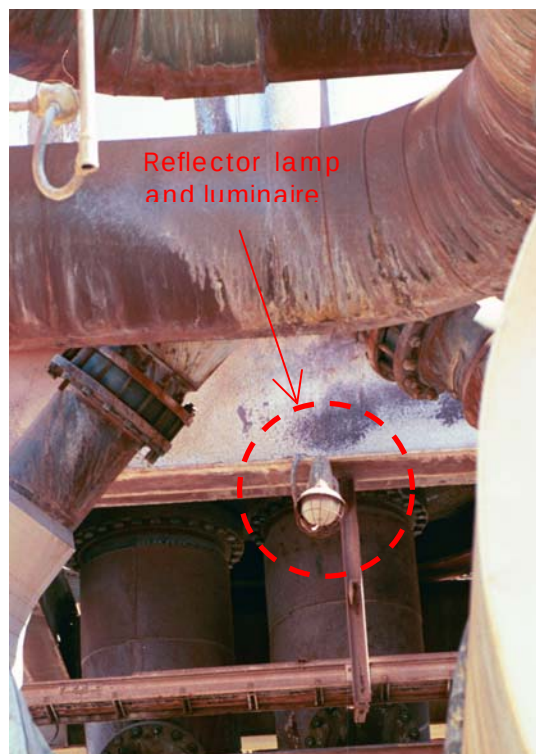


Photo 3. Typical lighting within plant structures – reflector lamp mercury vapour luminaire.

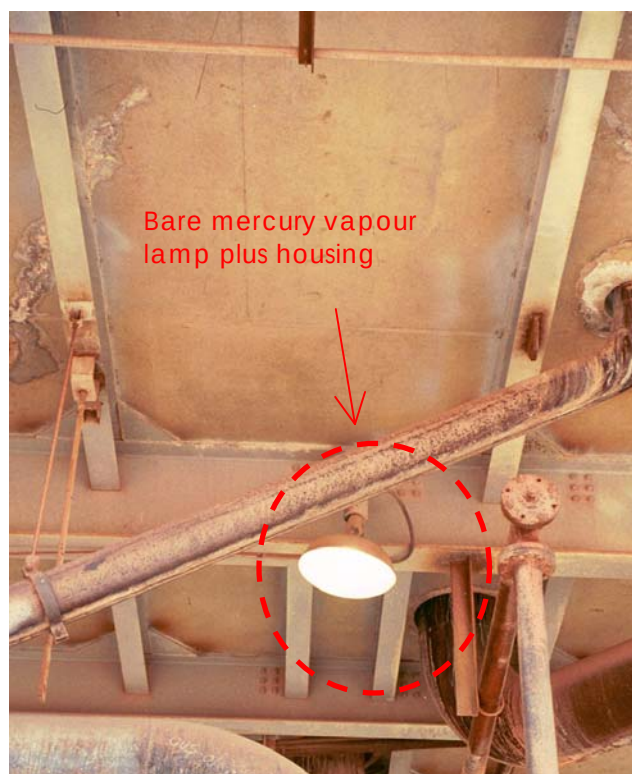


Photo 4. Typical lighting beneath plant – mercury vapour bare lamp with reflector above.

Photo 5. Typical lighting roadlighting luminaire used around the site.

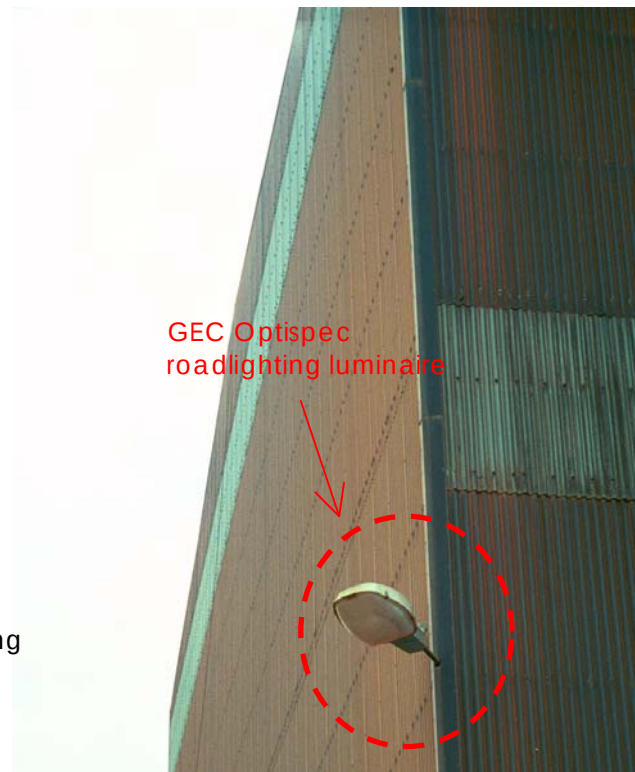


Photo 6. Another type of roadlighting luminaire – mercury vapour.

Photo 7. Main car park – EYE Azmet floodlights. One floodlight aimed with the peak at or above horizontal.



Photo 8. View of metal halide Azmet floodlight in main carpark from Melville Bay.



Photo 9. Galupa settlement



Photo 10. Pumping station adjacent Galupa settlement.

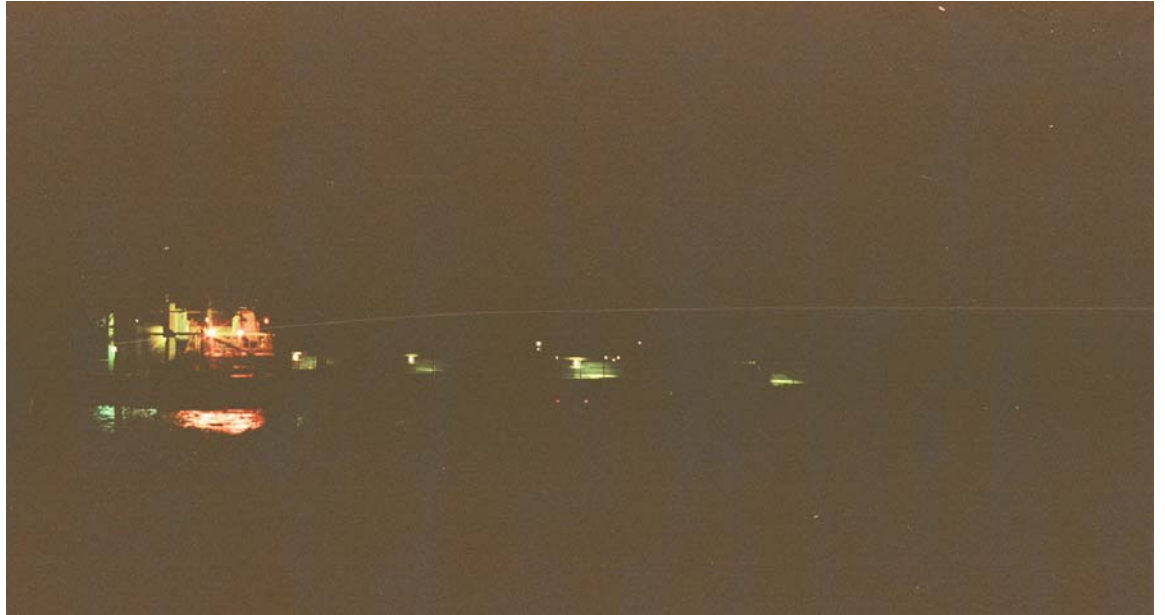


Photo 11. Lights on pumping station viewed from Galupa settlement



Photo 12. West Woody island showing the beach facing the refinery.



Photo 13. View of the refinery from East Woody island



Photo 14. View of refinery from Wallaby settlement.



Photo 15. View from West Woody island towards refinery.

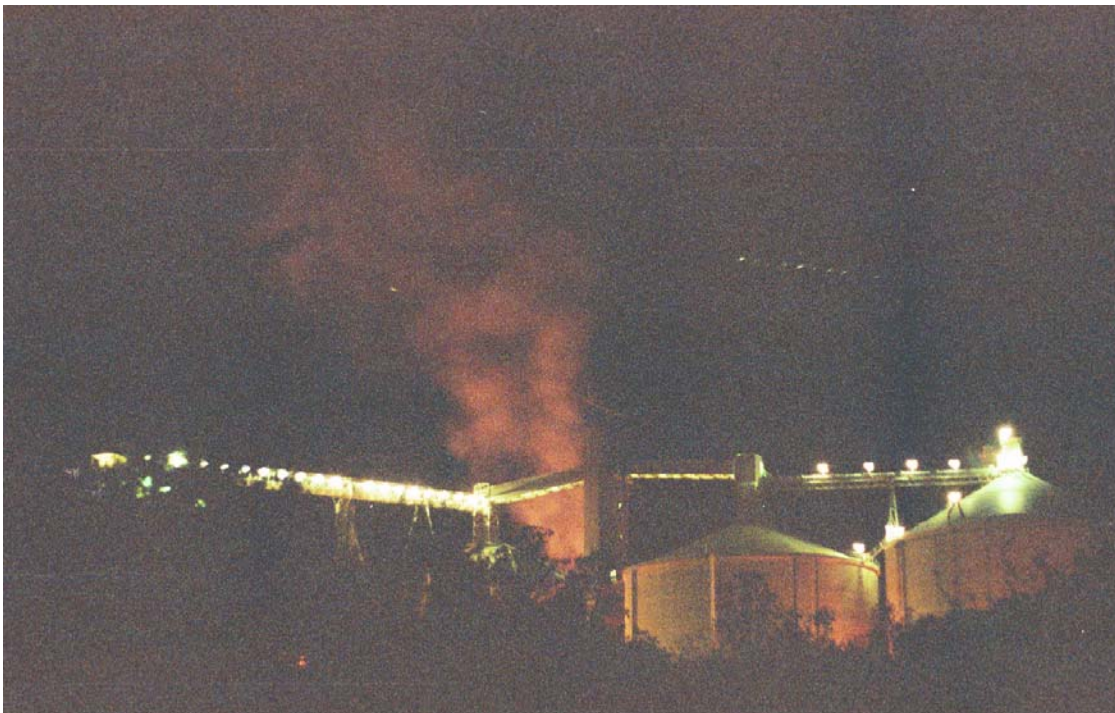


Photo 16. View from LM19 towards refinery – silos only visible from this point.



Photo 17. Refinery from position LM18.



Photo 18. General cargo wharf metal halide floodlighting



Photo 19 & 20. View from LM17 towards cooling towers and precipcs.

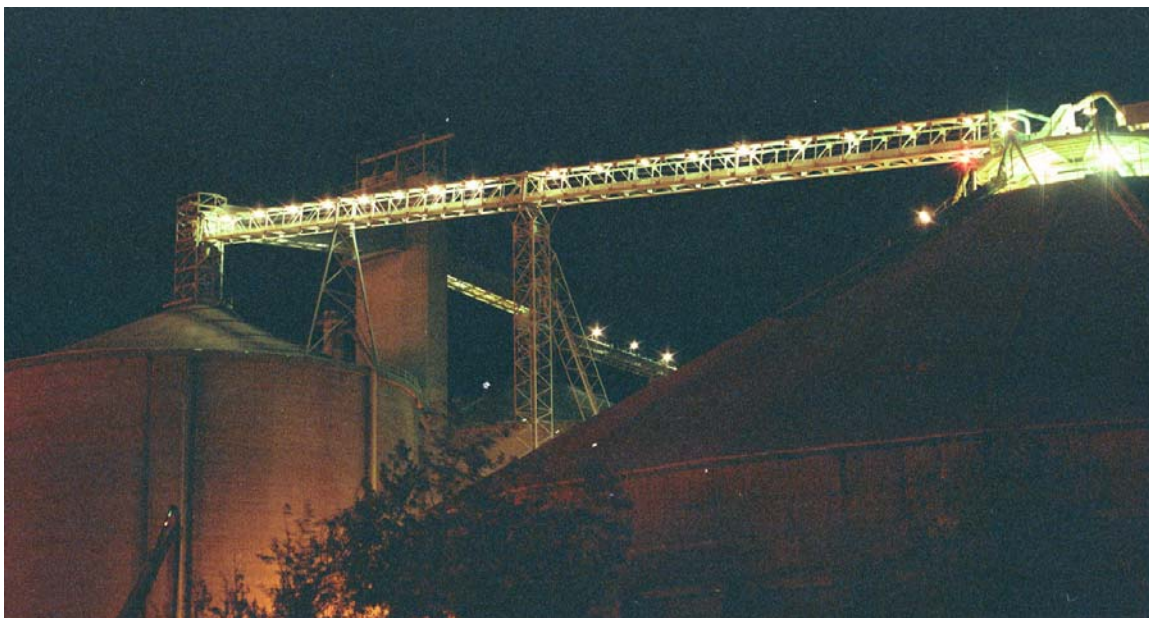


Photo 21. Old silo from position LM17 – mercury vapour lighting



Photo 22. From Arafura Sea position LM20 or 21 towards precip



Photo 23. Refinery from LM70.



Photo 24. Refinery and north shoreline from LM69.



Photo 25. View from LM59



Photo 26. View from LM58.

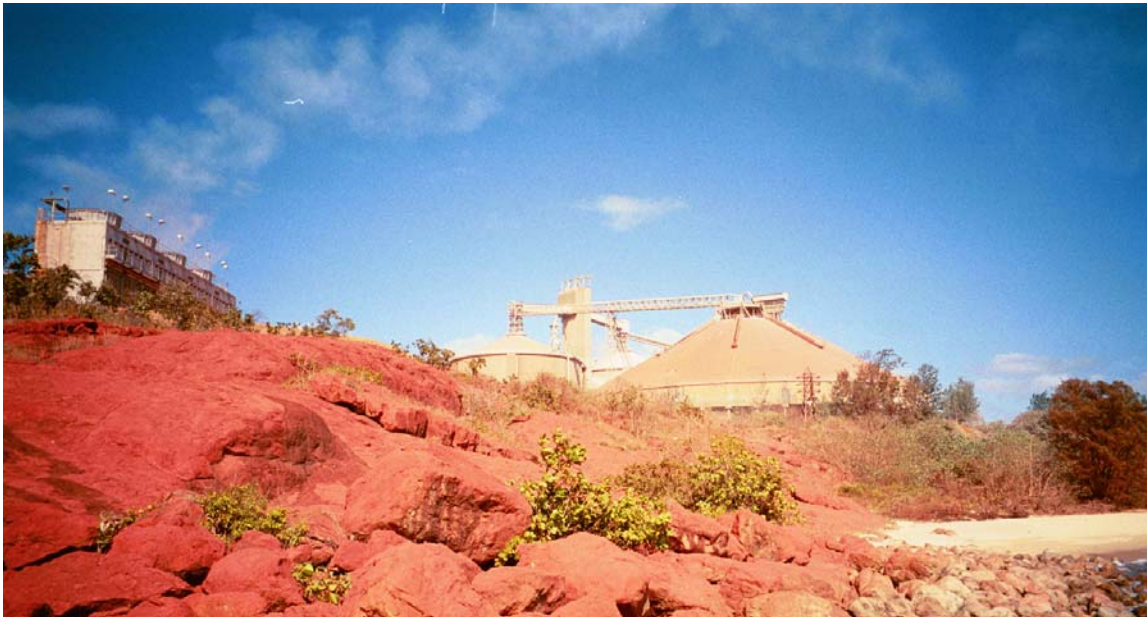


Photo 27. Cooling tower and old silo from north shoreline.

Photo 28. Cooling tower from north shoreline showing that there will be direct light spill from the floodlights onto the beach.

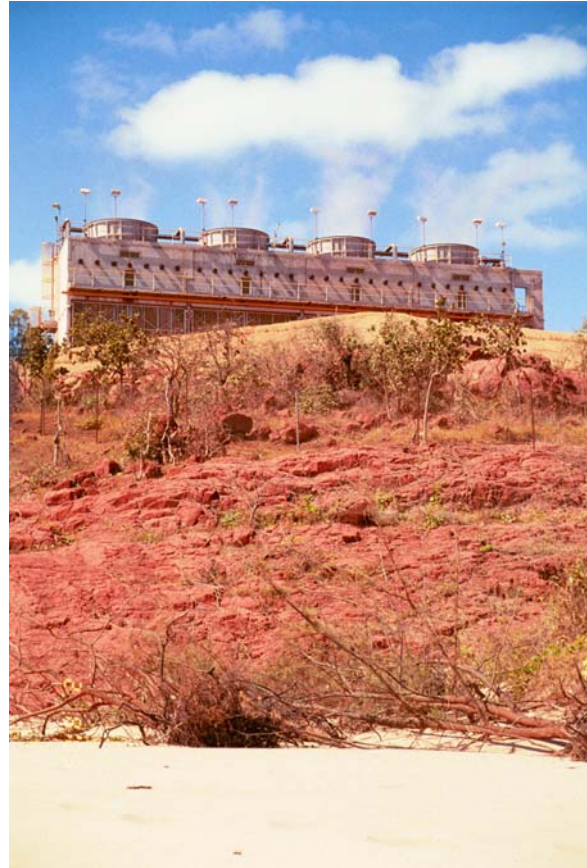


Photo 29. Old silo from north shoreline.





Photo 30. View east along north shoreline from LM67.



Photo 31. View of west shoreline from LM68.



Photo 32. Bulk cargo wharf from LM69.



Photo 33. View towards LM05 from general cargo wharf.



Photo 34. Refinery from LM15.



Photo 35. View from Arafura Sea LM36



Photo 36. View from approximately LM01 – road to Drimmie Head.

Photo 37. Light on side of thickner tank. Reflector lamp in housing.

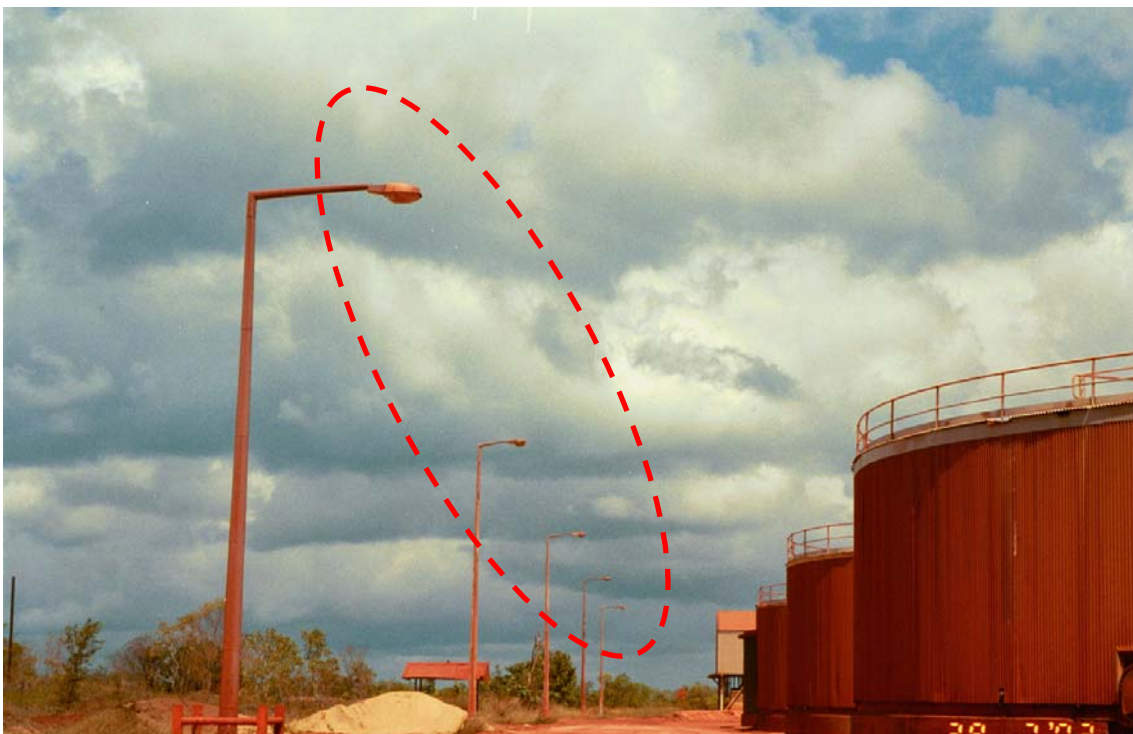


Photo 38. Roadlighting luminaires for general site circulation



Photo 39. Bulkhead luminaires on high level walkways above precipitates.

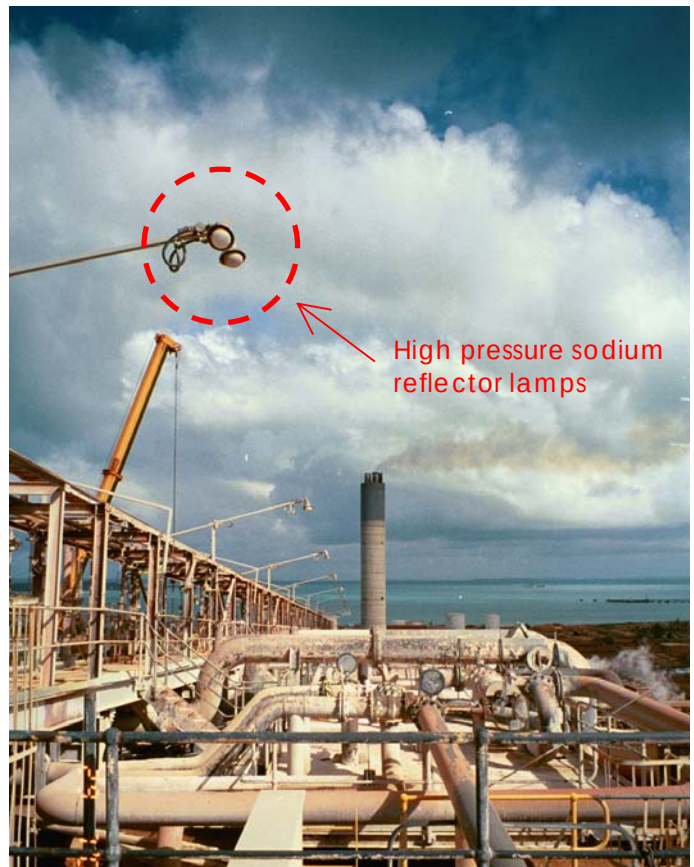


Photo 40. Reflector lamps on cantilever arms lighting into top of precipitates.

Photo 41. Access lighting on vertical calciner – weather proof fluorescent and floodlights

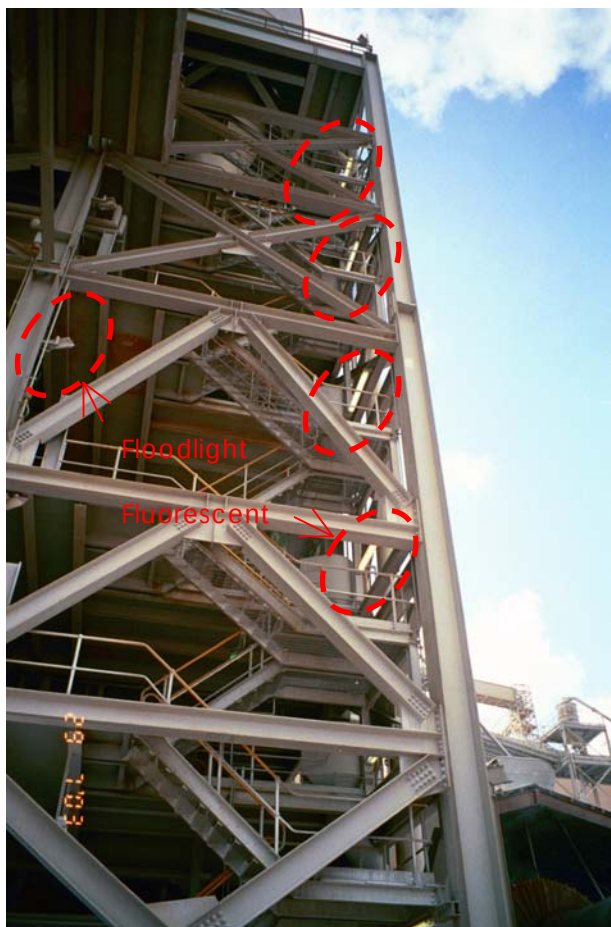
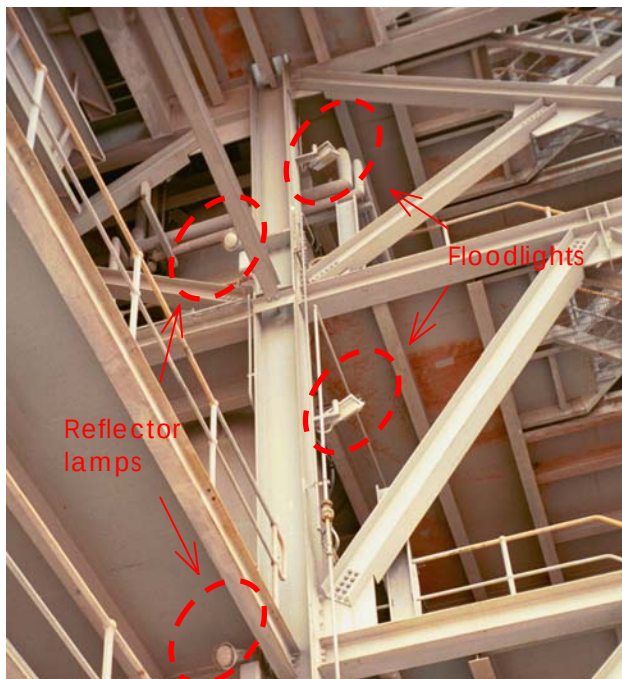


Photo 42. Access lighting on vertical calciner – Floodlights refinery and reflector lamps.



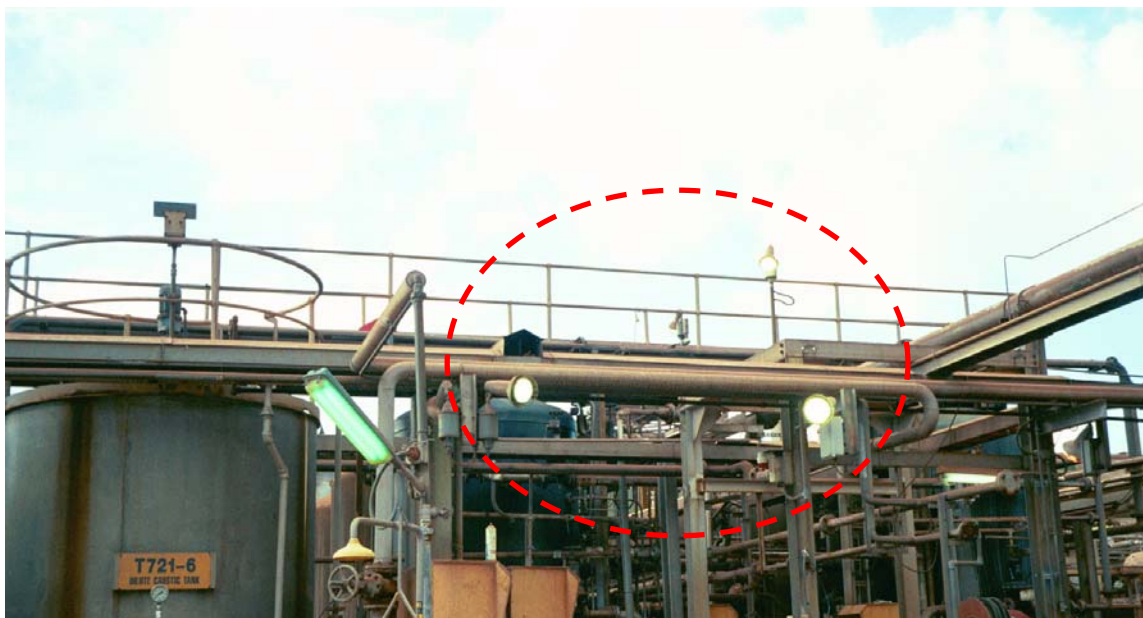


Photo 43. Typical low height structure lighting. Mercury vapour reflector lamps plus green emergency wash station lighting.



Photo 44. Typical use of bulkheads at low height – Evaporation area.



Photo 45. Azmet floodlights, fluorescent and reflector lamps on top of hydrate area.



Photo 46. Azmet floodlights on pole above thickner tanks.



Photo 47. Model of refinery – proposed stage 3 expansion in white colour.

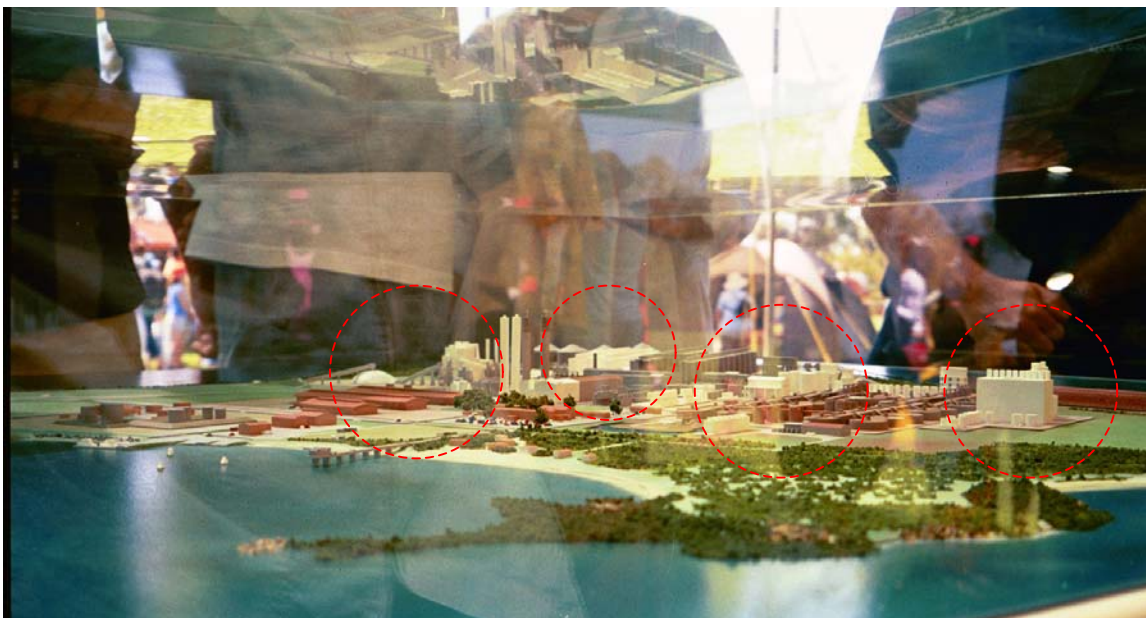


Photo 48. Refinery model with proposed stage 3 expansion shown in white colour. View from Inverell bay.



Photo 49. Model of refinery with proposed stage 3 expansion shown in white colour. View from north in the Arufura Sea.

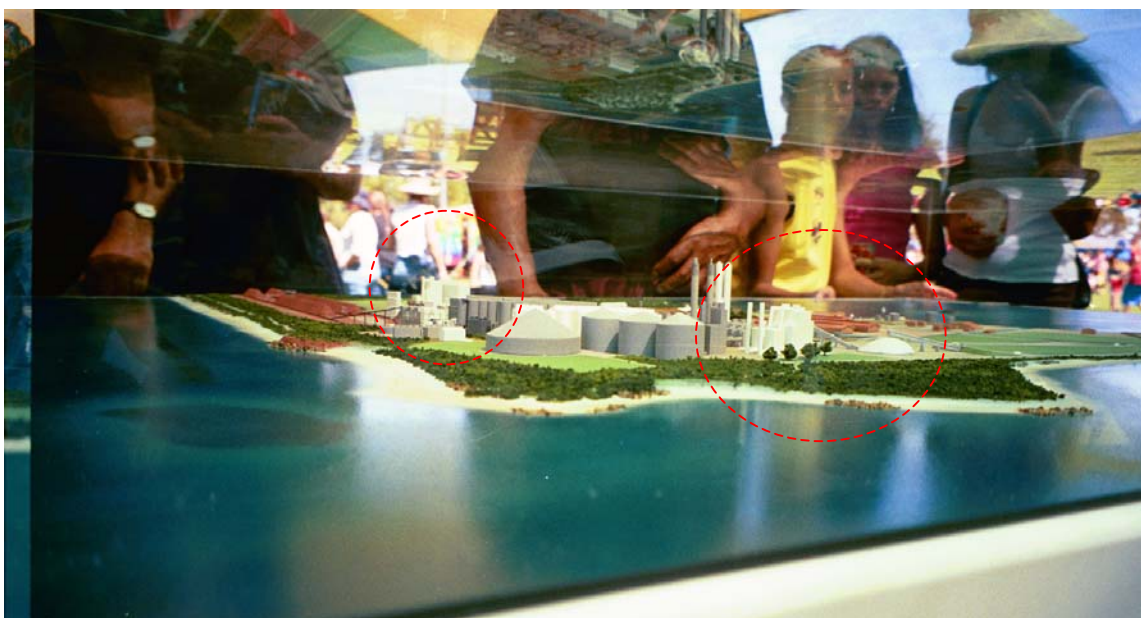


Photo 50. Refinery model with proposed expansion shown in white. View from off Wargarpunda Point.

APPENDIX D

Measuring Instrument Details

1. **Illuminance meter.** Minolta T1 auto ranging illuminance meter. Auto ranging from 0.01 lux to 100,000 lux. Last calibrated by a NATA registered laboratory 11/08/03.
2. **Luminance meter.** Minolta luminance meter LS-110, 1/3 rd acceptance angle auto ranging from 0.01 to 999,900 cd/m².
3. **Spectroradiometer.** PP systems Unispec spectrometer 300 to 1100 nm complete with 2.1mm fibre optic plus reference standard plus HP palm top.
4. **GPS** (Global Positioning System) satellite navigator Magellan GPS 310.

APPENDIX E

Stage 3 Impact Modelling

Assumptions

1. The various items of plant will be lit similarly to that which exists currently.
2. There will be many more fluorescent, mercury vapour and high pressure sodium reflector lamps and bulkhead luminaires in reality than used in these indicative calculations – that is the light spill will be greater than shown.
3. The area is flat and unobstructed.
4. Spill light calculations are always based on worst case, that is new equipment with no dirt accumulation or lumen depreciation.
5. The combination of assumptions 2 and 4 cancel out the effect of the other for the purpose of this exercise.

Gove Alumina Refinery

Stage 3 Impact Modelling

Date: 30-08-2003
Customer: Alcan Alumina Refinery - Gove
Customer Representative: Steve Vellacott
Designer: Tim Shotbolt

The nominal values shown in this report are the result of precision calculations, based upon precisely positioned luminaires in a fixed relationship to each other and to the area under examination. In practice the values may vary due to tolerances on luminaires, luminaire positioning, reflection properties and electrical supply.

Bassett Consulting Engineers Pty Ltd

Level 12
132 Arthur Street
North Sydney NSW 2059

Telephone: 02 9957 5577
Fax: 02 9954 0677
E-Mail: t.shotbolt@bassett.com.au

CalcuLuX Area 4.5b

Gove Alumina Refinery

Stage 3 Impact modelling

Bassett Consulting Engineers Pty Ltd
Date: 30-08-2003

Table of Contents

1. Summary	3
1.1 General Information	3
1.2 Observer Information	3
1.3 Project Luminaires	3
1.4 Calculation Results	3
2. Calculation Results	4
2.1 Grid: Iso Contour	4
3. Luminaire Details	5
3.1 Project Luminaires	5

Gove Alumina Refinery

Stage 3 Impact modelling

Bassett Consulting Engineers Pty Ltd

Date: 30-08-2003

1. Summary

1.1 General Information

The overall maintenance factor used for this project is 1.00.

1.2 Observer Information

Code	Observer	Position		
		X (m)	Y (m)	Z (m)
Aa	CentreVertical	0.00	0.00	40.00

1.3 Project Luminaires

Code	Qty	Luminaire Type	Lamp Type	Power (W)	Flux (lm)
A	35	Azmet3 asymmetric58 degrees	1 * 400HPS	438.0	1 * 50000
D	48	EYE watchman reflector lamp	1 * 400reflector	438.0	1 * 31000
E	6	Sam236 weatherproof	2 * tld36	92.0	2 * 500

The total installed power: 36.91 (kWatt)

Number of Luminaires Per Arrangement:

Arrangement	Luminaire Code			Power (kWatt)
	A	D	E	
CT2a	5	0	0	2.19
CT2b	4	0	0	1.75
Calcine1	0	0	6	0.55
Line	8	0	0	3.50
Line2	7	0	0	3.07
Precip1	0	12	0	5.26
Precip2	0	12	0	5.26
Precip3	0	12	0	5.26
Precip4	0	12	0	5.26
Purify1	6	0	0	2.63
Purify2	5	0	0	2.19

1.4 Calculation Results

(II)luminance Calculations:

Calculation	Type	Unit	Ave	Min/Ave	Min/Max
Grid	Illuminance -> Aa	lux	0.67	0.07	0.00

Gove Alumina Refinery

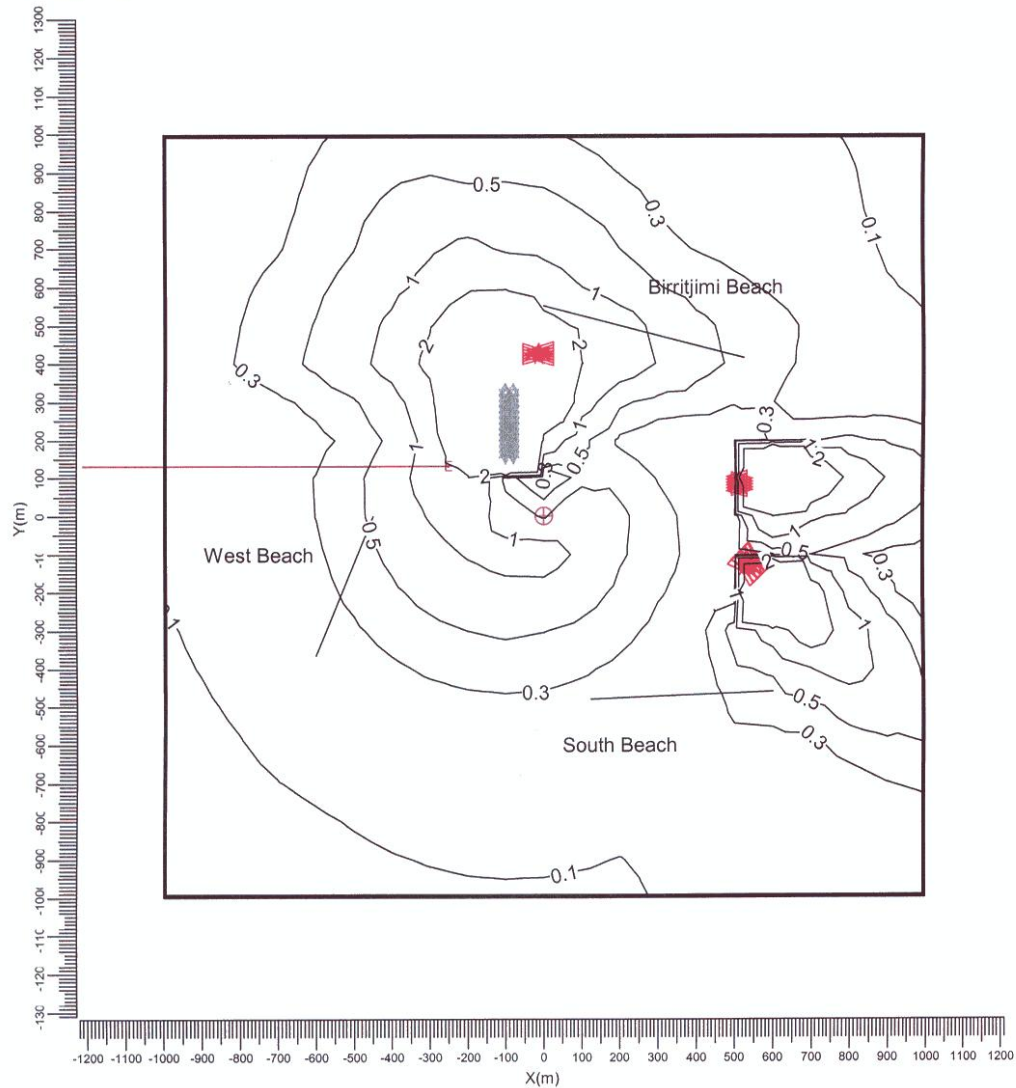
Stage 3 Impact Modelling

Bassett Consulting Engineers Pty Ltd
Date: 30-08-2003

2. Calculation Results

2.1 Grid: Iso Contour

Grid : Grid at Z = 0.00 m
 Calculation : Illuminance towards CentreVertical (lux)
 Height above grid : 0.00 m



A → Azmet3 asymmetric58
 degrees
 D → EYE watchman reflector
 lamp
 E → Msa 236 weatherproof Max
 Average 0.67
 Min 0.07
 Max 0.00

Project maintenance factor
 1.00

Scale
 1:15000

CalcuLuX Area 4.5b

Philips Lighting B.V.

Page: 4/6

Gove Alumina Refinery

Stage 3 Impact modelling

Bassett Consulting Engineers Pty Ltd
Date: 30-08-2003

3. Luminaire Details

3.1 Project Luminaires

Azmet3 asymmetric58 degrees 1 x 400HPS

Light output ratios

DLOR : 0.64

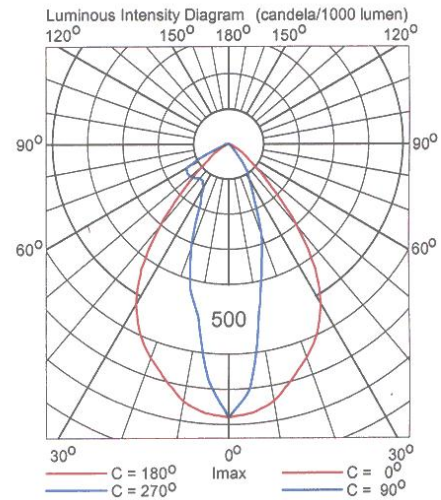
ULOR : 0.00

TLOR : 0.64

Lamp flux : 50000 lm

Luminaire wattage : 438.0 W

Note: Luminaire data not from database.



EYE watchman reflector lamp 1 x 400reflector

Light output ratios

DLOR : 1.00

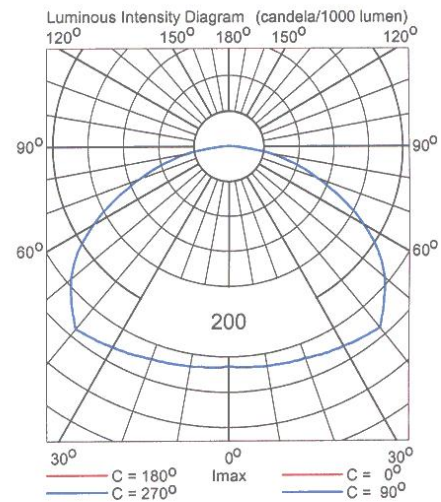
ULOR : 0.00

TLOR : 1.00

Lamp flux : 31000 lm

Luminaire wattage : 438.0 W

Note: Luminaire data not from database.



Gove Alumina Refinery

Stage 3 Impact modelling

Bassett Consulting Engineers Pty Ltd

Date: 30-08-2003

Sam236 weatherproof 2 x tld36 / 33

Light output ratios

DLOR : 0.65

ULOR : 0.07

TLOR : 0.72

Lamp flux : 500 lm

Luminaire wattage : 92.0 W

Note: Luminaire data not from database.

