18.0 Lighting

18.1 Background

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

The refinery expansion will introduce additional lighting to the site.

A lighting assessment has been undertaken by Bassett Consulting Engineers (2003). A copy of their report is given in Appendix G.

18.2 Standards

18.2.1 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 for the locations of buildings within vacant properties. The standard sets out criteria related to the human experience of light and provides criteria for both pre-curfew hours and post-curfew hours where the curfew time is established by the relevant regulatory authority. The criteria for late night (post-curfew which is typically after 2200 or 2300 hours) is considerably more restrictive. The Standard nominates the following vertical illuminance criteria for post-curfew hours:

- 4 lux – at the boundary of commercial and residential areas;
- 2 lux – in residential areas with light surrounds; and
- 1 lux – in residential areas with dark surrounds.

At Galupa, because it abuts a "commercial area" (the refinery), the 4 lux criteria could be applied. However, direct views of the refinery are not available from Galupa because of the intervening vegetation. Consequently, it could be argued that the most relevant criteria is that specified for residential areas in "light surrounds", that is 2 lux. The existing street light, which illuminates the area all night, would support this designation. Consequently, a standard of 2 lux has been applied in this assessment for Galupa and the other surrounding residential areas.

The refinery itself also has lighting standards that apply across the site. These are the Gove Standards Manuals GSM-ENG-4184-900 and 4194-901. 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.

18.2.2 Criteria for Animals

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. Another criteria with respect to the travel of hatchlings towards the sea is believed to be the "brightness" of light sources (www.turtletime.0rg/lighting/problems), that is, the horizon and the moon.

18.3 Existing Refinery Lighting

The characteristics of a light source (colour temperature (degrees Kelvin K), colour rendering (R_a) capability and lumen package (quantity of visible light – l m)) have implications both to the human visual system and the effectiveness of seeing. Colour temperature is the "whiteness" of the light with low colour temperatures being very yellow orange and high colour temperature being "bluish white". The following light sources exist at the refinery.

Table 18.3.1
Existing Light Sources

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	-	-

Lighting is generally used appropriately around the refinery with the top of the floodlights being horizontal and the peak intensity being at 60 degrees up from the nadir (downward vertical) minimising unnecessary light spill. However, there are some instances where the floodlights are aimed upwards a further 30 degrees which means the peak intensity is aimed horizontally and this is noticeable in Melville Bay.

18.4 Lighting Survey

18.4.1 Survey Methodology

A night-time light survey was conducted at various locations around the refinery from 28 July to 2 August 2003. Measurements were made as close to the refinery boundaries as possible both from land and from sea. Some measurements were also made from West Woody Island. 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 East Woody Island and the settlement of Gunyangara on Drimmie Peninsula. Details of the 76 survey locations are given in Appendix G.

18.4.2 Survey Results

Results of the survey are summarised in Appendix G.

There were two main types of information recorded during the survey - illuminance measurements and spectral measurements. Illuminance measurements are adjusted to the standard human eye response that shows peak sensitivity at the middle of the visible spectrum and very little sensitivity at either the low blue and high red end of the visible spectrum. Spectral measurements show all of the electromagnetic energy at the different frequencies without any bias towards the way the human eye responds.

18.4.2.1 Illuminance

Illuminance can be measured in the horizontal plane and as such measurements are independent of the direction of the light so long as it is above the horizontal. Illuminance is also measured in the vertical plane where it is dependent on direction. Both horizontal and vertical illuminance results have been recorded as appropriate during the survey.

The vertical illuminances (E_v) for the existing refinery are shown on Figure 18.4.1 as isolux lines (lines of equal lux). The results show the pattern of the light spill and that coincides with the height of the nearby structures and the external lighting associated with the various refinery areas. Illuminance measurements were not made along the north and west beaches because of access restrictions due to safety reasons. However, the illuminance at these locations was estimated based on measurements taken nearby but inside the refinery fence.

18.4.2.2 Spectral Analysis

Spectral analysis was used to verify the spectral signature of some of the light sources.

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 the beach to the north of the refinery 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), are also 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.

18.5 Existing Light Effects

At Galupa, the measured vertical illuminances were below the 2 lux criteria of AS 4282 – 1997. Nevertheless, lights on the saltwater pumping station offshore from Galupa will be reviewed. The survey has indicated that the high pressure sodium bulkhead lights at the pumping station appear quite bright. The light measurement was sufficiently high to be of concern although by itself does not breach the maximum tolerable value expressed in AS 4282 – 1997.

All other settlements are too distant to provide measurable data on the refinery lights. Whilst it is possible to see the refinery lights from other locations, illuminance measurement would not register on the light meter. This is because of the distance to the refinery and the small angle of view of the refinery's lights compared to the much larger angle of view of the dark sky. At these locations, the refinery is not a source of significant glare.

Light spill onto the beach to the north of the refinery has the potential to affect any nesting turtles that may be present. However, as discussed in Section 14.5.3, this beach is not a significant turtle nesting location and hence no significant effects on turtles have been recorded.

18.6 Expansion Impacts

The expansion of the refinery will result in an increased 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 nature and extent of their lighting, and their proximity to the point(s) of concern.

Figure 4.4.1 shows the areas within the refinery where the expansion will occur and hence where most of the additional lighting will be located. Whilst the lighting details have yet to be designed, the relative heights of the structures and the nature of the lighting in the various process areas can be estimated by consideration of the height and nature of the lighting in the existing areas.

The new precipitation area will result in additional lighting at a similar height and extent to that existing. The expansion of the calcination area will result in three new calciners with access lighting similar to that for the existing stationary calciner. Expansion of the hydrate area will mean more lighting similar to that which exists in that area.

A simple model of the additional lighting effects from the expansion has been developed. Details of this are given in Appendix G. The lighting effects from the expanded refinery predicted by the model are shown on Figure 18.5.1. This indicates that there will be a general increase in light effects to the north and south of the refinery. Areas along the beach to the north of the refinery and at Galupa could experience light levels in excess of 1 lux. The proposed tall structures associated with the new facilities at the southern and eastern end of the refinery are the main sources of increased light at Galupa. The model has predicted that the vertical illuminance will not exceed the adopted criteria of 2 lux (Section 18.2.1).

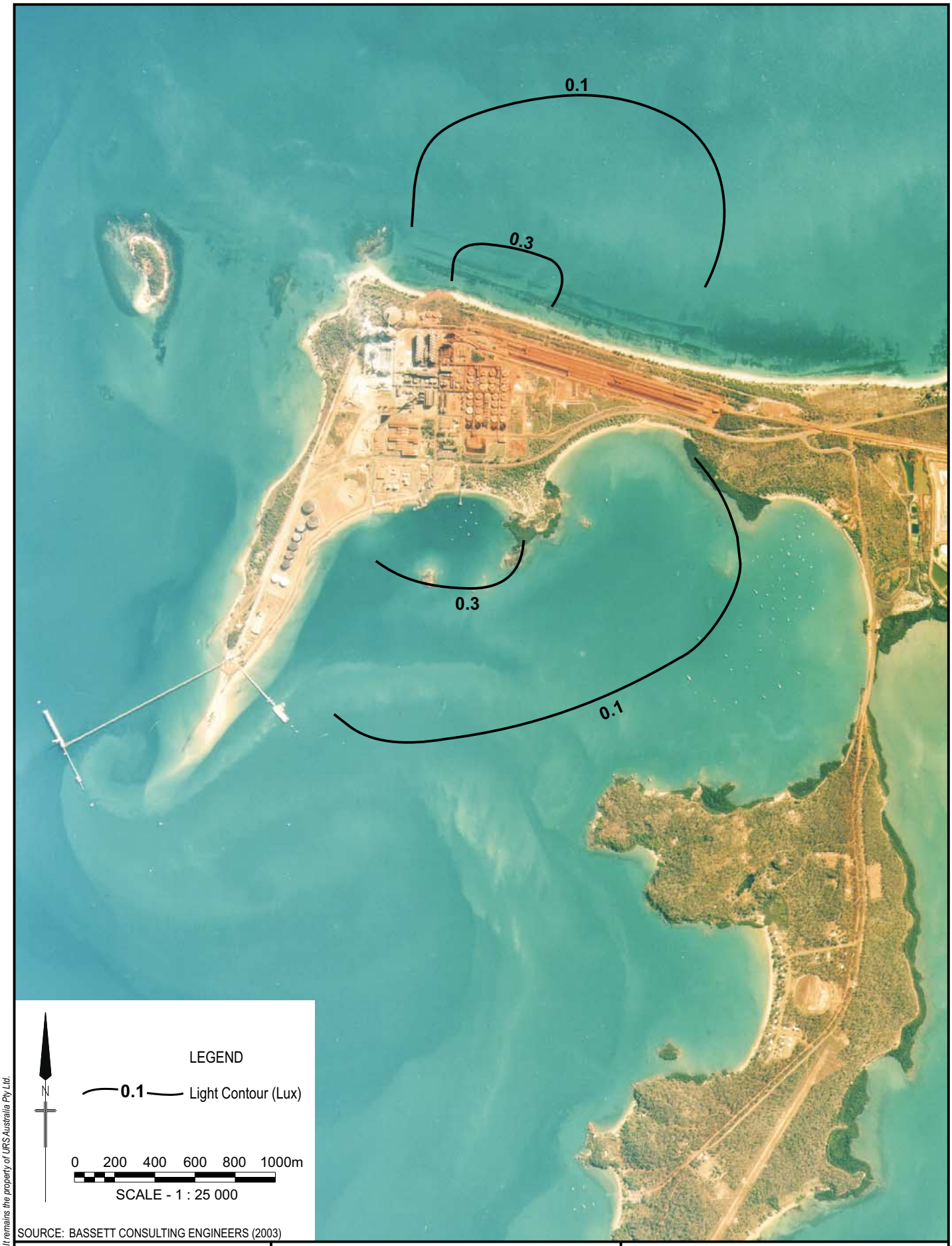
As the light criteria will not be exceeded at Galupa, the additional refinery lights are not expected to be a significant glare source. However, light levels in the area will increase from current levels. To minimise any effects from this increase, particular attention will be paid to the new lights to be installed at the eastern and southern sides of the refinery to ensure that light spill effects towards Galupa are minimised. Management strategies to achieve this are discussed in Section 18.7.

The increased light effects at other surrounding residential areas such as Wallaby Beach and Gunyangara will be minor and are unlikely to result in any significant increase in glare.

18.7 Management Strategies

A number of actions are proposed to be undertaken to reduce the overall impact of light spill from the expanded refinery. These include the following:

- New lights to be installed as part of the expansion will be selected so as to limit the light spill to the greatest extent possible commensurate with functional and safety requirements.
- Particular attention will be paid to the lights that will potentially affect Galupa to ensure that light spill in that direction is minimised and lights are turned away to face the opposite direction wherever possible.
- A review will be undertaken of existing lights to identify opportunities for reducing off-site light spill. Examples of potential strategies include:
  - fitting shrouds to limit light spill particularly to reflector lamps which generally provide broad light distributions with little control of spill; and
  - ensuring floodlights are placed with the front glass horizontal and the lamp facing downwards.



SOURCE: BASSETT CONSULTING ENGINEERS (2003)

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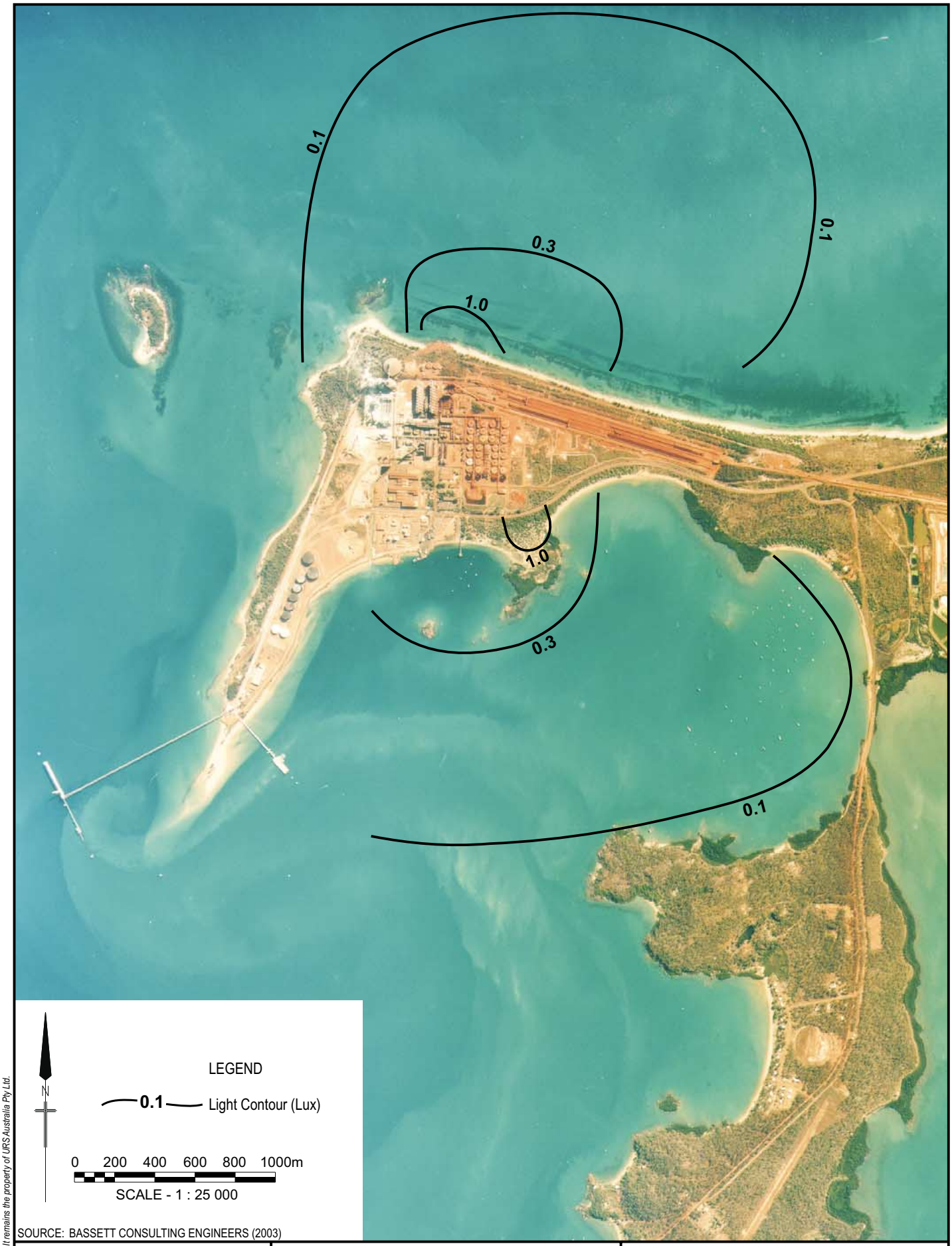
ENVIRONMENTAL IMPACT STUDY

LIGHT CONTOURS
EXISTING REFINERY

Project No. **12373-021-559**	Date 11-09-2003	Figure **18.4.1**
CAD File No. -g-049.cdr	Rev. A	A4



SOURCE: BASSETT CONSULTING ENGINEERS (2003)

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ALCAN GOVE REFINERY EXPANSION
ENVIRONMENTAL IMPACT STUDY

LIGHT CONTOURS
EXPANDED REFINERY

Project No. **12373-021-559**	Date 20-10-2003	Figure **18.5.1**
CAD File No. -g-050b.cdr	Rev. B A4	