APPENDIX P

Wind Effects Statement Report and Reflectivity Assessment

Prepared by
VIPAC Engineers

Ettalong Beach
218-220 Memorial Avenue & 47-50 The Esplanade
Ettalong Beach Town Centre

Development Application January 2010

Kann Finch Group

Ettalong Residential Wind Effects Statement Report

Report No. 30B-09-0436-TNT-446645-0

Vipac Engineers & Scientists Ltd

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EXECUTIVE SUMMARY

Kann Finch Group commissioned Vipac Engineers and Scientists Ltd to prepare a statement of wind effects for the ground level areas adjacent to the proposed **Ettalong Residential Development, NSW**. This appraisal is based on Vipacôs experience as a wind-engineering consultancy.

Drawings of the proposed Development were supplied by **Kann Finch Group** dated December 2009, as described in Appendix C

The findings of this study can be summarised as follows:

- The proposed Development is not expected to generate adverse wind conditions in the adjacent ground level areas.
- The proposed Development is not expected to generate ground level wind conditions in excess of the recommended criteria for safety, walking and standing.
- Vipac make no design recommendations in regard to ground level wind effects.

The assessments provided in this report have been made based on experience of similar situations in Ettalong and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without wind tunnel model testing can be in error. If it is necessary to verify the predictions in this statement, Vipac recommend a wind tunnel study of the proposed Development.

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1. INTRODUCTION

Vipac Engineers and Scientists have been commissioned by **Kann Finch Group** to carry out an appraisal of the pedestrian level wind effects for the proposed **Ettalong Residential** Development, Ettalong, NSW.

The proposed Development is a 25m high (approx.), 6 storey residential building, surrounded by a number of low to medium rise developments in all directions (see Figure 1). The site is located on a block bounded by Memorial Avenue to the west, The Esplanade to the south, vehicle access laneway to the north and by pedestrian laneway to the west.

A satellite image of the proposed Development site along with the surrounding terrain is shown in Figure 1 below.

Figure 1- Satellite image of the site of the proposed Ettalong Residential Development, Ettalong, NSW.

Figure 2 – Schematic east elevation of the proposed Development.

This report details the opinion of Vipac as an experienced wind engineering consultancy regarding the wind effects in ground level public areas and access-ways in and adjacent to the Development as proposed. No wind tunnel testing has been carried out for this Development. Vipac has carried out wind tunnel studies on a large number of developments of similar shape and having similar exposure to that of the proposed Development. These serve as a valid reference for the prediction of wind effects. Empirical data for typical buildings in boundary layer flows has also been used to estimate the likely ground level wind conditions adjacent to the proposed Development [2] & [3].

Drawings of the proposed Development were supplied by Kann Finch Group dated upto December 2009. A complete list of drawings supplied is provided in Appendix C of this report.

2. ANALYSIS APPROACH

In assessing whether a proposed Development is likely to generate adverse wind conditions in adjacent ground level areas, Vipac has considered five main points:

- The exposure of the proposed development to wind
- The regional wind climate
- The geometry and orientation of the proposed development
- The interaction of flows with adjacent developments
- The assessment criteria, determined by the intended use of the public areas affected by wind flows generated or augmented by the proposed development.

The pedestrian wind comfort at specific locations around a site may be assessed by predicting the worst annual 3-second wind gust expected at that location. The location may be deemed generally acceptable for its intended use if the annual 3-second gust is within the threshold values noted in Section 2.5. Where Vipac predicts that a location would not meet its appropriate comfort criterion, the use of wind control devices and/or local building geometry modifications to achieve the desired comfort rating may be recommended. For complex flow scenarios or where predicted flow conditions are well in excess of the recommended criteria, Vipac recommend scale model wind tunnel testing to determine the type and scope of the wind control measures required to achieve acceptable wind conditions.

2.1. SITE EXPOSURE

The proposed Development is located on a relatively flat terrain. Within 1km radius of the site of the proposed Development there is a mixture of low, medium and a few high-rise high-rise developments, expanses of the Ettalong beach and parklands.

Considering the immediate surroundings and terrain, the site of the proposed Development is assumed to be within Terrain Category 3 for winds approaching between south-west, north and north-east directions and Terrain Category 2 for all the remaining directions [1] as shown in Figure 3.

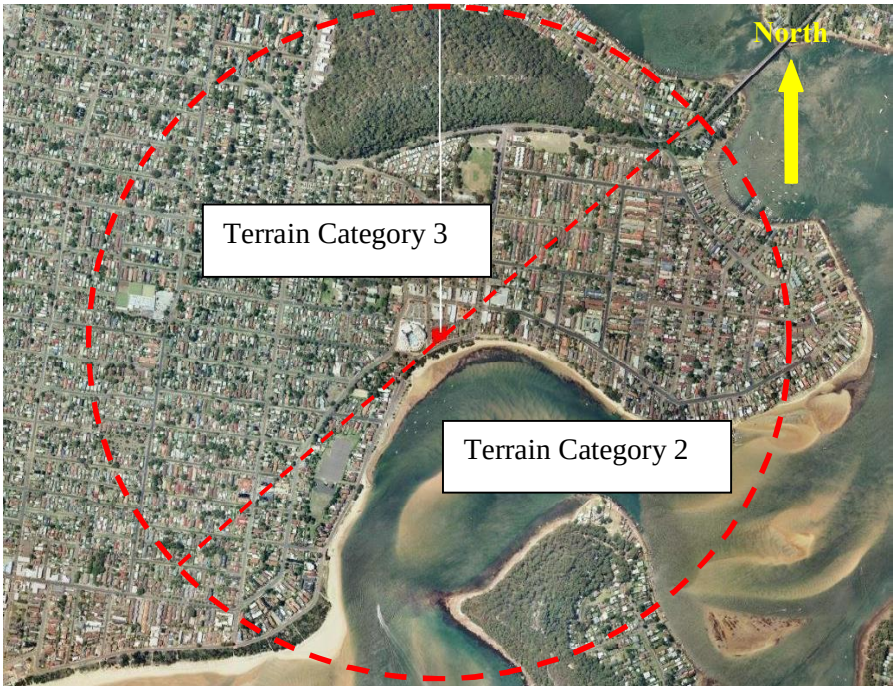


Figure 3- Assumed terrain roughness for wind speed estimation.

2.2. REGIONAL WIND CLIMATE

The mean and gust wind speeds have been recorded in the Gosford area for over 30 years. This data has been analysed and the directional probability distribution of wind speeds have been determined. The directional distribution of hourly mean wind speed at the gradient height (≈500m), with a probability of occurring once per year (i.e. 1 year return period) is shown in Figure 4. The wind data at this free stream height is common to all Gosford sites and may be used as a reference to assess ground level wind conditions at the Site.

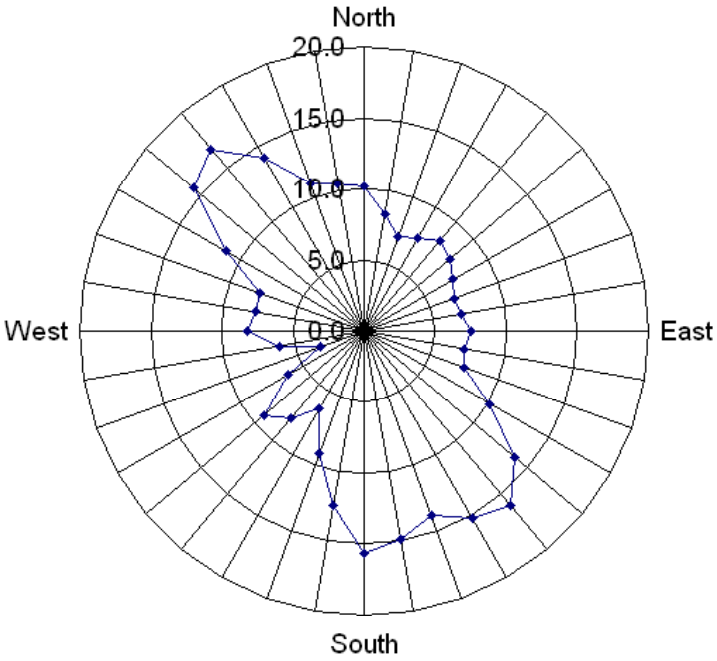


Figure 4 - Directional Distribution of Annual Return Period Mean Hourly Wind Velocities (ms-1) at Gradient Height of 500m for Gosford.

2.3. BUILDING GEOMETRY AND ORIENTATION

The proposed Development is a 6 storey residential building. The plan form dimensions of the Building are approximately 52 m x 57 m, with the longer axis running along east-west direction.

2.4. FLOW INTERACTIONS WITH ADJACENT DEVELOPMENTS

The proposed residential building is not expected to have any significant aerodynamic interactions with the neighbouring developments. Considering, their relative exposure to the strong wind directions of Ettalongôs wind climate, the ground level areas adjacent to the proposed building are expected to experience intermittent wind flows with low mean velocities.

2.5. ASSESSMENT CRITERIA

With some consensus of international opinion, pedestrian wind comfort is rated according to the suitability of certain activities at a site in relation to the expected annual peak 3-second gust velocity at that location for each wind direction. Each of the major areas around the site are characterised by the annual maximum gust wind speeds. Most patrons would consider a site generally unacceptable for its intended use if it were probable that during one annual wind event, a peak 3-second gust occurs which exceeds the established comfort threshold velocity. If that threshold is exceeded once per year then it is also likely that during moderate winds, noticeably unpleasant wind conditions would result, and the windiness of the location would be voted as unacceptable.

The threshold gust velocity criteria are:

Annual Maximum Gust Speed	Result on Perceived Pedestrian Comfort
>23m/s	Unsafe (frail pedestrians knocked over)
<16m/s	Acceptable for Walking (steady steps for most pedestrians)
<13m/s	Acceptable for Standing (window shopping, vehicle drop off, queuing)
<10m/s	Acceptable for Sitting (outdoor cafés, pool areas, gardens)

Table 1 – Recommended Wind Comfort and Safety Gust Criteria

In a similar manner, a set of hourly mean velocity criteria with a 1% probability of occurrence are also applicable to ground level areas in and adjacent to the proposed Development. An area should be within both the relevant mean and gust limits in order to satisfy the particular human comfort and safety criteria in question.

The threshold mean velocity criteria are:

Annual Maximum Mean Speed	Result on Perceived Pedestrian Comfort
>15m/s	Unsafe (frail pedestrians knocked over)
<10m/s	Acceptable for Walking (steady steps for most pedestrians)
<7m/s	Acceptable for Standing (window shopping, vehicle drop off, queuing)
<5m/s	Acceptable for Sitting (outdoor cafés, pool areas, gardens)

Table 2 – Recommended Wind Comfort and Safety Mean Criteria

Intended Use of Adjacent Ground Level Areas

- Residential entrances are located on Memorial Avenue side and on the eastern side of the proposed Development.
- Retail entrances are located on Memorial Avenue side, The Esplanade side and on the eastern sides of the proposed Development.
- Car park entrances are located on the northern side of the proposed Development

- Memorial Avenue, The Esplanade and the concrete laneway to the east are public walkways/ footpaths.

Recommended Criteria

The following table lists the specific areas adjacent to the Development and the corresponding recommended criteria.

Area	Recommended Criteria
Public Footpaths	Acceptable for Walking
Building Entrances	Acceptable for Standing
Apartment Balconies & Terrace	Acceptable for Safety*

Table 3 – Recommended application of criteria

Apartment Balcony and Roof Top Terrace areas Recommended Criterion Discussion

Apartment balconies are located on all four sides of the proposed Development. Vipac recommend as a minimum the apartment balcony areas meet the criterion for safety since,

- these areas are not public spaces,
- the use of these areas is optional,
- it is likely to be difficult to achieve wind conditions meeting a more stringent criterion than the safety criterion on the balcony areas of the proposed Development due to their exposure and the form and proximity of adjacent developments
- many similar developments in Ettalong and other Australian cities experience wind conditions on balconies and elevated deck areas in the vicinity of the criterion for safety.

However, Vipac wish to clearly state that meeting the safety criterion on balconies will be no guarantee that occupants will find wind conditions in these areas acceptable.

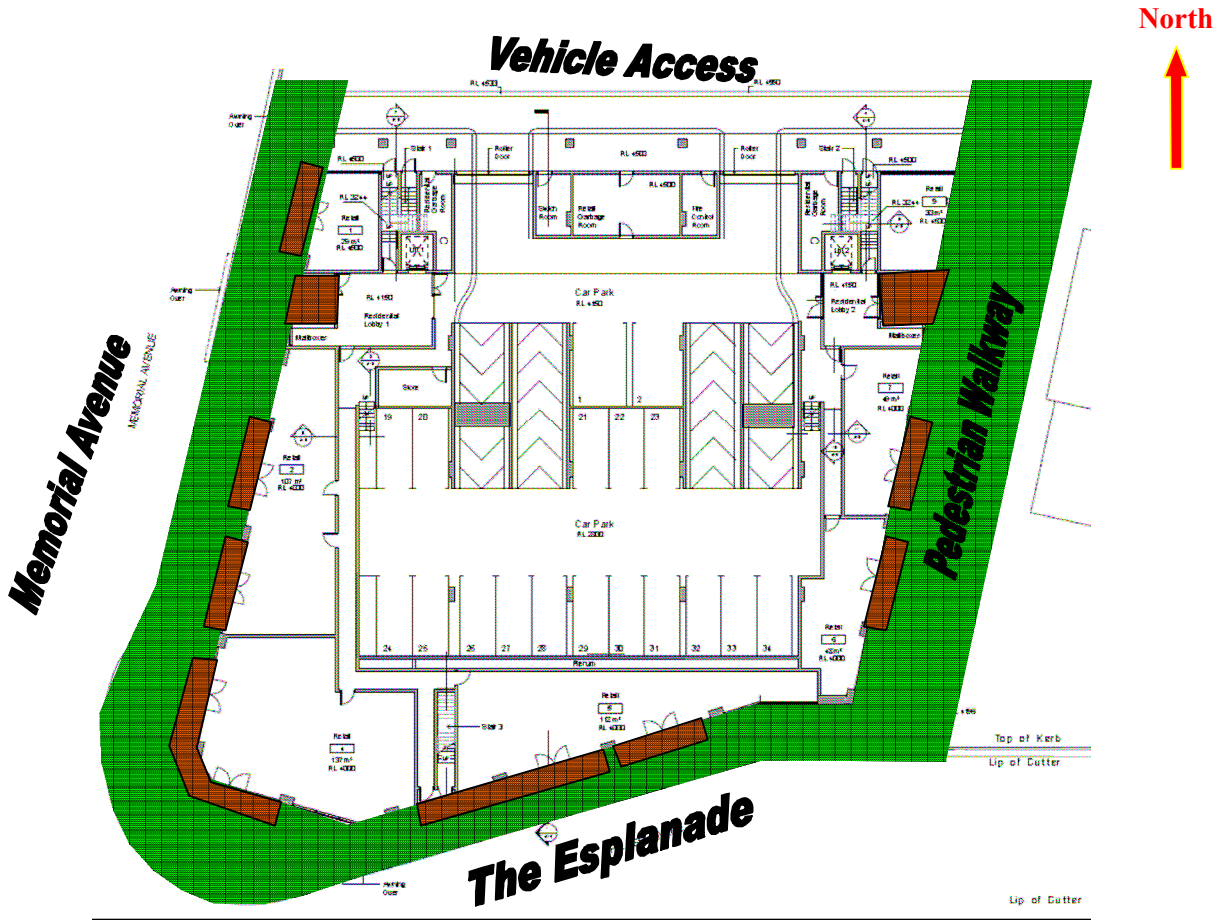
It is Vipacôs experience that balconies should be close to the criterion for sitting comfort in order that the majority of reasonable people consider such areas acceptable for their intended use from a wind point-of-view. Wind conditions over this criterion will tend to result in a perceived reduction in amenity of the area.

This perception may be due to:

- the cooling effect of the wind on the human body,
- the removal of lightweight items such as towels, newspapers, lightweight furniture (eg. plastic banana lounges),
- difficulty hearing others speak

Wind conditions meeting the criterion for safety may still result in the following adverse effects whilst the balcony area is unoccupied:

- the removal of lightweight furniture during storms,
- the removal of planter boxes during storms.



Plan – Ground Level

Recommended Acceptable for Walking

Recommended Acceptable for Standing

Figure 5 - Schematic plan view of the proposed Development with the recommended wind criteria overlaid on adjacent ground level areas.

3. PEDESTRIAN LEVEL WIND EFFECTS AND RECOMMENDATIONS

Discussion

The proposed Development is relatively exposed to the strong north-westerly winds, which could result in high ground level wind speeds on the Memorial Avenue side of the Development. However, considering the presence of discontinuous facades and canopies it is expected that any adverse effects (of the approaching wind directions) would be ameliorated. Furthermore, considering the aerodynamic interaction with upstream buildings, ground level wind speeds, on the Memorial Avenue side of the Development would often be intermittent in nature, with low mean velocities.

The south-easterly and southerly winds equally strong in magnitude, could result in channelling flows through the pedestrian walkway to the east of the proposed Development. However, considering the presence of discontinuous facades, no adverse wind conditions are expected in that region.

The region of the highest ground level wind speeds adjacent to the proposed Development is likely to be the pedestrian walkway to the east of the proposed Development. However, calculations from empirical data [2], [3] suggest ground level wind conditions generated by northerly westerly, southerly and south easterly winds would be within the criterion for acceptability for walking adjacent to the proposed Development. For other directions the form of the proposed Development is considered unlikely to produce adverse ground level wind effects or the wind climate for those directions is weak.

Key Points:

- The proposed Development incorporates a number of wind mitigating features, such as discontinuous tower façades, building setbacks and canopies.
- The proposed Development is not considered likely to generate a significant increase in wind conditions in adjacent ground level areas.
- Vipac does not expect the proposed Development to generate any wind conditions in excess of the recommended pedestrian comfort criteria mentioned in Section 2.5.
- Vipac predicts wind conditions on most of the apartment balconies and roof top terrace areas should generally be acceptable. Some balconies in building corner and at elevated levels may experience wind conditions close to or in excess of the safety criterion. Vipac note that such wind conditions are typical of balcony and roof top terrace areas in Australian cities.

3.1. RECOMMENDATIONS

Ground Level Areas

Vipac has carefully considered the nearby ground level public areas at the base of the proposed Development and predicts that the proposed Development would not generate wind conditions in these areas in excess of the recommended criteria. Therefore, Vipac make no recommendations regarding ground level wind conditions or the form of the proposed Development.

Apartment Balconies and Roof Top Terrace Areas

Whilst wind conditions will frequently be acceptable for out door recreation on the apartment balconies and roof top terrace areas, Vipac predicts that on high wind days wind conditions could be close to the criterion for safety in balconies at elevated levels and in the terrace areas. Lightweight outdoor lounges, tables and chairs will be at risk of being blown off from these areas when unattended, particularly during storms. There have been a number of cases in cities in Australia recently where outdoor furniture and even pot plants have been blown off elevated outdoor areas in multi-level developments representing a significant public risk. Occupants should be warned not to leave outdoor furniture in these areas.

4. CONCLUSIONS

An appraisal of the likely wind conditions adjacent to the proposed **Ettalong Residential Development**, NSW has been made.

Vipac have carefully considered the form and exposure of the proposed Development, nominated criteria for various ground level areas according to their function and referred to past experience to produce our opinion of likely ground level wind conditions adjacent to the proposed Development.

In Vipacôs opinion, no exceedences of the recommended wind criteria are likely to be generated by the proposed Development.

The recommendations and assessments provided in this report have been made based on experience of similar situations in Ettalong and around the world. As with any opinion, it is possible that an assessment of wind effects based on experience and without wind tunnel model testing may be in error.

This Report has been Prepared

For

Kann Finch Group

By

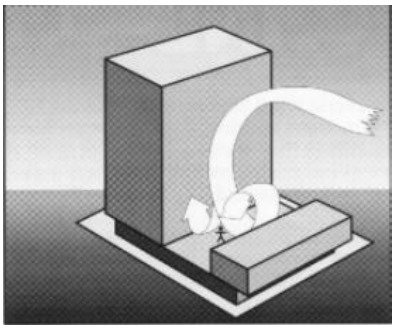
VIPAC ENGINEERS & SCIENTISTS LTD.

APPENDIX A - ENVIRONMENTAL WIND EFFECTS

Atmospheric Boundary Layer

As wind flows over the earth it encounters various roughness elements and terrain such as water, forests, houses and buildings. To varying degrees, these elements reduce the mean wind speed at low elevations and increase air turbulence. The wind above these obstructions travels with unattenuated velocity, driven by atmospheric pressure gradients. The resultant increase in wind speed with height above ground is known as a wind velocity profile. When this wind profile encounters a tall building, some of the fast moving wind at upper elevations is diverted down to ground level resulting in local adverse wind effects.

The terminology used to describe the wind flow patterns around the proposed Development is based on the aerodynamic mechanism, direction and nature of the wind flow.



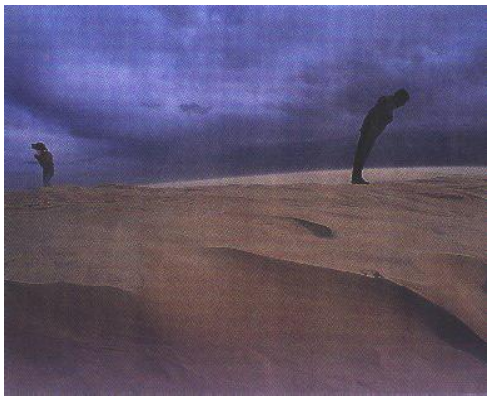
Downwash ï refers to a flow of air down the exposed face of a tower. A tall tower can deflect a fast moving wind at higher elevations downwards.

Corner Accelerations ï when wind flows around the corner of a building it tends to accelerate in a similar manner to airflow over the top of an aeroplane wing.

Flow separation ï when wind flowing along a surface suddenly detaches from that surface and the resultant energy dissipation produces increased turbulence in the flow. Flow separation at a building corner or at a solid screen can result in gusty conditions.

Flow channelling ï the well-known ñstreet canyonò effect occurs when a large volume of air is funnelled through a constricted pathway. To maintain flow continuity the wind must speed up as it passes through the constriction. Examples of this might occur between two towers, in a narrowing street or under a bridge.

Direct Exposure ï a location with little upstream shielding for a wind direction of interest. The location will be exposed to the unabated mean wind and gust velocity. Piers and open water frontage may have such exposure.



APPENDIX B - REFERENCES

[1] *Structural Design Actions, Part 2: Wind Actions*, Australian/New Zealand Standard 1170.2:2002

[2] *Wind Effects on Structures* E. Simiu, R Scanlan, Publisher: Wiley-Interscience

[3] *Architectural Aerodynamics* R. Aynsley, W. Melbourne, B. Vickery, Publisher: Applied Science Publishers

APPENDIX C – DRAWING LIST

Drawing Number	Title
A02	Site Plan
A04	Basement Plan
A05	Ground Floor Plan
A06	Mezzanine Level
A07	Level 1 Plan
A08	Level 2 Plan
A09	Level 3 Plan
A10	Level 4 Plan
A11	Level 5 Plan
A12	Level 6 Plan
A13	Roof Plan
A14	Section 1
	Aerial View Looking North
	View Looking Northeast
	View Looking East
	View Looking Southeast
	Aerial View Looking Northwest
	Section
	North Elevation
	South Elevation
	East Elevation
	West Elevation

Kann Finch Group

Ettalong Beach Residential

Reflectivity Assessment

Report No. 20C-09-0308-TRP-452518-0

Vipac Engineers & Scientists Ltd

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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Ltd. has been commissioned by Kann Finch Group to assess the interaction of the proposed Ettalong Beach Residential with the local environment in terms of Reflectivity.

The site is located on two blocks (Stage 1 and 2) bounded by existing developments adjoining the site. Ocean View Road is a local main street to the north of the Stage 2 site and Memorial Avenue is located to the west of both sites. There is a local street running north-south to the east side of the Stage 2 site. The south end of this local street joins another local street that runs in the NE-SW direction, separating the Stage 1 and 2 sites. The Esplanade bounds the Stage 1 site to the south. The proposed development will comprise of a 7-storey Retail/Residential building to the south (Stage 1) and a 2-storey Retail/Commercial building to the north (Stage 2).

The glazing elements of the proposed building have been investigated in this report as a potential source of traffic disability glare and pedestrian discomfort glare.

It has been concluded that no glazing or cladding elements of the development as proposed will cause adverse rail traffic disability glare at surrounding locations because of:

- The orientation of façade cladding elements and local streets.
- The developerôs choice of glazing, which is recommended to have a visible light reflectivity coefficient of 10% or less for:
  - All north/northwest-facing façade of Stage 1 building;
  - All south/southeast-facing façade for Stage 2 building;
  - All east- and west-facing facades for both Stage 1 and 2 buildings.
- Blockage to both incoming solar rays and outgoing reflections provided by architectural shading devices and low to mid-rise buildings in the vicinity, including future development[1] to the east of the site.
- Local traffic conditions and pedestriansô ability to adjust their line of sight to avoid any glare.

In summary, through a combination of choice of cladding, façade orientation and design and special façade treatments, no façades of the proposed development will produce reflections causing either disability glare for passing motorist or unacceptable discomfort glare for passing pedestrians.

[1] According to drawing number 5355-SK05 titled ñMassing Study,ò 11.09.09.

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1. BACKGROUND

Several factors must be considered when assessing the potential for rogue building reflections. Criteria to be considered include:

- Reflectivity coefficients of glazing and other specular type cladding surfaces.
- Incident angles of solar rays relative to cladding.
- Solar altitude/angles.
- The class of roadways surrounding the development.
- Pedestriansô access surrounding the site.

These and other considerations affecting glare potential are discussed further in Appendix A of this report. The methodology used by VIPAC to calculate and assess potential rogue building reflections is outlined in Appendix A.

2. SOLAR REFLECTIONS FROM THE PROPOSED BUILDING

Figure 1 shows an overall plan view of the development outlining its location with respect to the surrounding roadways and buildings.

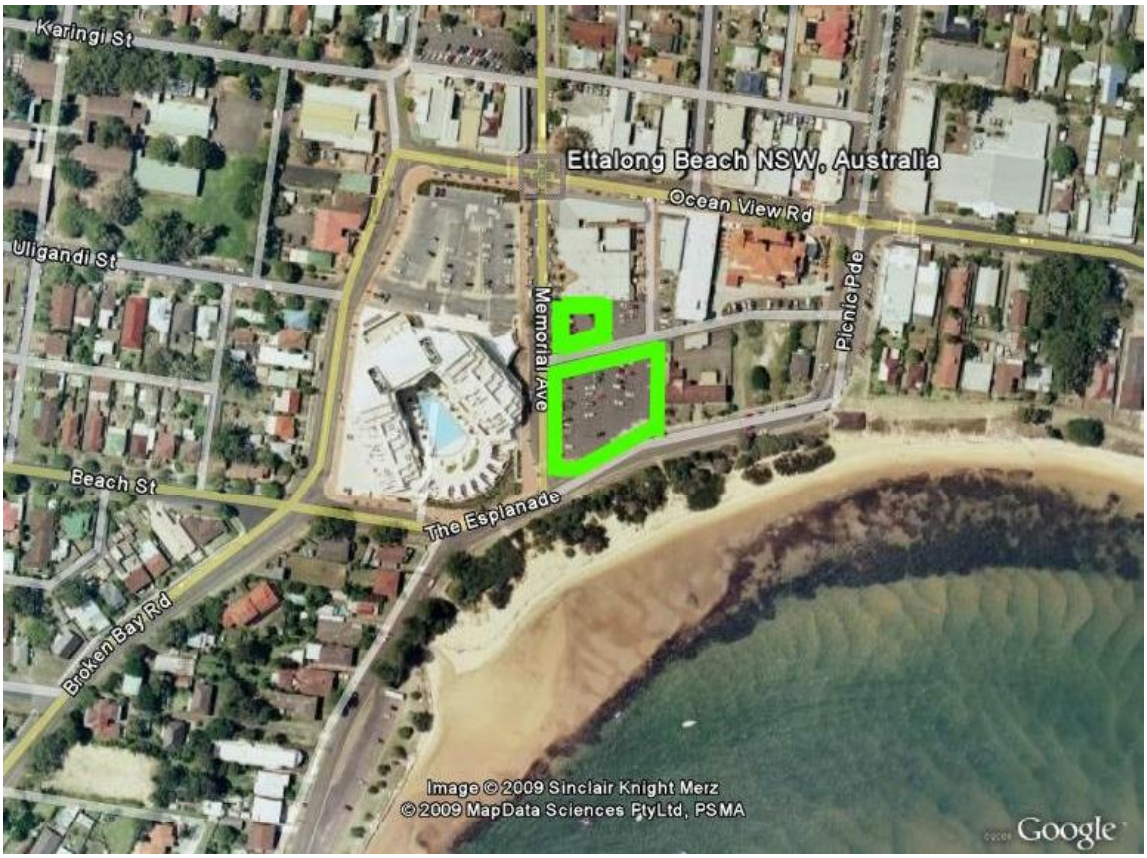


Figure 1 – Site of Proposed Development (highlighted in green) and Surroundings.

The proposed development is comprised of 2 buildings:

1. Stage 1 Retail/Residential: 7-storey building to the south, adjacent to Memorial Avenue and The Esplanade.

2. Stage 2 Retail/Commercial: 2-storey building to the north of Stage 1 site, separated by a local street running NE-SW.

Facades of the proposed buildings are constructed with mainly concrete walls and single glazing with the following features:

Table 1 – Façade Composition of the Stage 1 Building.

Façade	Glazing	Concrete/Masonry
Memorial Ave Façade	60%	40%
Northern Façade	70%	30%
Eastern Facade	60%	40%
The Esplanade Façade	80%	20%

Table 2 - Façade Composition of the Stage 2 Building.

Façade	Glazing	Concrete/Masonry
Memorial Ave Façade	75%	25%
Northern Façade	0%	100%
Eastern Facade	75%	25%
Southern Façade	40%	60%

In the analysis, the external glazing on all façade faces are assumed to have a visible light reflectivity coefficient of 20% or less (at normal incidence). Remaining façade areas comprise of concrete/masonry (having a less óspecularô and more ódiffuseô reflection properties compared to that of glass).

The shading effect of balconies, shading devices and any building protrusions is taken into account when determining the reflections off all façades in the assessment.

Local Traffic Environment ...

Ocean View Road is a local main street to the North of the site and Memorial Avenue is located to the west. Picnic Parade, located to the east of the site, connects to The Esplanade, which runs along the Ettalong beach to the south of the site. There is a small local street running north-south to the east side of the Stage 2 site, which joins another local

street that runs in the NE-SW direction, separating the Stage 1 and 2 sites. Direction of Traffic considered in this analysis is illustrated in Figure 2.

Local Built-Up Environment ...

The site is surrounded by low to mid-rise buildings in the vicinity. The south-eastern side of the proposed development, where the Ettalong beachfront is located, is mainly exposed terrain. Local terrain slopes down towards the south-east and mid-rise buildings to the west of the site provides shading for local traffic beyond Broken Bay Road.

3. REFLECTION PROJECTIONS

Direction of traffic considered in this analysis is illustrated in Figure 2 below.

Figure 3 indicates some of the ñobserverò locations monitored for reflected glare located on surrounding roadways and pedestrian areas, denoted by cyan-coloured dots. These observer locations represent:

1. North and South-bound traffic/pedestrians on Memorial Avenue.
2. East and West-bound traffic/pedestrians on Ocean View Road.
3. South-bound traffic/pedestrians on Picnic Parade.
4. NE and SW-bound traffic/pedestrians on The Esplanade.
5. NE and SW-bound traffic/pedestrians on Broken Bay Road.
6. East and West-bound traffic/pedestrians on Beach Street.
7. North, South, East and West-bound traffic/pedestrians on the two local streets surrounding the Stage 1 and 2 sites.

Figure 2 – Direction of Traffic Considered in the Analysis.

Figure 3 – Location of "Observers."
The green polygon denotes the proposed building site.

4. SOLAR ANALYSIS RESULTS

This analysis determines the possibility of adverse glare effects on pedestrians and motorists from facades of the development.

4.1. TRAFFIC AND PEDESTRIAN DISABILITY GLARE

Memorial Avenue:

Reflected solar rays may impact pedestrians and motorists on Memorial Avenue:

- During late morning to sunset throughout the year.

The late morning reflection conditions occur at about 11am through to mid-afternoon. Reflected solar rays from north/northwest facing facades may impact south-bound pedestrians and motorists north of the site on Memorial Avenue, while stray reflections from the west facing facades may impact north-bound pedestrians and motorists on other parts of Memorial Avenue. The predicted discomfort glares for the late morning reflection conditions do not exceed acceptable criteria due to the following factors:

- The solar altitude is higher during late morning to early afternoon, which exceeds the visual cut-off angle of motorists.
- Reflected solar rays are partially shaded by neighbouring buildings to the north of the site.
- The pedestrians have the ability to adjust their line of sight.

The late afternoon reflection conditions occur before sunset throughout the year. During summer months, reflected solar rays from west facing facades might affect south-bound pedestrians and motorists on Memorial Avenue. For the rest of the year, the late afternoon reflection conditions apply to north-bound pedestrians and motorists. The predicted discomfort glares for the late afternoon reflection conditions do not exceed acceptable criteria due to the following factors:

- Late afternoon solar rays are low in altitude and less intense compared to other times of the day.
- Incoming solar rays during late afternoon are partially shaded by neighbouring buildings to the west of the site.
- The pedestrians have the ability to adjust their line of sight.

To further reduce the disability glare, it is recommended that the glazing on all north and west facing façade is to have a visible light reflectivity coefficient of 10% or less to ensure there will be minimal reflective condition.

Given the above, these reflections are unlikely to cause adverse glare conditions for pedestrians and motorists.

Ocean View Road:

Reflected solar rays may impact pedestrians and motorists on Ocean View Road:

- From sunrise to sunset throughout the year.

The morning reflection conditions occur at sunrise through to mid-afternoon. Reflected solar rays from north facing facades may impact east-bound pedestrians and motorists on Ocean View Road, while stray reflections from the east facing facades may impact west-bound motorists on other parts of Ocean View Road. The predicted discomfort glares for the morning reflection conditions do not exceed acceptable criteria due to the following factors:

- Early morning solar rays are low in altitude and less intense compared to other times of the day. Incoming/reflected low altitude solar rays are partially shaded by building protrusions and also neighbouring buildings to the east and north of the site.
- The solar altitude is higher during late morning to early afternoon, which exceeds the visual cut-off angle of motorists.
- The pedestrians have the ability to adjust their line of sight.

The late afternoon reflection conditions occur before sunset throughout the year. Reflected solar rays from north facing facades might affect west-bound motorists on Ocean View Road. The predicted discomfort glares for the late afternoon reflection conditions do not exceed acceptable criteria due to the following factors:

- Late afternoon solar rays are low in altitude and less intense compared to other times of the day.
- Incoming/reflected low altitude solar rays during late afternoon are partially shaded by building protrusions and neighbouring buildings to the west of the site.
- The pedestrians have the ability to adjust their line of sight.

To further reduce the disability glare, it is recommended that the glazing on all north and east facing façade is to have a visible light reflectivity coefficient of 10% or less to ensure there will be minimal reflective condition.

Given the above, these reflections are unlikely to cause adverse glare conditions for pedestrians and motorists.

Picnic Parade:

Reflected solar rays may impact pedestrians and motorists on Picnic Parade:

- During early morning throughout summer months.

The early morning reflection conditions occur at about 5am during the above-mentioned timeframe and it applies to south-bound pedestrians and motorists on Picnic Parade. The predicted discomfort glares for these reflection conditions do not exceed acceptable criteria due to the following factors:

- Early morning solar rays are low in altitude and less intense compared to other times of the day.

- Incoming/reflected low altitude solar rays are partially shaded by building protrusions; future development[2] to the east of the site may also help blocking unwanted glare.

- The pedestrians have the ability to adjust their line of sight.

Given the above, these reflections are unlikely to cause adverse glare conditions.

The Esplanade:

Reflected solar rays may impact pedestrians and motorists on The Esplanade:

- During early morning and late afternoon throughout the year.

The early morning reflection conditions occur at sunrise and persist for approximately 2 hours, while the late afternoon reflection conditions occur at approximately 2 hours before sunset. It applies to west-bound pedestrians and motorists east of the proposed development and northeast-bound pedestrians and motorists southwest of the proposed development.

The predicted stray reflections may cause pedestrian/motorist discomfort with the assumed 20% reflective glazing, in particular for the east and west façade. The use of glazing with a visible light reflectivity coefficient of 10% or less is recommended for the east and west façade (for both Stage 1 and 2 buildings) in order to minimise discomfort glare. The modified discomfort glares for these reflection conditions are predicted to be at an acceptable level due to the following factors:

- Façade glazing incorporates a visible light reflectivity coefficient of 10% or less.

- Early morning and late afternoon solar rays are low in altitude and less intense compared to other times of the day.

- Incoming/reflected low altitude solar rays are partially shaded by building protrusions; future development[3] to the east of the site may also help blocking unwanted glare.

- The pedestrians have the ability to adjust their line of sight.

Given the above, these reflections are unlikely to cause adverse glare conditions for motorists.

Broken Bay Road and Beach Street:

Reflected solar rays may impact pedestrians and motorists on Broken Bay Road and Beach Street:

- From late afternoon till sunset throughout the year.

The late afternoon reflection conditions occur at approximately 2 hours before sunset. It applies to north/northeast-bound pedestrians and motorists on Broken Bay Road and west-bound pedestrians and motorists on Beach Street. The discomfort glares for these reflection conditions is predicted to be within acceptable criteria with the incorporation of façade glazing

[2] According to drawing number 5355-SK05 titled ñMassing Study,ò 11.09.09.
[3] According to drawing number 5355-SK05 titled ñMassing Study,ò 11.09.09.

that has a visible light reflectivity coefficient of 10% or less to the west façade (for both Stage 1 and 2 buildings) and by considering the following factors:

- Late afternoon solar rays are low in altitude and less intense compared to other times of the day.
- Incoming/reflected low altitude solar rays are partially shaded by building protrusions and neighbouring buildings.
- The pedestrians have the ability to adjust their line of sight.

Given the above, these reflections are unlikely to cause adverse glare conditions for motorists.

The Two Local Streets Surrounding The Stage 2 Site:

Reflected solar rays may impact motorists on the two local streets surrounding the stage 2 site (the two unlabelled streets in Figure 1):

- From sunrise to sunset throughout the year.

The morning reflection conditions occur at sunrise through to mid-afternoon. Reflected solar rays from north facing façade of Stage 1 building and east/south facing façade of Stage 2 building may impact east- and north-bound pedestrians and motorists. The predicted discomfort glares for these reflection conditions do not exceed acceptable criteria due to the following factors:

- Early morning solar rays are low in altitude and less intense compared to other times of the day. Incoming/reflected low altitude solar rays are partially shaded by building protrusions and also neighbouring buildings to the east and north of the site.
- The solar altitude is higher during late morning to early afternoon, which exceeds the visual cut-off angle of motorists.
- The pedestrians have the ability to adjust their line of sight.

The late afternoon reflection conditions occur before sunset throughout the year. Reflected solar rays from north facing façade of Stage 1 building and east/south facing façade of Stage 2 building may impact west-bound motorists. The predicted discomfort glares for the late afternoon reflection conditions do not exceed acceptable criteria due to the following factors:

- Late afternoon solar rays are low in altitude and less intense compared to other times of the day.
- Incoming/reflected low altitude solar rays during late afternoon are partially shaded by building protrusions and neighbouring buildings to the west of the site.
- The pedestrians have the ability to adjust their line of sight.

To further reduce the disability glare, it is recommended that the glazing on the north facing façade of Stage 1 building and east/south facing façade of Stage 2 building is to have a visible light reflectivity coefficient of 10% or less to ensure there will be minimal reflective condition.

Given the above, these reflections are unlikely to cause adverse glare conditions for motorists.

5. SUMMARY

Potential traffic disability glare and pedestrian discomfort glare from the glazing elements of the proposed development have been investigated.

It has been concluded that no glazing or cladding elements of the development as proposed will cause adverse rail traffic disability glare at surrounding locations because of:

- The orientation of façade cladding elements and local streets.
- The developerôs choice of glazing, which is recommended to have a visible light reflectivity coefficient of 10% or less for:
  - All north/northwest-facing façade of Stage 1 building;
  - All south/southeast-facing façade for Stage 2 building;
  - All east- and west-facing facades for both Stage 1 and 2 buildings.
- Blockage to both incoming solar rays and outgoing reflections provided by architectural shading devices and low to mid-rise buildings in the vicinity, including future development[4] to the east of the site.
- Local traffic conditions and pedestriansô ability to adjust their line of sight to avoid any glare.

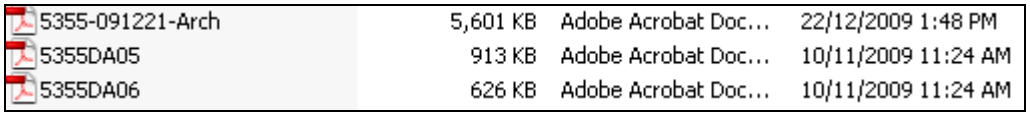
To further reduce the disability glare, it is recommended that the glazing on this façade is to have a visible light reflectivity coefficient of 10% or less to ensure there will be minimal reflective condition.

In summary, through a combination of choice of cladding, façade orientation and design, and special façade treatments, no facades of the proposed development will produce reflections causing either disability glare for passing motorist or unacceptable discomfort glare for passing pedestrians.

[4] According to drawing number 5355-SK05 titled ñMassing Study,ò 11.09.09.

6. ARCHITECTURAL DRAWINGS AND REFERENCES

The environmental assessment carried out in this report was based on the following architectural drawings and documents supplied by **Kann Finch Group**.



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5355DA06	626 KB	Adobe Acrobat Doc...	10/11/2009 11:24 AM

APPENDIX A - CONSIDERATIONS AFFECTING GLARE POTENTIAL & GENERAL PROCEDURE

Considerations Affecting Glare Potential

Several factors must be borne in mind in considering the potential for rogue building reflections, particularly in the case of traffic disability glare.

- The glass chosen for this project will have a reflectivity value of no greater than 10% at "incident angles" less than 70°. The incident angle is defined as 0° for a solar ray striking perpendicular to the plane of the glass.

- Thus, for reflections to occur which have the capacity to induce disability or discomfort glare, the oncoming solar rays would have to impact on the building at relatively high incident angles, greater than 70°, ie. close to parallel to the plane of the glazing.

- Studies on the visual cut-off angle of windscreens show that the sun altitude angle must be less than 25° to produce a disability glare event. In fact, on a practical level, solar altitudes greater than 20° are intersected and obstructed by a typical windscreen roofline.

- A further requirement regarding the sun position is that the full solar disc must be above the horizon. Since the solar disc subtends a finite angle of 1.5°, glare events will only occur when the solar altitude is greater than about 3°.

- Finally, the class of road (ie. freeway, trunk road, local street etc.) influences the acceptability level of building reflections. For example, some level of solar reflection may be acceptable for local traffic where the limiting speed is low but be unacceptable for freeway conditions with heavy, high-speed traffic.

Thus, the range of sun positions for which reflections off a vertical glazing element have the potential to produce a disability glare event can be greatly reduced.

In practice, the time of the day that a vertical glazing element can produce a disability glare event for motorists is typically early morning and late afternoon and when the incident radiation is close to parallel to the glazing element of interest and also has a low altitude angle. This restricts the incoming angles of solar radiation which can produce rogue reflections depending upon the time of the year.

Pedestrian discomfort glare can occur at other times of the day when the sun altitude is greater than 20° above the horizon. However, in assessing the potential for glare in these cases, it should be borne in mind that a pedestrian has the ability (in most instances) to adjust his/her line of sight to a more horizontal view away from the glare source.

From the range of sun positions on days of interest throughout the year and the position and orientation of the glazing element of interest in a building, the resultant reflection envelope on the ground can be calculated using simple trigonometry.

Given a set of reflections, the issue of most significance is the effect of these reflections on the ability of a driver or pedestrian to perceive an object in their vision field. The perception of an object depends on the luminance of that object relative to the illumination of the background. For example, if the target and the background have the same colour and the same level of illumination, then it will be impossible to distinguish the target from the background.

VIPAC's glare recognition methodology uses target recognition procedures originally developed by NASA and also used by NATO.