SITE SPECIFIC DESIGN CRITERIA ANALYSIS

Job #WSS163584

Prepared for:
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Forester Road
ST MARYS NSW
Australia 2760

Certified by:
Taberco Engineering

Issued:
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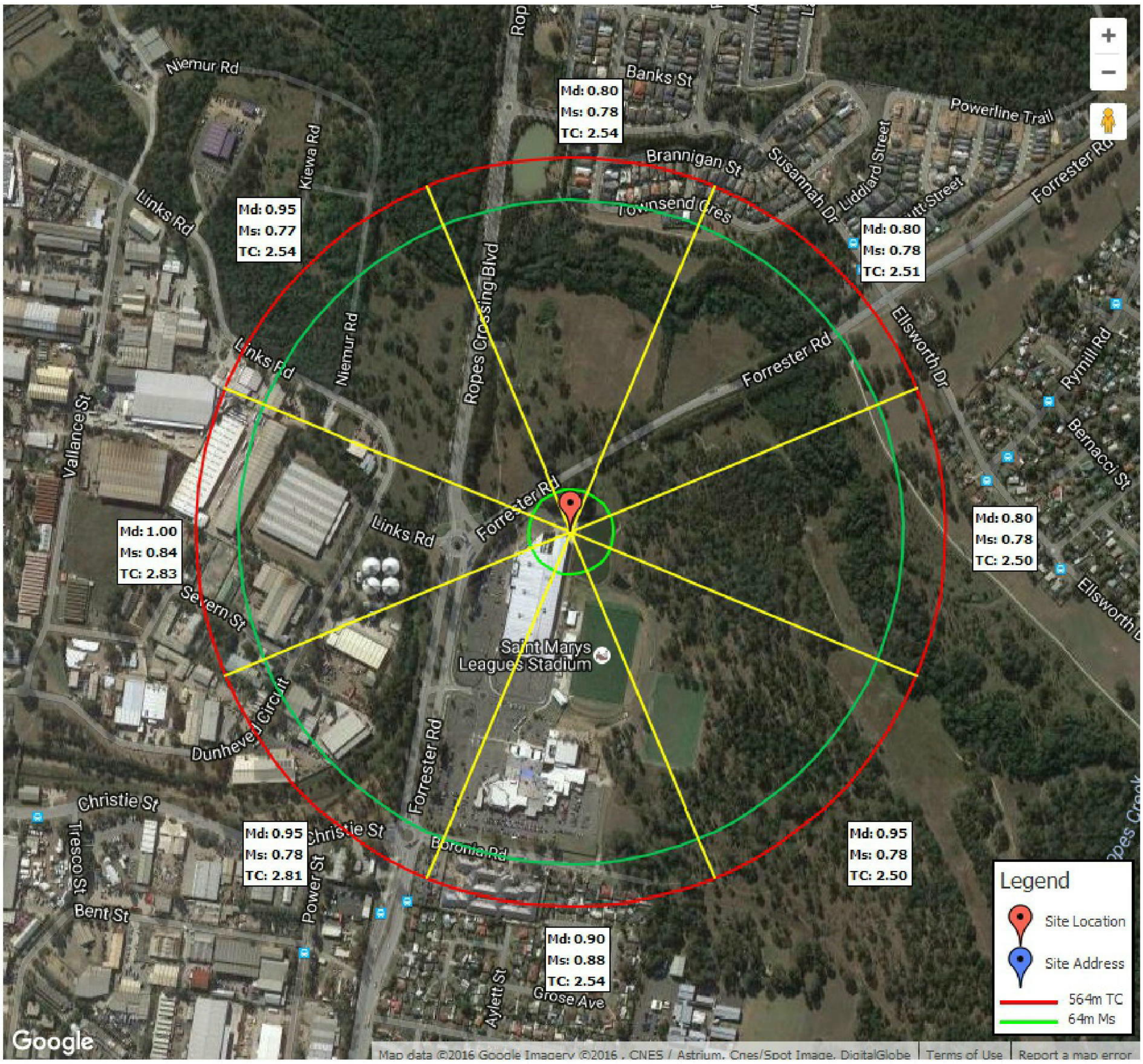
Building Details:
Span: 15
Height: 2.4
Length: 15



Site Address:
Forester Road
ST MARYS NSW
Australia 2760

Executive Summary - Site Specific Analysis

The design analysis of the building has not been considered for each of the 4 orthogonal directions. Hence the maximum wind speed in any of the 8 cardinal directions has been used as the design wind speed. This is a conservative approach.

Each cardinal direction has been considered and the results are summarised below

Factor	N	NE	E	SE	S	SW	W	NW
Wind Region	A2							
Importance level (IL)	2							
Regional Wind Speed (Vr)	45							
Terrain Category (TC)	2.54	2.51	2.5	2.5	2.54	2.81	2.83	2.54
Terrain Category Multiplier (Mz)	0.87	0.87	0.87	0.87	0.87	0.85	0.84	0.87
Shielding Multiplier (Ms)	1	1	1	1	1	0.85	0.85	1
Topographic Multiplier (Mt)	0	0	0	0	0	0	0	0
Wind Direction Multiplier 1 (Md1)	0.8	0.8	0.8	0.95	0.9	0.95	1	0.95
Site specific design wind speed (Vsite1)	31.3	31.3	31.4	37.2	35.2	30.8	32.3	37.1

Wind Direction Multiplier 2 (Md2)	0.8	0.8	0.8	0.95	0.9	0.95	1	0.95
Site specific design wind speed (Vsite2)	31.3	31.3	31.4	37.2	35.2	30.8	32.3	37.1

Design Wind Speed (Vsite1)	37.2 m/s	for the resultant forces and overturning moments on the complete building and wind actions on major structural elements.
Design Wind Speed (Vsite2)	37.2 m/s	For all other cases, including cladding and immediate supporting members (Purlins and Girts)
Snow Load	Nil	
Seismic Factor	Nil	

The following pages detail how these results were obtained.

This report details how the Site Specific Design Criteria has been determined. Specifically, the following is detailed

1. Site Specific Design Wind Speed
    a. Importance Level
    b. Wind Region
    c. Annual Probability of Exceedance
    d. Regional Wind Speed - Vr
    e. Wind Direction Multiplier – Md
    f. Terrain category & Terrain Category Factor –Mzcat
    g. Shielding Multiplier – Ms
    h. Topographic Factor – Mt
2. Ground Snow load- Sg
3. Earthquake Probability & Hazard Factor – Kp & Z

1.a Importance Level - 2

We have confirmed with the client that an Importance Level of 2 is appropriate based on the building types given in the NCC Vol 1 table B1.2a , and the NCC Guide to Vol 1 where it lists examples of building types for various Importance Levels and also the consideration of hazard to human life combined with impact on the public as per table B1.2

Should the certifiers come across any information that may challenge this, then please contact us so that we can discuss and reassess if necessary.

A generalised description of Importance Levels is given in table B1.2a of the NCC 2016 BCA - Volume One.

Importance Level	
1	Buildings or structures presenting a low degree of hazard to life and other property in the case of failure
2	Buildings or structures not included in Importance Level 1, 3 or 4
3	Buildings or structures that are designed to contain a large number of people.
4	Buildings or structures that are essential to post-disaster recovery or associated with hazardous facilities

B1.2

STRUCTURE

Example

A hospital may be of Importance Level 4 if it is the only hospital in an area. The same hospital may be of Importance Level 3 if it is one of many in an area.

A general method for the determination of the Importance level of any building is to assess the hazard to human life and the impact on the public in the event of building failure as follows:

Building Importance Levels					
		Impact on the public			
		I (Low)	II (Moderate)	III (Substantial)	IV (Extreme)
Hazard To Human Life	A (Low)	1	2	2	3
	B (Moderate)	2	2	3	3
	C (Substantial)	2	3	3	4
	D (Extreme)	3	3	4	4

The annual probability of exceedance varies with the type of action.

Example

Building failures due to earthquake or cyclone may be widespread and therefore have more impact on the public than say thunderstorms, that affect relatively smaller areas.

Table B1.2a

A generic description of building types has been provided to which Importance Levels have been assigned. The "Importance Level" concept is applicable to building structural safety only. More specific examples are provided in the following Table. The examples are not exhaustive.

Importance Level	Examples of building types
1	Farm buildings and farm sheds Isolated minor storage facilities Minor temporary facilities.
2	Low rise residential construction Buildings and facilities below the limits set for Importance Level 3.
3	Buildings and facilities where more than 300 people can congregate in one area. Buildings and facilities with a primary school, a secondary school or day care facilities with a capacity greater than 250. Buildings and facilities with a capacity greater than 500 for colleges or adult educational facilities Health care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities Jails and detention facilities Any occupancy with an occupant load greater than 5000 Power generating facilities, water treatment and waste water treatment facilities, any other public utilities not included in Importance Level 4 Buildings and facilities not included in Importance Level 4 containing hazardous materials capable of causing hazardous conditions that do not extend beyond property boundaries.
4	Buildings and facilities designated as essential facilities Buildings and facilities with special post disaster functions Medical emergency or surgery facilities Emergency service facilities: fire, rescue, police station and emergency vehicle garages Utilities required as backup for buildings and facilities of Importance Level 4 Designated emergency shelters Designated emergency centres and ancillary facilities Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond property boundaries.

Importance levels must be assigned on a case by case basis.

1 b. Wind Region - A2

The wind regions for Australia are given in figure 3.1 (A) of AS/NZS 1170.2:2011 - Structural design actions. Part 2: Wind actions plus amendments (herein after referenced as AS/NZS 1170.2)

The site is located at Forester Road ST MARYS NSW Australia 2760 which has the geographic coordinates of -33.7434, 150.7801.
Based on the Wind Region Map below, the site is located in Wind Region A2

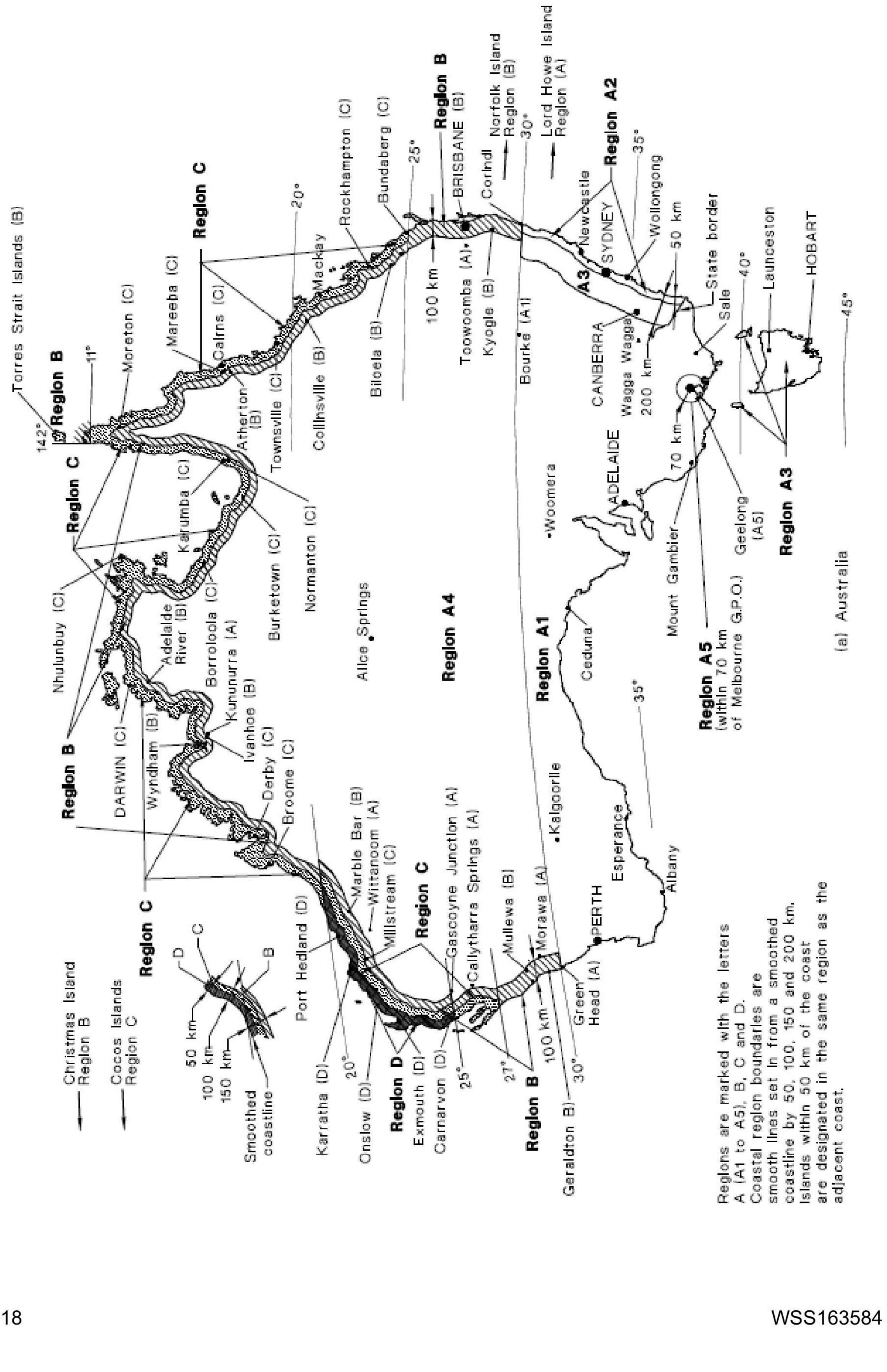


FIGURE 3.1(A) WIND REGIONS

1 c. Annual Probability of Exceedance - 1:500

Table B1.2b - Design Events for Safety of the NCC 2016 BCA - Volume 1 gives the annual probability of exceedance.

Importance Level	Annual probability of exceedance			
	Wind		Snow	Earthquake
	Non Cyclonic	Cyclonic		
1	1 : 100	1 : 200	1 : 100	1 : 250
2	1 : 500	1 : 500	1 : 150	1 : 500
3	1 : 1000	1 : 1000	1 : 200	1 : 1000
4	1 : 2000	1 : 2000	1 : 250	1 : 1500

For wind, as the site is non cyclonic and has an importance level of 2, the Annual Probability of Exceedance is read from the table as 1:500

1 d. Regional Wind Speed Vr = 45 m/s

From Table 3.1 of AS/NZS 1170.2 for Region A2 and an Annual Probability of Exceedance of 1:500 gives a Regional Wind speed of 45 m/s (V_r)

TABLE 3.1

REGIONAL WIND SPEEDS

Regional wind speed (m/s)	Region				
	Non-cyclonic			Cyclonic	
	A (1 to 7)	W	B	C	D
V_1	30	34	26	$23\times F_C$	$23\times F_D$
V_5	32	39	28	$33\times F_C$	$35\times F_D$
V_{10}	34	41	33	$39\times F_C$	$43\times F_D$
V_{20}	37	43	38	$45\times F_C$	$51\times F_D$
V_{25}	37	43	39	$47\times F_C$	$53\times F_D$
V_{50}	39	45	44	$52\times F_C$	$60\times F_D$
V_{100}	41	47	48	$56\times F_C$	$66\times F_D$
V_{200}	43	49	52	$61\times F_C$	$72\times F_D$
V_{250}	43	49	53	$62\times F_C$	$74\times F_D$
V_{500}	45	51	57	$66\times F_C$	$80\times F_D$
V_{1000}	46	53	60	$70\times F_C$	$85\times F_D$
V_{2000}	48	54	63	$73\times F_C$	$90\times F_D$
V_{2500}	48	55	64	$74\times F_C$	$91\times F_D$
V_{5000}	50	56	67	$78\times F_C$	$95\times F_D$
V_{10000}	51	58	69	$81\times F_C$	$99\times F_D$
V_R ($R \geq 5$ years)	$67–41R^{-0.1}$	$104–70R^{-0.045}$	$106–92R^{-0.1}$	$F_C\,(122–104R^{-0.1})$	$F_D\,(156–142R^{-0.1})$

1 e. Wind Direction Multiplier - Md

Table 3.2 of AS/NZS 1170.2 gives the relevant factors for Region A2 in all 8 Cardinal directions

TABLE 3.2

WIND DIRECTION MULTIPLIER (M_d)

Cardinal directions	Region A1	Region A2	Region A3	Region A4	Region A5
N	0.90	0.80	0.85	0.90	1.00
NE	0.80	0.80	0.80	0.85	0.85
E	0.80	0.80	0.80	0.90	0.80
SE	0.80	0.95	0.80	0.90	0.80
S	0.85	0.90	0.80	0.95	0.85
SW	0.95	0.95	0.85	0.95	0.90
W	1.00	1.00	0.90	0.95	1.00
NW	0.95	0.95	1.00	0.90	0.95
Any direction	1.00	1.00	1.00	1.00	1.00

1 f. Terrain Category & Terrain/Height Multiplier - Mz

AS/NZS 1170.2 Section 4.2.1 details the types of terrain categories that are applicable. These are:

Terrain Category 1 (TC 1) : Very exposed open terrain with few or no obstructions and enclosed, limited sized water surfaces at serviceability and ultimate wind speeds in all wind regions, e.g. flat, treeless, poorly grassed plains; rivers, canals and lakes; and enclosed bays extending less than 10km in the wind direction.

Terrain Category 1.5 (TC 1.5) : Open water surfaces subjected to shoaling waves at serviceability and ultimate wind speeds in all wind regions, e.g. near-shore ocean water; large unenclosed bays on seas and oceans; lakes; and enclosed bays extending greater than 10km in the wind direction

Terrain Category 2 (TC 2) : Open terrain, including grassland, with well scattered obstructions having heights generally from 1.5m to 5m, with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees and uncut grass.

Terrain Category 2.5 (TC 2.5) : Terrain with a few or isolated obstructions. This category is intermediate between TC 2 and TC 3 and represents the terrain in developing outer urban areas with scattered houses, or large acreage developments with fewer than 10 buildings per hectare.

Terrain Category 3 (TC 3) : Terrain with numerous closely spaced obstructions having heights generally from 3 to 10m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare. e.g. suburban housing, light industrial estates.

Terrain Category 4 (TC 4) : Terrain with numerous large high (10m to 30m tall) and closely spaced obstructions, such as large city centres and well developed industrial complexes.

TABLE 4.1

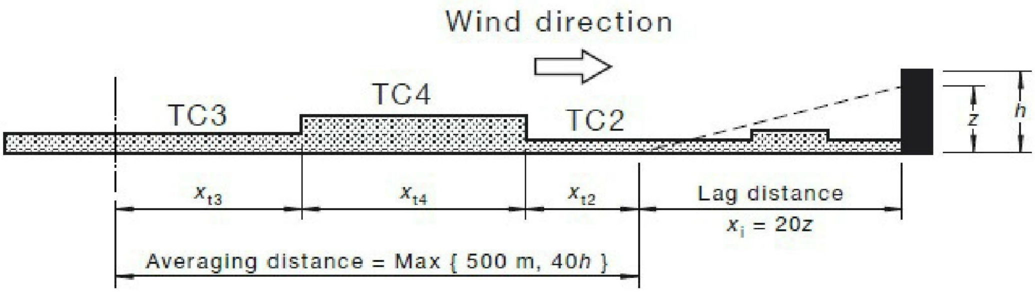
TERRAIN/HEIGHT MULTIPLIERS FOR GUST WIND SPEEDS IN FULLY DEVELOPED TERRAINS—ALL REGIONS

Height (z) m	Terrain/height multiplier ($M_{z,cat}$)			
	Terrain category 1	Terrain category 2	Terrain category 3	Terrain category 4
≤3	0.99	0.91	0.83	0.75
5	1.05	0.91	0.83	0.75
10	1.12	1.00	0.83	0.75
15	1.16	1.05	0.89	0.75
20	1.19	1.08	0.94	0.75
30	1.22	1.12	1.00	0.80
40	1.24	1.16	1.04	0.85
50	1.25	1.18	1.07	0.90
75	1.27	1.22	1.12	0.98
100	1.29	1.24	1.16	1.03
150	1.31	1.27	1.21	1.11
200	1.32	1.29	1.24	1.16

Note: For intermediate values of height and terrain category, use liner interpolation.

AS/NZS 1170.2 Section 4.2.3 goes on to describe the averaging of terrain categories and terrain height multipliers.

The Lag distance (in this case equivalent to the shielding zone) has been ignored when considering the terrain category.



$$M_{z,cat} = \frac{M_{z,cat2}\,x_{t2} + M_{z,cat4}\,x_{t4} + M_{z,cat3}\,x_{t3}}{x_{t2} + x_{t4} + x_{t3}} \quad \text{for the case illustrated}$$

NOTE: The terrain within the lag distance, x_i, is ignored when averaging terrain-height multipliers.

FIGURE 4.1 EXAMPLE OF AVERAGING OF TERRAIN-HEIGHT MULTIPLIERS

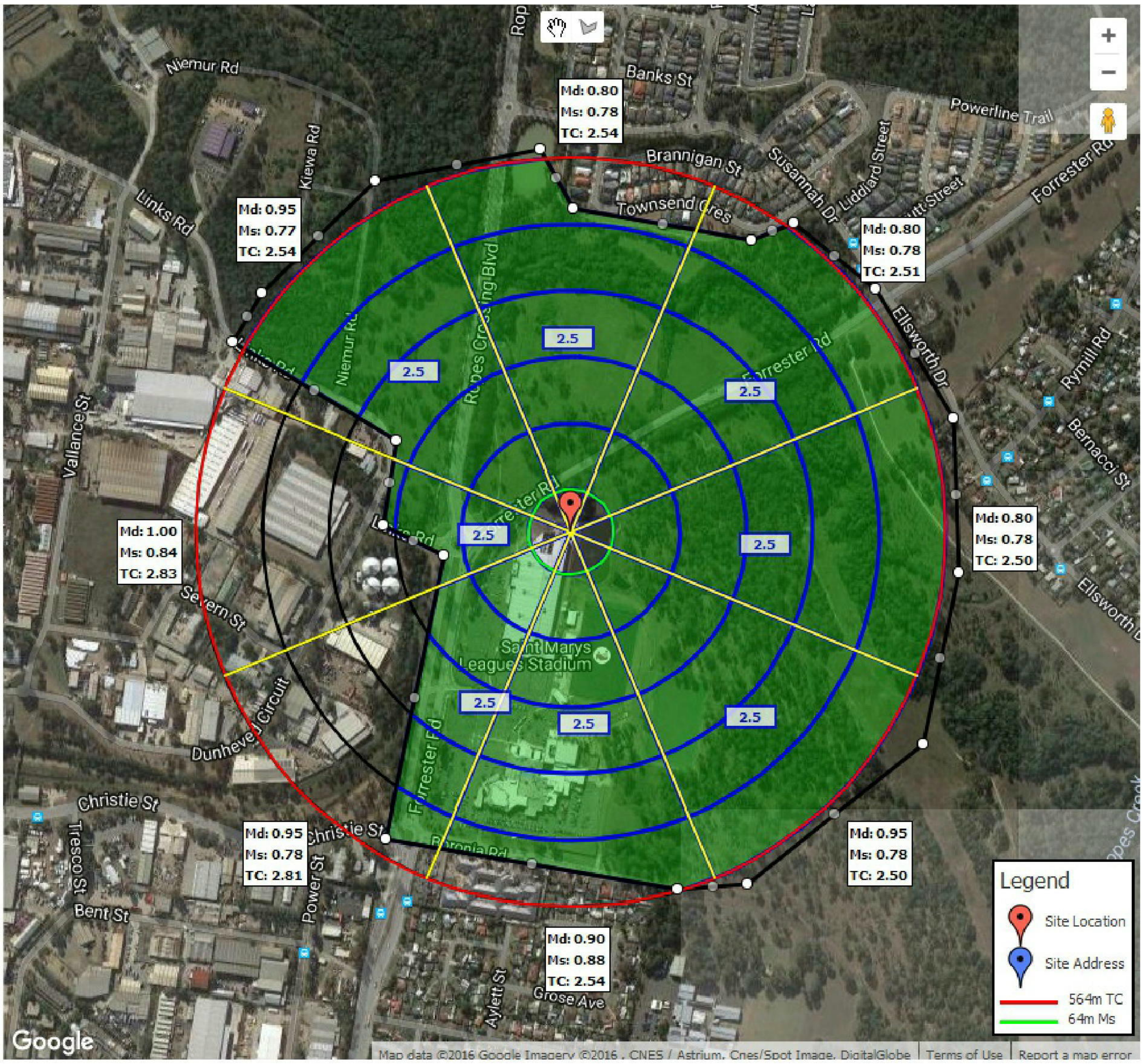
Further to this averaging process is the need to often consider various changes in Terrain Category other than the simple case of changes occurring as the distance is fanned out from the site.

Where appropriate, a method of considering 100m sectors within each cardinal direction and then averaging the terrain category within each sector based on area has been adopted. This method requires advance programing techniques in combination with Google mapping API's, but gives the most accurate result.

The image below shows the terrain category determined for each of the 8 cardinal directions.

Assessment has also taken into account the probable future development 5 years after construction of the building. The result of this assessment is:

Within the terrain category zone the satellite image shows the extent of current development and likely development within the next 5 years.



The average height of the building is 3.20 meters. Using table 4.1 from AS/NZS 1170.2 the value of Mz can be interpolated

Factor	N	NE	E	SE	S	SW	W	NW
Terrain Category	2.54	2.51	2.5	2.5	2.54	2.81	2.83	2.54
Terrain Category Multiplier	0.87	0.87	0.87	0.87	0.87	0.85	0.84	0.87

1 g. Shielding Multiplier -Ms

As per AS/NZS 1170.2 clause 4.3.1 shielding from tress or vegetation has not been included.

Four (4) factors have to be considered:

1. Only buildings whose height is equal to or greater than the building being considered shall be deemed to provide shielding.
2. Shielding is considered only within the area of 20 times the average height of the building being considered.
3. Each 45 degree sector must be considered individually – 8 cardinal directions
4. If the slope of the terrain is greater than 0.2 (1:5), then no shielding is applicable. (100m rise or fall over 500m).

Assessment has also taken into account be the probable future development 5 years after construction of the building. The result of this assessment is:

Within the shielding zone the satellite image shows the extent of current development and likely development within the next 5 years.

The shielding parameter (s) in Table 4.3 shall be determined as follows:

$$s = \frac{l_s}{\sqrt{h_s b_s}} \qquad \text{. . . 4.3(1)}$$

where

l_s = average spacing of shielding buildings, given by:

$$= h\left(\frac{10}{n_s} + 5\right) \qquad \text{. . . 4.3(2)}$$

h_s = average roof height of shielding buildings

b_s = average breadth of shielding buildings, normal to the wind stream

h = average roof height, above ground, of the structure being shielded

n_s = number of upwind shielding buildings within a 45° sector of radius $20h$ and with $h_s \geq z$

From this shielding parameter, the shielding multiplier can be interpolated from Table 4.3 of AS/NZS 1170.2

Factor	N	NE	E	SE	S	SW	W	NW
n_s	1	1	1	1	1	1	1	1
l_s	47.96	47.96	47.96	47.96	47.96	47.96	47.96	47.96
h_s	7	7	7	7	7	7	7	7
b_s	47.84	47.84	47.84	47.84	11.7	47.08	17.55	48.8
s	2.62	2.62	2.62	2.62	5.3	2.64	4.33	2.59

TABLE 4.3

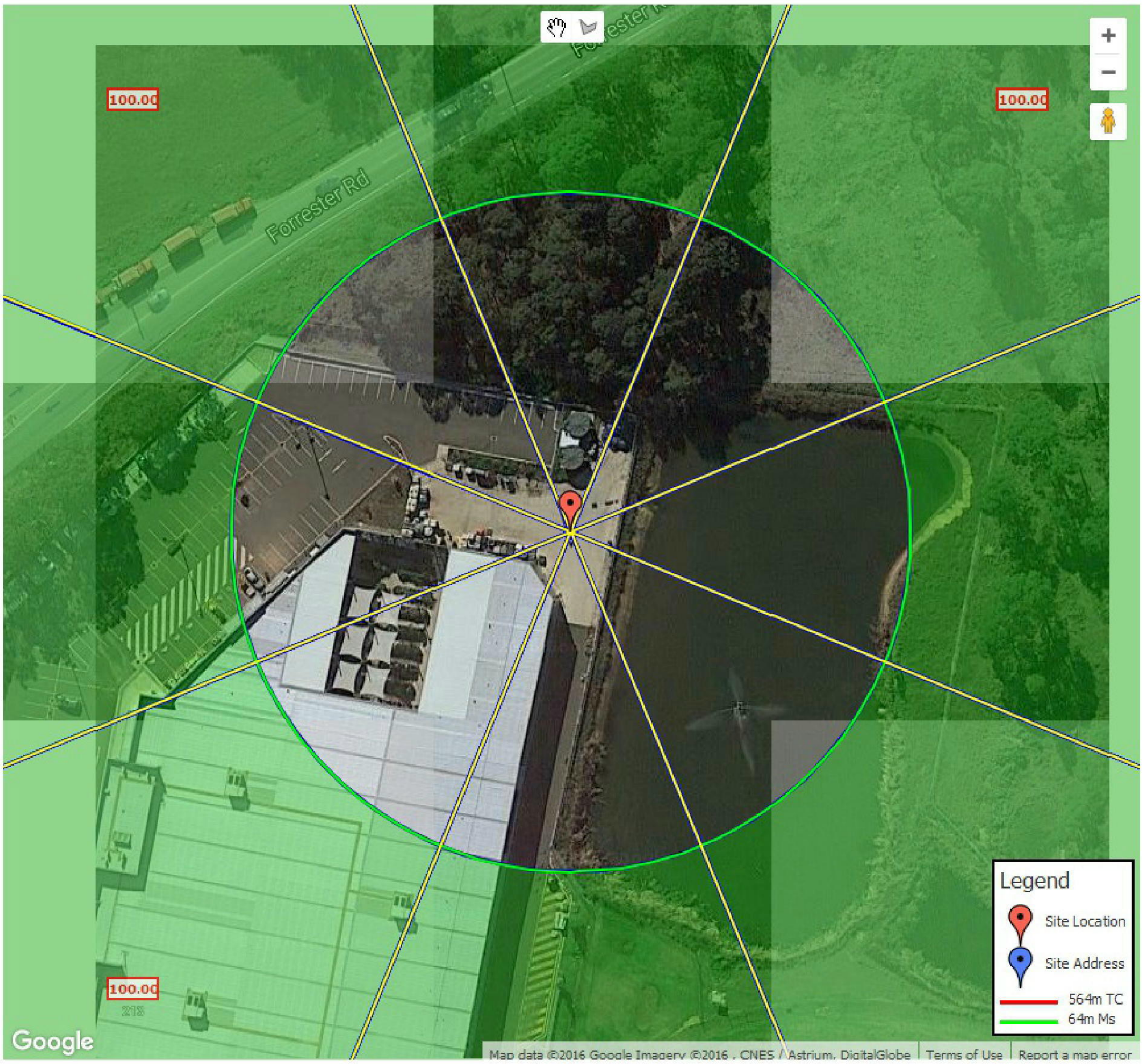
SHIELDING MULTIPLIER (M_s)

Shielding parameter (s)	Shielding multiplier (M_s)
≤1.5	0.7
3.0	0.8
6.0	0.9
≥12.0	1.0

NOTE: For intermediate values of s, use linear interpolation.

Shielding has been assessed using advance programing techniques in combination with Google mapping API's.

The image below shows this technology applied in all 8 Cardinal directions with the shielding multiplier shown for each Cardinal direction.



Shielding is considered in all 8 cardinal directions.

Factor	N	NE	E	SE	S	SW	W	NW
Shielding Multiplier (Ms)	1	1	1	1	1	0.85	0.85	1

1 h. Topographic Multiplier - Mt

As per section 4.4 of AS/NZS 1170.2, a Topographic Factor is not applicable where

1. The distance from the building, to the peak of the hill, is greater than 10 times the Buildings elevation above sea level.
2. For buildings less than 12.5m average roof height, if within a 500m radius of the building, the average slope is less than 0.05 (25m rise or fall)

Using advance programing techniques in combination with Google mapping API's we are able to determine if a rise or fall of 25m in each Cardinal direction is exceeded. This is shown by a red diamond situated on the topographic ring.

In this case there is no Topographic Factor to consider in any direction. Mt = 1

2. Ground Snow Load

The site is outside of the boundaries given in AS/NZS 1170.3:2003 - Structural design actions. Part 2: Snow and ice actions plus amendments (herein after referenced as AS/NZS 1170.3) for snow load regions. Hence no snow load is applicable.

3. Earthquake Hazard Factor (Z)

The earthquake factor (kp) has been deemed insignificant to the design of this particular building.