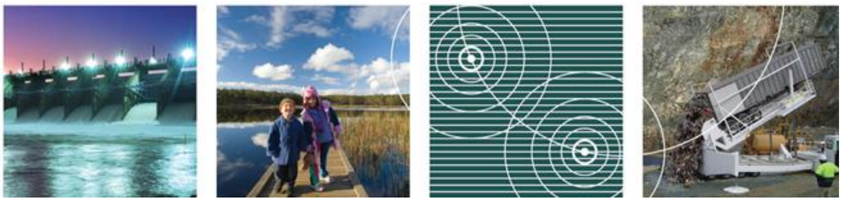

Sustainability Report

60 Wallgrove Road, Minchinbury - Industrial Lands

Commercial-in-Confidence

Afterton Ltd

23 July 2009

Sustainability Report

Prepared for

Afterton Ltd

Prepared by

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Table of Contents

1.0 Introduction

Sustainable design principles for the proposed Minchinbury industrial development located at the M4/M7 motorway junction are identified both qualitatively and quantitatively within this report. The sustainability strategies presented respond to the requirements of the Draft SEPP (WSEH) and Director General's Requirements by reducing:

1. Greenhouse gas (GHG) emissions and;
2. The consumption of potable water.

The analysis considers local site features, local climate data and possible development strategies. Sustainability strategies to reduce energy use, reduce water and improve pedestrian comfort have been recommended. The energy use scope has been extended to include recommendations on reducing the carbon content of building and infrastructure materials used in the development.

This report has been prepared by AECOM as part of a Concept Design Report to be completed by EDAW AECOM. A detailed assessment of the water-related issues is addressed in the accompanying Water Sensitive Urban Design (WSUD) report prepared by EDAW.

2.0 Site Climatic Conditions

The local climatic conditions and topography of the site influence the wind flow patterns and consequently have effect on the opportunities for energy efficiency in building design and orientation and pedestrian comfort across the site.

2.1 Site Topography

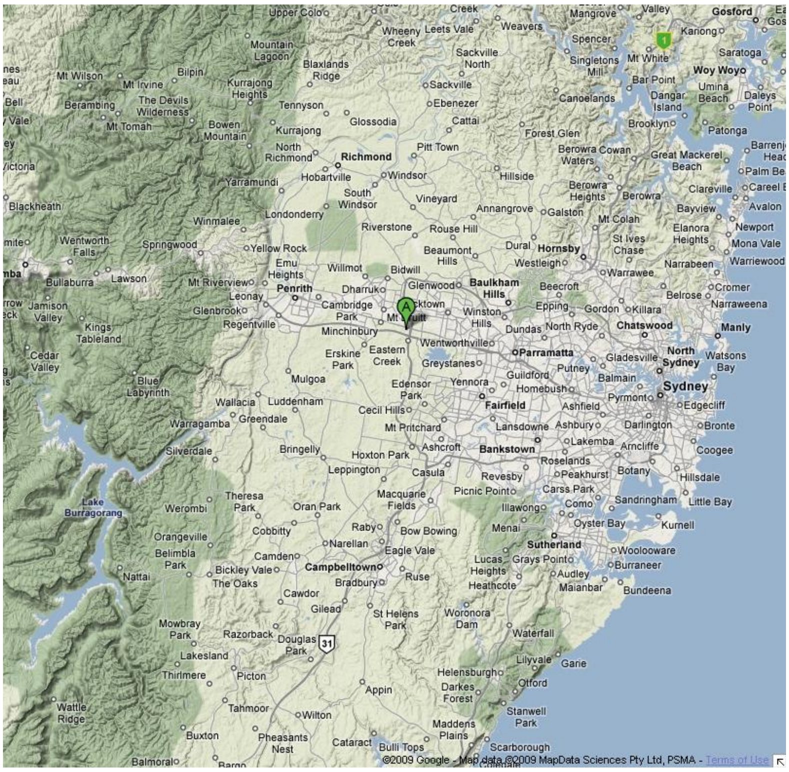


Figure 1: Site location

The topography of the site and its surrounding is generally level with a slight incline on the south-western surrounding of the site. The surrounding land use around the site is generally cleared land with occasional single-storey residential areas. Site contours are indicated below.

Figure 2: Site contours and topography

2.2 Predominant Site Wind Conditions

Seasonal wind roses for Horsley Park which is located approximately 7km from the site were obtained from the Bureau of Meteorology (BOM). Analysis for summer and winter conditions indicates the following climatic conditions.

Figure 3 shows the seasonal wind roses for Horsley Park which is located approximately 7 km from the site. The data was obtained from the Bureau of Meteorology (BOM), and was measured every 3 hours from 1/9/1997 to 6/72009, excepting short periods of instrument maintenance or downtime. The probability-weighted average wind speeds excluding calms are 5.2 m/s for summer, 4.7 m/s for autumn, 4.7 m/s for winter and 5.6 m/s for spring.

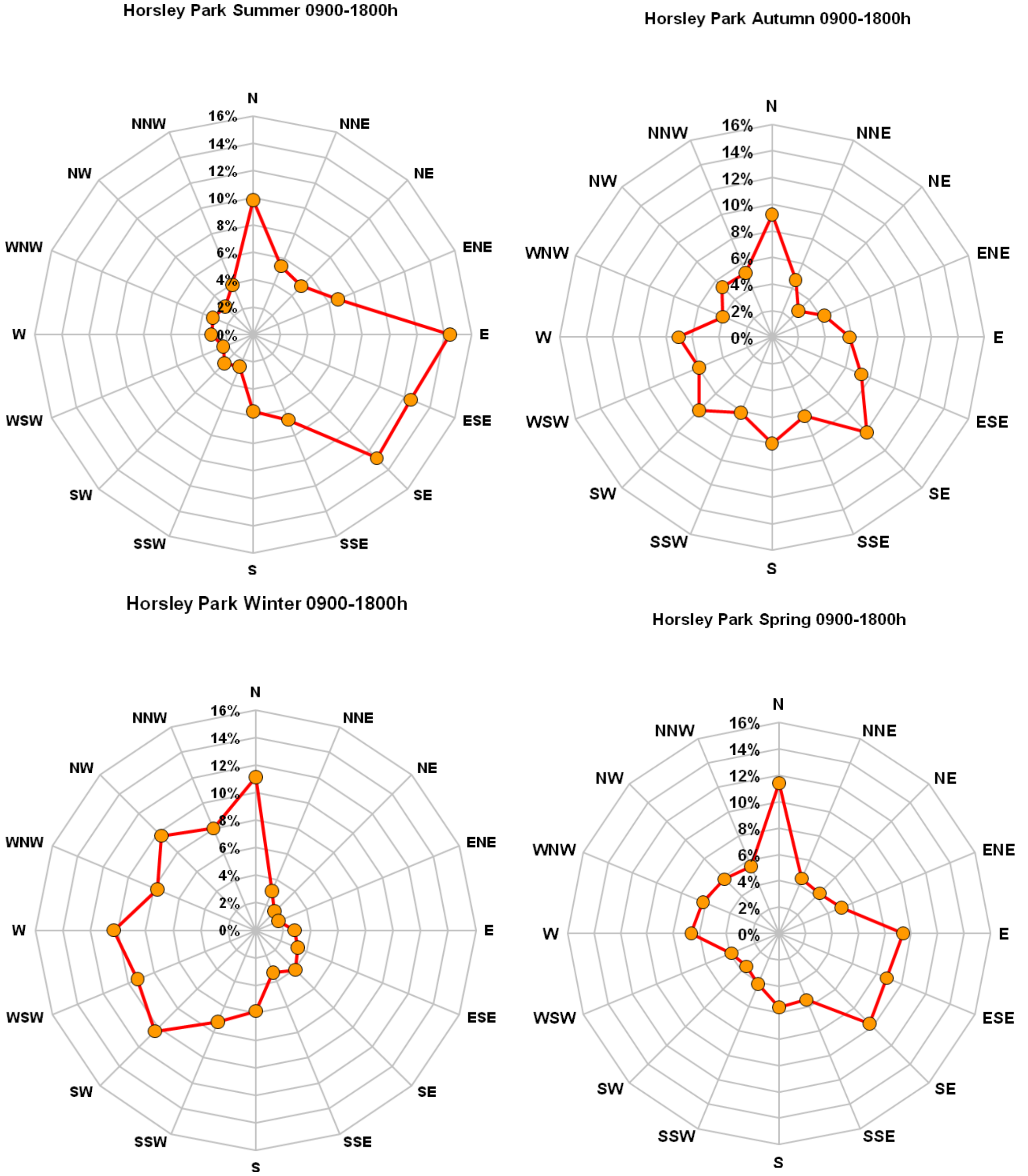


Figure 3: Seasonal wind roses for the weather station at Horsley Park (site 067119) derived from 3-hourly data from BOM from 1997 to 2009.

Further investigation into the wind profile during the day for summer is as shown below in Figure 4. The data shows that in the morning, northerly and southerly winds are common and in the afternoon, east to south-easterly winds are common. Mean temperature at 9am for summer is 21.4°C and at 3pm is 27.2°C.

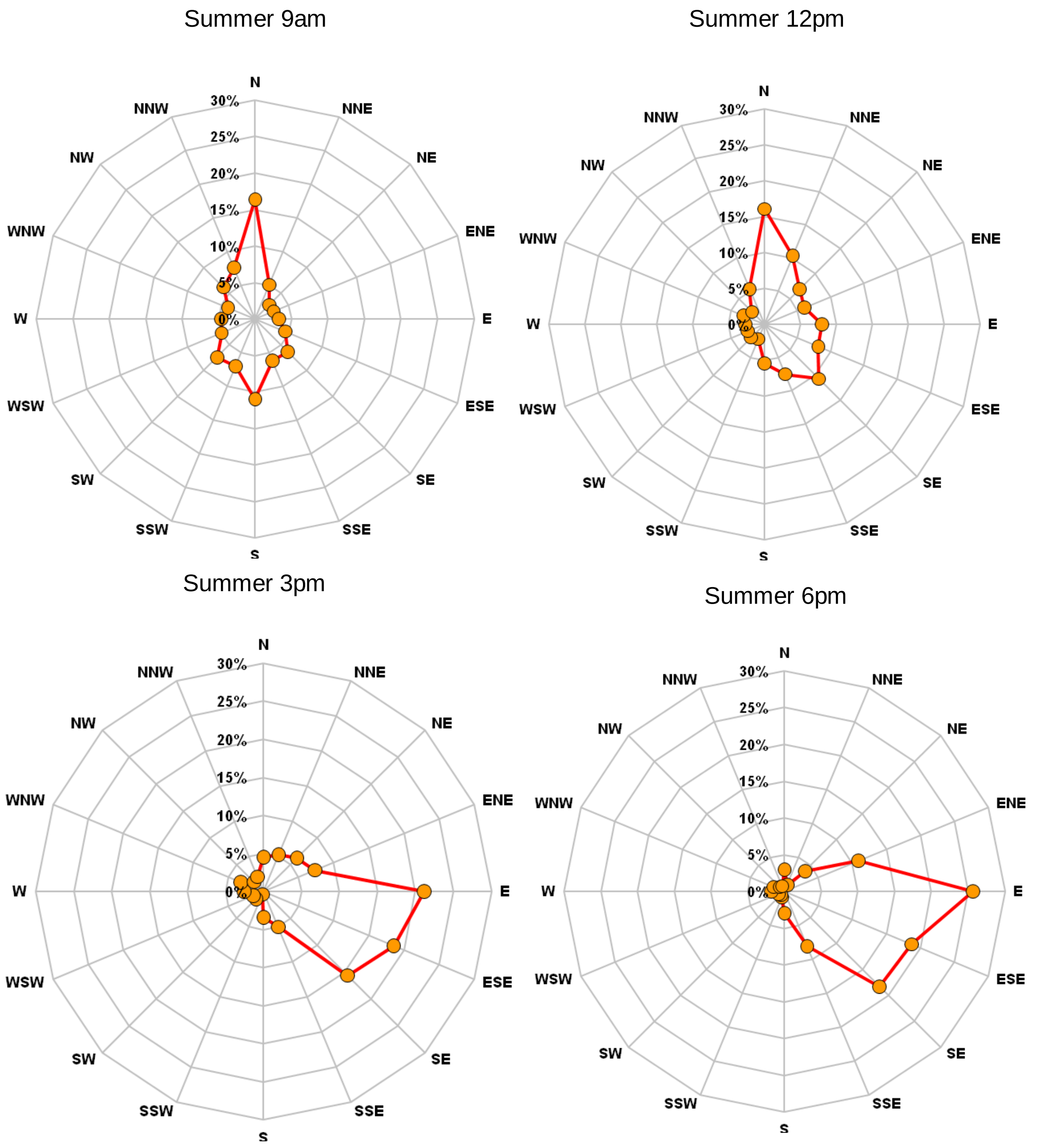


Figure 4: Summer wind roses for the weather station at Horsley Park (site 067119) derived from 3-hourly data from BOM from 1997 to 2009.

Figure 5 provides a general site depiction of the dominant wind conditions based on analysis of local weather data. Winds from directions other than those depicted in Figure 5 are still expected to occur, but less frequently.

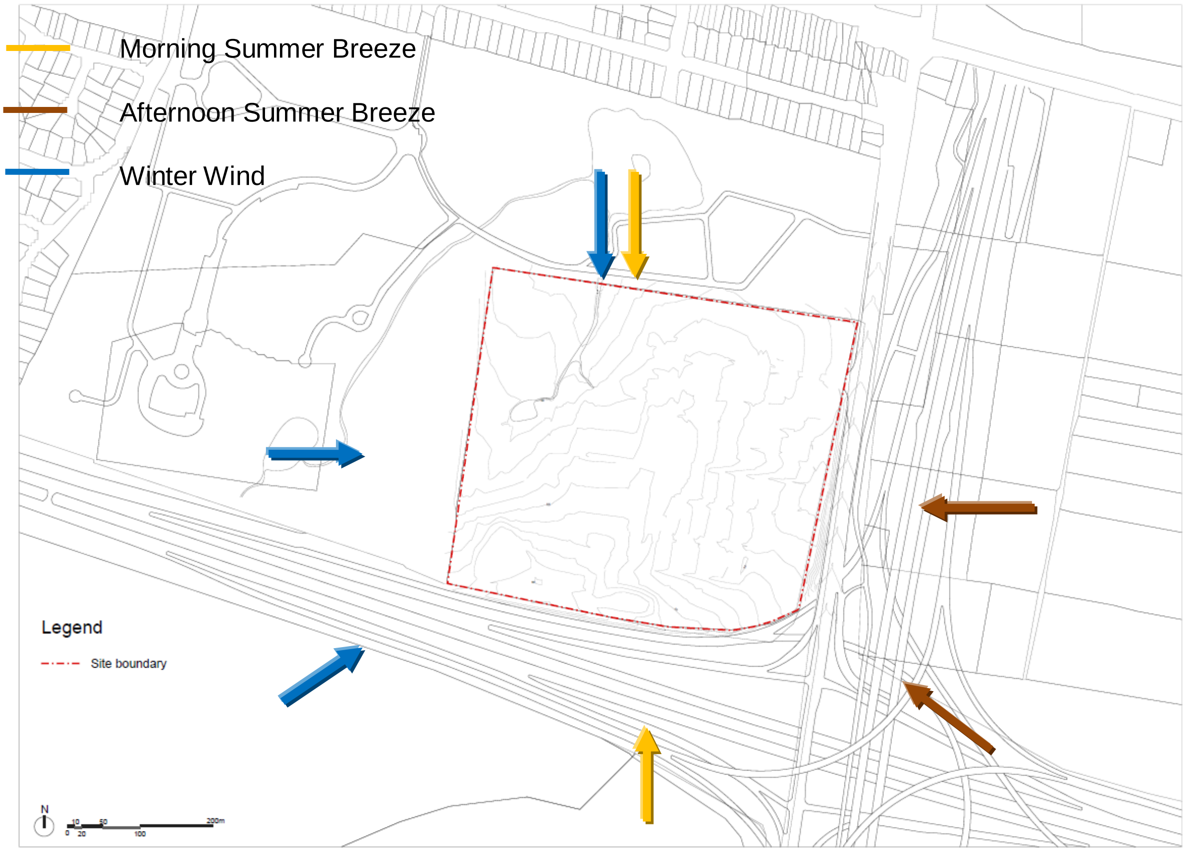


Figure 5: Site with surroundings indicating dominant summer and winter winds.

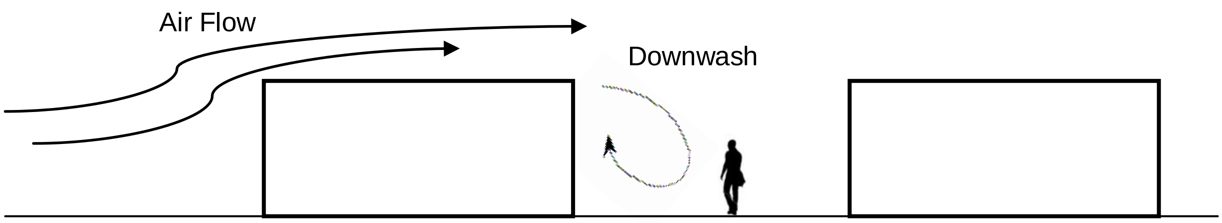
3.0 Sustainable Design Strategies

3.1 Public Domain/Sitewide Sustainable Design Strategies

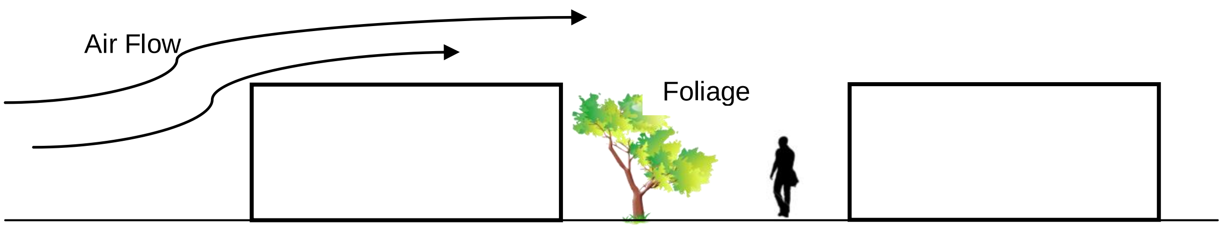
3.1.1 Wind Effects between buildings

Air flow around, over and through buildings must negotiate sharp corners, narrow openings and vertical obstructions. As a result, air flow patterns in the built environment are typically complex, featuring recirculation zones, rapidly rising or falling flows and regions of stagnation.

Building downwash occurs on the upwind side of building, primarily due to the blocking effect of large structures or buildings. Wind impacting on large buildings is partially directed downward on the upwind side. On the lee side, downwash occurs due to air flow over the building forming a recirculation zone which in turn forms a downward stream somewhat set back from the building. Downwash may result in accelerated wind speeds at pedestrian levels.



Downwash may be mitigated by the use of canopies, alcoves, high level foliage close to or above building height to create a canopy or the provision of adequate space between neighbouring buildings as shown below. Defining adequate space will depend on building heights and likely wind gust speeds.



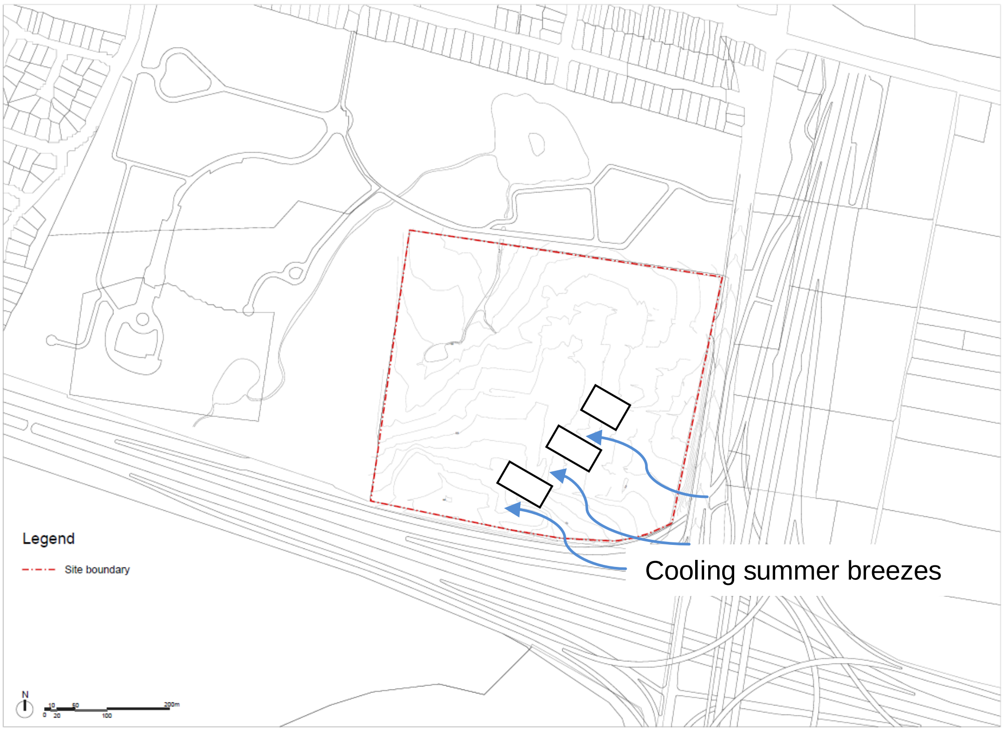
Horizontal steering occurs through the gaps of buildings in the form of flow-stream compression, corner acceleration and vortices and may contribute to unpleasantly high wind speeds and gusty wind conditions at street level. Undesirable horizontal wind effects may be mitigated by some form of porous screening in the form of louvres or perforated walls, or landscaped hedges or trees.

Based on a review of the site's local weather data and taking into consideration local topography and surrounding built form, the following provides a summary of sustainable design options which are considered feasible for the site's future development.

3.1.2 Pedestrian Comfort in Summer

In the generally hot and humid conditions in the site area during summer, the majority of wind conditions, i.e. cooling easterly breezes, will improve the thermal comfort of occupants and pedestrians through their evaporative effect on human skin. Strong and gusty winds (most commonly from north, south and south-easterly to easterly headings), however, may produce discomfort in sedentary users and pedestrians, and also result in inconvenience during outdoor operations (e.g. loading/unloading) and the scattering of rubbish etc. in refuse and recycling areas.

In order to maximise the effects of wind on the increased thermal comfort during summer, buildings should be orientated to allow, south, east and south-easterly winds to flow through the site. An example of a building orientation that provides a passage for south-easterly breezes is indicated below.



Areas with typically sedentary use, such as open dining areas, patios etc, should be located in order to have access to easterly and south-easterly winds.

It is acknowledged that planning for south easterly winds may deflect or reduce the penetration of north easterly winds and that some compromise will be necessary. Future planning should aim to maximise permeability towards the eastern side of the site.

3.1.3 Winter

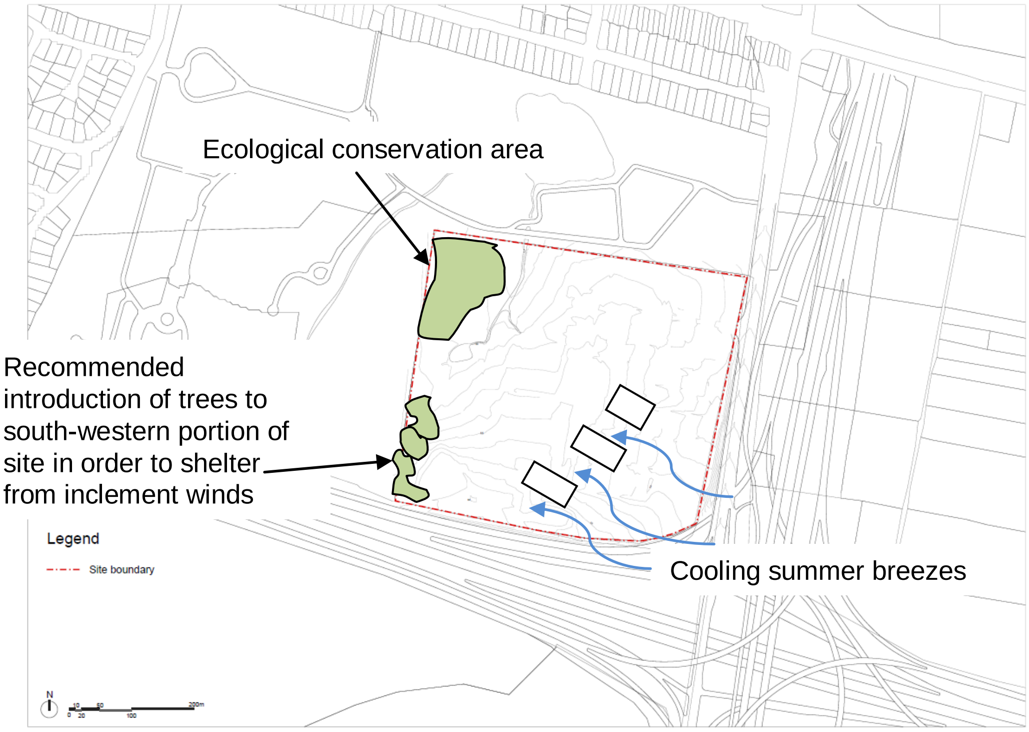
Generally, exposure to moderate and strong winter winds should be minimised for pedestrian comfort. Analysed wind data indicates there is a high occurrence of winds from the south west through to north. Therefore, site design should consider configuration of buildings in order to minimise exposure to these winds.

The following design implications should be taken into account when considering the shielding from winds during winter:

- Avoid installing loading dock bays and access facing anywhere between south-west to north
- Place higher buildings towards the south-west and western edge of the site to shield areas from winter winds, while having regard to corner, downwash and lee effects
- Plant and maintain sufficiently dense landscaping (trees and foliage) or shelter at the south-west and western edge of the site boundary to help mitigate the effect of strong winter winds. The landscaping should at:
    - Be composed of evergreens, and;
    - Be composed of trees with significant leaf density down to near-ground level or under-planting with similar effect, and;

- Feature trees which are at least 3 m high.
- Avoid placing open dining areas and patios at areas which are exposed to south-west and western winter winds

Preservation of the ecological conservation area located in the north western portion of the site will also assist in sheltering inclement winds from the west during winter months.
Future planning should aim to minimise permeability towards the western side of the site.



3.1.4 Microclimatic Conditions

Buildings and landscaping features on individual sites or common/circulation areas can have a strong influence on microclimate and pedestrian comfort at site or street level. Thus, open space areas and areas where people are likely to congregate should take into consideration the likely microclimatic effects of surrounding adjacent buildings and infrastructure, such as solar access during winter, wind breaks etc.

Due to the channelling of winds, horizontal steering may occur along pathways and the streetscape, causing pedestrian discomfort. In the absence of appropriate landscaping, winds may accelerate and can lead to strong turbulent gusts which may result in pedestrian discomfort. Landscaping concepts may assist in mitigating these effects, and the planting of trees on the windward side of the footpath which feature higher leaf density down to near-ground level, or under-planting with similar effect should be considered in the landscaping design.

3.1.5 Site Features

In order to encourage alternate modes of transport to and within the site, consideration of adequate cycleways and walking paths linking the site infrastructure to the motorway interchange should be provided.

If buildings are set back from the road and footpaths, alternate means of shading should be provided for walkways, in the form of retained or re-established flora/landscaping.

By limiting hardstand/hard surfaces and reducing the extent of hard stand in single areas such as car parks or open space concreted areas may also assist in reducing the local heat island effect. Intermittent 'softer' areas such as grass, landscaping etc should be considered as an alternative.

3.1.5.1 Landscaping Materials

Figure 1 below provides comparison of carbon dioxide equivalent of 1kg of hardstand materials generally used at industrial sites (bitumen, plain concrete mix and concrete mix with flyash). As indicated, replacement of concrete mix with flyash reduces the CO2e by approximately fifteen percent. Materials with lower embodied carbon dioxide should be considered during the design and construction of the proposed development.

1 kg	Bitumen, at consumer/AU U	0.66 kg CO2e
1 kg	Concrete plain mix	0.25 kg Co2e
1 kg	Concrete 30% flyash mix	0.21 kg CO2e

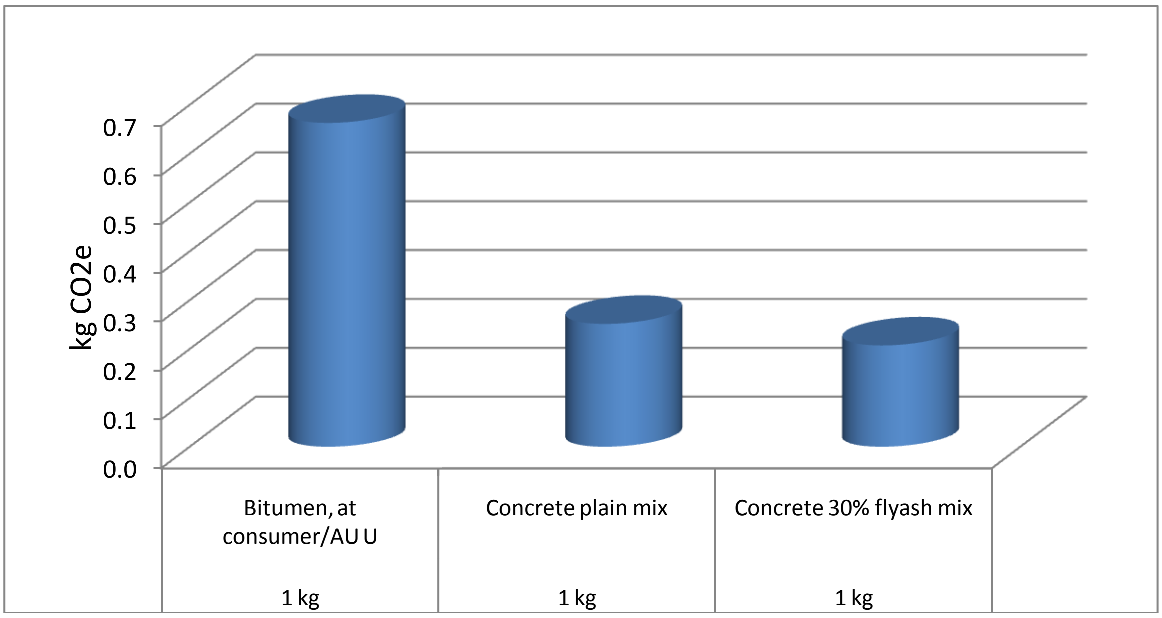


Figure 6: Carbon dioxide equivalent of generic hardstand materials

3.2 Building Sustainable Design Strategies

3.2.1 Sustainable Building Design

A commitment to sustainable development incorporates best practice energy management, the use of renewable resources and reducing the impact of buildings on the environment. Aspects of sustainable building design that can be considered for the Minchinbury development include:

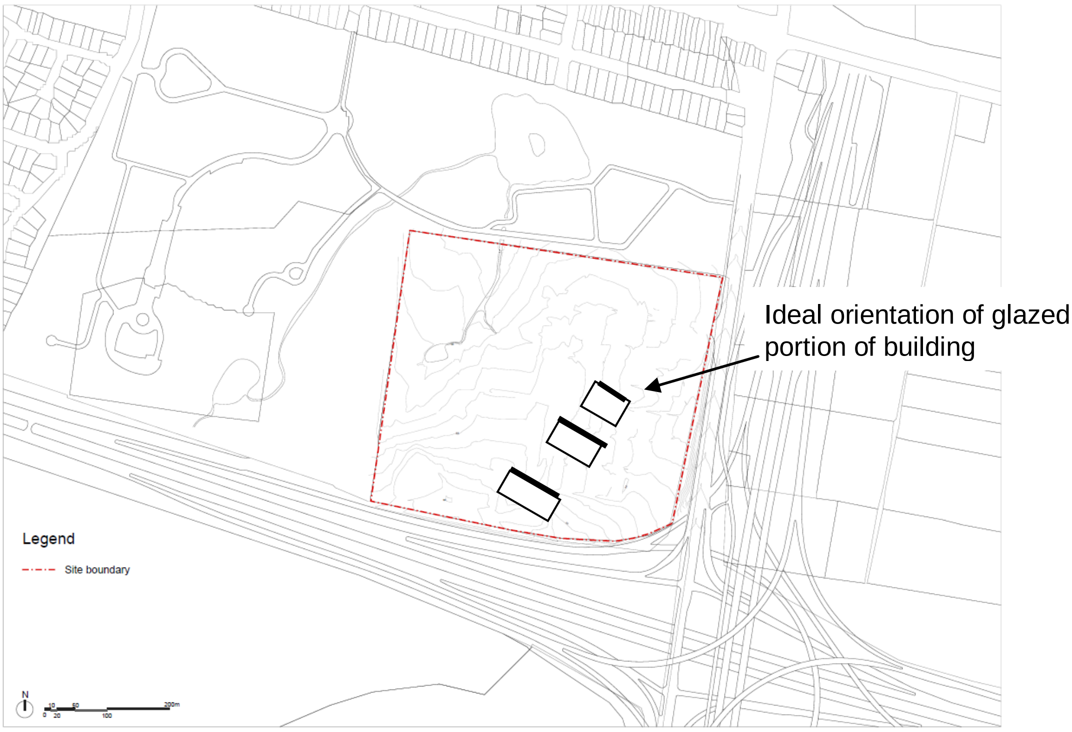
1. Minimising energy use by incorporating passive design principles into the building form (shape, size, depth, orientation);
    a. Minimise solar heat gain
    b. Maximise natural daylight and diffuse natural light
    c. Encourage natural ventilation where possible
2. High performance building envelope;
3. Water conservation
    a. Rainwater reuse, water recycling, stormwater management

    b. Water efficient fittings
4. Environmentally sound materials
    a. Include recycled materials or materials with a high recyclable content
    b. Minimise embodied energy of materials

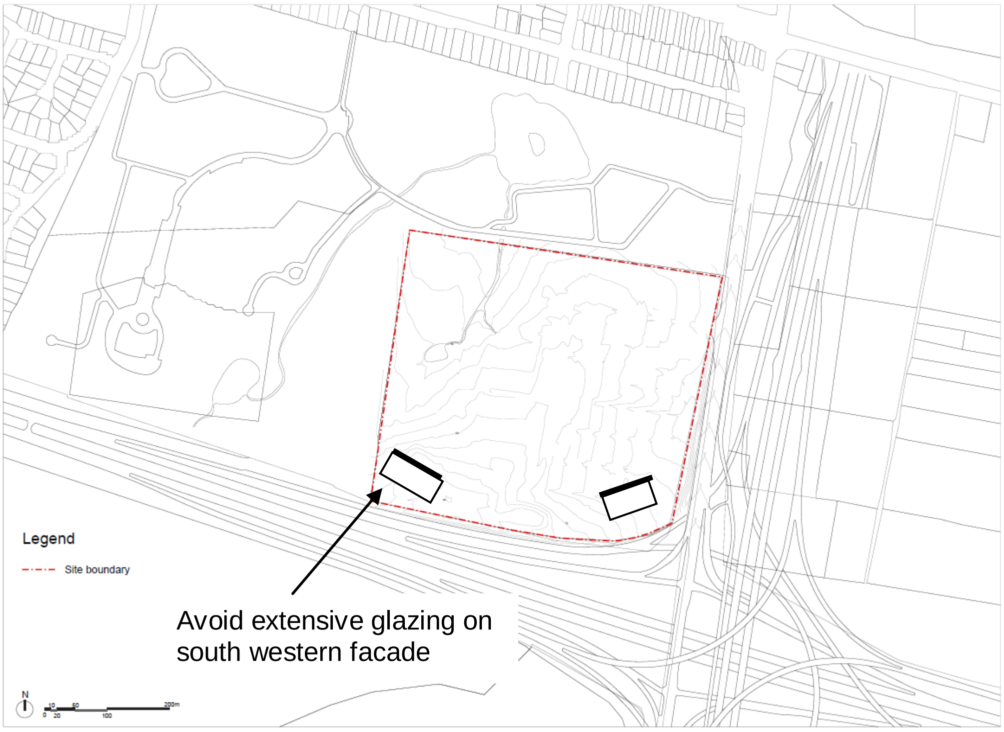
3.2.2 Building Orientation

Based on the assessment of wind data for site and predominant seasonal wind directions, the placement of trees and/or buildings along the south western fringe of the site would assist in reducing the effects of potential hot summer gusts from the west.

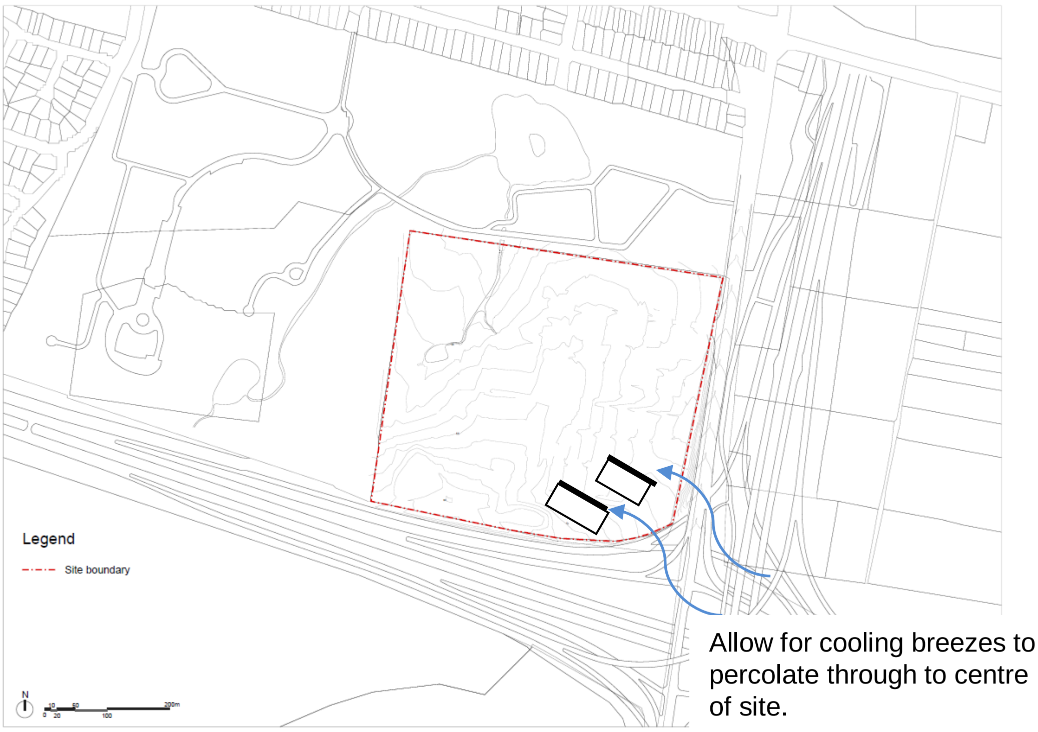
Orientation of glazed portions of the building to face the north and east will assist in reducing heat loads within the buildings. Where possible, office frontage or orientating the more exposed portions of the building towards the north or east should be considered in the building design.



It is noted there are two areas of high visibility or 'landmark' sites on the site, which have high visibility from the motorway interchange are located in the south western and south eastern portions of the site. Considering the climatic conditions of the site, the south western location would be subject to hot dry winds and setting sun in summer, and cold winds in winter. This suggests the use of extensive glazing orientated towards the south west may create excessive internal discomfort and result in high heating and cooling requirements. As such landmark buildings with extensive glazing or façade facing the motorway (south west) should be avoided at this location. Indicative orientation of landmark buildings is presented below.



For the south-eastern location, any infrastructure may be more open to the prevailing breezes. However, the design of such a located building should consider allowing breezes to percolate through the site to centrally located buildings behind.



3.2.3 Water Conservation

Efficient Fixtures
Water efficient fixtures (those with a higher WELS rating) reduce overall potable water consumption. Choice of water efficient hydraulic fittings such as tapwares, dual flush toilets, urinals and shower heads all have the potential to reduce water consumption.

Recycling
Consideration of either a site-wide water recycling system (such as rainwater harvesting) or individual recycling systems for a building would also reduce the reliance on mains water consumption. Collecting rainwater from roofs or buildings and other impervious surfaces for the re-use in toilets or site irrigation where appropriate will also reduce water consumption.

3.2.4 Energy Conservation (Building Form)

The thermal performance of the building envelope is a critical sustainable design strategy. The envelope design should consider, where appropriate:

- Optimisation of glazing shading coefficient to control solar heat gain and visual light transmission for external views and occupant comfort;
- Provision of external solar shading to limit solar heat gain- shading devices can also be deployed during summer months and retracted during winter months;
- Specification of high performance thermal insulation on roofs and walls;
- Provision of radiant barriers in the roof insulation.

3.2.5 Energy Conservation (Natural Ventilation)

Low storey buildings have strong potential to use natural ventilation, subject to the local winds and anticipated internal heat loads. The implementation of natural ventilation design principles, including operable windows and/or louvres, will generate low-resistance air paths within the building and reduce the air-conditioning requirement.

Consideration of the placements of doors, windows and ventilation louvres of the buildings in order to maximise ventilation due to east and south-easterly winds should be taken into account. Low-storey buildings have the potential to use natural ventilation in order to maximise the cooling effect of summer breezes.

Some examples of natural ventilation and passive design principles that can be considered during the detailed design phase are:

- Building orientation with the long-axis approximately normal to prevailing cooling breezes;
- Incorporation of some thermal mass to smooth temperature variations within the space, for example, exposed concrete floors to the winter sun;
- Cross-ventilation paths where possible to draw in cool air at low level and to exhaust warm air at high level;
- Inclusion of green walls or green roof to absorb heat
- Provision of low-energy ceiling mounted fans in common areas

3.2.6 Energy Conservation (Active)

Energy use and a dependence on mechanical services can be minimised within the office spaces by considering the following active approaches to energy conservation:

Optimise HVAC System

- Minimise the mechanical cooling and heating requirements by servicing only the zones of the building which require thermal control.
- Selection of high performance, energy efficient HVAC systems and controls

- Use of Building Management Systems, or other, to enhance the HVAC operation and lighting control.

Low-energy lighting and good lighting design

- Efficient lights and fittings
- Lighting controls and zoning
- Motion sensors and manual override

Good lighting design aims to improve the efficiency of artificial lighting, for example by lighting only necessary spaces during off-peak times. The system can incorporate strategies such as occupant sensing and day-night use modes to control the lighting and yield energy savings. This approach reduces greenhouse gas emissions and the associated cooling requirements

Efficient appliances

- Selection of low energy computing equipment, fridges, microwaves, heaters etc

3.2.7 Renewable Energy

There is potential to either generate renewable energy at the site, or to purchase green power off-site, in order to further reduce the carbon footprint of this development. The choice of renewable technology and the size of the system will be determined by the cost and/or the available space on-site. The following technologies could be considered:

- Wind power purchase off-site (approximately 5 cents/kWh)
- Photovoltaic array on-site (approximately $10 per Watt peak)
- Solar hot water system if sufficient demand for hot water exists
- Ground source heat pump that can run the air conditioning system.

Photovoltaics

Opportunities for solar collectors exist at the site on surfaces that have relatively unobstructed access to sunlight. The typical rule-of-thumb for a solar array is:

- The surface should be orientated somewhere between north-west to north-east
- The surface is typically tilted between 23 degrees to 30 degrees from the horizontal to achieve optimum performance.
- Allow an area of approximately $10m^2$ for an array that generates approximately 1kW peak of power (this is a typical house installation size).

Photovoltaic installations on a pitched roof or a flat roof can typically satisfy the basic design guidelines above.

3.2.8 Materials Selection

A comparison of embodied energy calculations of environmentally sound materials against a generalised business as usual (BAU) case for nominated surfaces/areas for infrastructure has been undertaken, which estimates the benefits of using alternate materials such as recycled materials etc.

3.2.8.1 Building Materials

Building materials will inevitably contribute a significant portion of the development's embodied energy use. Comparison of a range of common building materials below indicates the significant difference in carbon dioxide equivalent between the use of aluminium building applications and more environmentally applications such as eco-bricks for construction. The proposed development should consider the more environmentally sustainable alternatives to building applications other than aluminium if feasible and practical.

Unit	Building Material	kg CO2e
1 kg	Aluminium, building applications	18.6
1 kg	Steel Bluescope port kembla	3.11
1 kg	Steel Bluescope port kembla 20% recycled	2.80
1 kg	Flat glass, uncoated, at plant	0.71
1 kg	Hardwood	0.45
1 kg	Structural Pine	0.39
1 kg	Bricks	0.25
1 kg	Eco-bricks	0.20

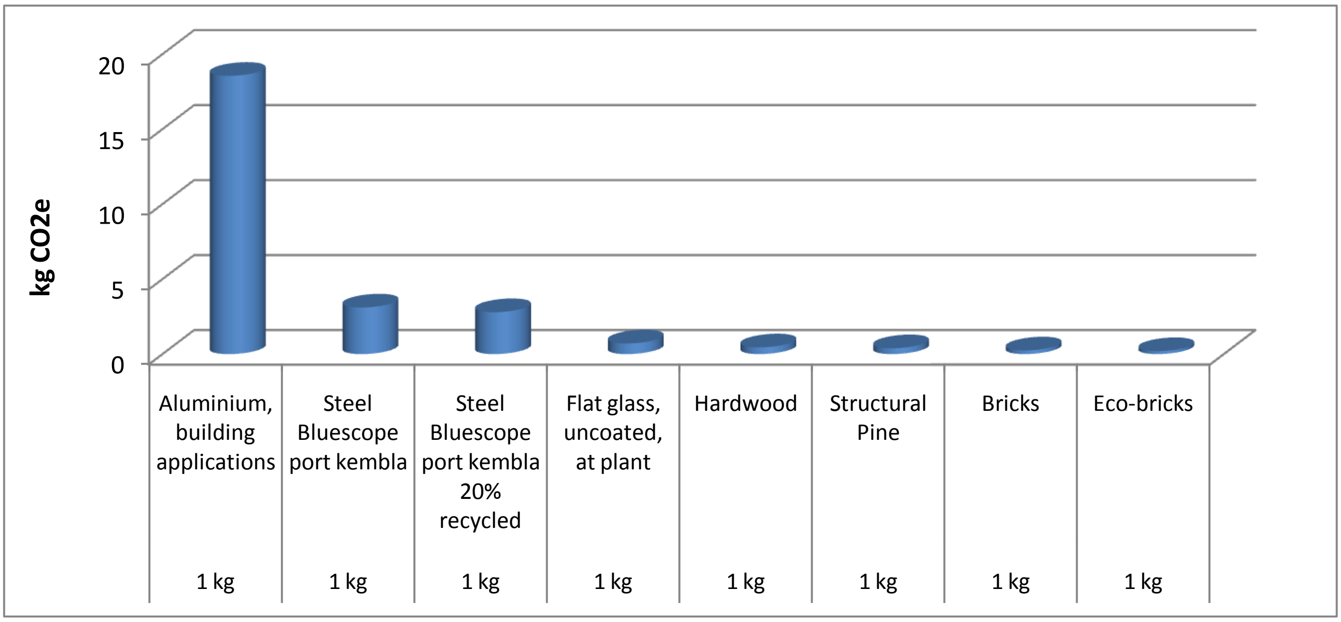


Figure 7: Comparison of carbon dioxide equivalent for building materials

4.0 Conclusion

The strategies presented above include a combination of initiatives which are based on improving comfort levels both within and outside the buildings, site-wide water consumption and individual energy consumption. It is considered the above mentioned factors provide an indication for an appropriate concept design which, when considered in the overall site design, will allow for maximisation of the site features and local climatic conditions.