4 February 2021

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Bathla Investments Pty Ltd
Universal Property Group P/L
T/as Bathla Investments
PO Box 270
WENTWORTHVILLE NSW 2145

Attention: Emma Fleming

Dear Emma

182 Guntawong Road, Riverstone
Cross Ventilation Assessment – Letter of Advice

SLR Consulting Pty Ltd (SLR) has been engaged by Bathla Investments Pty Ltd to qualitatively assess the natural ventilation potential of the proposed residential development at 182 Guntawong Road, Riverstone. Specifically, this report is concerned with the potential for units utilising highlight windows and/or skylights to comply with natural ventilation requirements proposed within the ADG.

SLR has previously assessed the natural ventilation potential for the proposed site. Results highlighted within SLR report 610.30135-R01-v1.0, dated 18 November 2020, concluded that 60.7% (51 of 84) of apartments would comply with ADG requirements. Additionally, apartments utilising slots and recesses within the development façade were also highlighted and could further increase compliance to 65.5% (55 of 84) of apartments, given support through computational modelling.

Within the scope of this letter and based on professional experience assessing similar developments, SLR has detailed requirements to be placed on apartments utilising highlight windows to slots and clerestory windows to roof, in order for those apartments to provide sufficient natural cross ventilation to living areas. This assessment is based on architectural plans prepared by the Bathla Group, drawing set DA-001 to DA-029 revision E, dated 22 January 2021.

Natural Ventilation via Highlight Windows

SLR is of the opinion that the provided slots are appropriately sized to allow airflow through apartments without the risk of air becoming trapped and not circulating out of designated slots.

In addition, SLR is of the opinion that highlight windows can provide sufficient airflow dependant on the effective open area. In order to meet a suitable minimum air change volume for the proposed apartments, SLR recommends that all highlight windows used for natural ventilation purposes have an effective open area no less than 1 m^2.

Natural Ventilation via Skylights

SLR is of the opinion that apartments with operable skylights can provide appropriate natural ventilation to living areas. SLR would recommend that any skylights used have multiple openings, as this would best maximize the negative pressure experienced and enhance natural ventilation.

Yours sincerely

JAMES CLEARY
Senior Project Consultant

Checked/ Authorised by:
Dr Neihad Al-Khalidy

1 Site and Surrounds

The proposed development is located in the Riverstone East precinct, which is currently a semi-rural area with many surrounding sites in various stages of development. The site is zoned for both low and medium density housing with a height limit of 9.9-12.9 metres. The area to the west is generally low-level residential housing.

Figure 1 Development Site Location

Image: Nearmap, 3 August 2020

2 Australian Design Guide Requirements

The State Environmental Planning Policy (SEPP) 65 supported by the Australian Design Guide is relevant to the assessment of the natural ventilation through residential components of proposed development. Section 4B-3 of the Australian Design Guide states that:

At least 60% of apartments are naturally cross ventilated in the first nine storeys of the building. Apartments at ten storeys or greater are deemed to be cross ventilated only if any enclosure of the balconies at these levels allows adequate natural ventilation and cannot be fully enclosed.

The following points from the design guide are also noted.

- Overall depth of a cross-over or cross-through apartment does not exceed 18m, measured glass line to glass line.
- Natural ventilation to single aspect apartments is achieved with a light well or stack effect ventilation (or similar) or courtyards or building indentations have a width to depth ratio of 2:1 or 3:1 to ensure effective air circulation and avoid trapped smells.

- In cross-through apartments external window and door opening sizes/areas on one side of an apartment (inlet side) are approximately equal to the external window and door opening sizes/areas on the other side of the apartment (outlet side).

There are no specific requirements (eg air changes per hour) in the ADG guideline.

AS1668.2-2002 "The use of ventilation and airconditioning in buildings Part 2: Ventilation design for indoor air contaminant control (excluding requirements for the health aspects of tobacco smoke exposure)" recommends 3 air changes per hour for habitable rooms to satisfy the air quality requirements.

3 Natural Ventilation

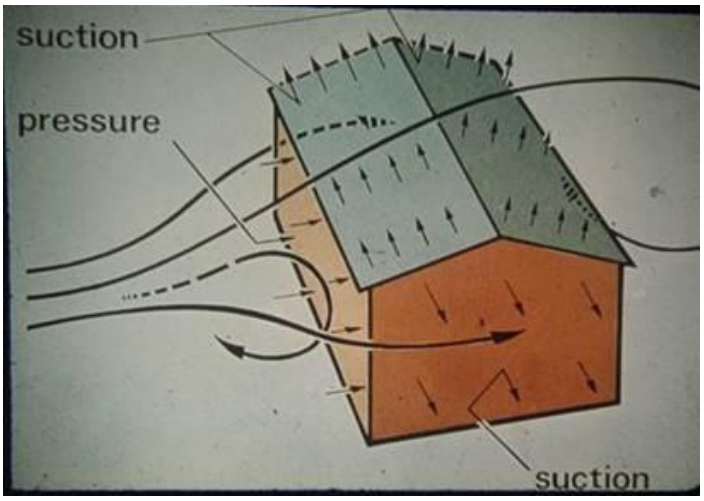
3.1 General Principles

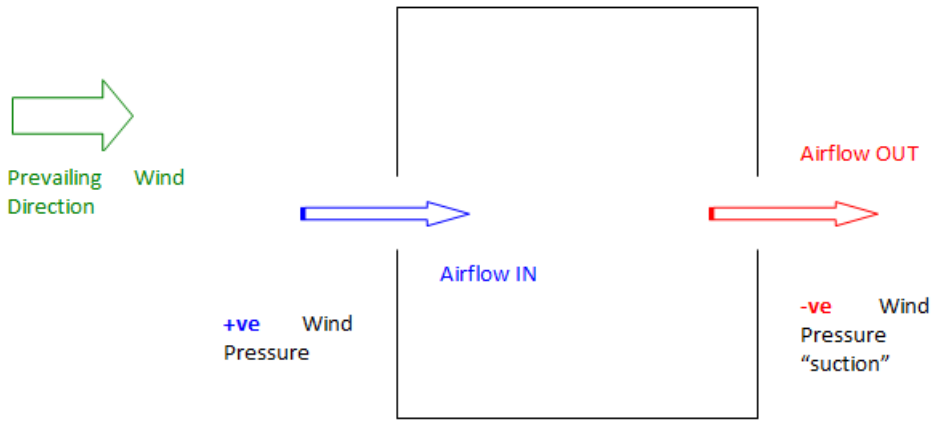
A key feature of the proposed development is the incorporation of façade openings designed to enable various spaces within the development buildings to make use of wind–induced natural ventilation throughout the year thereby minimising energy costs.

Wind-induced natural ventilation works on the straightforward principle of differential pressure. If a building envelope has multiple openings and there exists a pressure difference between those openings, e.g. the wind pressure at one opening is greater than the pressure at the other opening; airflow will be pushed through the building in the direction positive to negative.

The resulting amount of airflow through the building envelope will be a function of the magnitude of the pressure differential, size of the various building openings and degree of "blockage" in between. These features are illustrated in **Figure 2**.

Figure 2 Wind-Induced Natural Ventilation via Differential Pressure





4 Assessment of Natural Ventilation Potential

As covered within SLR report 610.30135-R01-v1.0, 60.7% (51 of 84) of apartments would comply with ADG requirements. Further to this conclusion, it was found that apartments utilising slots and recesses could further increase compliance to 65.5% (55 of 84) of apartments, given support through computational modelling.

In considering recesses and articulations proposed for the development, SLR has noted that while these façade features are not within the width to depth ratio required under the ADG, appropriate conditions for natural ventilation are still present. SLR has found that numerical solutions including Computational Fluid Dynamics (CFD) and wind tunnel studies can prove these apartments to provide appropriate through apartment ventilation and circulation, for natural ventilation requirements. These slots and articulations create pressure differences across the various facades and encourage cross ventilation through an increased number of apartments.

Similarly, the use of operable skylights can result in pressure differences that drive natural ventilation currents through apartments. The negative pressure induced at the roof of the development can produce a chimney effect within apartments which provides appropriate natural circulation of air through apartments, capable of meeting ADG requirements.

SLR has assessed the proposed developments potential to achieve natural ventilation to apartments through highlight windows connected to building slots and skylights.

4.1 Natural Ventilation Potential using Highlight Windows

Apartments within levels 1 and 2 of the proposed development designed with highlight windows to slots are identified in **Figure 3**. **Figure 4** shows the typical highlight windows provided to proposed apartments.

Figure 3 Apartments Utilising Highlight Windows

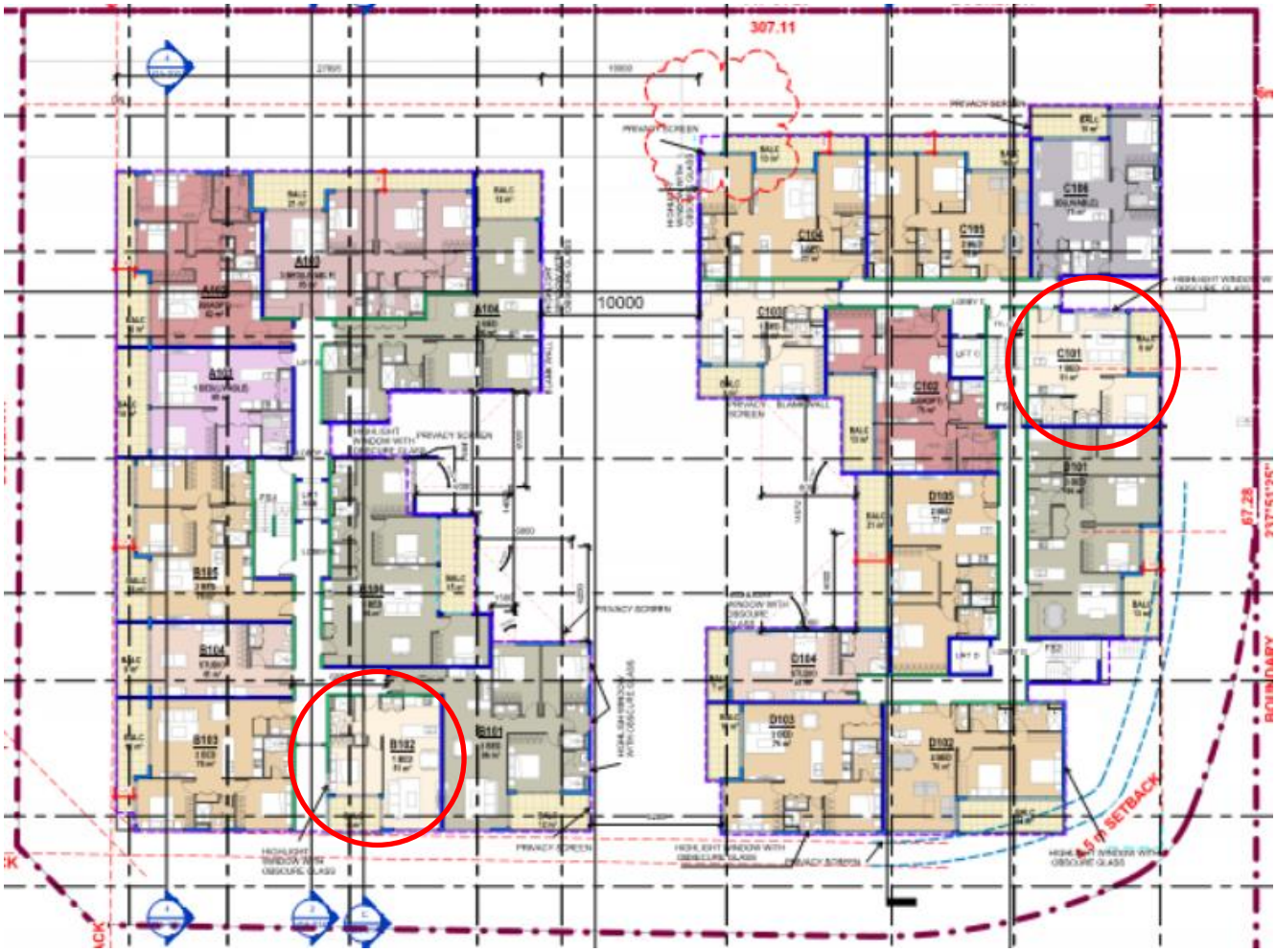


Figure 4 Typical Highlight Window

Through **Figure 3** it can be seen that the provided slots for the highlighted units do not fit within the width to depth ratio specified under the ADG guidelines. Based on previous Computational Fluid Dynamics (CFD) experience and natural ventilation modelling for similar developments and building sizes, SLR is of the opinion that the provided slots are appropriately sized to create pressure differences between the openings and allow for airflow through apartments without the risk of air becoming trapped and not circulating effectively.

When considering the allocated highlight windows identified in **Figure 4** and throughout the project, SLR is of the opinion they are sufficiently sized dependant on the effective open area. In order to meet a suitable minimum air change volume for the proposed apartments SLR recommends that all highlight windows used for natural ventilation purposes have an effective open area no less than 1 m^2.

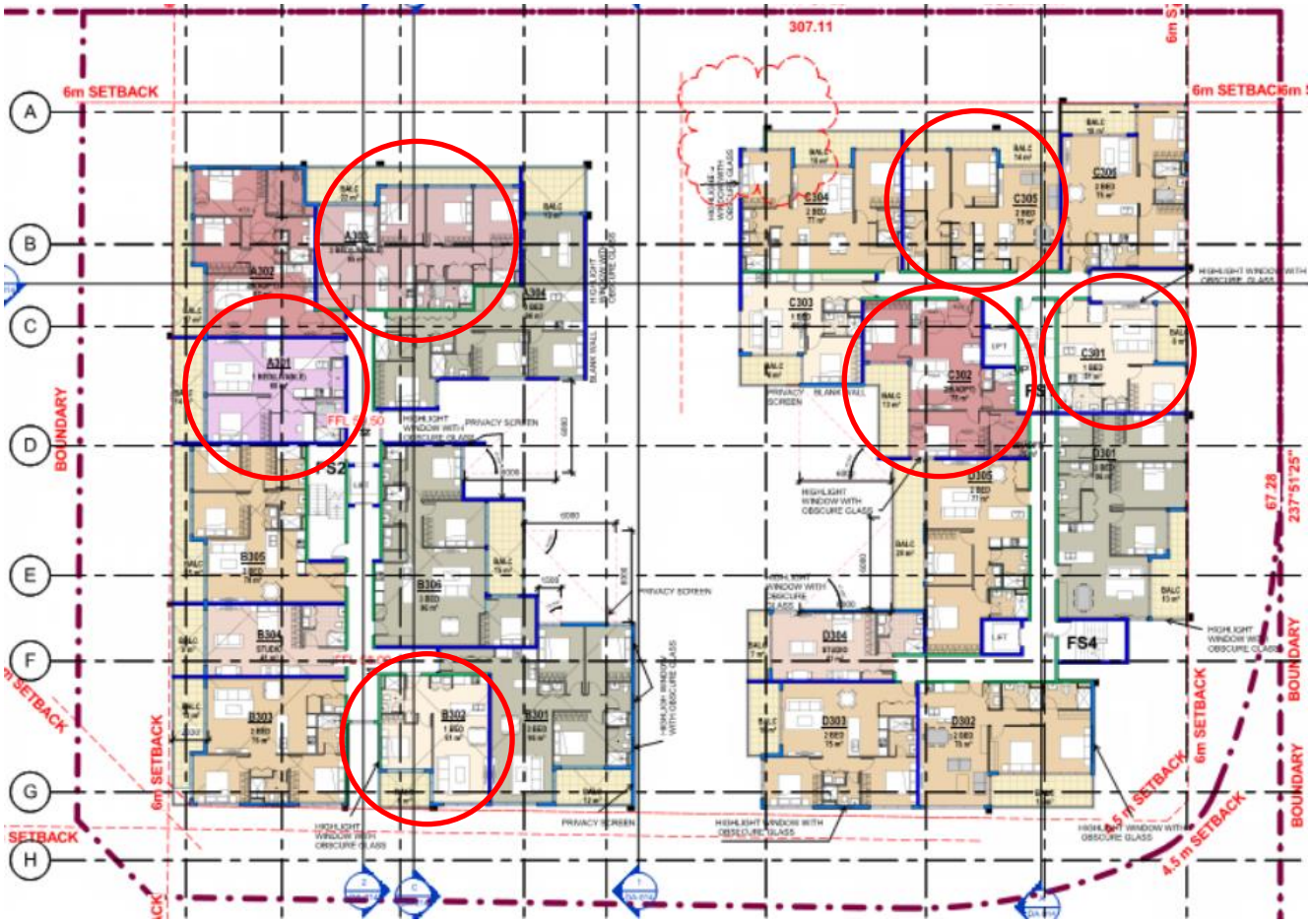
4.2 Natural Ventilation Potential using Skylights

The development design has proposed the use of operable skylights to the upper level for natural ventilation purposes. This provision can be used to provide cross ventilation to habitable areas of apartments which do not achieve dual aspects via their facades. Apartments which have been identified to utilise skylights for natural ventilation purposes have been highlighted in **Figure 5**.

The utilisation of skylights can allow for pressure induced air flow through the allocated apartments, with the negative pressure experienced at the roof promoting natural ventilation currents through the apartment.

From experience gained through previous quantitative CFD assessments, SLR is of the opinion that apartments with operable skylights can provide appropriate natural ventilation to the identified apartments. SLR would recommend that any skylights used have multiple openings, as this would best maximize the negative pressure experienced and enhance natural ventilation.

Figure 5 Potential Apartments that could be Naturally Ventilated via Skylight



5 Expert Details and Qualifications

James Cleary, Senior Project Consultant – CFD, Wind and Energy

I, James Cleary, am a Senior Project Consultant for CFD, Wind and Energy at SLR Consulting. A copy of my CV is attached.

I have produced this report and have read and agree to be bound by the Expert Witness Code of Conduct set out in schedule 7 of the Uniform Civil Procedure Rules 2005 (NSW).

I declare that I have made all the inquiries which I believe are desirable and appropriate, and that no matters of significance which I regard as relevant have, to my knowledge, been withheld.

I am a Senior Consultant with an Honours Degree in Mechanical Engineering.

My background in aerodynamics and computational fluid dynamics has allowed me to tackle a wide range of fluid flow problems across wind engineering and industrial processes.

Neihad Al-Khalidy, Technical Discipline Manager and Supervisor

I, Dr Neihad Al-Khalidy, am a Technical Discipline Manager for CFD, Wind and Energy at SLR Consulting. A copy of my CV is at attached.

I have supervised this report and have read and agree to be bound by the Expert Witness Code of Conduct set out in schedule 7 of the *Uniform Civil Procedure Rules 2005* (NSW).

I declare that I have made all the inquiries which I believe are desirable and appropriate, and that no matters of significance which I regard as relevant have, to my knowledge, been withheld.

I am a Technical Director with a Mechanical Engineering Bachelors' Degree, Masters in Air Conditioning and Refrigeration Engineering and a Doctorate in the field of Numerical Techniques.

I am a Chartered Professional Engineer MIEAust CPEng, Australian Institute of Engineers, Member of Australian Wind Engineering Society and Member of Council on Tall Buildings.

I have recently joined the editorial board of the International Journal of Architectural Engineering Technology and recently published my invited paper entitled "Better Natural Ventilation Design for Single Sided Apartments Utilising Computational Fluid Dynamics".

I have managed many industrial and commercial projects throughout Australia, UK, SE Asia and the Middle East in the fields of CFD, Natural Ventilation Design, ADG Compliance and Expert Witness Reports. Analytical Calculation (Building Facades, Condensation and Insulation Assessment), Wind, Ecologically Sustainable Development, Building Energy Rating, Exterior Lighting, Solar, Reflectivity and Overshadowing.

My background combines an extensive academic record including 55 technical papers in prestigious International Journals and conferences plus an international track record in consulting activities ranging across a wide variety of industries. International Publications including CFD approach to enhance natural ventilation in residential and industrial buildings.

The opinions expressed in the report and letters are based on our own review of the development's drawings and previous computer simulations of similar developments and I do not rely on the opinions of others.

CURRICULUM VITAE

NEIHAD AL-KHALIDY

TECHNICAL DIRECTOR

CFD, Wind & Energy, Asia-Pacific

QUALIFICATIONS

BE (Mech)	1986	BSc in Mechanical Engineering
ME(AirCond)	1989	Master in Air Conditioning and Refrigeration
PhD Mech Eng	1996	PhD in Mechanical Engineering

EXPERTISE

- Computational Fluid Dynamics
- Risk assessment of stack effect in high rise buildings including wind, HVAC and buoyancy combined effects on noise and building performance
- NABERS and Green Star Simulations
- Natural Ventilation Studies - SEPP 65
- Carpark modelling (design optimisation, cost effective solutions and compliance with national and international standards)
- Building Energy Studies, ESD
- Building Solar and Lighting Studies
- Combined External-Internal Air Flow Analysis
- Acoustically Induced Vibration
- Fluid Flow Pulsation Assessment

Neihad Al-Khalidy offers expertise in fluid and thermal technologies ranging from mechanical, chemical, building technology and environmental analysis to the aerodynamic modelling of aircraft and ships. He has considerable experience in engineering analysis, design, teaching a range of mechanical engineering subjects and mathematical modelling of fluid flow and thermal system.

Neihad initially completed a Master of Air Conditioning and Refrigeration Engineering followed by 7 years of experience consulting in air condition systems, heat exchanger design and managing system design and installation. In 1996 Neihad completed his PhD in developing numerical algorithms for solving phase change problems. Two years of consulting work at the University followed where he co-ordinated various projects in fluid flow and optimization of building energy consumption. Moving to Australia in 1999 Neihad joined CANCES where he has conducted numerical analyses on a range of fluid flow problems including multiphase flows, turbulent flow through pumps and improving the efficiency of power station condensers. From 2001 to 2007 Neihad worked at Vipac as a specialist consultant and Building and Infrastructure Team Leader.

Prior to joining SLR Consulting in early 2008, Neihad worked as an Advanced Analysis Specialist at Worley Parsons Melbourne Office developing the business in the area of CFD and consulting in a range of engineering projects.

Neihad's background combines an outstanding academic record (including 45 technical papers in prestigious International Journals and conferences in the USA, UK, Canada, Japan, Russia, Germany, Spain and Poland plus an international track record in consulting activities ranging across a wide variety of industries.

Neihad has managed many industrial and commercial projects throughout Australia, SE Asis and the Middle East in the fields of CFD, Analytical Calculation (Building Facades, Condensation and Insulation Assessment), Ecologically Sustainable Development, Building Energy Rating, Exterior Lighting, Solar, Reflectivity and Overshadowing, Acoustically Induced Vibration and Pulsation Assessment.

PROJECTS

Wind Engineering Projects

- Wind Modelling of Perth Underground Bus Port (Brookfield Multiplex)
- Discovery Point Environmental Wind Studies and fire modelling (Australand)
- Wind Engineering of Telehouse Development in London (Telehouse)
- 344 Oxford Street, Bondi Junction Development CFD and Wind Tunnel Studies (Lindsay Bennelong)
- Wind Modelling of CUB Master Plan (Fraser Property Pty Ltd)
- Wind Engineering of Islands Development Freemantle (Stockland)

Wind & CFD Assessments /Projects

- CFD, Wind Tunnel and Full Scale Measurements of Bondi Junction Plaza Development (Westfield Design and construction, Sydney)
- Wind Assessment of Columbia Precinct (Multi-Building) Development (PD Mayoh Architects)
- Wind Assessment (Combined CFD/Wind Tunnel Testing) of 480 Queen Street, Brisbane, CBD (Grocon)

Natural Ventilation Studies

- Combined Internal-External Fluid Flow Assessment of RESMED New Building (Toland Williams-Sydney)
- Natural Ventilation Modelling of 40-48 Atchison Street, Development, St Leonards (Australand, Sydney) and Australian Science Building, University of Flinders (Bestec-Adelaide)

Thermal Design and Comfort

- Thermal and Design Study of HT Transit Case (ADI Australia)
- Natural and Mechanical Ventilation System of 320 Harris Street, Ultimo (Marchese and Partners Architects, Sydney)
- Wind, Infiltration and Air Quality CFD Modelling of Claremont Village CBD Court Development (Multiplex Perth)
- Thermal Comfort Study of Curtain University of Sport Arena, Perth (James Architects)

Mircoclimate and Thermal Comfort

- Study of Gate Garden in Dubai (Hyder Middle East)
- Wafi City Redevelopment in Dubai (MKM Commercial Holdings)
- Changi Airport Terminals in Singapore (KAAS Authority) and Doha Technology Park (Woods Bagot Sydney/Middle East Offices)
- Advanced CFD Modelling for the Air Quality assessment of Entire Brisbane City (Energex).

MEMBERSHIPS	
Member	Chartered Professional Engineer MIEAust CPEng, Australian Institute of Engineers
Member	Australia Wind Engineering Society
Member	Australian Institute of Refrigeration, Air Conditioning and Heating

ACCREDITATIONS	
Accredited	Green Star Professional - Green Building Council of Australia
Accredited	National Australian Built Environment Rating System (NABERS) Accredited Professional -Department of Environment, Climate Change and Water, Australia
Accredited Professional	Commercial Building Disclosure Lighting Accredited Professional, National Energy Efficiency Program

CURRICULUM VITAE

JAMES CLEARY

SENIOR PROJECT CONSULTANT

CFD, Wind & Energy, Asia-Pacific

QUALIFICATIONS

BE (Mech) 2014	Bachelor of Mechanical Engineering (Honours), RMIT University, Victoria, Australia

EXPERTISE

- ESD
- Solar access and overshadowing assessment
- Building energy and thermal comfort software simulation
- Environmental impact wind assessment
- Natural ventilation assessment
- Nabers energy modelling
- BASIX and Nathers assessment
- BCA section J DTS assessment
- Renewable energy
- ESD/Sustainability reports

James Cleary has an Honours degree in Mechanical Engineering from RMIT University. His knowledge relating to thermo and fluid dynamics, heat and mass transfer and renewable energy systems, allows James to apply a flexible approach, both technical and practical, in the design, analysis and implementation of energy systems.

Prior to joining SLR, James' project experience included the design and installation of a heat capture and thermal storage system, employed within a sun tracking heliostat field.

James has numerous years of experience working within building and HVAC industries which includes the installation and balancing of HVAC systems, efficiency assessments and maintenance of existing designs. James continually incorporates this past experience in his current projects, working on optimising future installations for urban and rural environments.

PROJECTS

14 Schofields Road, Schofields, NSW, Australia	Thermal comfort modelling through BERSPro, along with BASIX and Energy Efficiency Assessments.
128 Bunnerong Road, Pagewood, NSW, Australia	Solar access assessment for building facades, solar access to apartments and communal spaces and environmental wind impact assessment.
47 Spurway Drive, Baulkham Hills, NSW, Australia	Solar access assessment for building facades, solar access assessment to apartments and overshadowing assessment, natural ventilation assessment.
30 Fairway Drive, Baulkham Hills, NSW, Australia	Solar access assessment for building facades, solar access assessment to apartments and overshadowing assessment, natural ventilation assessment.

Bankstown Compass Centre, Bankstown, NSW, Australia	Overshadowing assessment for neighbouring environment
Dee Why Town Centre, Dee Why, NSW, Australia	Section J DTS and JV3 assessment, overshadowing assessment for neighbouring environment, environmental wind impact assessment
Branksome Serviced Apartments, Mascot, NSW, Australia	Section J compliance assessment.
100 Macquarie Street, Liverpool, NSW, Australia	Green Star daylighting and water assessment, thermal modelling.
84-90 Gordon Crescent, Lane Cove, NSW, Australia	Solar access to apartments and communal spaces assessment.
Heartland Holden Site, NSW, Australia	Thermal Comfort modelling through BERSPro, along with BASIX and Energy Efficiency Assessments.
500-520 Pacific Highway, Sydney, NSW, Australia	Solar access to apartments assessment.
1-7 Haldon Street, Lakemba, NSW, Australia	Natural ventilation Assessment.
40 Dwyer Street, North Gosford, NSW, Australia	Thermal Comfort modelling through BERSPro, along with BASIX and Energy Efficiency Assessments.
400-404 Mann Street, North Gosford, NSW, Australia	Thermal Comfort modelling through BERSPro, along with BASIX and Energy Efficiency Assessments.
55-57 Flinders Street, Surry Hills, NSW, Australia.	Reflectivity assessment
38 Pelican Road, Schofields, NSW, Australia	Thermal Comfort modelling through BERSPro, along with BASIX and Energy Efficiency Assessments.
811 Elizabeth Street, Zetland, NSW, Australia	ESD and sustainability report
Guildford New Dan Murphy and Hotel Refurbishment	Section J DTS report

MEMBERSHIPS

Member	Engineers Australia