CROSS VENTILATION ASSESSMENT

Villawood - Stage 1

Prepared for:

Traders in Purple
Governor Macquarie Tower
1 Farrer Place,
Sydney NSW 2000

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Traders in Purple (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.30935-R01-v1.1	5 August 2022	Peter Hayman, James Clearly	Dr. Neihad Al-Khalidy	Dr. Neihad Al-Khalidy
610.30935-R01-v1.0	2 August 2022	Peter Hayman James Clearly	Dr. Neihad Al-Khalidy	Dr. Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Traders in Purple to assess the natural ventilation potential for the proposed Villawood - Stage 1 development. This report will use the combination of a qualitative review and a quantitative CFD assessment to assess the natural ventilation under the Apartment Design Guide (ADG). This report will form part of the development application to The City of Canterbury-Bankstown.

At least 60% of apartments are required to be 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.

Developments, which seek to vary from the minimum standards, must demonstrate how natural ventilation can be satisfactorily achieved, particularly in relation to habitable rooms.

Natural Ventilation Potential

The proposed development implements a number of the ADG recommendations to maximize the natural cross ventilation throughout the development.

- The proposed development has been provided with openings on multiple sides of the apartments for the majority of proposed floor plans, allowing it to make use of wind-induced natural ventilation throughout the year and thereby minimising energy costs.
- The overall depth of cross-over or cross-through units does not exceed 18 m as per the Design Criteria of Objective 4B-3.

Natural cross ventilation to many single aspect apartments can in some cases be achieved via building indentations. This is anticipated within ADG Section 4B which states in its opening paragraph that “Natural cross ventilation is achieved by apartments having more than one aspect with direct exposure to the prevailing winds, **or windows located in significant different pressure regions**, rather than relying on purely wind driven air”.

SLR has identified further apartments that could potentially achieve natural cross ventilation through utilising building slots and recesses with windows attached. These were analysed using Computational Fluid Dynamics (CFD) numerical modelling. The CFD assessment has led to the incorporation of a number of design changes to the initial set of the architectural drawings including:

- Revised openable window areas to single aspect apartments that rely on building indentations
- Added windows to Units 303 and 304
- Operable skylight to Unit 211

The following conclusions have been reached based on a qualitative review of the floorplans of the ADG complaint dual aspect units and quantitative numerical modelling of non-dual aspect units:

- Overall, 60.6% (80 out of 132) of the apartments in the first nine levels in the development will be naturally cross ventilated.

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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Traders in Purple to assess the natural ventilation potential for the proposed Villawood - Stage 1 development. This report will use the combination of a qualitative review and a quantitative CFD assessment to assess the natural ventilation under the Apartment Design Guide (ADG).

This report will form part of the development application to The City of Canterbury-Bankstown.

1.1 Site and Surrounds

The proposed sits approximately 200m southwest of Villawood Station, with the site bound by Kamira Court and Kamira Avenue to the east and west respectively. A proposed extension to Howatt Street will bound the south of the site. Surrounds of the site are predominantly low-level with there being some mid-level development immediately east of the proposed

Figure 1 Site Location

Image: Nearmap, 19 May 2022

1.2 Development Description

From the drawings provided, the proposed development will comprise a 12-storey building inclusive of:

- Ground level with residential apartments, building lobbies, communal facilities, communal outdoor space and car parking;
- Level 1 and 2 with residential apartments and car parking;
- Level 3 podium with residential apartment and communal open space;
- Level 4 to 7 with residential apartments;
- Level 8 with residential apartments and communal open space;
- Level 9 with residential apartments;
- Level 10 roof non-trafficable roof with allocation for solar panels.

Perspective View from North is shown in **Figure 2**.

Figure 2 Elevation North

Image: DKO

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.

Natural cross ventilation to many single aspect apartments is achieved via building indentations. This is anticipated within ADG Section 4B which states in its opening paragraph that "Natural cross ventilation is achieved by apartments having more than one aspect with direct exposure to the prevailing winds, or windows located in significant different pressure regions, rather than relying on purely wind driven air"

2.1 Effective Cross Ventilation

There are no specific requirements (eg air changes per hour) in the ADG guideline. However, AS1668.2-2002 "The use of ventilation and air-conditioning in buildings Part 2" states:

- 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.

ASHRAE recommends that homes receive 0.35 air changes per hour but not less than 15 cubic feet of air per minute (cfm) per person (7.5 l/s/person).

The City of Sydney CoS)has provided a design guide to be used to confirm the adequacy of natural ventilation proposals in apartment buildings in that do not meet the prescriptive requirements of the Apartment Design Guide (ADG) Objective 4B-1 (eg apartments in noisy road).

- The CoS design guide requires 10 litres/second/person where the number of persons is equal to the number of bedrooms in the apartment +1 for 85% of all hours in the year for cross-through and cross-over apartments, or 90% of all hours in the year for all other apartments.
- This allows designs to deliver smaller opening sizes than required by the prescriptive design guidance of the ADG.
- The CoS design guideline also states that specific façade pressure coefficients may be determined using wind tunnel or computational fluid dynamic (CFD) testing which more accurately accounts for the surrounding features (buildings, streets, topography).

The objective of the ADG is to ensure that indoor air quality and thermal comfort is optimised, and reliance on mechanical ventilation reduced. The ADG provides design guidance to allow for effective cross ventilation well above the minimum ASHRAE or City of Sydney (Alternative natural ventilation of apartments in noisy environments) requirements.

SLR considers the 3 air changes per hour suitable to provide effective cross ventilation, reduce reliance on mechanical ventilation and satisfy the air quality requirements. The adopted air changes per hour in the current study is well above the minimum ASHRAE or City of Sydney requirements

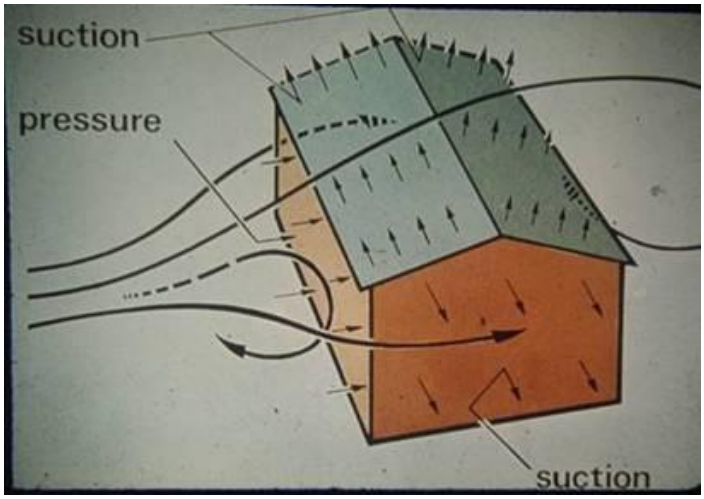
3 General Principles

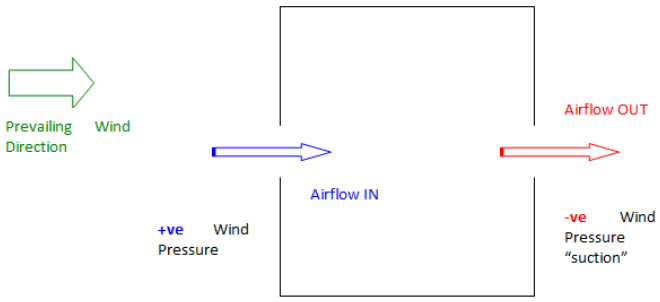
A key feature of the proposed development is the incorporation of façade openings designed to enable various spaces within the development buildings to make use of wind–induced natural ventilation throughout the year thereby minimising energy costs.

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, the size of the various building openings and degree of "blockage" in between. These features are illustrated in **Figure 3.**

Figure 3 Wind-Induced Natural Ventilation via Differential Pressure





4 Assessment

4.1 Qualitative Assessment

The natural ventilation for the proposed residential development has been qualitatively assessed. Ventilation is achieved by the differential pressure between the different building facades. Examples of the natural ventilation principles that apply for the proposed development are shown in **Figure 4**. Full diagrams for natural ventilation can be found in **Appendix A**.

The following comments are made regarding proposed natural ventilation system for the development:

- Operable windows are provided to all façade orientations.
- Minimal shielding is expected to upper levels; therefore, the proposed development benefits from all prevailing Sydney winds, creating the potential for cross ventilation.
- Operable skylights have been proposed to apartments 207, 208, 209, 212, 213 and 214.
- Based on a qualitative study 52.3% (69 of 132) of the apartments within the proposed development comply with the cross-ventilation requirements of the Australian Design Guide for the first nine stories (Refer **Table 1**)

Table 1 Apartments with Openings to Support Natural Ventilation

Level	Number of Apartments	No. Apartments Cross Ventilated (Qualitative)	Total (%)	Possible Apartments to be Quantitively assessed (CFD)
LG	12	5	41.7%	2
L01	10	3	30.0%	3
L02	18	11	61.1%	3
L03	16	9	56.3%	0
L04	16	9	56.3%	0
L05	16	9	56.3%	0
L06	16	9	56.3%	0
L07	16	9	56.3%	0
L08	12	5	41.7%	1
Total	**132**	**69**	**52.3%**	**9**

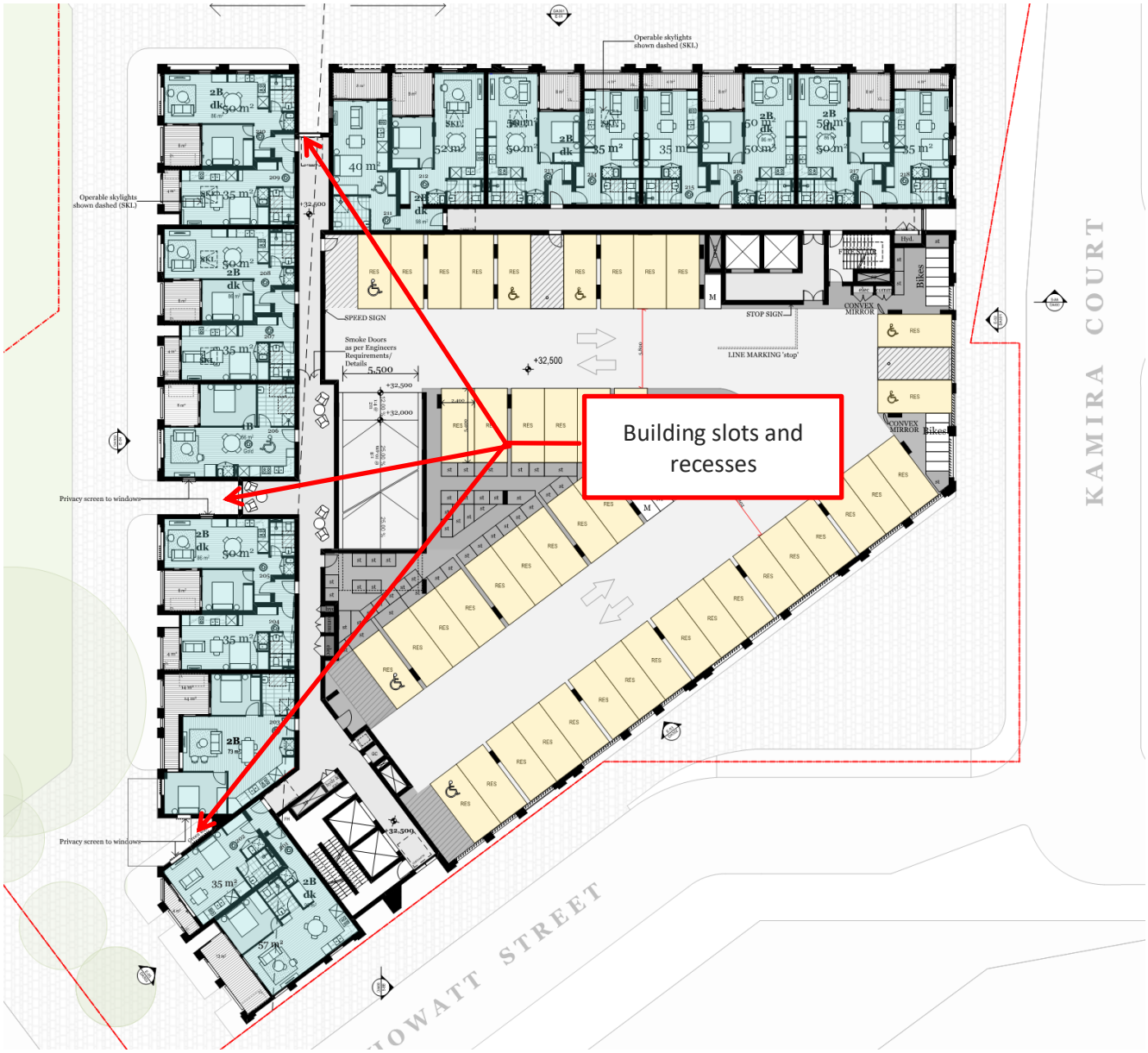
Figure 4 Natural Ventilation Example for the Site – Level 2

5 Quantitative CFD Assessment

Recesses and articulations create pressure and velocity differences across the various facades and encourage cross ventilation through an increased number of apartments. From experience 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.

SLR has been asked to assess the apartments that connect to the "slots" of each building an example of which are shown in **Figure 5**.

Figure 5 Examples of Slots and Recesses



These recesses and articulations create pressure and velocity differences across the various facades and encourage cross ventilation through an increased number of apartments. From experience SLR has found that

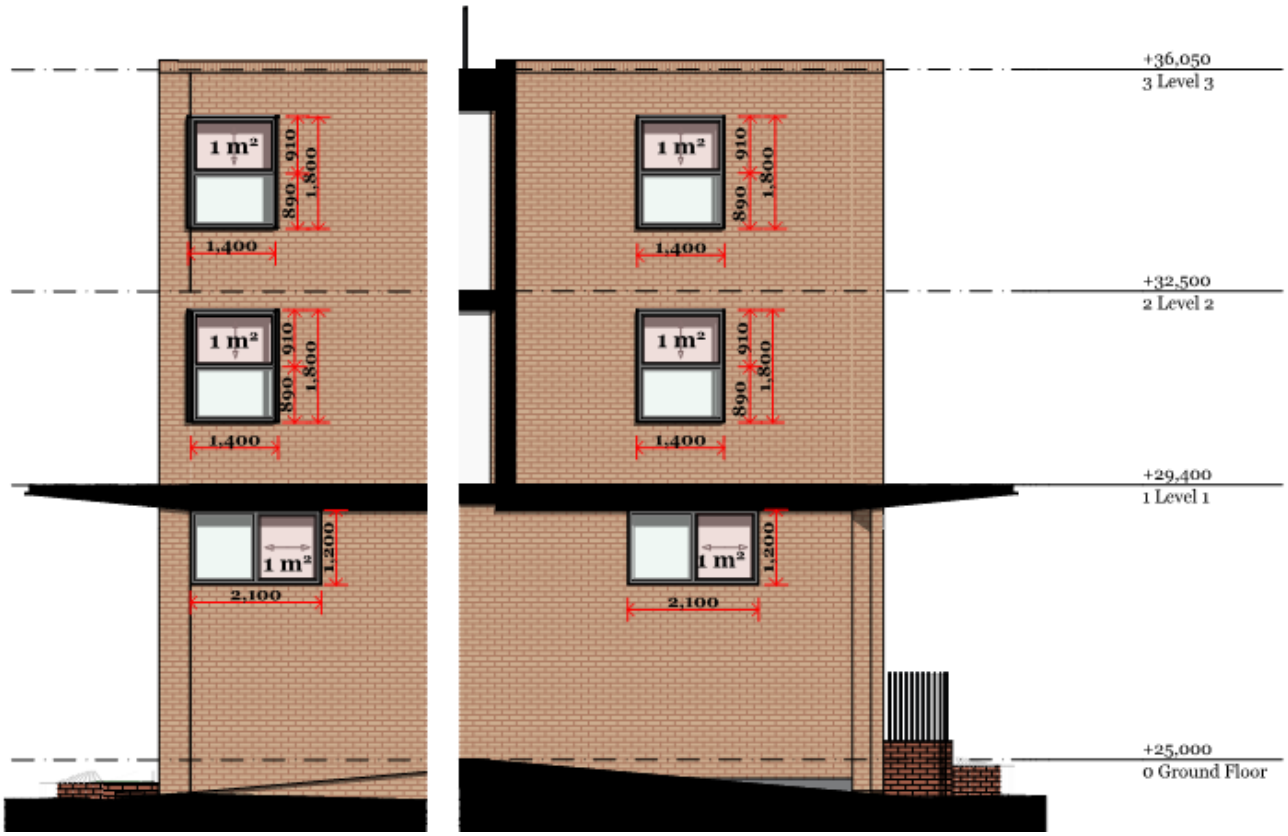
numerical solutions including Computational Fluid Dynamics (CFD) and wind tunnel testing can prove that these apartments provide appropriate through apartment ventilation and circulation, for natural ventilation requirements.

A detailed computer model of the development was created based on the Architectural Drawings and CAD models supplied by Crone Architects. Representative apartments in the various Block were included for detailed numerical assessment. The Computational Fluid Dynamics (CFD) specialised software FLUENT was used to model the following wind directions.

- North east
- South east
- South
- South West
- West
- North West

Operable windows were modelled as per the provided architectural drawings and doors to balconies were assumed to be fully open.an example of the modelled window sizes is shown in the figure below.

Figure 6 Slot Windows



In each case a wind speed of 1.66 m/s was used at 10 m high. Based on actual wind data across 11 years, the average wind speed measured at Sydney Olympic Park is higher than 2 m/s at 10 m above ground 69% of the time. The numerical modelling results in this study are therefore conservative and the cross ventilation will likely increase with increasing approaching wind speeds.

Simple blocks were used for nearby surrounding buildings to include the impact of the surroundings on the natural ventilation for the proposed building. All velocities in the images are in metres per second and the simulation results are presented at a typical chest height of 1.5 metres above the floor level. This height is indicative only to show the flow around the apartment. SLR uses the modelled speeds to check there is at least three air changes per hour for each apartment.

5.1 CFD Results

SLR deems an apartment to have adequate natural ventilation if it shows reasonable airflow for four of the six wind directions tested. Reasonable flow means the apartment has airflow of at least three air changes per hour (at least 0.1 m/s through some areas) and shows good flow from room to room without short circuiting.

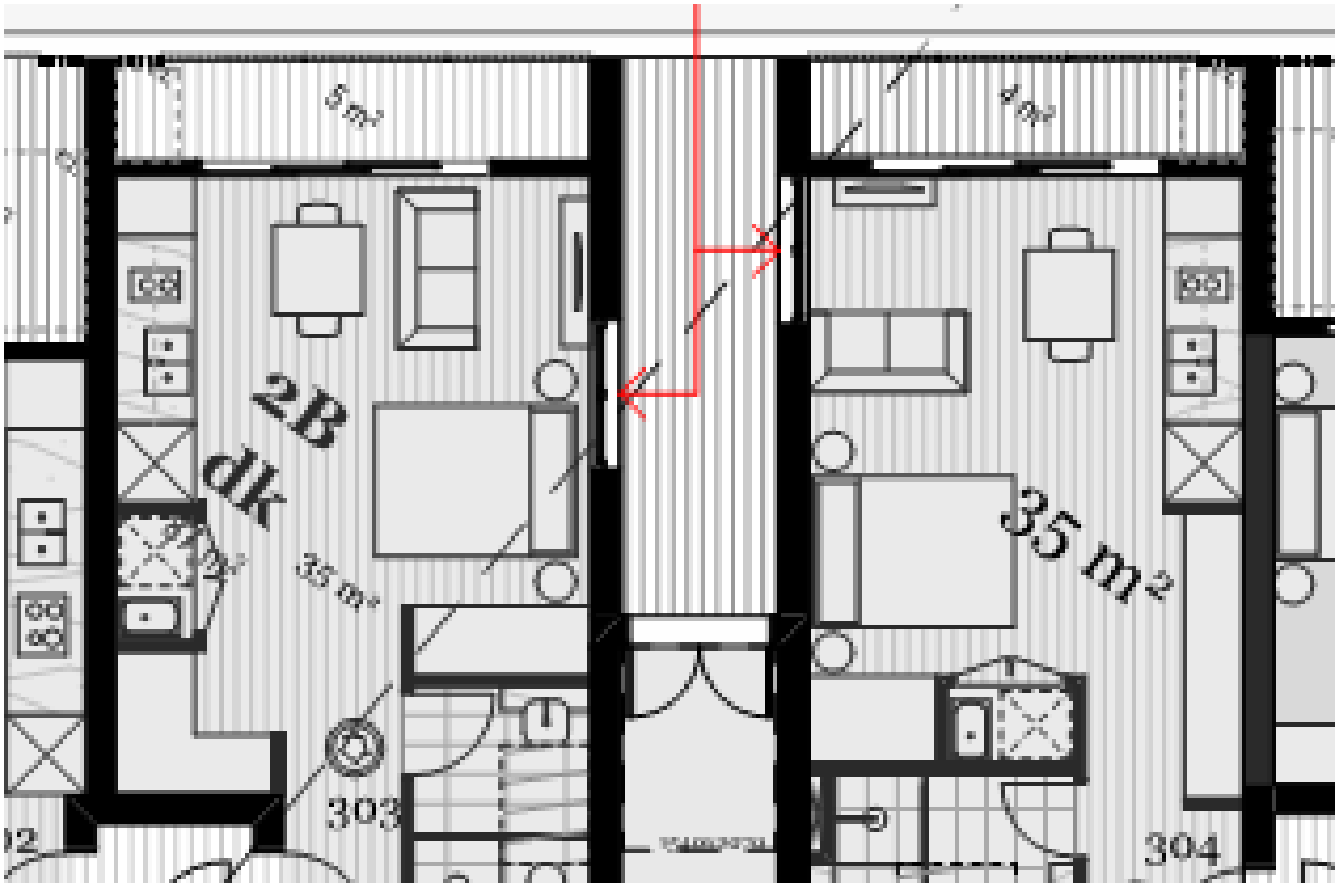
Images of the CFD results are detailed in **Appendix A** and summarised in the following tables.

Table 2 Air Changes per Hour

Tested Apartment	North East Winds	South East Winds	South Winds	South West Winds	West Winds	North West Winds	Overall Result
005	3.1	4.3	7.4	6.2	7.6	3.9	PASS
006	5.5	4.2	5.1	6.3	1.6	7.7	PASS
103	1.6	5.0	1.7	10.3	8.0	13.6	PASS
105	6.1	9.1	4.8	14.4	15.2	13.1	PASS
106	3.2	2.1	3.9	14.4	8.4	5.9	PASS
203	2.3	5.6	2.1	6.8	4.5	15.3	PASS
205	6.9	8.3	2.1	11.2	19.8	15.2	PASS
206	4.6	2.3	3.6	12.8	10.3	6.8	PASS
809	9.7	3.5	1.4	17.2	6.2	7.0	PASS

Following on from the modelling SLR worked with the client on design alterations to enable additional units to pass. Units 303 and 304 were identified as candidates and windows were added to the slot between the two with an operable area of 1 m^2 (refer **Figure 7**). Considering the results of the modelling and the size if these units it is SLR's opinion that 303 and 304 will receive adequate ventilation with the addition of these windows.

Figure 7 Additional Openings



6 Overall Natural Ventilation Results

SLR modelled units on representative levels to gain an understanding of apartments across all levels.

Units on other levels are expected to perform in a similar manner to the nearest modelled apartment of the same layout. The overall results are shown below.

The following conclusions have been reached based on both the qualitative and quantitative numerical modelling results:

- 60.6% (80 out of 132) of the apartments will be naturally cross ventilated.

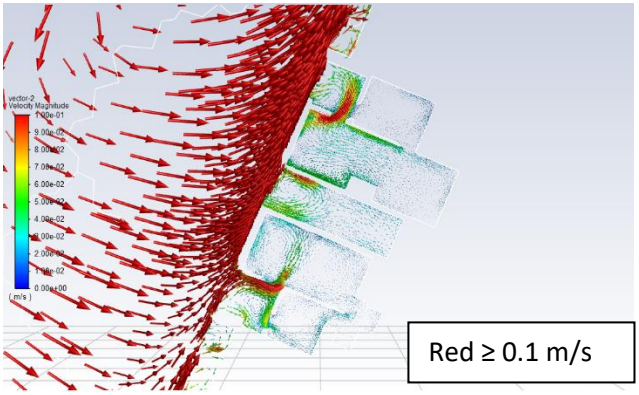
Table 3 Results Summary

Building	Number of Apartments	No. Apartments Cross Ventilated (Qualitative)	Additional Apartments from Building slots (CFD)	Combined Total	Combined Total (%)
LG	12	5	2	7	58.3%
L01	10	3	3	6	60.0%
L02	18	11	3	14	77.8%
L03	16	9	2	11	68.8%
L04	16	9	0	9	56.3%
L05	16	9	0	9	56.3%
L06	16	9	0	9	56.3%
L07	16	9	0	9	56.3%
L08	12	5	1	6	50.0%
Total	**132**	**69**	11	80	60.6%

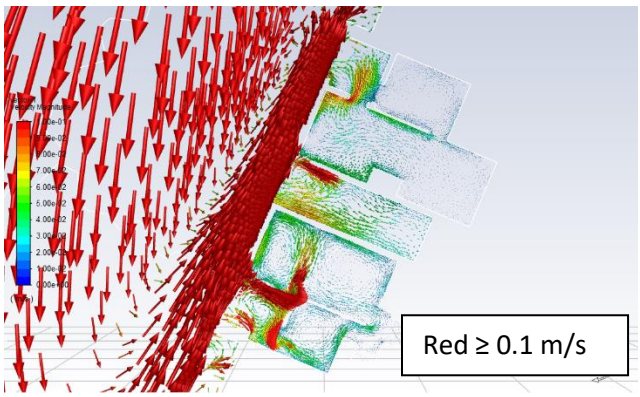
APPENDIX A

Vector Flow Diagrams

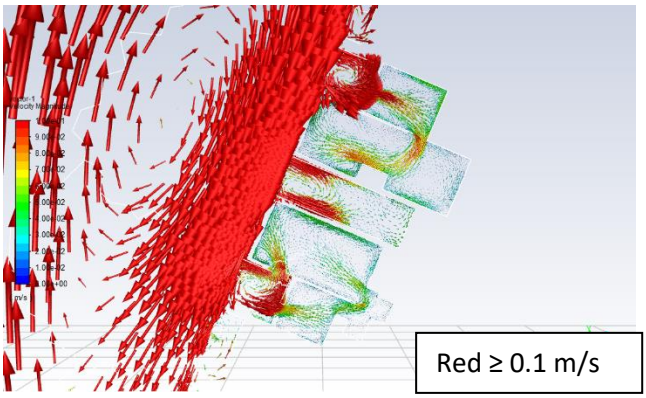
Ground Level



Northeast



Southeast



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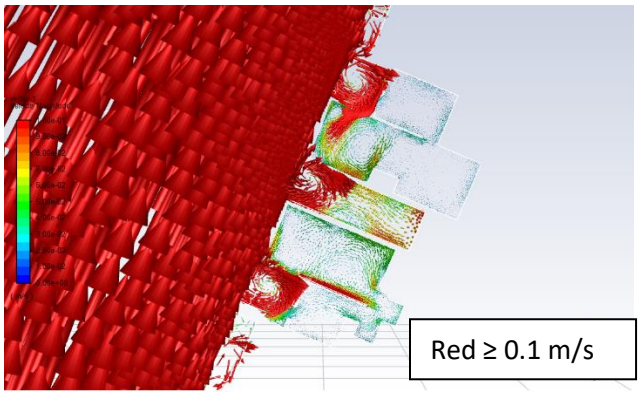

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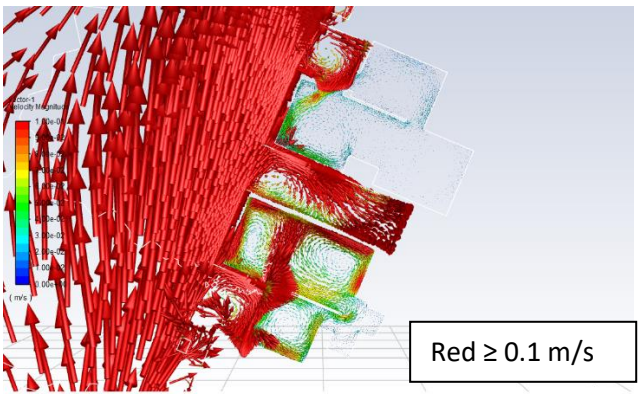

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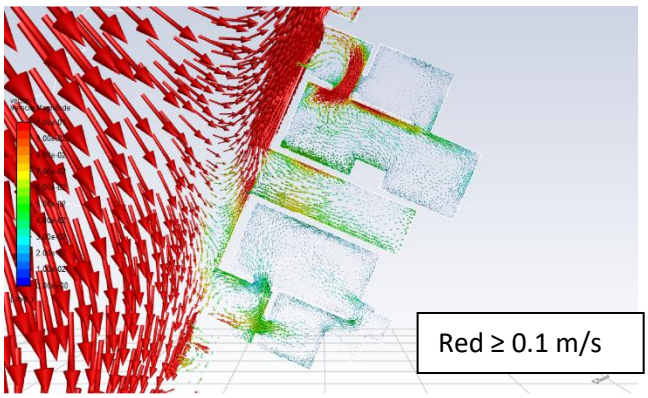
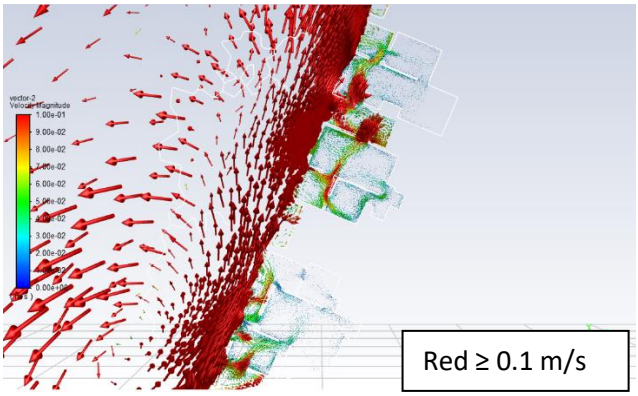


Northwest

Level 1



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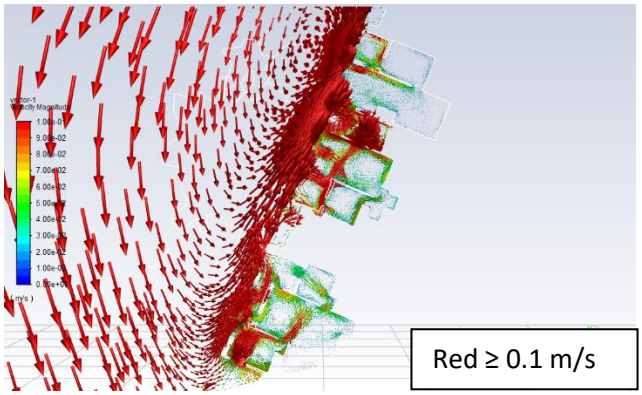

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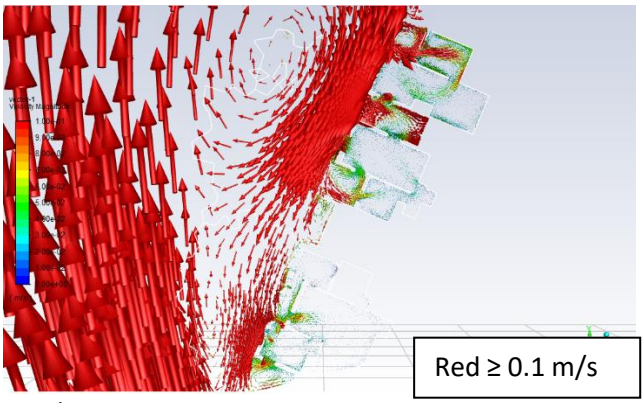

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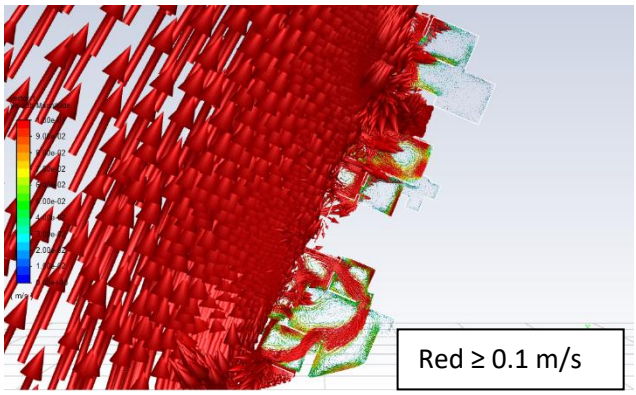

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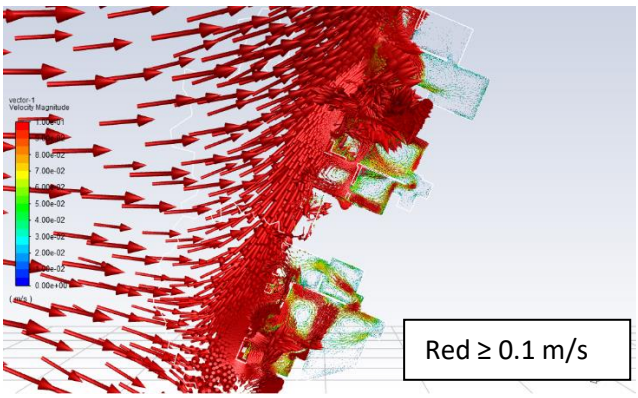

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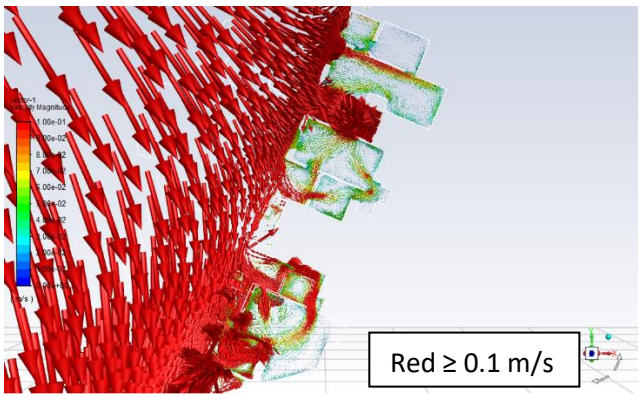

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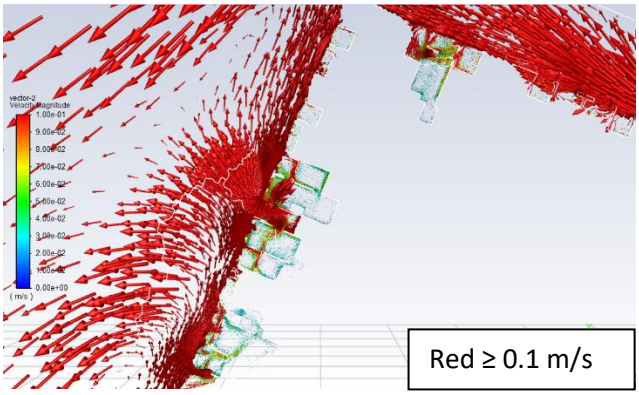
Level 2



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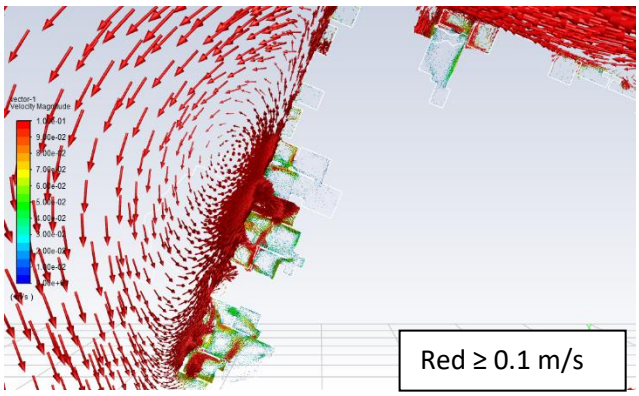

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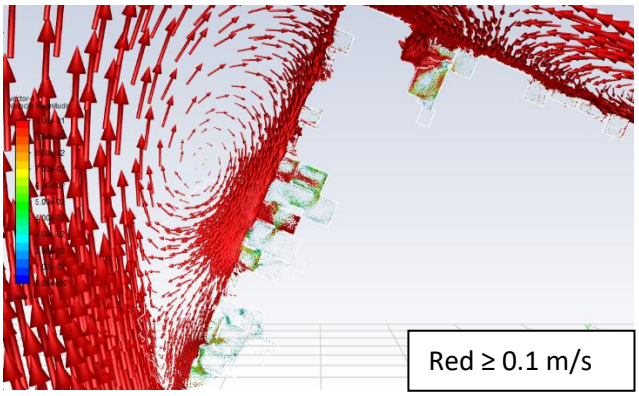

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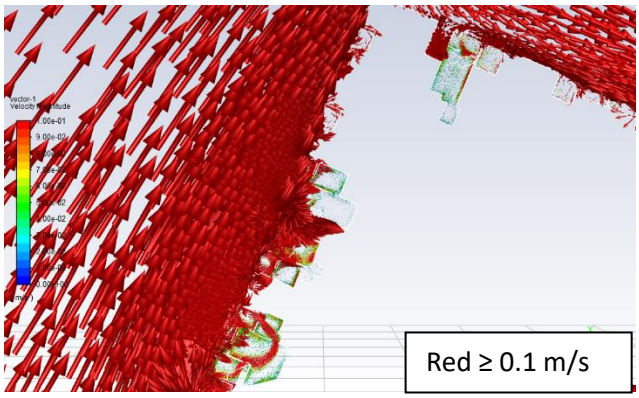

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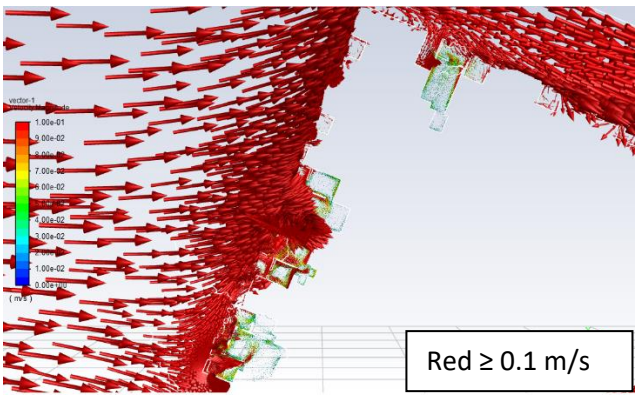

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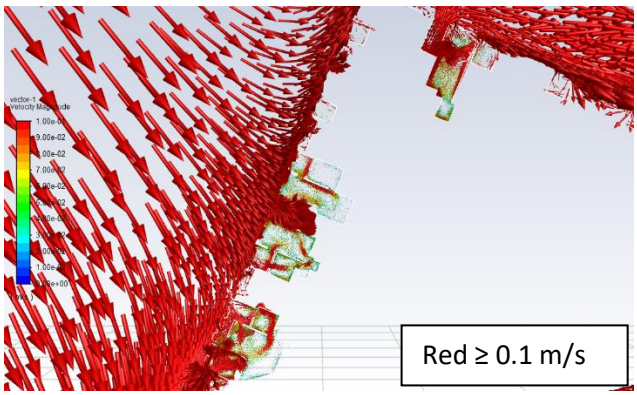

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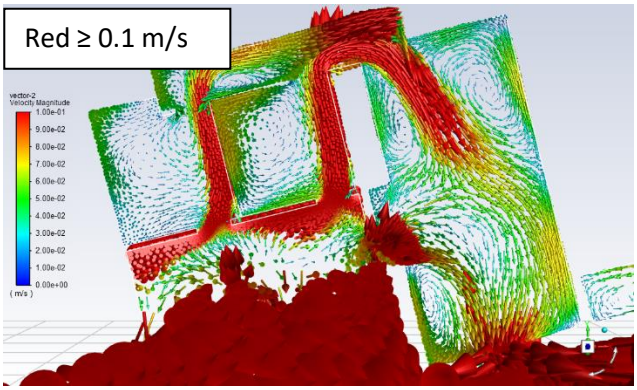
Level 8



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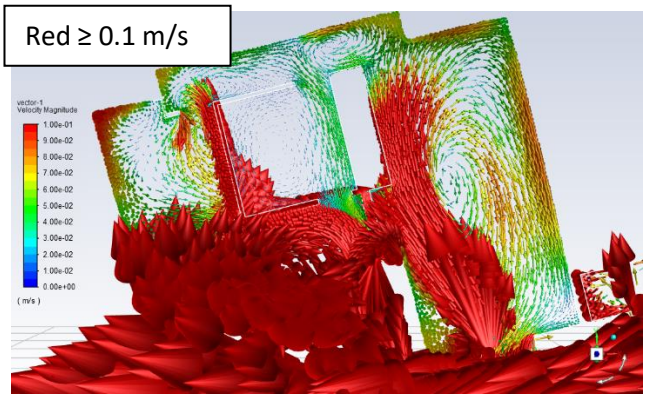

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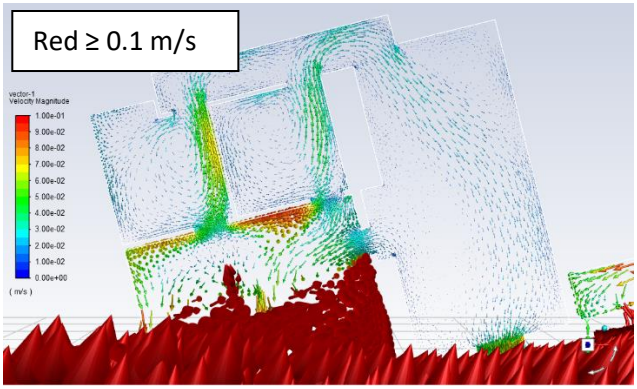

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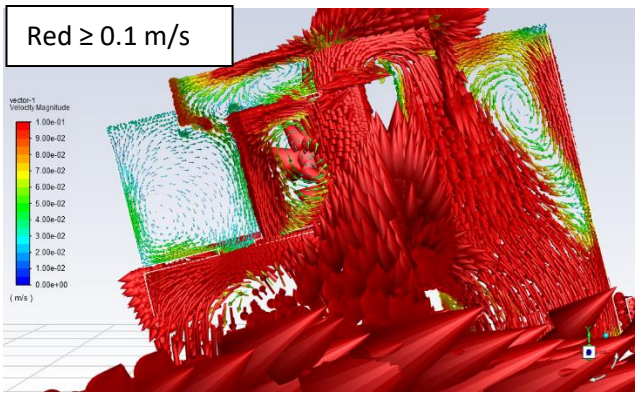

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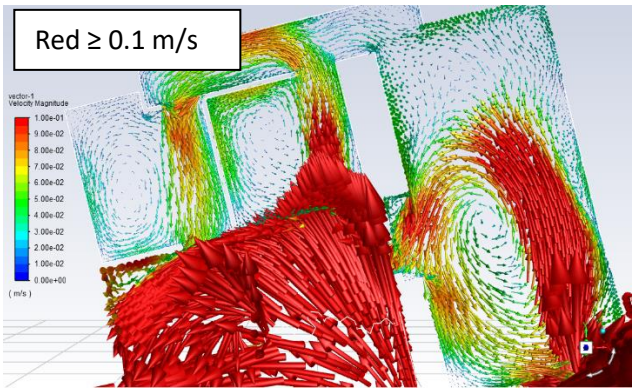

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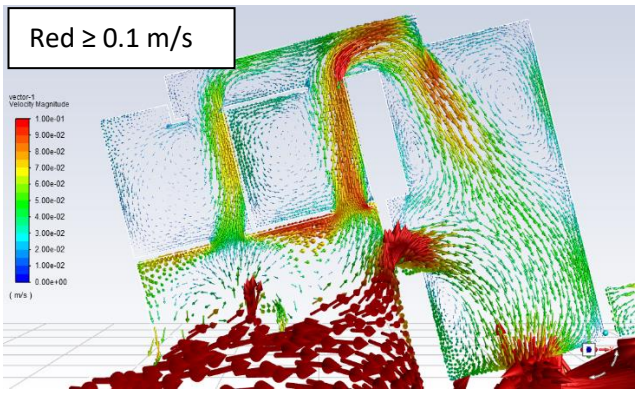

Northwest

APPENDIX A

Passing Method

Level G	Passing Method	Level 1	Passing Method	Level 2	Passing Method	Level 3	Passing Method
001	Dual Aspect	101	Dual Aspect	201	Dual Aspect	301	Dual Aspect
002	Dual Aspect	102	Dual Aspect	202	Dual Aspect	302	Dual Aspect
003	Dual Aspect	103	Pass via CFD	203	Pass via CFD	303	Qualitative Assessment
004		104		204		304	Qualitative Assessment
005	Pass via CFD	105	Pass via CFD	205	Pass via CFD	305	
006	Pass via CFD	106	Pass via CFD	206	Pass via CFD	306	Dual Aspect
007		107		207	Skylight	307	Dual Aspect
008		108		208	Skylight	308	Dual Aspect
009		109		209	Skylight	309	Dual Aspect
010	Dual Aspect	110	Dual Aspect	210	Dual Aspect	310	
011				211	Skylight	311	Dual Aspect
012	Dual Aspect			212	Skylight	312	
				213	Skylight	313	Dual Aspect
				214	Skylight	314	Dual Aspect
				215		315	
				216		316	
				217			
				218	Dual Aspect		

Level 4	Passing Method	Level 5	Passing Method	Level 6	Passing Method	Level 7	Passing Method	Level 8	Passing Method
401	Dual Aspect	501	Dual Aspect	601	Dual Aspect	701	Dual Aspect	801	Dual Aspect
402	Dual Aspect	502	Dual Aspect	602	Dual Aspect	702	Dual Aspect	802	
403		503		603		703		803	
404		504		604		704		804	
405		505		605		705		805	Dual Aspect
406	Dual Aspect	506	Dual Aspect	606	Dual Aspect	706	Dual Aspect	806	Dual Aspect
407	Dual Aspect	507	Dual Aspect	607	Dual Aspect	707	Dual Aspect	807	Dual Aspect
408	Dual Aspect	508	Dual Aspect	608	Dual Aspect	708	Dual Aspect	808	
409	Dual Aspect	509	Dual Aspect	609	Dual Aspect	709	Dual Aspect	809	Pass via CFD
410		510		610		710		810	Dual Aspect
411	Dual Aspect	511	Dual Aspect	611	Dual Aspect	711	Dual Aspect	811	
412		512		612		712		812	
413	Dual Aspect	513	Dual Aspect	613	Dual Aspect	713	Dual Aspect		
414	Dual Aspect	514	Dual Aspect	614	Dual Aspect	714	Dual Aspect		
415		515		615		715			
416		516		616		716			

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