WMI/WRH

Project Application Report

Building Services and Structure

FINAL

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Project Application Report

Building Services and Structure

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Contents

Appendices

1 INTRODUCTION

Arup has been commissioned by Capital Insight to provide structure, acoustic, mechanical, electrical, hydraulic, fire and lift services design input for the new Westmead Millennium Institute and Westmead Research Hub located on the Westmead health campus. The purpose of this design report is to inform the project application submission.

This document describes the key features of the building design principles for structure and services.

2 BUILDING FORM

The building is a new medical research facility building and provides seven (7) storeys plus rooftop plantrooms and basement.

The building generally comprises write up areas and research laboratories. Research laboratories comprise wet labs, dry labs and several specialised laboratories. Labs are to be designed to PC2 levels. One specific lab will be designed to PC3 level.

3 CONSTRUCTION STAGES

They are several options for the building size within stage 1 which meet different construction cost and fit out mix. They are listed as stage 1 A, B, C and D below. There is a potential for further stage 2 development (extra 7 500 m2) which has been considered by the design team. Arup has been directed to design the services for stage 1 only assuming the stage 2 extension will have dedicated stand alone plant. However, full consideration is given to provide a consistent service strategy in the design of the various options within stage 1 and its strategy can be applied to stage 2.

STAGE 1:

Within stage 1, one or more construction stages are considered. Staging options are listed as follow:

- OPTION A – MINIMAL DEVELOPMENT (9,470 m^2)

  This option is a minimal development with a limited footprint building comprising basement, lower ground, podium, 5 levels of labs/write up areas and roof plant. Some of the plant will need to be located external to the building envelope and be integrated into the future extension or relocated with associated cost and complication.

- OPTION B – MINIMAL DEVELOPMENT WITH BASEMENT + LG PODIUM (10,830 m^2)

  This option is identical to option A except that it has 1 300 m2 of extended lower ground and basement which provides greater area to provide all of the central plant within the Basement/Lower ground.

- OPTION C – REDUCED STAGE1 DEVELOPMENT WITH BASEMENT + LG PODIUM (13,315 m^2)

  Option C has 2 500m^2 of extended upper floors comprising an additional fire stair. Additional space will be served by on floor plant and central plant.

- OPTION D – STAGE1 DEVELOPMENT (15,000 m^2)

  Complete stage 1 building.

STAGE 2:

Stage 2 is a future extension of approximately 7,500m^2 to the North end of the stage 1 building. No future equipment space provisions will be made within the stage 1 building to serve the future extension. Stage 2 will be treated as a separate building with stand alone services but consideration will be given to arrange plant in a manner where stage 1 central plant can be physically extended. (Possibly located at the edge of the stage1/stage 2 line)

4 EXISTING SITE INFRASTRUCTURE

4.1 Introduction

This section reviews and reports on the infrastructure requirements for the proposed development. This information results from a separate appointment in which Arup was appointed by Health Infrastructure to investigate the existing infrastructure. This appointment resulted in a report.

The report finds that:

- Most services that the development requires can be adequately provided by the existing infrastructure. The exceptions are noted:
- Consultation with the user group for Sydney West Area Health Service (SWAHS), Children's Medical research Institute (CMRI) and the Children's Hospital at Westmead (CHW) has informed the extent of connection to the existing site infrastructure. The outcome is that all services that the new building will require will be standalone and not connected to the Westmead site nor to the CMRI or CHWI;
- The new building will be provided with a new substation which will be fed from the Integral Energy network. Further negotiation with Integral Energy is required to finalise network upgrade requirements.

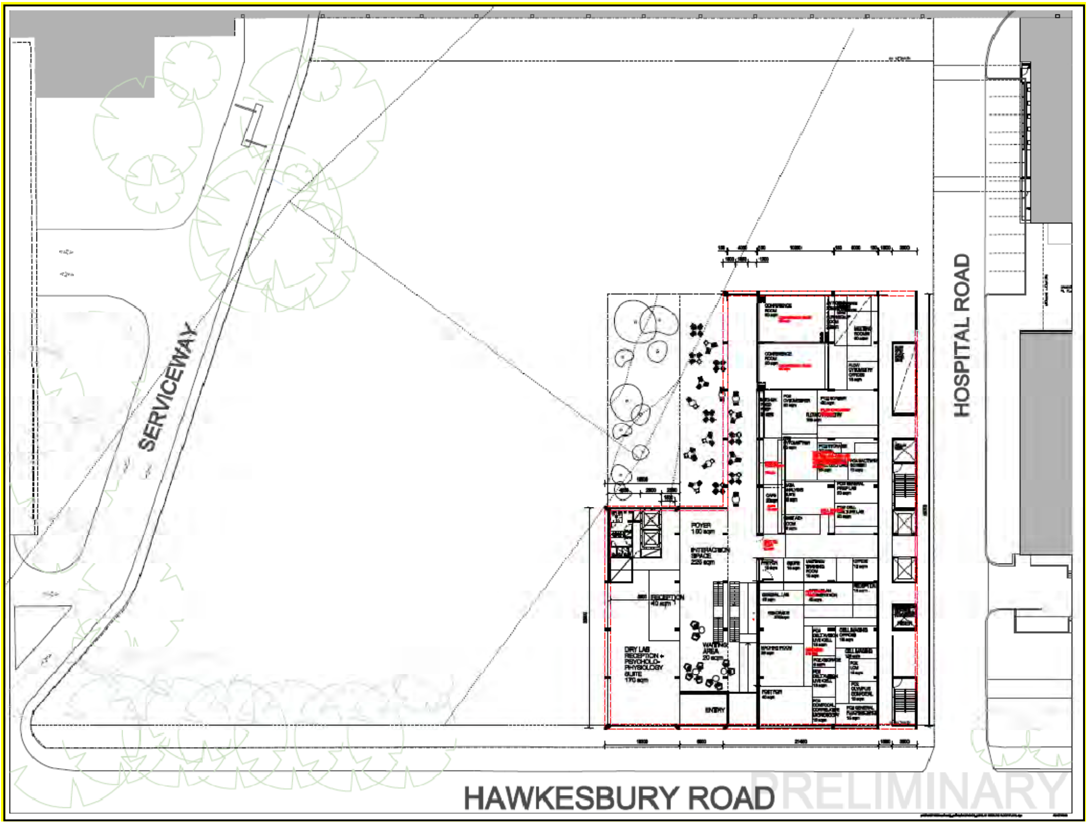
This report represents the findings and outcomes from a number of information sources:

- Site investigations undertaken by Arup. We have visited the site and undertaken non invasive inspection of the site and surrounds;
- Site survey information as documented within Plan of Detail and Levels over part of Westmead Hospital and Hawkesbury Road, Westmead being Lot 100 in DP1119583, by Lockley Land Title Solutions
- Dial before you dig information sourced during period from December 2009 to January 2010
- Meetings with the user group for Sydney West Area Health Service (SWAHS) for this project
- Meeting on 5th March 2010 at Westmead Children's Hospital with Greg Craig from CMRI and Stuart Deck from Westmead Childrens Hospital

This section identifies any specific requirements that apply to the proposed development in terms of site infrastructure and also confirm any requirements that SWAHS may have for the development.

The proposed development

The proposed WMI/ WRH is to be developed in separate stages as described in Section 3 of this report. The proposed buildings are to be located on the Westmead site at the location depicted below (Stage 1 only is shown):



4.2 Hydraulics

4.2.1 Water

A water reticulation line runs within the building footprint. The line appears to be servicing some buildings which will be demolished.

It is expected that the future buildings will be serviced by the DN150 CICL or DN250 DICL water main which is located on the North-Western side of Hawkesbury Road. These dual water mains will provide adequate points of connection to achieve a grade 1 supply to the development for potable water and fire fighting.

Any assets not owned by Sydney Water Corporation such as those which traverse the site, are deemed low value assets which will be re–routed to suite basement extents and future servicing requirements. During design development the route for water supply will be determined and that of minimal impact to adjacent utilities will be recommended.

Non potable water

Non potable water will be provided by the buildings rainwater harvesting system supplemented by the mains supply.

Laboratory water (including RO, demineralised, copper free or other)

SWAHS has identified that there is a potential third party supplier of Reverse Osmosis (RO) or Demineralised water to the entire Westmead site. This incentive involves the supplier reusing existing gas mains to deliver water to the site. The feasibility for this incentive is dependant upon the likely draw off of water that the site requires. During scheme design and design development the designers for the WMI/WRH building will provide estimates of water flow to SWAHS to assist in determining the feasibility of third party supply. Initial planning stages for the WMI/WRH building will however allow for their own independent laboratory water equipment.

No other connection to the existing or future buildings is currently proposed.

4.2.2 Sewerage

There are no public sewerage assets within the building footprint. Located within the vicinity of Institute Road there is a DN300 gravity sewer main which drains toward the North-West of the development site.

The future servicing of the development will be largely via gravity lines where possible to the DN300 main identified on the dial before you dig plans. Design development will dictate whether a small transfer pump station will be required to lift flows to a level where a gravity line can transfer the wastewater. An expected flow rate of no more than 2L/s can be achieved should non gravity connection be required. The development site is located at the upstream end of the existing sewerage reticulation. Site survey to obtain invert levels and Closed Circuit Television inspection will be necessary to incorporate this existing line in the overarching servicing of the building at the time of detailed design.

4.2.3 Laboratory Waste

The new development will contain facilities that will require treatment prior to discharge to sewer. Dilution tanks will be provided within the new development to treat the laboratory waste sufficiently prior to discharge. Dilution tanks and associated plant will be stand alone and sized for the proposed development only.

4.2.4 Stormwater

Enquires have been made with Parramatta City Council to obtain background data on the trunk stormwater infrastructure present on site. A meeting was held with the drainage engineer where trunk infrastructure and flooding potential were discussed. The information provided suggested that the 20 year ARI flood events recorded did not extend to the building footprint. There was no noted inundation or historical data to indicate that a higher level of flood immunity was required.

Arup has obtained council plans which date back more than 15 years and indicate that trunk stormwater traverses around the development site and ultimately drains to Toongabbie Creek. Arup has verified through discussions with hospital maintenance staff and through discussions with the Council, that the entire hospital precinct is drained in the same fashion. Invert levels of the stormwater were not supplied. However, it is noted that a stormwater line appears to partially service Hawkesbury Road, Jessie Road and adjoining properties bound by Hainsworth Street. From the information supplied, it appears that the development would be able to connect to these lines for the purposes of building drainage. The development will not significantly alter the runoff potential (volume of stormwater) of the site nor will it affect any flood or overland drainage paths. Future servicing of the stormwater can be via a junction pit built over the DN450 diameter stormwater line or by directly breaking into an existing junction pit.

A CCTV should be completed and further discussions with Parramatta City Council drainage engineers undertaken to finalise the drainage strategy during design development.

Onsite stormwater detention may be required for the site and will need to be sized in accordance with the Upper Parramatta River Catchment Trust Onsite stormwater detention handbook. Preliminary sizing indicate that the storage will need to be 182m^3 with a flood storage volume of 62m^3 inclusive. This is based on a permissible site discharge of 455m^3/ha. It is noted that the Upper Parramatta River Catchment Trust consider on site detention as a site wide requirement rather than a single specific improvement or addition to a commercial/ industrial style development. Details of on site detention requirements will be determined in design development.

4.2.5 Water recycling

Rain water capture and re-use:

Rain water capture and re-use is an appropriate strategy for this project. Parramatta Council has advised that sizing of the detention system can be reduced if reain water capture and reuse is provided..

Grey and/or Blackwater recycling:

Neither Parramatta Council nor SWAHS have a requirement for grey or Blackwater recycling. However SWAHS have identified that there is a potential Blackwater recycling plant being considered for Westmead Hospital Site. This plant is in very early feasibility stages and there is no guarantee that the plant will be incorporated. Discussions thus far have confirmed that in terms of the proposed new buildings it would not be necessarily an appropriate strategy to duplicate Blackwater treatment plants across the Westmead site. Therefore there are two conditions for the proposed WMI/WRH development:

1) The next stages of concept development for the WMI/WRH building shall assume that no site blackwater treatment will be provided on the site; and
2) That should the development of the blackwater campus system be concurrent with the design development of the new building, consideration shall be given to connection to this campus infrastructure.

4.3 Power

4.3.1 Existing electrical services

An Integral Energy substation is present at the eastern corner of the site (corner of Hawkesbury Rd and access road to CMRI), in the grassed area adjacent to the existing carpark. A second substation is located at the existing CMRI site in its south east corner adjacent to the road dividing the CMRI from the proposed site of WMI/WRH.

Underground electricity assets are present on the site. A low voltage electricity cable runs from the substation in the eastern corner in a westerly direction across the existing carpark, connecting to the “Childflight” building. A further underground line runs from the “Geriatric Medicine Domiciliary Care Unit” building to the “Grevillea Cottage” building. Another low voltage cable is running from the “Grevillea Cottage” building in a south-easterly direction, terminating in the vicinity of the traffic island on the access road.

Based on the As Installed drawing (“As installed buried services co-ordination & HV cable location” drawing number 18-B1-AB-(E) 037) and verbal conversation with SWAHS it appears that there are no high voltage cables present on the proposed WMI/WRH/ site.

It is not anticipated that existing electricity assets will pose any obstacles to redevelopment of the site.

4.3.2 Connection to Westmead Hospital HV network

The Westmead Hospital Campus is a high voltage (HV) customer and the existing HV network is maintained by Sydney West Area Health Service (SWAHS). Arup estimated the preliminary maximum demand for the new development in order of 4.2 MVA, including 20% spare capacity. At present there are two high voltage feeders installed from the Integral Energy zone substation to the Westmead Hospital Campus main high voltage switchboard. The existing Westmead Hospital HV ring does not have capacity to supply the required load to the new development. It is also noted that the existing main HV switchboard is more than 30 years old and reaching the end of its life.

Integral Energy have advised that in order to supply the requested power the Integral Energy zone substation needs to be upgraded. There are two potential approaches to provide power for the new development:

1. Upgrade the two existing HV feeders. Since there is no spare capacity within the existing HV main switchboard, and its modification is not recommended due to its age, this solution would require installation of a new main HV switchboard. This would cause major disruption of power supply to the Westmead campus and introduce a major cost. It is not proposed to adopt this option.
2. New separate HV feeder in addition to two of existing HV feeders. This solution would be adequate to provide a single HV feed for the new WMI/WRH development without the need to modify the existing Westmead Hospital HV main switchboard and HV network. The new HV feeder would serve a new standalone substation within the vicinity of the new development. A Single HV cable should be sufficient for the WMI/WRH development as it is not envisaged that dual supply is required. It is noted that NSW Health TS-11 recommends that dual feed to healthcare facilities should be considered. The reasons for this are in relation to power resiliency for critical care needs. The WMI/WRH project will not contain healthcare needs that warrant this dual supply and therefore it is proposed that single supply (supplemented with diesel generator and/or UPS systems for specific equipment) is provided.

Integral Energy are currently reviewing their infrastructure design to serve the new development. In order to determine this, extra information is being sourced regarding future plans on the Westmead Campus. Integral Energy have informally advised that it may be possible for them to provide a separate HV feed and this needs to be confirmed.

4.4 Alternative power sources

Cogeneration/ Trigeneration

Discussion with SWAHS had indicated that there is a potential cogeneration system being considered for the Westmead hospital site. Opportunity for connection to this future system has been discussed and the following has been determined:

- The proposed location for the cogeneration system is likely to be a significant distance from the new development. Costs and inefficiencies associated with piping connections for heat reclaim and reuse are expected to prevent connection to this system;
- The design development stage for the development should consider the feasibility of connection to the site trigeneration system.

There has also been the identification of an existing cogeneration equipment currently installed at Nepean Hospital which SWAHS has expressed a desire to consider for reuse for the WMI/WRH development. This will be considered in the next stages of the project.

4.5 Communication Services

4.5.1 Existing communication services

The site survey shows an above ground communications line running in the vicinity of the internal access road adjacent to the existing carpark. At the north-west side of the carpark the line goes underground where it appears to connect to the cluster of buildings in the northern corner of the site. At the southern end of the site the communication line also goes underground at a power pole and appears to connect to the Telstra owned network in the vicinity of the intersection of the internal access road and Hawkesbury Road. An above ground connection is also present between the two small buildings that are to be demolished.

These communication lines do not appear on any service providers plans so it is assumed that these assets are internally owned. They will be rerouted round the new development where necessary. No externally owned communication lines appear to be present on the site.

Surrounding the site there are a number of externally owned assets. A sole fibre optic line runs through Westmead Hospital to the south of the Millennium Institute. Telstra plans also indicate the presence of conduits running along the south east side of Hawkesbury Road.

4.5.2 New WMI/WRH development communication services

The new WMI/WRH development will be connected to the Telstra network (running along Hawkesbury Road) via a new cable. The size and type of the future cable is to be determined after briefing meeting with WMI/WRH. It has been confirmed that the interconnection of the new WMI/WRH development to the Westmead Hospital/SWAHS communication network is not required.

The new WMI/WRH development will be interconnected with the existing University of Sydney Network. Further briefing meetings will determine the type and location of the above connection. In addition Arup were advised that WMI and WRH will have a common Main Communication Room.

4.6 Natural Gas

The Westmead hospital precinct has existing natural gas infrastructure and there is also an existing 75mm nylon 210 Kpa authorities gas main located in Hawkesbury Road. Due to the location of the existing precinct gas mains being remote to the proposed site it is proposed that the site be serviced by the authorities gas main in Hawkesbury road.

4.7 Medical Gases

Arup have liaised with SWAHS to determine if there is any potential to source medical gasses from the existing site. Due to the physical distance from the existing gas stores and the expected requirement for specialised gasses within the new development It is proposed that a stand alone medical gases strategy will be provided for the new WMI/WRH building,

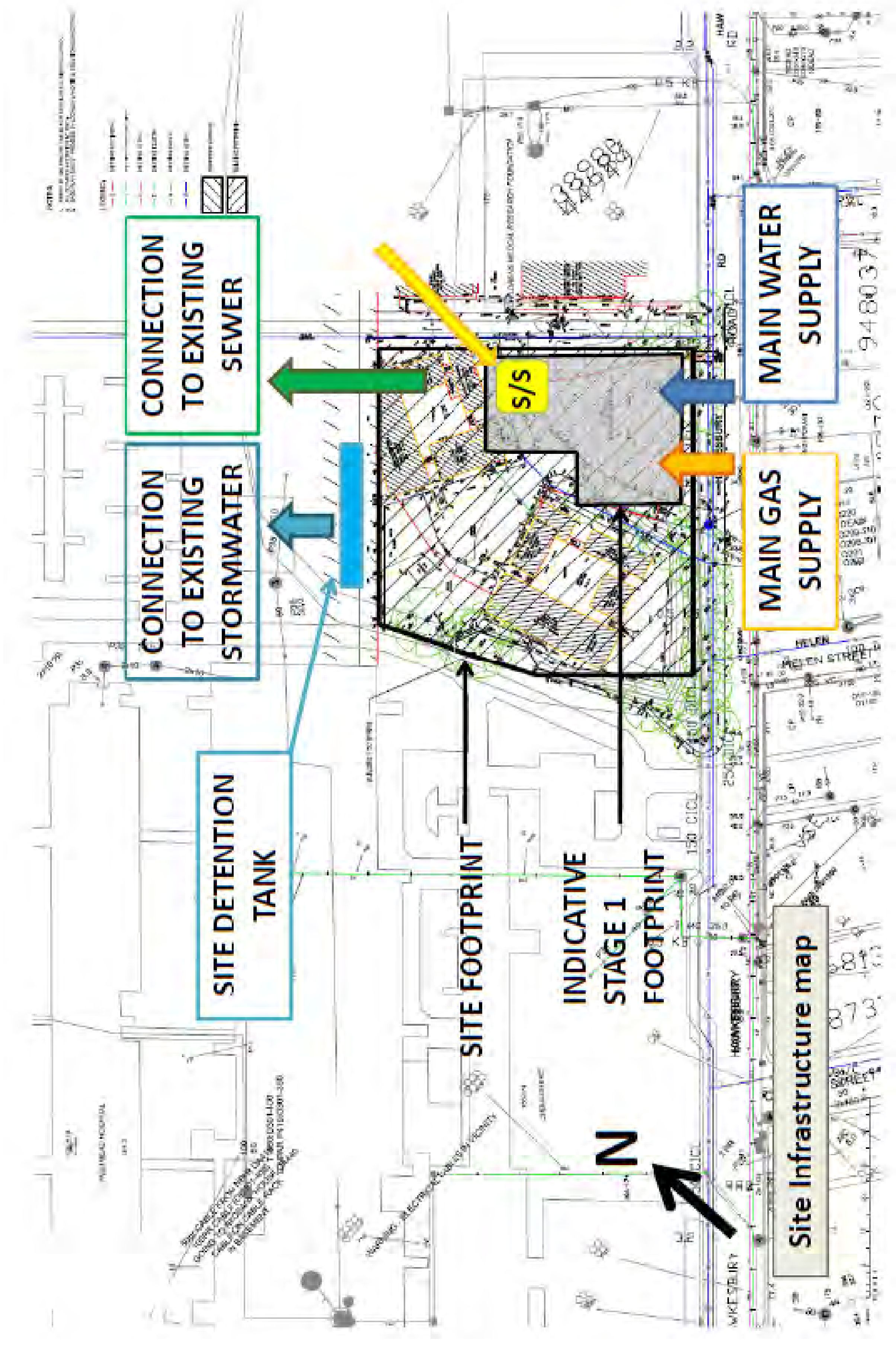
It is proposed that there may be future potential integration of medical gasses plant for CMRI and the proposed development. The extent of this is unknown at this stage. The planning for the proposed development will however aim to locate medical gas stores in reasonable close proximity to CMRI for ease of future integration or sharing of plant.

4.8 Mechanical services & Building Management Systems

Investigations have been made in conjunction with discussions with SWAHS over any potential integration with existing mechanical services systems. It has been concluded that integration with existing systems will not be possible or appropriate for the new development. All mechanical services systems, including chilled water, heating hot water and ventilation systems for the WMI/WRH building will be standalone and sized to serve the buildings only.

The proposed development will have discharges from fume flues and other discharges that are deemed offensive or objectionable. These fume flues will be discharged above the roof in accordance with Australian Standards .

The building Management system (BMS) for the new development will be a stand alone system with no requirement for cross connection to the existing Westmead Hospital systems.


CONNECTION TO EXISTING SEWER
CONNECTION TO EXISTING STORMWATER
SITE DETENTION TANK
SITE FOOTPRINT
INDICATIVE STAGE 1 FOOTPRINT
S/S
MAIN WATER SUPPLY
MAIN GAS SUPPLY
HELEN STREET
N
Site Infrastructure map

5 STRUCTURE

5.1 Site

General

The site is approximately 110 m x 100 m on plan and is currently occupied by two buildings and bitumen car parks. The majority of the site is level but it rises steeply at the southern boundary by approximately 4m.Site surveys have been carried out and the following reports interpret the survey information:

- Westmead Hospital Geotechnical Interpretive Report by Aecom - 23 February 2010
- Environmental Site Assessment Report, Westmead Hospital, Westmead, NSW, by Aecom -12 March 2010

Adjacent Structures

Note that there are other buildings and infrastructure adjacent to the site. The implications of the demolition and construction activities on these neighbours will need to be considered.

Demolition operations traditionally cause noise, dust and vibration. Construction is typically less disruptive than demolition; however, it will still cause some vibration, noise and dust. Mitigation measures will need to be put in place to limit these impacts.

5.2 Ground Conditions

A summary of the Geotechnical Interpretive Report mentioned above is given below. For further information refer to the detailed report.

The Sydney geological map indicates that the site is underlain with Bringelly Shale of the Wianamatta Group. The site investigation results are consistent with this regional geology.

The boreholes show a thin layer of fill generally consisting of sandy silts and gravels overlying shale that generally increases in strength with depth. In one of the bore holes a layer of residual soil was identified at approximately 1.3 m from the surface. The cores also had zones of core loss which is likely to be due to weaker, friable or fragmented bands in the rock strata.

From the Environmental Report ground water occurs between 14.7 and 17.865 m AHD, the report also mentions water at 1.155 m to 1.435 m AHD. The site ground level is generally between 21m and 25m AHD. Clarification is being sought from Aecom on the water levels for the site.

The Environmental Report mentions possible contamination on the site; refer to this report for further details. This report also mentions acid sulphate soils class 5. In the next phase we will address the nature of the soil and if necessary specify a sulphate resisting concrete.

5.3 Construction Stages

There are several options for the building size within stage 1 which means a different construction cost and fit out mix. They are listed at stage 1 A, B, C and D below. There is also a potential for stage 2 development (extra 7 500 m2) which has been considered by the design team.

- Option A - Minimal Development (9,470 m^2)

- Option B - Minimal Development with Basement + LG Podium (10,830 m^2)
- Option C – Reduced Stage 1 Development with Basement + LG Podium (13,315 m^2)
- Option D – Stage 1 Development (15,000 m^2)

The main structural implications for the options are discussed below:

General Issues

- If option A, B or C is chosen then a key issue will be keeping the rest of the facility operational during the second phase of construction works. Construction and demolition activities have the potential to cause vibration, noise and dust which that may impact on adjacent structures and activities. Where possible, design options that will minimise vibration during construction should be selected.
- To reduce the vibration impacts associated with phased construction, a joint (either temporary or permanent) should be detailed between the phases. This would isolate the second phase construction activities from the operational facilities. This joint could be stitched together once construction was completed.
- In each case the first phase will need to be designed to be stable in its own right. This may involve additional or thicker core walls being installed initially.
- A reduced floor plate may impact on the dynamic characteristics of the floor plate. This is because continuity of floor plate can often help dynamic performance.
- If the temporary facade line is not on a column line, the structure could be designed to either cantilever or an additional line of columns used to provide support. If the space is to be used for vibration sensitive work then columns will be required, as a cantilever will not provide the necessary vibration performance.

Option A

- Option A has a reduced basement and podium; therefore the subsequent phasing would include the extension of the basement and podium horizontally, with the superstructure added above. The key issue for the later construction phase will be extending the basement, as this will involve cutting through an existing basement retaining wall. The connection onto uppers floors will be more straightforward, as it will involve removing the temporary facade to join the new superstructure floors.

Option B and C

- Option B and C are similar structurally, in that they both consider a completed basement and podium structure and vary the amount of superstructure above Ground Level that is built. In either case the Basement and LG structures would be designed to carry the full Stage 1 development, with columns, stability walls and foundations designed to carry the total development loads. Couplers would be cast into the top of the walls and columns for the future extension. These couplers would need to be protected by using a concrete layer or similar. The extensions would involve removing the existing cladding to join the new superstructure floors together as per Option A above.

5.4 The Structural Concept

The Stage 1 building is L shaped on plan, and consists of 2 main building blocks with combined Lower Ground and Ground Levels. The upper floors are separated by the atrium and linked by bridges. The larger block is 60 m x 36 m on plan and contains the laboratories at the upper levels with Hub functions at the lower levels. The smaller block is 30 m x 10 m on plan and contains office type functions such as write up areas.

5.5 Foundations

Based on the current architectural grid the foundations will consist of pad footings in the shale. For the most heavily loaded columns the pads footings founded in the Class V shale (i.e. close to ground level) will be approximately 2.8 m x 2.8 m on plan. Where the pads are deeper they may be smaller, approximately, 2.4 m x 2.4 m if they are in the higher capacity Class IV shale.

Where the columns sit on top of the basement wall they will be supported by the retaining wall piles and a capping beam.

As these shales are known to be reactive to moisture they may soften when excavated. The base of the foundations will need to be dewatered and cleaned and a blinding layer placed quickly to prevent deterioration of the founding shales.

5.6 Basement

Based on the geotechnical report the retaining walls of the basement will consist of either bored soldier pile walls or a dowel and shotcrete system.

Where the basement excavation is adjacent to existing buildings or roads (i.e. the Hawkesbury Road and Hospital Road/CMRI) then the impact of ground movement on these structures will need to be considered. This may mean that a more rigid retention system will be used in these areas to minimise ground movements.

Note that some retaining walls will also be required at LG level due to the fall across the site.

5.7 Superstructure

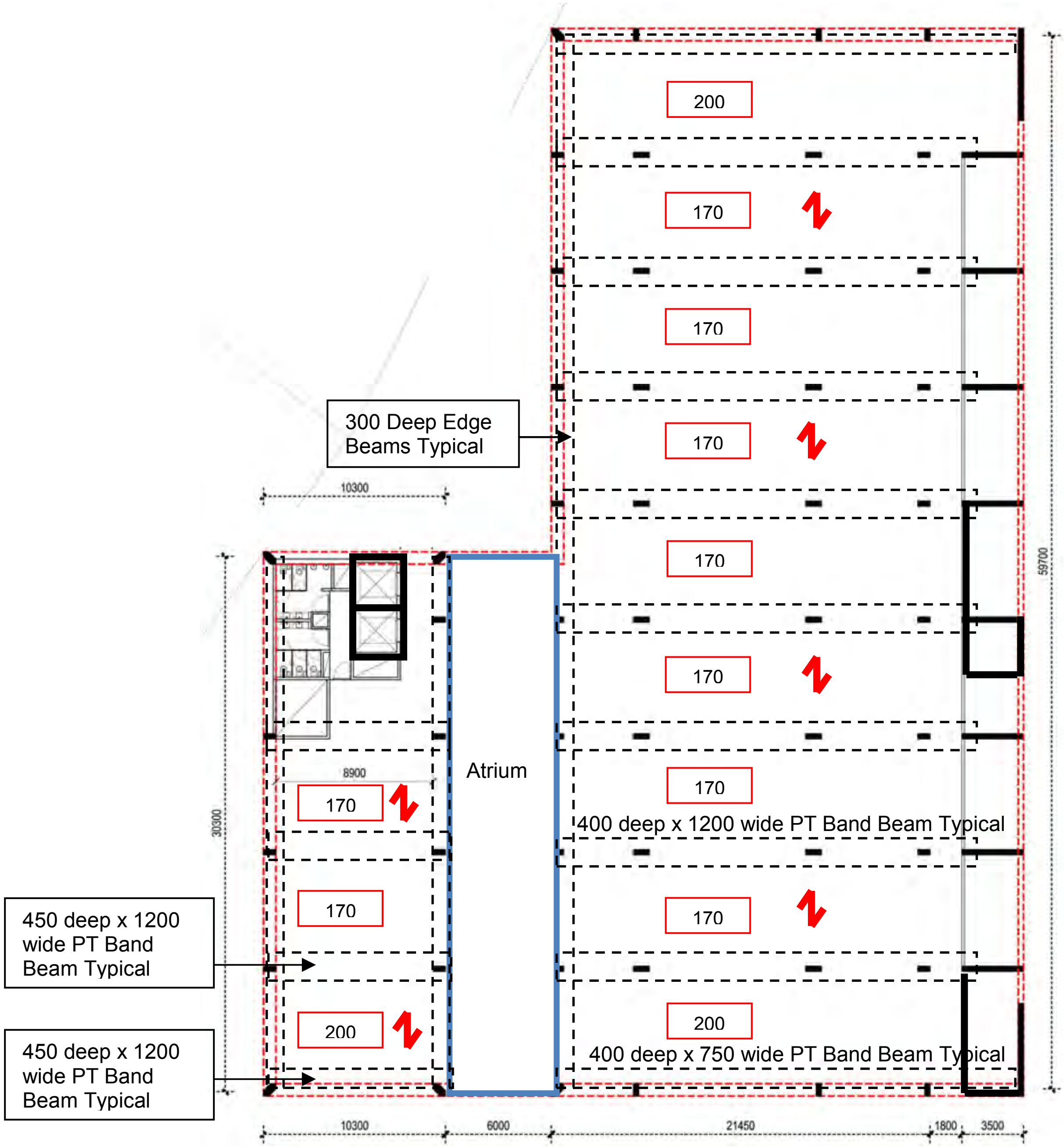
The current concept for the superstructure floors consists of post-tensioned (PT) concrete slabs and band beams. For the large block the beams consist of 1200 mm wide x 400 mm deep PT beams. The smaller block has 1200 mm x 450 mm deep PT beams. The slabs are 170 mm thick typically, increasing to 200 thick in the end spans. Note that at this stage dynamics have not been considered, see also section 5.11below.

The band beams span between reinforced concrete columns or reinforced concrete walls. The most heavily loaded column is 400 x 900 on plan at the lower levels, reducing to 300 x 900 above Ground Floor. The edge columns are expressed on the outer face of the building.

The bridges across the atrium may be concrete or steel depending on the architectural intent for this area. These bridges will have a movement joint at one end, as the two blocks will move independently above the common ground floor level.

The glazing to the atrium will be full height; and the support to this glazing is still to be developed. However, if the same cladding system is to be used all around the building then supporting beams will be required at floor levels. As with the bridges the glazing will need a movement joint at one end due to deal with the relative movements between the two blocks.

The loading dock is currently proposed on the LG level, this will require a column free space and thus transfer structures will be required in the Ground Floor Slab. As the loading dock is located on a suspended slab it will need to be isolated from the rest of the floor plate for vibration purposes see also section 5.11 below.



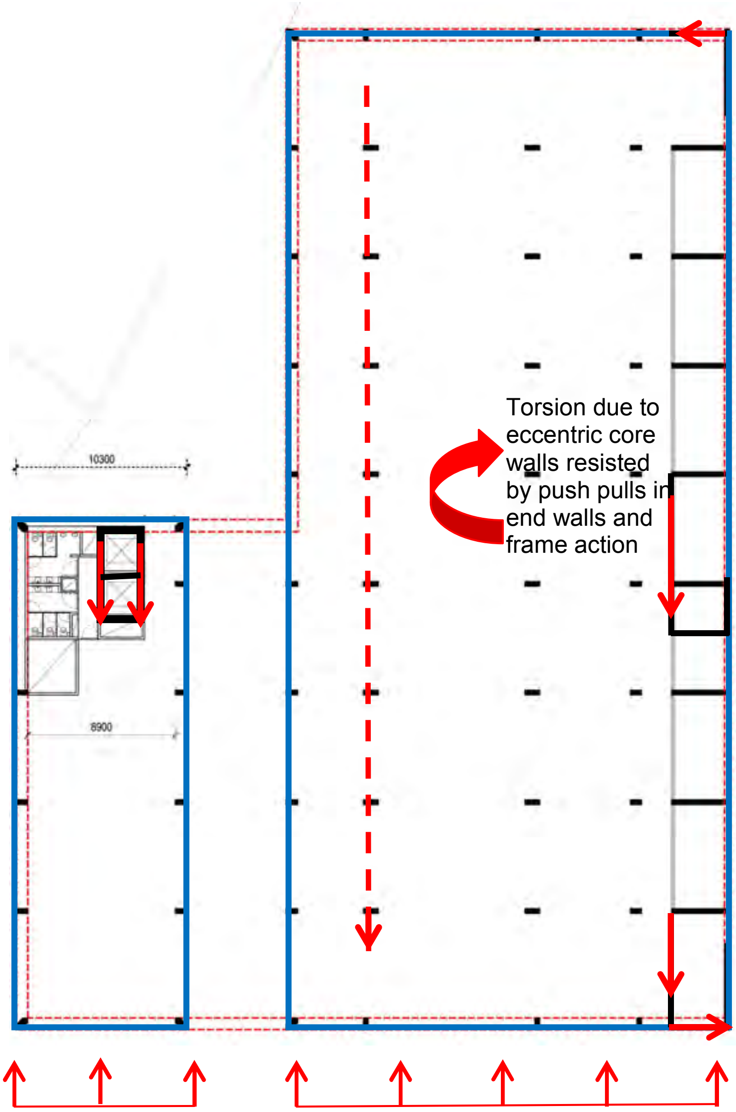
Typical Floor Layout (Note that dynamics have not been considered at this stage)

5.8 Stability

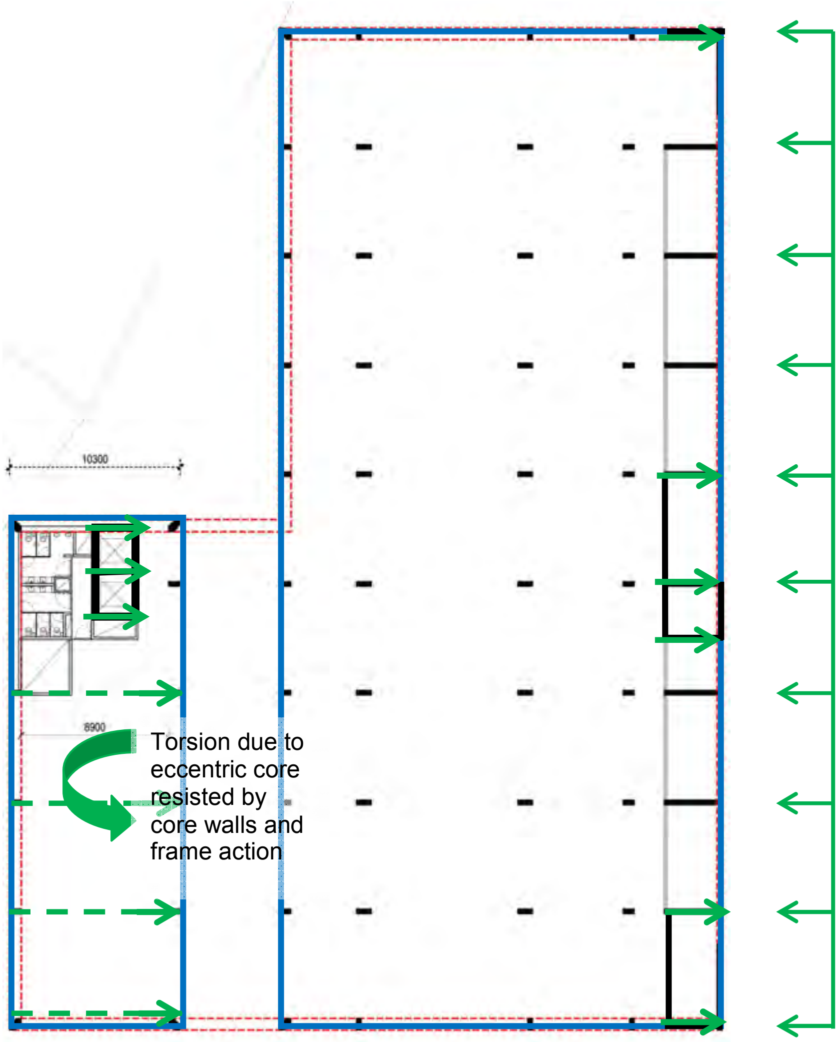
Above Ground Floor the stability of the two blocks is considered independently.

The larger block will use a combination of the concrete walls to the lift, stairs and service riser cores, and frame action to resist lateral loads. In the short direction the short walls of the cores will provide the necessary stability. In the long direction the cores are eccentric to the floor plate which will cause torsion. This torsion will be resisted by the end core walls and frame action.

For the smaller block, the core will resist the lateral loads in the long direction. In the short direction the core is eccentric. The torsion generated will be resisted by the core and frame action.



Stability in Long Direction



Stability in Short Direction

5.9 Flexibility

Future flexibility in the building will generally consist of three main components structurally:

1. Loading
2. Penetrations
3. Vibration

Loading

The whole of the roof plant level should be designed for plant loading to allow for future expansion of plant areas.

Penetrations

With a PT structure normal practice is to mark out the location of the PT tendons on the soffit of the slab. This can then act as a guide for forming future penetrations without seriously impacting on the capacity of the slab. The tendons in the slab will typically be at 1 m to 1.4 m centres in each direction, therefore this provides a good level of flexibility for future small penetrations. Large penetrations would need to be reviewed in detail, note that this would apply to both PT and RC construction. If necessary, areas can be designated as future knock out panels, and the slab designed to suit.

Vibration

Areas can be designed to achieve better vibration criteria than strictly required according to their current function to address future needs. The amount of flexibility required will be informed by the dynamic analysis of the structure during the next phase of design. During this phase it will be possible to evaluate the additional cost involved in increasing dynamic performance of the spaces for future flexibility so that an informed decision can be made by the client.

5.10 Performance Requirements

5.10.1 Loading

Dead Load

In addition to the self weight of the structure the following superimposed dead loads have been considered in the appropriate areas:

Description	**Load** **kPa**
Ceiling and Services	1.5
Finishes: Laboratories, vinyl flooring Corridors, lobby areas etc.	 0.0 2.4
Partitions (assumed to be lightweight)	 1.0
Roof: Finishes to falls, or plant plinths, assume150 mm average	3.6

Live Loading

Loading	Live Load kPa
Laboratories	3.0
Offices	3.0
Stairs and Corridors	4.0
Roof Plant Rooms	7.5

Horizontal Loads

The design of the stability elements is based on the worst case loading of the notional horizontal, wind or seismic loads.

5.10.2 Imposed Movements

Deflection limits

The reinforced concrete elements have been sized to limit deflections to the values given in AS3600 2001 Table 2.4.2

Type of Member	Deflection to be considered	Deflection limitation for spans	Deflection limitation for cantilevers
All members	The total deflection	1/250	1/125
Members supporting masonry partitions	The deflection which occurs after the addition or attachment of the partitions	1/500 where provision is made to minimize the effect of movement otherwise 1/1000	1/250 where provision is made to minimize the effect of movement, otherwise 1/500

Lateral Drift

The stability elements are designed to limit the inter-storey lateral drift to 1/500 under wind loads.

5.10.3 Design Standards

The structures will be designed to comply with the Building Code of Australia and relevant Australian Standards (latest editions).

AS 1170	Structural design actions
AS 2243	Safety in Laboratories
AS 2982	Laboratory Design and Construction
AS 3600	Concrete structures
AS 3700	Masonry structures
AS 4100	Steel structures

5.11 Vibration

5.11.1 Introduction

There are three critical issues to be considered with respect to vibration:

- Animal Facilities
- Sensitive Laboratory Equipment
- Construction Vibration

Animal Facilities

The animal house is currently located with most of the facility on a ground bearing slab and part of the facility on a suspended slab. Although known to be vibration sensitive spaces, there is little available guidance on acceptable vibration levels for laboratory animal houses. Placing the Animal House on a slab on grade will minimise the risk of unacceptable levels of vibration. Where the slab is suspended we would suggest a vibration criterion of VC-A but this needs to be agreed with the client.

Sensitive Laboratory Equipment

The proposed facility contains both general laboratory space and a number of areas with more sensitive laboratory equipment. The structural design is likely to be governed by the requirement to meet the vibration criteria for sensitive equipment and therefore there is an associated cost in specifying a particular criterion.

The generic vibration criteria for sensitive equipment are given in Appendix A. The proposed vibration criteria for WMI are given in the table below. This was discussed and agreed with the client and laboratory consultant at the meeting on the 22 April 2010

Area	Vibration Criteria
General Labs	Response Factor (RF)= 1.0
Support Rooms	VC-A generally (RF = 0.5), but identify areas which achieve VC-B (RF = 0.25).
Sensitive Equipment Areas	VC-C (RF =0.125) maybe up to VC-D (RF= 0.0625). (Refer also to generic vibration criteria in appendix A for sensitive equipment, or manufacturers specifications) .

Construction Vibration

Construction and demolition activities have the potential to cause vibration levels that may impact on adjacent structures and activities (particularly if their operations are sensitive to vibration such as the Animal House and Laboratories in the CMRI). This will also be relevant to the WMI phased construction methodology, as the rest of the facility will need to remain operational during the construction of the subsequent phases.

Certain activities are more likely to cause vibration than others. Examples of activities that are of particular concern are:

- Demolition of adjacent structures

- Excavation
- Piling
- Crane and vehicle movements

Where possible, design options that will minimise vibration during construction should be selected.

5.11.2 Impact of the Vibration Criteria on the Cost Estimate

To determine an indication of how vibration criteria impacts on cost, some of our recent lab and hospital projects (including the CMRI and HMRI)have been reviewed. Based on these projects an estimate of increase in concrete volume with increasing vibration criteria has been determined and is shown in the table below. Clearly concrete volume is only one indication of cost (reinforcement rates, programme issues etc. are all important) however for this early stage it gives an indication of the relative increase in cost with increasing vibration criteria. Please note these values strongly depend upon the span – the values quoted are for grids similar to that currently intended for this project.

Design Type	Vibration Criteria	Approximate Increase in Concrete Volume Relative to Basic Design
Basic design (office)	None	+ 0%
General Labs	RF = 1	+20%
Support Rooms	VC-A, RF = 0.5, some local VC-B	+40%
Sensitive Equipment	VC-C with some VC-D	See comments below.

Appendix B contains a mark up of the current architectural drawings which identifies the extent of the vibration sensitive areas. These drawings are based on advice from the Laboratory Consultant.

VC-C with some VC-D (RF=0.125 and RF= 0.0625 respectively)

The easiest way to achieve VC-C and VC-D is by having these areas on a slab sitting on the ground. It is possible to design a suspended slab to achieve VC-C and VC-D, but it is more expensive. Based on the advice from the Laboratory Consultant it appears that only a small area of suspended slab needs to achieve VC-C and VC-D (see also the mark ups included in Appendix B). Therefore the impact on the overall cost will be small. If the VC-C areas are on suspended slabs then it is worth noting the following:

- Equipment isolation may be an economic option instead of trying to stiffen up the structure.
- Additional columns reducing the spans in these areas are recommended to minimise the extra structural cost.
- Linking floors together with tie columns will improve performance (approximately 50% of floor area moves to the next level of vibration criteria).

It is recommended that measures such as those discussed above and developed more at the next stage are used. However VC-C can be achieved in a local area without such measures by significantly increasing the mass and stiffness of the floor locally. This might need to be something in the order of an approximately 700 mm thick flat slab or a waffle slab locally to the area of concern.

5.11.3 Other Considerations

Other items that will be considered in further detail from a vibration perspective are:

- Location of plant.
- Car parking From a vibration point of view, the best location for the car parking is on a slab sitting on the ground. This is because cars travelling on a suspended slab would send vibration through the structure and impact on the other levels. This project has no parking within the building however if this should be included then vibration should be considered.
- Loading Dock – Similar to car parking, the best location for the loading dock is on a slab sitting on the ground from a vibration point of view. However, the loading dock is currently located on a suspended floor slab. This means that the loading dock slab will need to be isolated from the rest of the structure by a movement joint to prevent vibration transfer into adjacent areas. Additional columns will also be required as any columns that run through the slab and support other levels will need to be isolated from the slab, again to prevent vibration transfer.
- For an economic design and to allow for future flexibility, it is recommended that sensitive equipment requiring special vibration criteria be grouped together as far as possible and ideally be remote from sources of vibration such as elevators or plant rooms. Positioning of plant rooms above sensitive equipment should be avoided.
- Vibration levels due to normal building use, such as people walking pushing trolleys etc. can be reduced by avoiding positioning corridor zones down the centre of structural bays and avoiding placing sensitive equipment near the centre of bays.

6 ELECTRICAL AND COMMUNICATION SERVICES

6.1 General

The design of the electrical and communications services will be focused on achieving the following objectives:

- Electrical Services to satisfy the functional requirements of each area.
- Electrical Services to be of an appropriate standard
- Electrical Services to be designed so as to provide a high level of flexibility.
- Design to minimise running and maintenance costs.

6.1.1 Design Criteria

- Electrical Services to comply with the Building Code of Australia.
- Electrical Services to comply with current Australian Standards where applicable and particularly the following.

AS 3000	SAA Wiring Rules
AS 1680	Interior Lighting
AS 1158	Pedestrian Lighting
AS 4282	Obtrusive Lighting
AS 2293	Emergency Evacuation Lighting in Buildings
AS 1136	Low Voltage Switchgear and Control gear Assemblies
AS 3008.1	Electrical Installation - Selection of Cables
AS3080	Telecommunications installations - Generic cabling for Commercial premises
AS 3013	Electrical Installations - Wiring systems for specific applications
AS/NZS 2982	Laboratory design and construction (2010)
AS/NZS 2243	Safety in laboratories

6.2 Electrical Supply

6.2.1 Existing services

Refer to Section 4.3.1

There are currently two (2) kiosk substations on the development site. It is proposed that these will be removed or relocated and retained LV supplies diverted as required.

It is not anticipated that other existing electricity assets will pose any obstacles to redevelopment of the site.

6.2.2 Connection to Westmead Hospital HV network

Refer to Section 4.3.2

There is still undergoing negotiations with IE for the final supply arrangement.

6.2.3 Supply Authority Application

An application to IE is to be submitted, with all associated monopoly fees paid, to confirm the status of the supply and approval of the preferred overall topological strategy and any required associated costs for IE to provide this additional supply.

6.2.4 New Private Substation

It is proposed that a new private basement chamber substation to supply the LV installation is provided within the new building containing all transformers, HV/LV switchgear and associated protection devices. It is proposed the general design is to be based on current IE standards and guidelines.

The substation will be established within the Stage 1 works.

It must be noted that if only the Stage 1 Option A development is undertaken, this will restrict the required area to locate the proposed substation within this building. In this instance, it is proposed that the new substation be established within the adjacent area allocated to Stage 1 Option B, with adequate future allowance to minimise the disruptions in the event of future development.

The substation will be designed to permit construction of future stages while maintaining power.

6.3 Main Switchboard

It is currently proposed that 3 main switchboards (MSB's) will be installed and will be located as near as practicable to the new substation to AS3000 and AS1136 to Form 3b and fully type tested to AS3439. The MSB's will be fitted with Air Circuit Breakers and Moulded Case Circuit Breakers to suit.

The boards will be accommodated within a 2-hour fire-rated enclosure, with two diverse egress paths as required by the BCA.

6.4 Standby Diesel Generator

6.4.1 Generator

A standby diesel generator will be installed to ensure that a reliable alternative electrical supply is available in the event of interruption of the mains power supply. The sizing is to be confirmed during ongoing design development.

The function of the diesel generator is proposed to supply life safety and critical equipment loads throughout the facility. This unit is not proposed to be sized to allow full business continuity in the event of the loss of mains power.

It is proposed that the generator will be located within the plantroom of the WMRI. The generator is to be housed within a custom built acoustically treated room or canopy. A new generator switchboard will be provided adjacent to the new generator.

A generator connection point is proposed to be located at street level to connect a future portable generator in the event that the main generator fails or is undergoing repair.

6.4.2 Load Bank

It is proposed that a load bank shall be provided to test the generator operation to 100% of capacity. This should be located in the vicinity of the generator set and generator switchboard. This will provide resistive load to simulate a live load situation.

6.4.3 Fuel Supply

It is proposed that a new bulk fuel storage tank will be provided to supply the generators at full power for 48-hours continuous operation without the need for refuelling during this time. This shall be provided at the lowest basement level within a 3-hour fire-rated enclosure. The bulk fuel tank will be provided to AS1940.

Fuel polishers/filters and pumps are to be installed to ensure provision of a reliable fuel supply to the standby power generation system.

The fill-point is to be located at street level, accessible by refuelling tankers. A vent pipe is to be located in clear view of this fill-point.

6.4.4 Generator Switchboard

A new generator switchboard will be provided to allow distribution of the standby generator supply to the WMRI facility.

Confirmation of the standby power requirements in all areas is to be reviewed to assess the final distribution scheme and location of transfer switches and contactors within the MSB's, generator switchboard and DB's during design development.

6.5 Power Distribution

It is proposed that power will be distributed from the MSB's as follows:

- Floor sub distribution boards will be installed in lockable cupboards for each floor to supply the floor light and small power loads including power for workstations and other services.
- Laboratory sub distribution boards will be installed in lockable cupboards for each floor to supply the floor light and small power loads including power for laboratories.
- Plant sub distribution board to supply HVAC system control panel, water, fire, lifts and other associated system control panel.

6.6 Small Power

Adequate small power outlets will be provided in all floors and, where practical or by code, will be RCD protected.

In laboratories, emergency isolation of all electrical supplies within the laboratory will comply with AS2243.7.

All fixed appliances such as electric stoves, hot water systems, etc, will have the fixed wring terminating in an isolating switch situated close to the unit.

6.7 Lighting

6.7.1 General Lighting

Area lighting will generally be with fluorescent lights which will be selected for easy repairs and maintenance. Lighting levels will be in accordance with the AS 1680.

Lighting systems will utilise high efficiency lamps with a long life. Infrequently accessed spaces will be provided with lighting controls with occupancy detection. These systems will be provided with override switching as appropriate.

Internal lighting control will be provided in general areas to reduce the energy usage of unoccupied spaces by motion sensors, PE cells and time scheduling.

6.7.2 Emergency and Exit Lighting

Computer monitored emergency and exit lighting will be provided in accordance with the AS2293 in all areas requiring emergency lighting such as stairs, internal passageways, and exit from the floor and building.Exterior Lighting

External Lighting will be in accordance with AS/NZS 1158 Lighting for roads and public spaces, AS 4485 Security for health care facilities and AS 4282 Control of the obtrusive effects of outdoor lighting. The external lighting controls will be by PE cells, time-clocks and external motion sensors where required.

6.8 Communication Services

The internal distribution of communications services is to be provided to AS3080, WMRI/WRH and University standards and referenced to TS11 recommendations and is to be capable of 10Gb/s bandwidth to each telecommunications outlet (TO). It is proposed that a minimum performance of Cat6A horizontal cabling is utilised to achieve this.

A new Main Distribution Room (MDR) is proposed to be established on the lower level of the new Stage 1 development for incoming service provider lead-in cabling. This room will be sized to accommodate both main distribution frames (MDF's) and service provider fibre racks/UPS units to ensure compliance with the National Broadband Network (NBN) requirements.

The service provider lead-in cabling is proposed to be connected to the existing Telstra Network running along Hawkesbury Road.

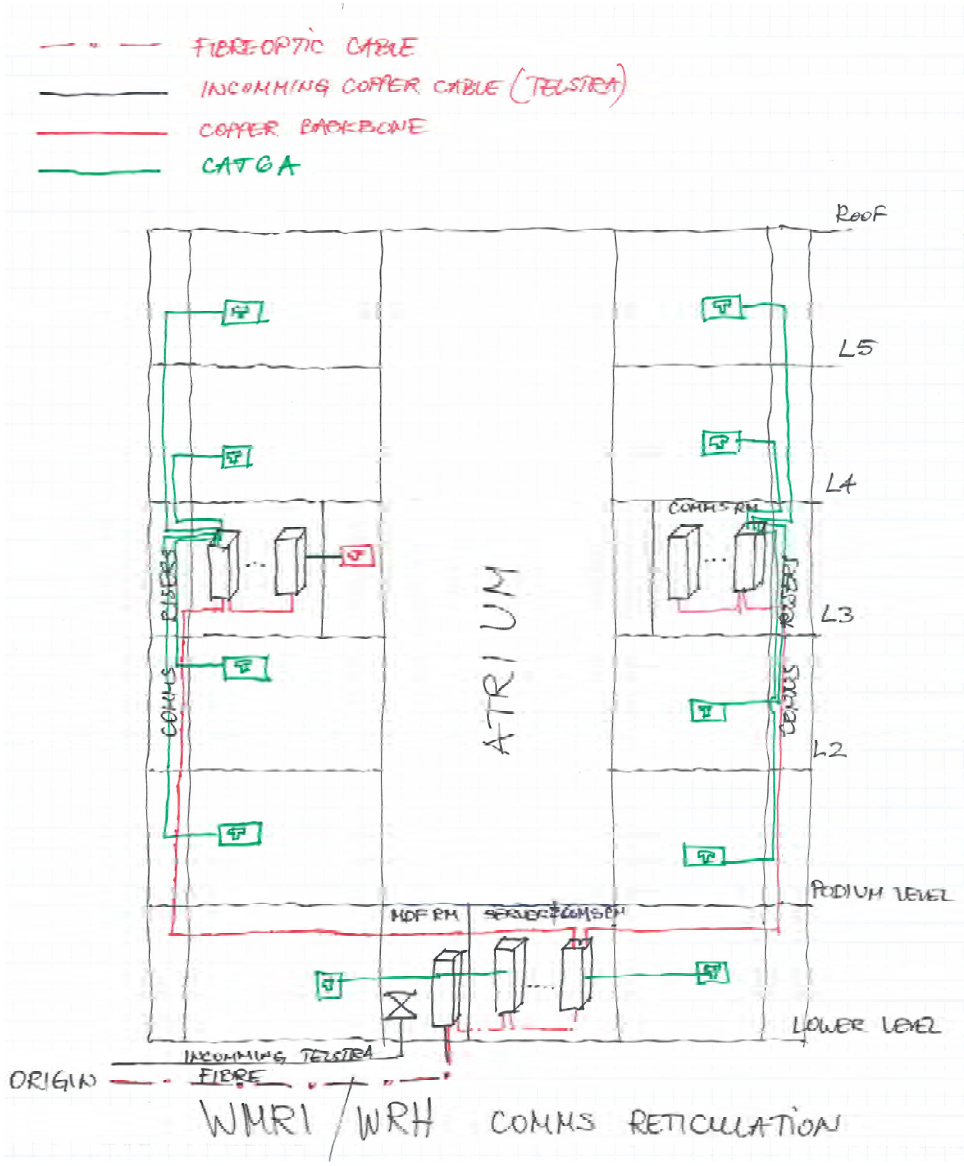
A new combined Building Distributor (BD) and server room is proposed to be located adjacent to the MDR. A fibre interconnection will be provided to the existing University Network's Campus Distributor (CD) within in-ground conduits to the new BD.

Two vertically aligned communications risers are proposed to be located at either side of the atrium and will vertically reticulate all ELV cabling requirements for the electrical installation, including communications, television, security and BMCS cabling.

Two (2) floor distributors (FD's) are proposed to be located on Level 3 on either side of the atrium, adjacent to the communications risers. These are to be located to ensure minimal disruption within sensitive areas in the event of modifications or maintenance within other areas.

The FD's will be connected via fibre interconnection directly to the BD. Additional communications Cat6A cabling is also to be provided subject to final lengths of cable paths between the BD and the FD's.

The FD's are proposed to service the TO's two levels above or below this level in addition to Level 3 TO's. See WMRI/WRH Comms Reticulation schematic below:



6.9 Security Services

A new security system will be provided with access controls, lift security, intruder detection, duress alarms and CCTV cameras are to be installed as per the drawings and interfaced into the ICT system where applicable.

6.10 Television

A complete free-to-air and pay TV compliant television system shall be provided. The master antenna shall be installed on the roof of the facility (northern aspect). Outlets will be provided in areas as required with splitter/tap provision within the communications risers for future outlets.

7 MECHANICAL SERVICES

7.1 Design Criteria

7.1.1 General & Energy

The building will be designed to meet the functional requirements of the spaces, including special laboratory requirements, whilst seeking to minimise energy use through the adoption of variable speed drives to fans and pumps where feasible and appropriate.

Central chillers will be selected to exceed the minimum energy performance requirement of the BCA Section J.

7.1.2 Regulation, Standards and Authorities

The air conditioning and mechanical ventilation system will be designed to comply with all relevant codes and standards, including:

- Provision of mechanical ventilation systems in accordance with current: AS1668.1, AS1668.2 and BCA;
- Smoke hazard management in accordance with the current BCA and/or fire engineers requirements;
- Hot water boiler design will be in accordance with Gas authority and Local Council regulations;
- AS/NZS 2982:2010 Laboratory design and construction;
- AS/NZS 2243 Safety in laboratories.

7.1.3 External Design Conditions

Location: Parramatta North.

Elevation: 60m above sea level.

Summer: 35°C DB, 24°C WB.

Winter: 5.5°C DB.

Source: Australian Institute of Refrigeration, Air-conditioning and Heating (AIRAH DA09 manual)

7.1.4 Internal Design Conditions

The following values are notional and subject to design development and detailed design.

Room	Occupancy (m^2 /Person)	Room Temp (°C)	Relative Humidity (%)*	Min. Outside Air (l/s/person)	Lighting Load (W/m^2)	Small Power (W/m^2)	Noise Level (NR)
Office	10	22.5 ± 2.0	40 – 70	7.5	15	20	40
Meeting Rooms	1	22.5 ± 2.0	40 – 70	10	20	15	35
Toilets	N/A	NC	NC	N/A	N/A	N/A	45
Atrium	N/A	NC**	NC	N/A	N/A	N/A	40
Laboratories	12	22.5 ± 1.5	40-60	10	15	35***	40
Laboratory Write up	5	22.5 ± 2.0	40-70	10	15	35***	40
Cool Room	Nil	4.0	N/A	N/A	N/A	N/A	N/A

NC = Not Controlled

N/A = Not Applicable

* No humidity control will be provided. The relative humidity range is generally achieved as a result of mechanical cooling.

** Not air-conditioned. Space will be tempered via return/spill air from adjacent conditioned spaces.

*** Values to be refined once equipment information is available. This is a general allowance however.

7.1.5 Exhaust rates:

Generally-	In accordance with AS1668.2
Toilets -	The greater of 10L/s/m^2 floor or 25L/s/fixture
Grease arrestor -	5 L/s/m^2 floor, 100 L/s min.
Cleaner cupboard -	5 L/s/m^2
Garbage room -	5 L/s/m^2, 100 L/s min.
Plantroom / storage room -	5 L/s/m^2 or sufficient to remove heat generated, 100 L/s min.
Laboratory (special)	To meet special requirement

7.2 Proposed HVAC Systems

7.2.1 Proposed Systems

The air conditioning and ventilation system will consist of:

1. Chilled water air handling plant located on centralised roof plant and in the basement or in dedicated plant on floors.
2. Water cooled chillers for central cooling and gas fired hot water heater for heating;
3. Cooling towers in the roof plant;
4. Underfloor system will be considered for write up and admin areas;
5. Mechanical ventilation to toilet and back of house areas.

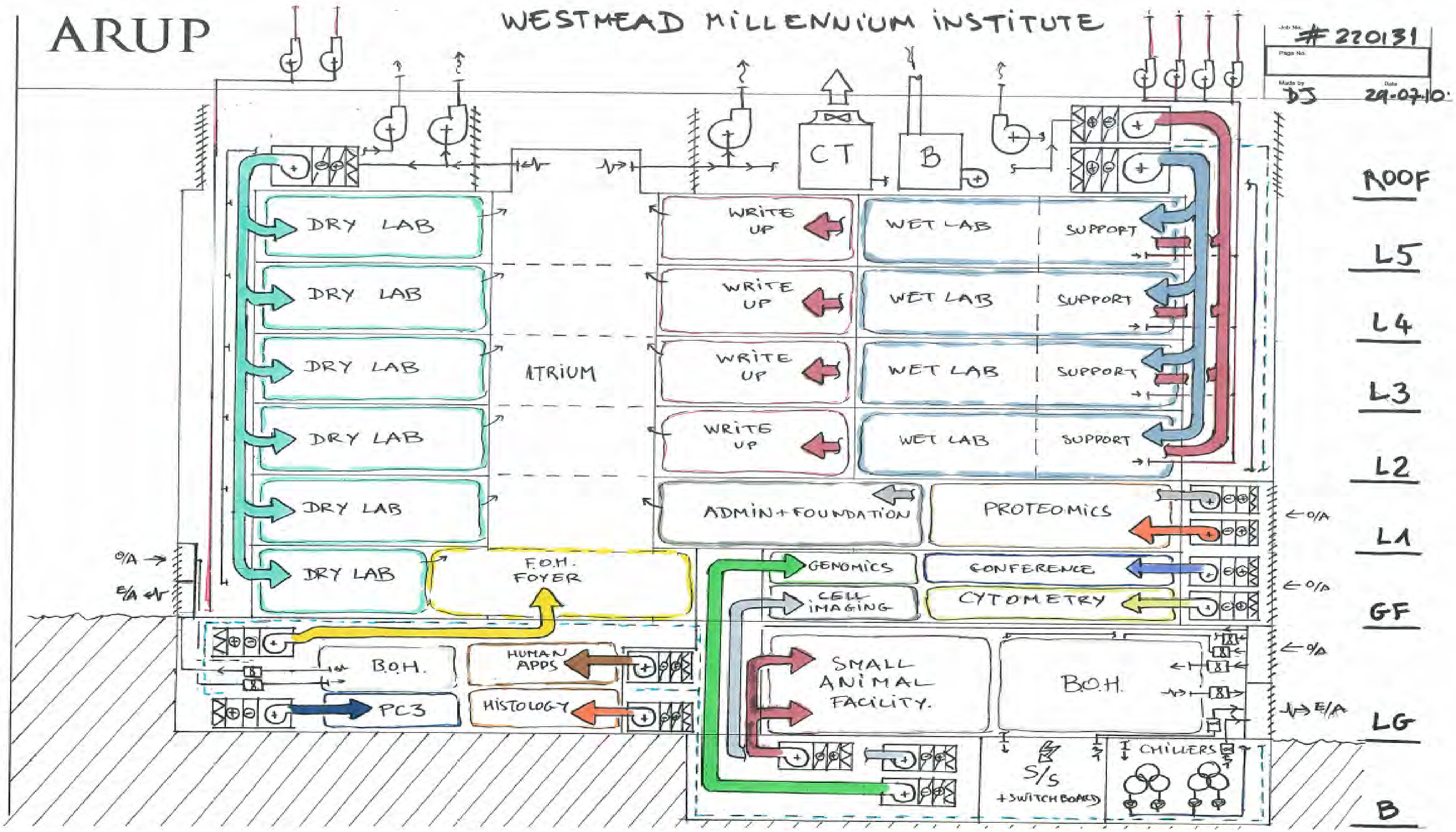


Fig. 1: Mechanical services concept diagram which states the general principle of the mechanical design

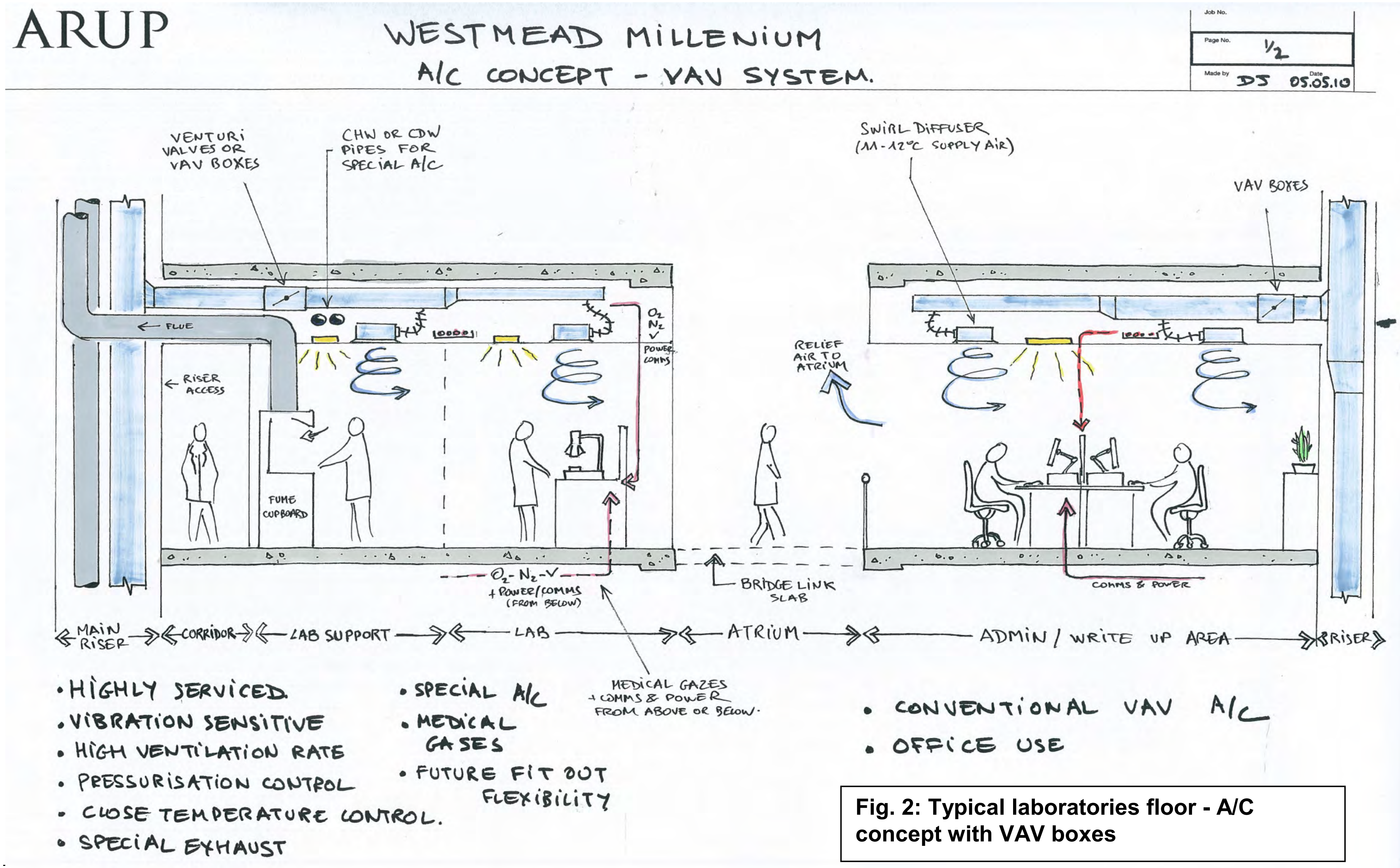


Fig. 2: Typical laboratories floor - A/C concept with VAV boxes

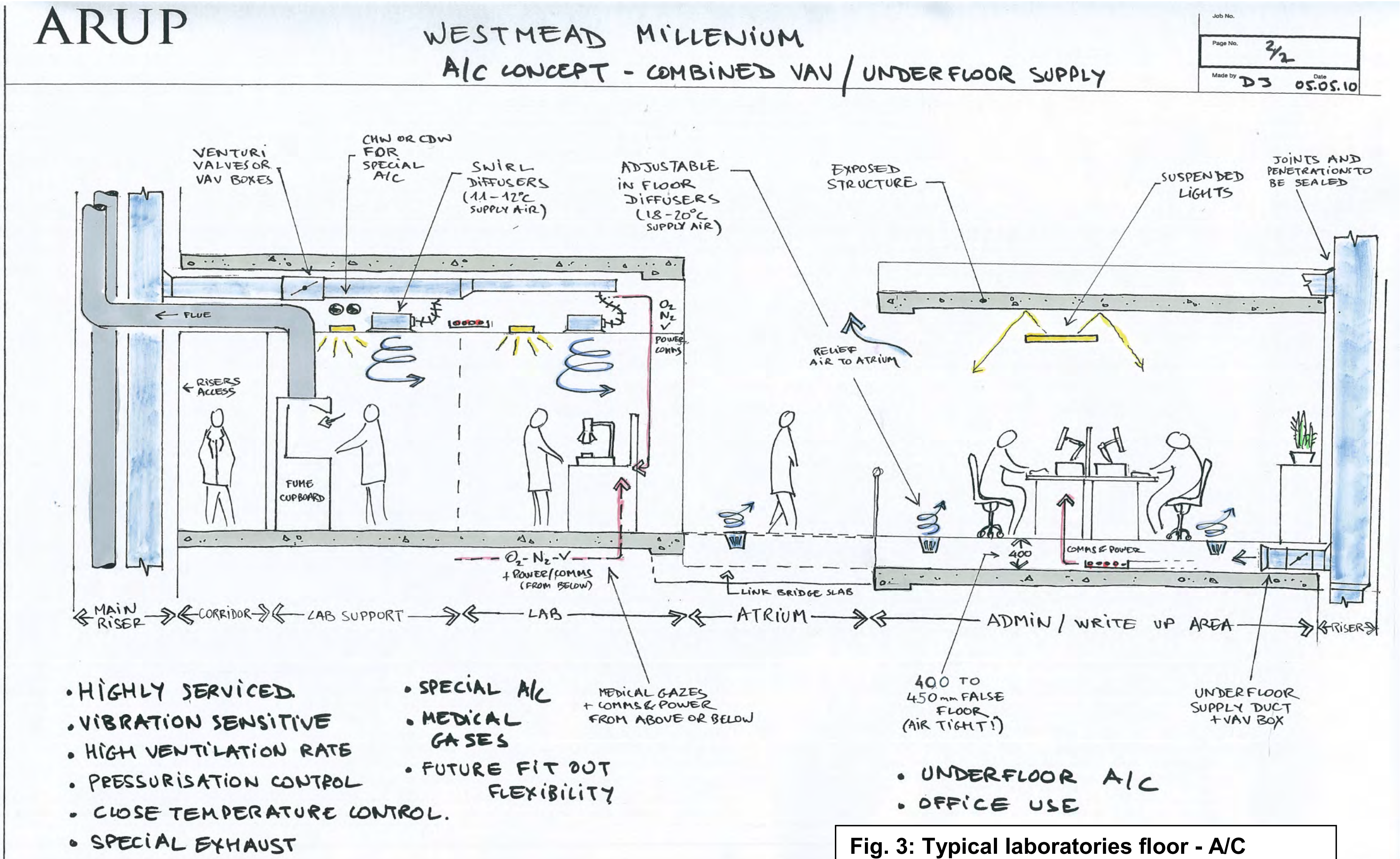


Fig. 3: Typical laboratories floor - A/C concept with VAV boxes for Labs/Support and Underfloor Displacement system for write Up Areas

7.3 Central Heating and Cooling Plant

Chilled water will be generated by water cooled chillers selected for high efficiency. Chilled water storage vessels will be considered to minimise chiller run times at part loads. This will depend on the building use profile.

Heat produced by chillers will be rejected via cooling towers located at the roof level.

Chillers will run on refrigerant with zero ozone depletion potential with a minimum Coefficient of Performance (COP) to exceed the minimum requirements of the Building Code of Australia section J.

Duty and standby circulation pumps will be provided.

Gas fired modular boilers will be used to generate hot water for space heating.

Hot and chilled water will be reticulated to various parts of the building via variable flow circuits. Pumps will be fitted with variable speed drives (for variable flow systems only) and high or premium efficiency motors.

7.4 Air Handling Unit Plant

7.4.1 Air handling units

Air conditioning plant will be located on dedicated plant on the floors, in the basement and in the roof plant.

7.4.2 Air delivery

Air will be delivered to occupied floors via ducted risers to ceiling diffusers via a combination of variable air volume and constant volume systems. Opportunity for underfloor air delivery will be consider during design development phase.

7.4.3 Free cooling and heat reclaim

Air side economy cycles will be provided for all systems, except where not appropriate for specific lab function.

Heat reclaim will be considered from labs and fume exhausts.

Natural / mechanical night purge systems to purge heat from the building fabric overnight will be considered.

7.4.4 Air filtration

High quality air filters in compliance with AS 1324 will be used in air handling units. The main and coarse filters will have minimum standards equivalent to type 2 class B with a performance rating of F4 and type 2, class B respectively. Filters will also be provided for outside air intakes into plantrooms and fume cupboard make up air intakes.

Where required for specific laboratories, High Efficiency Particulate Arrestance (HEPA) filters will be provided.

Carbon filtration will be considered for all air intakes to mitigate fumes from the helicopter entering the building. The possibility of bypasses to these filters when there is no helicopter traffic will be investigated in Design Development.

Air intakes will also be arranged to, as far as practicable, be remote from the helicopter flight path.

7.5 Mechanical Ventilation

All mechanically ventilated areas including toilets, tearooms, cleaner's rooms, garbage room, plantrooms, grease arrestor room and storerooms will be ventilated in accordance with the current AS 1668.2.

7.6 Special laboratory Systems

7.6.1.1 Fume exhaust

Fume cupboard exhaust systems will be provided. Extract fans will be located on the roof and discharges will comply with AS1668 for noxious discharge.

Fume flue dispersion modelling will be undertaken during design development to optimise the location of fume flue exhausts and optimise discharge velocities, heights and directions.

Mixed flow impeller exhaust systems, potentially in a manifolded arrangement, will be considered for fume cupboard discharges to ensure effective dispersion of fumes whilst minimising energy use.

7.6.1.2 Supplementary exhaust system

Specific local exhausts to dedicated equipment will be provided where necessary. These exhausts will discharge above roof level in accordance with AS1668.

7.6.1.3 Supplementary Air conditioning systems

Specific air conditioning systems will be provided to areas that require 24h cooling or/and special conditions. These systems will be either water cooled package units or fan coil units.

7.6.1.4 PC3 lab

PC3 lab will be served by a separate air handling systems adjacent to PC3 lab. Plant will have its own outside air and exhaust air discharge and will be provided with HEPA filters.

7.7 Future Tenant Plant and Riser Space

Provision for additional future tenant plant and risers space will be considered to provide an appropriate level of flexibility for future building fit out and new laboratories technologies.

This will be benchmarked against smaller facilities and recognized future benchmarks to gauge extent.

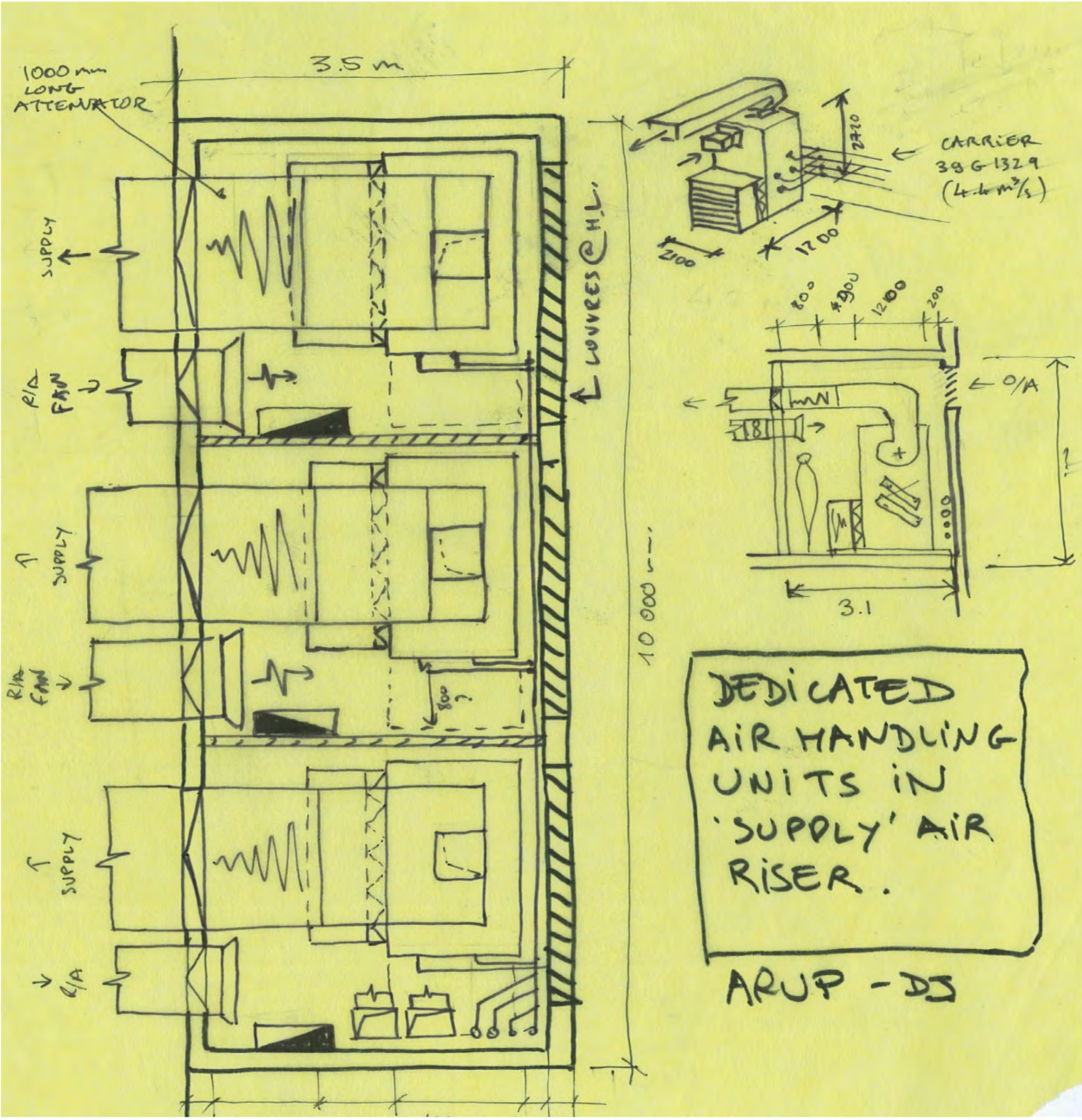
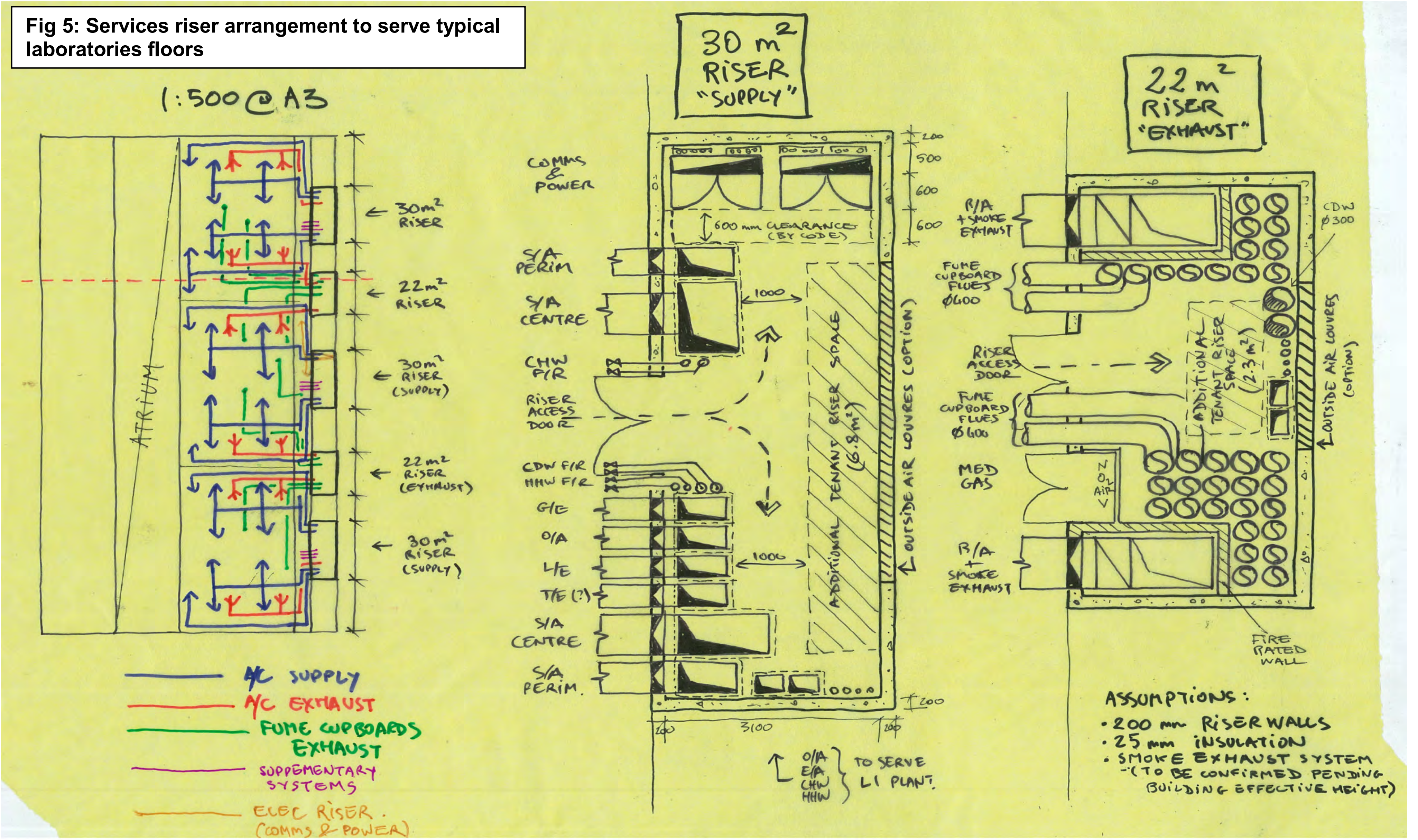


Fig. 4: Concept sketch showing on floor dedicated air handling plant
On floor plant will be used where special use requirements exist (e.g 24h operation, high heat load, segregation of equipment, PC3 spaces, etc.)

Fig 5: Services riser arrangement to serve typical laboratories floors



7.8 Smoke Management

A fire engineered ventilation solution will be provided which comprises (subject to detailed design):

- A stair pressurisation system including all fire egress paths will be designed in accordance with AS1668.1;
- Lift shaft pressurisation systems will be provided in accordance with AS1668.1 and the fire engineering strategy;
- Possible Atrium smoke exhaust or natural relief and make up air;
- Shut down of laboratory air conditioning systems except fume cupboard fans.

Non laboratory air conditioning systems serving the fire affected floor that communicate directly with the atrium is to shut down. Those parts of the air handling system serving the non-fire affected floors that communicate with the atrium are to operate on 100% outside air. Return air is to shut down.

The final strategy will evolve until the design development stage.

7.9 Systems redundancy

There will be standby diesel generator power provided for the essential mechanical services, laboratories and associated mechanical systems.

No stand by cooling or heating capacity is proposed.

Air handling plants serving critical laboratories, including animal laboratories, will be designed with a level of redundancy which may include duplicate air handling units.

7.10 Level of flexibility

Additional riser space will be provided for future flexibility when rearranging the floor space from Lab area to Write Up area or vice versa. Services design will include provision for additional riser space to fit oversized ducts, pipes and additional fume exhaust flues.

The level of flexibility will be defined in accordance the client’s requirements during design development and detailed design stage.

7.11 Staging

7.11.1 Stage 1 and stage 2

Construction will be undertaken in several stages that have major impact on the mechanical design strategy.

There are two main construction stages: Stage 1 and Stage 2. It is understood that Stage 2 may occur sometime in an undefined but distant future.

In order to minimise plant space and to anticipate the possibility of stage 2 never being built, the 15 000 m2 GFA stage 1 building will be provided with mechanical plant sized for stage 1 development only.

Stage 2 is a 7 500 m2 GFA extension adjacent to Stage 1, and will be serviced separately with stand alone centralised plant.

Mechanical design of stage 1 will consider opportunity to group centralised plant with Stage 2 future main plant into a single area, such as cooling tower plant and possibly chiller plant. This would provide some of the benefits of grouping plantrooms. (Shared maintenance and equipment replacement access, combined ventilation louvres...etc.)

However, no future provision for equipment space, ventilation, electricity supply, water supply, drainage or access will be provided within stage 1.

7.11.2 STAGE 1 – Sub stages A, B, C and D

Stage 1 may be developed into one or more of the following 4 options:

- OPTION A – MINIMAL DEVELOPMENT (9 470 m^2)

  This option is a minimal development with a limited footprint building. This requires some of the mechanical central plant to be located outside to the building footprint and be integrated into the future extension or relocated with associated cost and complication. Cooling towers will be located on the roof plant along with AHU plant serving the upper floors. Basement will be dedicated to AHU plant serving Ground Floor and Lower Ground Floor. Chiller plant may be combined with main switch rooms and substation in an energy centre plant space

- OPTION B – MINIMAL DEVELOPMENT WITH BASEMENT + LG PODIUM (10 830 m^2)

  This option is identical to option A except that it has 1 300 m2 of extended lower ground and basement. Chiller plant will be located in the basement or Lower Ground the central plant within the Basement/Lower ground.

- OPTION C – REDUCED STAGE1 DEVELOPMENT WITH BASEMENT + LG PODIUM (13 315 m^2)

  Option C has 2 500m^2 of extended upper floors. Additional space will be served by on floor AHU plant and by central AHU plant located on the extended roof. Mechanical services will be provided to occupied floors via additional service risers contained within the extension.

- OPTION D – STAGE1 DEVELOPMENT (15 000 m2)

  The Option D extension comprises 1 700m^2 of extended upper floors. Additional space will be served by on floor AHU plant and central AHU plant located on the extended roof. Mechanical services will be provided to occupied floors via additional service risers contained within the extension.

The above strategy for the pursued option(s) will be developed during the design development stage.

7.12 Building Controls

An electronic control system will control all HVAC equipment. The system will be based on a DDC system. Capability to integrate into the site existing Building Management and Control System (BMCS) network will be considered. The BMCS will be able to automatically control, monitor and provide alarms for the nominated building services.

The system will allow time scheduling and facility for optimum start/ stop commands to minimise energy use for building warm up or cool down.

An operator interface panel will be provided within the plantroom MCC to allow monitoring, control and adjustment of the control system.

Laboratories will be provided with a control system, which may form part of the BMCS, which will maintain and control the various supply and exhaust systems to maintain airflow requirements and in some circumstances pressure control, in accordance with Australian Standards.

8 HYDRAULIC SERVICES

8.1 General

The design will be in accordance with relevant design codes including: AS/NZS 3500 all sections, AS 5601, NSW Code of Practice for Sanitary Plumbing and Drainage, BCA, Sydney Water Corporation, Australian Standards, Local Council regulations and manufacturers requirements.

8.2 Domestic Cold Water

A new water main connection will be provided by the authorities' water main in Hawkesbury Road. A water meter assembly and building backflow prevention device (RPZD) will be provided on the supply.

A variable speed coldwater pump set and accumulator will be located in a coldwater services pump room. Potable coldwater will be provided to each level with pressure reduction valves utilised on the lower levels to ensure supply pressures do not exceed 500kPa.

The coldwater supply will generally be supplied vertically via a number of service riser ducts providing water to all areas of the building while minimising horizontal pipe reticulation. Each riser duct will have isolation valves to facilitate maintenance shut downs.

Back flow protection (RPZD Valves) will be provided to all laboratories to protect against cross connections between the laboratories and the potable water supply. In each laboratory eyewash/safety showers and wash basins will be provided with potable pressure stabilised supply. RPZD valves will be located within the laboratories in a recessed stainless steel box. Isolation valves will be provided to all laboratories within the RPZD valve box for the non-potable supply and within the thermostatic mixing valve box for the potable water supply.

Potable water will also be supplied to the staff amenities public amenities, cafe, wash basins and other potable fixtures.

8.3 Domestic Hot Water

A gas fired potable hot water system to supply the building will be located in the roof level plant room. Solar preheat will be considered in conjunction with other solar initiatives.

A circulating hot water service will be provided to the building with a dual hot water circulating pump set located in the roof top plant room. Hot water will reticulate to the building by a number of service riser ducts providing water to all areas of the building while minimising horizontal pipe reticulation / dead legs. Each riser duct will have isolation valves to facilitate maintenance shut downs.

Back flow protection (RPZD Valves) will be provided to all laboratories to protect against cross connections between the laboratories and the potable hot water supply. Each laboratory wash basin will be provided with potable warm water supply. RPZD valves will be located within the laboratories in a recessed stainless steel box. Isolation valves will be provided to all laboratories within the RPZD valve box for the non-potable hot water supply and within the thermostatic mixing valve (TMV) box for the potable hot water supply.

Potable hot and warm water will also be supplied to the staff amenities, public amenities, canteen, wash basins and other potable fixtures. All pipework will be insulated to minimise heat loss, this is to include pipework up and down stream of TMV's. Insulation will be 25mm of foil faced mineral wool. Where necessary regulating trace heating tapes will be provided on dead legs.

Warm water will be provided by thermostatic mixing valves housed in recessed stainless steel wall boxes which incorporate hot and cold water isolation valves.

8.4 Fixtures and Fittings

The building will be provided with water saving outlets and appliances for water and energy savings as follows:

Wash basin taps – 5 Star

WCs – 4 Star 3 litre half/4.5 litre full flush

Urinal – 6 Star smart flush

The sanitary fixtures and tapware will be selected by the Architect to meet those Water Efficiency Labelling and Standards (WELS) ratings.

Water flow restrictors will be provided to all tapware and fittings to limit water consumption.

8.5 Stormwater and Roof Water Drainage System

Refer to Section 4.2.4

8.6 Water recycling

Refer to Section 4.2.5

8.7 Sediment and Erosion Control

Sediment and erosion control during construction will be the responsibility of the contractor and will include those measures required by the local authorities including:

- Minimise area to be cleared and leave as much vegetation as possible. Install temporary fences to define 'no go' areas that are not to be disturbed.
- Install sediment fence(s) along the low side of the site before work begins.
- Divert water around the work site and stabilise channels, but ensure that you do not flood the neighbouring property.
- Establish a single stabilised entry/exit point. Clearly mark the access point on an access map that has a delivery point indicated for all supplies.
- Leave or lay a kerb-side turf strip (for example, the nature strip) to slow the speed of water flows and to trap sediment.
- Check the erosion and sediment controls every day and keep them in good working condition.
- Where topsoil is stockpiled, ensure it is within the sediment controlled zone.
- Always be aware of the weather forecast.
- Stabilise exposed earth banks (eg vegetation, erosion control mats).
- Fill in and compact all trenches immediately after services have been laid.
- Install site waste receptacles (mini-skip, bins, windproof litter receptors).

- Sweep the road and footpath every day and put soil behind the sediment controls.
- Connect downpipes from the guttering to on site detention or the stormwater drain as soon as the roof is installed.
- Revegetate the site as soon as possible. The erosion and sediment control devices must be kept in place until 70% of the site has been revegetated.

8.8 Sewer and Sanitary Plumbing System

It is proposed to connect sanitary drainage from the building to the existing authorities' sewer drain. An aerial drainage system compliant with AS3500 will be installed to reticulate to the base of all sanitary plumbing risers. Sanitary drainage from lower levels will be captured by a sewer pump station and pumped out to the gravity drainage system. Consideration will be given to proving HDPE material pipework in lieu of PVC for environmental credits.

A fully vented modified sanitary drainage system designed to comply with AS3500 will be installed in the building. The sanitary drainage stacks will be separated into:

- Toilet stacks and kitchenette stacks draining directly to the sewer system;
- Laboratory Stacks draining to a dilution/stabilisation pit;
- Cafeteria/cafe stacks draining to a grease arrestor;

Material to be used for sanitary drainage:

- Laboratory and toilet stacks HDPE or polypropylene if high temperature discharge;
- Grease stacks HDPE insulated and trave heated where necessary.

Pipe work design concept will utilise multiple vertical pipe work stacks to minimise horizontal pipe as this increases flexibility for future alterations.

An above ground grease arrestor will be provided subject to the inclusion of a café or similar area. A dilution pit will also be required to treat laboratory waste.

The exact configuration of the trade waste systems will be dependent on the constituents within the waste.

8.9 Natural Gas Supply

All gas fitting and natural gas installation will be carried out to AS5601, Gas Supply Authority Recommendations and AGA approvals.

A natural gas supply will be delivered to the building for mechanical plant, hot water heating and laboratory use. An application will be made for a tapping to be made to the authority natural gas supply main.

The system will incorporate a footpath shut off isolation valve with a spare valve key located in the gas meter room. Property isolating valves will be utilised before and after the meter along with, filters and regulators. The meter will be supplied by the gas authority and fixed in the gas meter position at the property boundary.

Gas flues from hot water heaters and boilers will extend through the roof to terminate to atmosphere. All rooms containing gas-burning appliances will be adequately ventilated.

8.10 Medical Gas – RO – Vacuum supply plant

Laboratories services such as lab gases, RO and demineralised water will be provided to meet the project specific requirements. The benefits of central system and local systems will be reviewed in detail during the next phase.

The current planning comprises centralised carbon dioxide, oxygen and nitrogen bulk tanks to be located adjacent to the loading docks.

Specialized gases such as food grade CO2, Argon will be via localised bottles located at the room level.

8.11 Building Options

The building options have no major impact on the design of the hydraulic services. The following is noted:

- Additional risers will be provided within extended footprints to service the floor.
- Incoming and outgoing services will be sized to suit the full Stage 1 envelope.

9 FIRE SAFETY ENGINEERING

9.1 General

This section concerns the fire safety design of the new Millennium Institute at the Westmead Hospital Campus, NSW and those specific issues that will impact on planning and hence are Development Approval related issues for the building.

The reader is referred to the full project description in this report and the Architectural design by Bligh Voller Nield architects (BVN). However the following general description is provided for context:

- The development is a new seven (7) storey plus basement research building consisting of PC2 laboratories (BCA Class 8), small areas of conference suites (BCA Class 9b), cafes (BCA Class 6) as well as write up areas, and administration (BCA Class 5). There are areas associated with support services and plant space at basement and roof level 7.
- The building has a Rise in Storeys of seven(7) and an Effective Height of approximately 28m from Lower Ground to the highest occupied level as per the Building Code of Australia 2010 (BCA) Deemed to Satisfy (DtS) Provisions.
- The site is sloping with direct access at ground level from Hawkesbury Road and direct access at Lower Ground Level from the north/north east of the site.
- The building has interconnection of write up and dry labs from Ground to Level 5/6 via an open atrium.
- The building population for the purposes of the fire safety design will be based on the clients required population in lieu of DtS occupancy giving considerably lower populations in the building.

A fire engineering review of the Stage 1 conceptual design has been undertaken by Arup on schematic drawings provided by BVN Architects dated 25/06/2010. For this building, the BCA requires the following fire safety measure to be provided to satisfy the Performance Requirements of the BCA either through the DtS Provisions or through Alternative Design Solutions:

- Structural fire rating and fire compartmentation to limit fire and smoke spread between buildings and within the building and protect fire isolated egress routes and emergency equipment;
- Limiting travel distances to points of choice, exits and between exits;
- Providing exits and paths of travel with suitable dimensions for the likely occupant numbers;
- Provide first aid fire fighting measures for use of building occupants;
- Provide Fire Hydrants and Boosters for Fire Brigade use;
- Provide sprinkler protection throughout;
- Limit the movement of smoke through the building and atrium by implementing smoke hazard management strategies including mechanical systems where necessary;
- Protect fire isolated exits from smoke with pressurisation systems;

- Provide smoke detection throughout and sound systems and intercom systems for emergency purposes;
- Standby power; and
- Emergency lighting and exit signage.

The review has indicated that the fire safety design of the building will generally satisfy the Performance Requirements of the BCA 2010 by complying with the DtS Provisions. However, there are some aspects of the design that are developed using performance based Alternative Solutions to achieve compliance with the Performance Requirements. Key strategies are likely to consider:

- Wet labs, including PC2 Physical Containment labs and flexible use areas separated from the atrium with full height fire and smoke rated construction. This construction may be used as the line for horizontal means of escape from the atrium through the labs to reach the fire isolated stairs and to separate alternative exit stairs. This will help to limit fire and smoke spread, reduce travel distances and help enable extended travel times, as well as enable an egress strategy for mobility impaired occupants.
- Smoke containment barriers and smoke exhaust from the atrium to dilute smoke and limit smoke spread. Consideration will be given to separation of the atrium from the floor in a fire if detailed smoke modelling demonstrates the need to contain smoke.
- Fire rated connection of the new building with the existing Children's Medical Research building at lower ground.
- Fire spread to existing adjacent buildings will be assessed to see if additional external wall wetting systems are required, however preliminary information indicates that existing buildings are greater than 6m from the building façade on the same site and from the subject building to the site boundary and road, therefore no additional protection to openings is likely to be required.
- Maintaining exhaust risers from Labs.

9.2 Stage 1 Option A (option to partially construct Stage 1) – Preliminary review.

If the design is partially constructed as indicated in Figure 1 below, the building will potentially have one fire isolated stair serving Level 1 - 6 and an open stair in the atrium. As a result there will be extended travel in a single direction to a required exit, however it is considered that this is achievable based on the following key fire safety considerations;

- The area of the building in Option A may be considered as having an Effective Height of less than 25m due to the sloping site and access from Hawkesbury Rd. Under this interpretation one fire isolated exit under the DtS Provisions may be permitted.
- The low population at each level will mean that evacuation times will be equivalent to a DtS design. In addition the horizontal exits provide additional time for occupants to escape once they have passed through. Therefore the capacity of the single 1m wide stair be satisfactory for the design.

Therefore in order to address the extended travel distances and egress from the atrium the following fire safety measures are proposed:

- Fire and smoke rated separation can be provided between the write up/admin areas and the wet lab areas to limit smoke and fire spread. The separation will help provide occupants with horizontal egress between the two areas, which will reduce travel distances from the atrium;
- A minimum of two horizontal exits will be provided between the write up/admin area and the wet lab to provide occupants with alternative exits from the Atrium side;
- The write up/admin area is provided with an internal stair connecting all levels. The interconnecting stair is not considered a required exit, however it is considered it can be used for egress for the occupants in the write up/admin area in the event of a fire in the wet labs if necessary. The internal stair will only be used by the occupants in the write up/admin area on the fire affected floor to evacuate to the level below, where they can either continue to egress via the open stair or egress via the horizontal exits to the wet lab area and then via the fire isolated stair. Hence, this can be compared to a DtS complying design where an internal stair connecting two levels is permitted;
- Stair pressurisation to the fire isolated stair. The stair pressurisation will help limit smoke spread into the stair and facilitate evacuation via the stair for the occupants on the levels above the fire affected floor.
- Extended fire hydrant coverage will be addressed as per the BCA and Australian Standards with additional hydrants and hose reels on the floor.

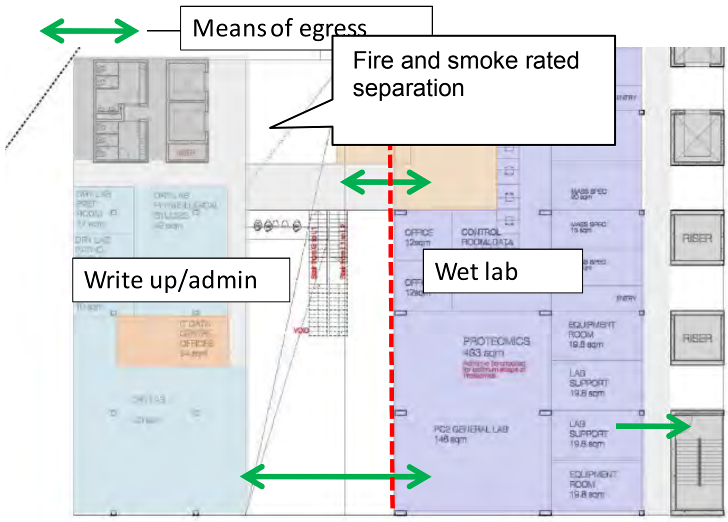


Figure 1 – Indicative areas of Stage 1 Option A

9.3 Stage 2

As the details of Stage 2 are developed, the fire engineering strategy will be adapted to integrate the stage 2 development. If the two stages are separate buildings, the risk of fire spread between buildings will be assessed and protection to non fire rated elements will be applied where the assessment deems it necessary.

Where the two stages are connected, the fire engineering solution will be adapted to integrate future building extension. This will be provided either through suitable fire separation or allow for connection of fire services and systems to provide a united building.

9.4 Conclusion

The fire engineering design adopted for the building will develop Alternative Design Solutions to achieve compliance with the Performance Requirements of the BCA. Major changes to the current building form will not be required. The fire safety requirements of AS/NZS2982:2010 (Laboratory Design and Construction) will also be considered as part of the design and it is considered that the fire safety requirements can be achieved.

Further detailed assessment will be carried out to further consider egress (both horizontally and vertically); smoke control methodology to manage smoke spread via the atrium and egress routes, as well as considering Fire Brigade access and fire fighting provisions.

It is anticipated that other non- compliances with the deemed to satisfy DTS Provisions of the BCA will occur as the design develops and these would be addressed through performance based design. It is considered that there are no issues that would affect the building layout and form arising from fire safety and hence no impediments to the issuing of a Development Approval for the project.

10 FIRE SERVICES

10.1 General

The building will be more than 25 meters in height and will require grade 1 water supplies for the fire sprinkler and fire hydrant systems.

Systems will include (subject to detail design)

- Fire hydrants
- Hose reels
- Automatic Fire Sprinklers
- Automatic fire detection and alarm system to AS 1670
- A Sound System and Intercom System for Emergency Purposes (SSISEP)
- AS 1670.1 Smoke detection
- Extinguishers

10.2 Fire Hydrants

A fire hydrant service will be provided to satisfy requirements of the Building Code of Australia, AS 2419 and the local fire brigade requirements.

It is proposed that a new connection will be made to the authority's water main in Hawkesbury Road and the building will be provided with a new inlet booster.

Fire hydrant test water will be recirculated through a fire test water storage tank adjacent to the fire hydrant booster pumps and this will eliminate test water wastage during periodic testing

10.3 Fire Hose Reels

A fire hose reel service will be installed to satisfy BCA requirements, AS 2441, AS3500 and local government requirements. Each fire hose reel will take off from the potable cold water service.

Subject to the fire engineering solution fire hose reels will be located within 4 meters of required fire exits and as required to provide effective coverage for fire fighting operations.

10.4 Automatic Sprinkler System

The building might require sprinklers. An automatic sprinkler system will be installed to satisfy requirements of the fire engineering brief and AS2118.1. The sprinkler system will be provided with a separate connection to the authorities' water main in Hawkesbury Road and a fire booster assembly in a BCA compliant recessed cabinet within the façade.

Flow switches will be provided to each level and at separate compartments. Their test drains will be directed to the rain water storage tank. Fire sprinkler test water will be recirculated through a fire test water storage tank adjacent to the fire sprinkler booster pumps and this will eliminate test water wastage during periodic testing.

10.5 Automatic Fire Detection and Alarm System

An automatic fire detection and alarm system will be provided to satisfy the Building Code of Australia, AS1670 and the local government requirements.

The automatic smoke detection and alarm system will protect the whole of the building and associated facilities for smoke hazard management control.

The automatic fire and smoke detection system will have a main microprocessor type FIP located in the ground floor lobby capable of operating a distributed and or multi loop network of conventional and or analogue addressable smoke and heat detectors and other ancillary devices.

Heat detectors will be provided in areas not suitable for smoke detectors.

The smoke hazard management system will interface with essential services equipment via the main FIP fire fan control module located in the foyer or accessible by ground floor access.

10.6 Sound System and Intercom System for Emergency Purposes (SSISEP)

A Sound System and Intercom System for Emergency Purposes (SSISEP) will be provided to satisfy the Building Code of Australia. The SSISEP panel will be located next to the FIP in the ground floor lobby.

The system will be interfaced with other essential services, i.e. automatic fire detection and alarm systems and smoke hazard management controls including provision of a remote PA system console in a designated security area.

Speakers will be provided throughout all areas of the building as surface mounted speakers' fittings with horn speakers in the car park and plant room areas.

Break glass stations will be connected to the SSISEP system.

10.7 Distribution Piping and Wiring Systems

The fire services and life safety distribution piping and wiring systems will be coordinated with the architectural design and all other services to follow set services routes throughout the complex to conceal services wherever possible and minimise any access for maintenance and servicing.

10.8 Passive Fire Protection

All fire services passing through any walls, floors and ceilings required to have a fire resistance level (FRL) rating will be sealed with approved passive fire protection systems to satisfy the Building Code of Australia, AS1530 and Local Government requirements.

10.9 Portable Fire Extinguishers

Portable fire extinguishers will be provided to satisfy clause of the Building Code of Australia, AS 2444 and local government requirements.

Generally fire extinguishers will be distributed throughout the building in areas of specific hazard and will be selected according to hazards.

Fire extinguishers in public areas will be in fire hose reel cupboards.

11 VERTICAL TRANSPORT SERVICES

11.1 Introduction

The project will be provided with a modern high performance elevator system designed and installed in accordance with the relevant requirements of the lift code AS1735, the Building Code of Australia and Workcover Authority requirements.

All elevators will incorporate facilities for persons with disabilities, fire brigade operations and stretcher access requirements.

The Vertical Transportation design is being developed to incorporate sufficient vertical transportation elements to meet the anticipated demands and quality of service for a medical research facility.

The proposed lift arrangement is in accordance with Construction Staging Option 1

11.2 General

Two (2) passenger and Two (2) machine-roomless goods lifts will be provided. The lift configuration will be divided between 2 individual cores:

Core 1 – Staff & Public Passenger Lifts

Core 2 – Back of House Passenger/Goods Lifts

11.3 Lift Type

In order to minimise the impact of headroom and machine room spatial requirements all lifts are proposed to be machine-roomless type (MRL) with a running speed between 1.0 mps and 1.6 mps.

11.4 Sustainability

The lift installation will be designed to deliver a level of service with a minimal environmental impact.

All lifts shall include Variable Voltage Variable Frequency (VVVF) motor drives ideally with Regenerative Drive feature's which allows the elevator to generate power back into the electrical grid when the out of balance load is assisting the direction of travel. We would note that the efficiencies of regenerative drive are subject to traffic profiles along with the speed, rise and duty of the lift.

11.5 Standards and Regulations

The lift installation will be developed in accordance with the following standards;

- AS1735 Lifts, Escalators and Moving Walks
- AS1735.12 Facilities for Persons with disabilities
- AS 1428.2: Design for Access and Mobility; Part Two: Enhanced and Additional Requirements – Buildings and Facilities;
- AS 4431 Guidelines for Safe Working on New Lift Installations in New Constructions;
- Building Code of Australia;
- TS-11 as applicable;

- AS/NZ 3000: Electrical Installations (known as the Australian/New Zealand Wiring Rules). Wiring requirements for lift installations;
- AS/NZ 3008: Electrical Installations – Selection of Cables;
- Cable sizes for lift installations;
- AS2982 Laboratory Design and Construction – General Requirements;
- AS2243 Safety in Laboratories – Planning and Operational Aspects.

11.6 Maintenance Requirements

All equipment shall be of latest technology with a proven reliability and serviceability under the anticipated traffic loads and environment.

Particular attention shall be afforded to the design and layout of equipment to make provisions for suitable maintenance access in accordance with safe working practices.

12 ACOUSTIC DESIGN

12.1 Site Description

The proposed Westmead Millennium Institute is to be constructed on the grounds of Westmead Hospital, on the site of the current Chesalon and Marion Villa buildings.

The site is bounded by Hawkesbury Road to the south-east, by the Children's Medical Research Institute buildings to the north-east, by a multi-storey carpark and roof-mounted helipad to the north-west, and by an at-grade visitor carpark to the south-west.

The nearest residences are located on the opposite side of Hawkesbury Road to the proposed WMI site, with the nearest residence being the multi-level apartment block at 195 Hawkesbury Road, approximately 30 m from the WMI building.

A site plan of the proposed WMI site vicinity is given in Figure 2:

Figure 3: Site Plan of Westmead Hospital Vicinity, showing location of proposed WMI building and helicopter pad.

12.2 Noise Survey

12.2.1 Purpose of the Noise Survey

A noise survey was carried out to assess the current ambient noise levels around the proposed Westmead Millennium Institute site and to identify noise sensitive receivers. Attended monitoring of noise levels in the vicinity of the WMI site was conducted to:

- Indentify potential noise-sensitive receivers in the vicinity.
- Verify the applicability of unattended noise survey data measured for the adjacent Children's Medical Research Institute (CMRI) building as representative background noise data for the WMI project.

12.2.2 Methodology

12.2.2.1 Unattended Noise Survey

An unattended noise survey was carried out in January/February 2009 as part of an acoustic assessment for the refurbishment of the adjacent CMRI building.

The noise survey locations were selected so that the loggers measured representative ambient noise levels for adjacent noise sensitive receivers.

Two noise loggers (RTA Technology Type 2 Noise Loggers: Serial nos. 009 and 031) were set up at the following locations from 30 January 2009 to 6 February 2009:

- The south-eastern site boundary of the Kerry Packer Institute for Child Health Research
- The south-eastern site boundary of the CMRI, adjacent to Hawkesbury Road, opposite 201 Hawkesbury Road.

The loggers recorded L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} noise parameters over 15 minute intervals continuously during the survey period.

Weather patterns were noted during this period and where noise levels were affected the data was not used. The loggers were checked for calibration before and after the monitoring period and no deviation had occurred.

The average noise levels throughout the monitoring period have been determined from all days with valid data.

Average noise levels for the loggers are presented graphically in Figure 4 and Figure 5. The raw data from the logger is available upon request.

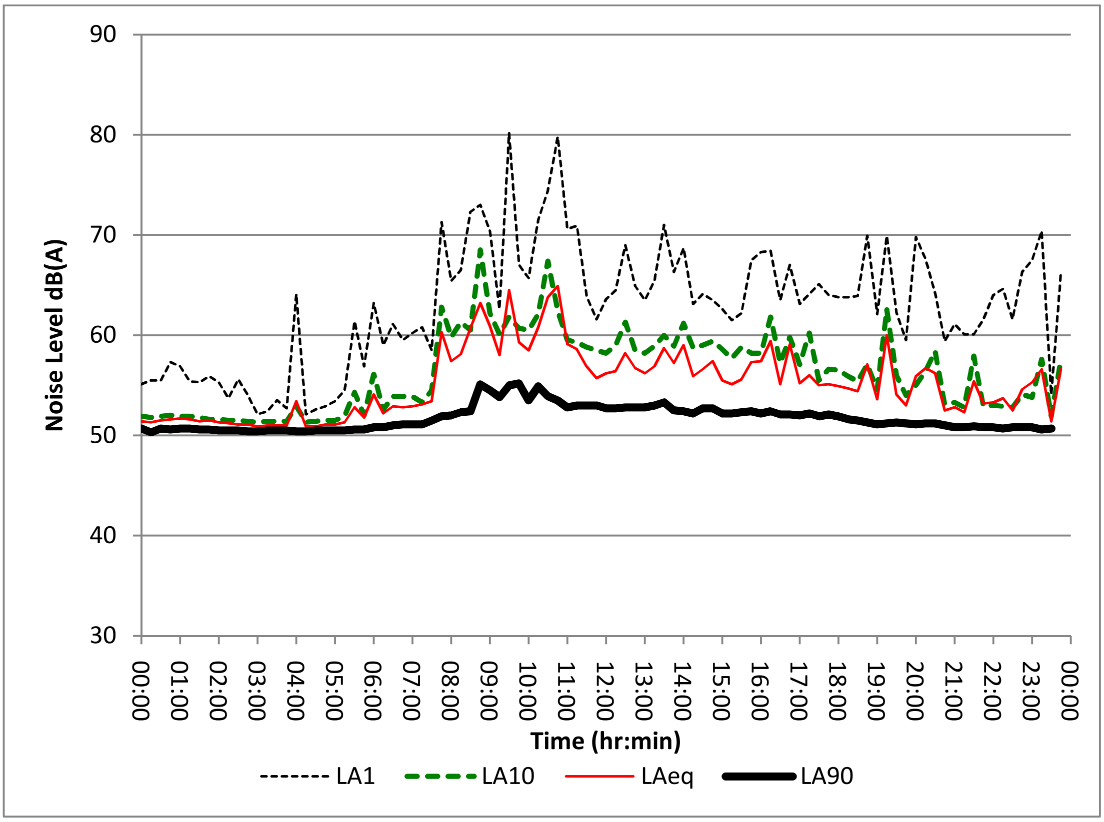


Figure 4: Average Noise Levels at South-Eastern Boundary of Kerry Packer Institute for Child Health Research, Westmead Hospital, 30 January 2009 to 6 February 2009, dB re 20µPa

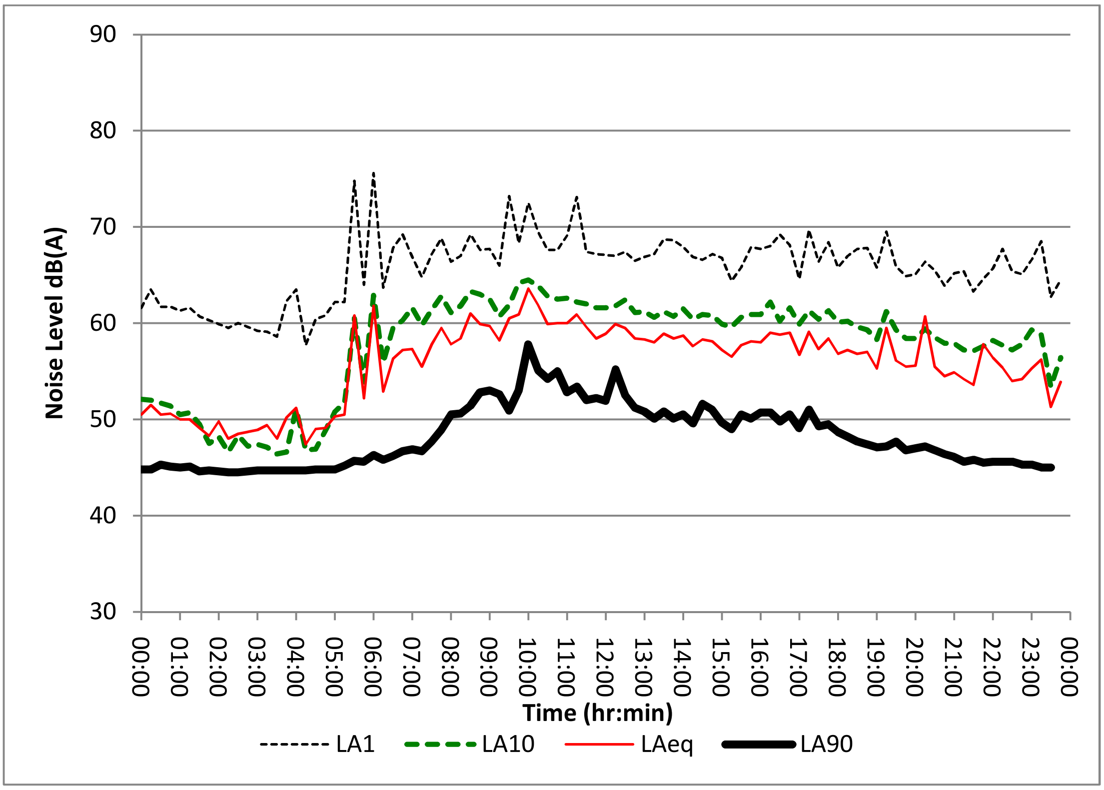


Figure 5: Average Noise Levels at South-Eastern Boundary of Children's Medical Research Institute, Westmead Hospital, 30 January 2009 to 6 February 2009, dB re 20μPa

12.2.2.2 Attended Noise Measurements

To supplement and verify the noise logger data for the CMRI, attended noise measurements in the vicinity of the WMI site were taken by Cameron Hough and Caroline Grandjean-Thomsen of Arup Acoustics on 9 April 2010.

The noise measurements were conducted using a Brüel and Kjær Type 2236 sound level meter, checked for calibration against a Brüel and Kjær Type 4231 calibrator. No significant drift in calibration occurred.

The meter was set up on a tripod so that the microphone on the meter was approximately 1.2 m above the ground. Measurements were taken in general accordance with AS 1055.1[1]. The attended noise measurements are summarised in Table 1:

[1] Australian Standard AS1055.1 (1997) *Acoustics – description and measurement of environmental noise. Part 1: General procedures*

Table 1: Attended Noise Measurements at proposed WMI Site, 9 April 2010, dB re 20µPa

Location	Time (hrs)	Noise Level dB(A)				Comments
		L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	
1	1540-1555	59	54	52	50	In carpark at northern end of proposed WMI site Constant plant noise from mechanical plant at CMRI, intermittent traffic on internal roads of Westmead Hospital, traffic noise from Hawkesbury Road, bird and insect noise
2	1600 - 1615	73	68	64	51	On footpath outside 195 Hawkesbury Road Traffic noise from Hawkesbury Road – frequent, but free-flowing traffic; pedestrian traffic

12.2.3 Ambient Noise Environment

The area surrounding the proposed WMI site is characterised by a mixture of traffic noise from Hawkesbury Road, mechanical plant noise from Westmead Hospital buildings and natural sounds. Noise levels generally decrease in the evening, with near-constant industrial noise levels from surrounding buildings at Westmead Hospital forming the background noise level during the night time period.

These characteristics are consistent with an 'Urban' area as defined in the NSW Industrial Noise Policy (INP)[2].

12.2.4 Noise Sensitive Receivers

The most-sensitive noise-sensitive receivers are anticipated to be the receivers on Hawkesbury Road (represented by 195 Hawkesbury Road, which is a multi-level residential block and is the closest residential property to the WMI site), and noise-sensitive areas within the Westmead Hospital precinct, such as the Kerry Packer Institute for Child Health, located to the north-east of the WMI site.

12.3 Design Criteria

12.3.1 Indoor Noise Levels

12.3.1.1 Background Noise

Recommended satisfactory and maximum internal noise levels and reverberation times for various types of building occupancy are given in AS2107. The AS2107 internal noise levels apply to steady-state background noise within the building occupancy, such as mechanical services noise.

The single-number noise levels specified by AS 2107, however, do not provide for control of the spectral balance and "character" of a background noise level. For this reason, the Noise Rating (NR) curves are recommended to be used in design of the WMI buildings.

[2] NSW EPA (2000) Industrial Noise Policy

NR curves allow the spectral balance of the background noise spectrum to be controlled so that the resulting sound spectrum is considered “neutral”, without prominent low-frequency “rumble” or high-frequency “hiss”.

For typical background noise spectra, the dB(A) rating and the NR curve number are approximately 5 dB apart – e.g. a spectrum rated at NR 40 would typically have an overall single-number value of ~45 dB(A).

Recommended AS2107 internal design levels and corresponding NR design curves for various spaces for the Westmead Millennium Institute are presented in . In general, Arup Acoustics recommends designing to the maximum AS2107 sound levels so that the background noise spectrum is more effective in acting as masking sound.

Table 2: AS2107 Internal Design Sound Levels, dB L_{Aeq}.

Type of Occupancy	Recommended Maximum Sound Level	
	dB(A)	**NR**
Meeting rooms	40	35
Conference/Seminar rooms	40	35
Corridors and lobby spaces	50	45
Kitchens, sterilising and service areas	55	50
Laboratories	50	45
Office Areas – Enclosed	40	35
Office Areas – Open Plan	45	40
Waiting rooms, reception areas	50	45

12.3.1.2 Maximum Noise Levels

The location of the proposed WMI building next to the helipad at Westmead Hospital means that the WMI building will be exposed to helicopter noise levels from flights using the helipad.

Helicopter noise levels breaking-in through the façade have the potential to cause significant disturbance to users of the WMI. Control of the helicopter noise levels is therefore an important part of achieving an appropriate work environment for the intended functions of the WMI.

Guidance on maximum noise levels within buildings from aircraft is given in Australian Standard AS 2021:2000[3], which recommends the following maximum noise levels for various building usages:

[3] Australian Standard AS 2021 (2000) *Acoustics – Aircraft noise intrusion – Building siting and construction*

Table 3: AS2021 Maximum Internal Sound Levels from Aircraft, dB re 20µPa

Type of Occupancy	Maximum Sound Level dB(A)
Auditorium	55
Conference/Seminar rooms	55
Corridors and lobby spaces	65
Kitchens, sterilising and service areas	75
Laboratories	65
Office Areas – Enclosed	55
Office Areas – Open Plan	65
Waiting rooms, reception areas	65

12.3.1.3 Small Animal Facility

The small animal facility at the WMI is likely to be especially sensitive to noise intrusion. Laboratory animals are sensitive to external noise intrusion, which may cause behavioural modification, affect their breeding, and potentially cause physical distress, depending on the level of the noise.

Research concerning the sensitivity of laboratory animals is not yet conclusive; however, guidance for noise levels in animal facilities is given in the UK *Code of Practice for the Housing and Care of Animals Used in Scientific Procedures*[4]*,* which gives recommendations for the background sound level as 50 dB(A)/NR45, at which level "it is unlikely that there will be damage to animals… when the room is in use".

As the Code of Practice states, the hearing sensitivity of different species varies in terms of overall threshold of hearing and the frequency where hearing is most sensitive, and therefore it is recommended that helicopter maximum noise levels within the animal house be designed to comply with 50 dB(A)/NR 45.

By designing an intrusive noise source – helicopter noise – to be equal to the background noise level is conservative, and is unlikely to result in adverse impacts to the operation of the animal house.

4

12.3.2 Room Acoustics

Recommended mid-frequency internal reverberation times for various spaces for the Westmead Millennium Institute are given in AS2107. These reverberation times are generally considered to be appropriate for an office/laboratory building such as the WMI.

presents a summary of applicable reverberation time criteria for internal areas of the WMI development.

Table 4: AS2107 Internal Design Reverberation Times.

Type of Occupancy	Recommended Mid-Frequency Reverberation Times, s
Meeting rooms	0.6-0.8
Conference/Seminar rooms	0.6-0.7
Corridors and lobby spaces	0.4-0.6
Kitchens, sterilising and service areas	0.6-0.8
Laboratories	0.6-0.8
Office Areas – Enclosed	0.6-0.8
Office Areas – Open Plan	0.4-0.6
Waiting rooms, reception areas	0.4-0.7

12.3.2.1 Atrium

The atrium at WMI will be adjacent to occupied areas of the building (including the ground-floor waiting area, and write-up areas on upper levels). There is the potential for noise transfer between floors at WMI via the atrium which may cause disturbance for occupants, particularly if the atrium at WMI is open-edge.

An overly-reverberant room acoustic within the atrium will also make speech communication within the waiting area difficult, since late-reflected reverberant sound will mask successive words and reduce intelligibility.

Control of the room acoustics of the atrium can assist in reducing disturbance to occupants by providing a more “subdued” acoustic environment. Areas of localised absorption within the atrium or on the soffit of areas opening to the atrium can assist by absorbing acoustic energy.

AS 2107 presents recommended design curves for spaces for speech. For a space with the volume of the WMI atrium, a mid-frequency reverberation time of 0.9-1.0 s is recommended. Designing the atrium at WMI to meet the recommended “speech” design target will assist in allowing speech communication within the occupied areas of the atrium, and will also assist in controlling disturbance to other occupants of the WMI by reducing the overall reverberance of the atrium.

12.3.3 Environmental Noise

The New South Wales environmental noise policy relating to industrial noise is the *New South Wales Environment Protection Authority Industrial Noise Policy* (INP)[5] dated January 2000. Noise emission from plant and equipment on the WMI site is required to comply with the noise limits assessed in accordance with the INP.

The objective of the INP is to protect residential areas from noise generated by commercial, industrial or trade premises. Noise limits are set based on land use in the area and existing background noise levels. Compliance is achieved if the adjusted L_{Aeq} noise level at any residence affected by noise from the facility is below the noise limit. The adjusted L_{Aeq} is determined by applying corrections for such noise characteristics as duration, intermittency, tonality, and impulsiveness.

The assessment of noise emission under the INP is based on the calculation of a noise limit at a receiver position, taking into account the land-use in the surrounding area and the background noise level.

The INP separates the day into three different time periods – day, evening and night. These time periods are detailed in .

Table 5: Industrial Noise Policy Time Periods

Period	Day of Week	Time period
Day	Monday-Saturday	0700-1800hrs
	Sunday, Public Holidays	0800-1800hrs
Evening	Monday-Sunday	1800-2200hrs
Night	Monday-Saturday	2200-0700hrs
	Sunday, Public Holidays	2200-0800hrs

The INP provides guidance on acceptable noise levels from the introduction of new industrial noise sources to an area. The assessment procedure for industrial noise sources has two components:

- Controlling intrusive noise impacts in the short term for residences.
- Maintaining overall noise level amenity for various land uses, particularly residences

Both of these components result in noise criteria that should not be exceeded in order to avoid any adverse noise impacts on the affected areas. Both criteria should be taken into account when assessing the noise impact of industrial source(s) associated with the proposed development, and where the intrusiveness and the amenity criterion differ, the lower of the noise criteria is generally adopted as the project-specific noise criterion, although in some circumstances it is necessary to specify both criteria as the project-specific criteria.

12.3.3.1 Intrusiveness Criterion

A 15-minute sampling period is typically used when measuring the level of intrusive noise. This is taken to be a reasonable estimate of the period over which annoyance may occur. Therefore the intrusiveness criterion is summarised as follows:

[5] NSW EPA (2000) Industrial Noise Policy

$$L_{Aeq\ (15\ min)} \leq L_{A90\ (15\ min)} \text{ background Level} + 5 \text{ dB}$$

Because of the variable nature of background noise levels, the INP specifies single number background noise levels for use in setting the intrusiveness noise criterion. The Assessment Background Level (ABL) for each time period of a day is the level exceeded by 90 % of the $L_{A90,15min}$ measurements during that time period, and can be considered the “minimum repeatable” . The Rating Background Level (RBL) for a particular time period is the median of the ABL values for that time period for each day of the measurement period.

Industrial noise from the subject development should be controlled to not exceed the Rating Background Level (RBL) + 5 dB at the boundary of any residential noise sensitive receiver.

Using the noise logger data from the CMRI noise loggers, the intrusive noise criteria for WMI have been derived, as presented in Table 6:

Table 6: Intrusiveness criteria for Westmead Millennium Institute, dB re 20μPa

Receiver	Time Period	Rating Background Level	Intrusiveness Criterion
Internal Hospital Receivers (e.g. Kerry Packer Institute for Child Health)	Day	52 dB(A)	**57 dB(A)**
	Evening	51 dB(A)	**56 dB(A)**
	Night	50 dB(A)	**55 dB(A)**
Hawkesbury Road Receivers (e.g. 195 Hawkesbury Road)	Day	49 dB(A)	**54 dB(A)**
	Evening	46 dB(A)	**51 dB(A)**
	Night	45 dB(A)	**50 dB(A)**

12.3.3.2 Amenity Criterion

Criteria for the protection of amenity are given for various types of land usage and different times of the day. The amenity criterion is set so that the L_{Aeq} noise level from the industrial noise source does not increase the total industrial noise levels at the receiver above the acceptable noise level (ANL) for that land usage.

The amenity criterion is set based on how close the existing average L_{Aeq} industrial noise levels are to the ANL, using the adjustment factors given in Table 2.2 of the INP.

In cases where the existing average L_{Aeq} noise levels from industry exceed the ANL by more than 2 dB(A), and the existing noise levels are unlikely to decrease in future, then the amenity criterion is set to be 10 dB(A) lower than the existing noise levels at the receiver.

The amenity criteria for WMI are summarised in Table 7:

Table 7: Amenity Criteria for Westmead Millennium Institute, dB re 20μPa

Receiver	Time Period	Existing Industrial L_{Aeq} Noise Level	Acceptable Noise Level (ANL)*	Modification to ANL**	Amenity Criterion
Internal Hospital Receivers	Day	52 dB(A)	60 dB(A)	ANL-0 dB	**60 dB(A)**
	Evening	51 dB(A)	50 dB(A)	ANL-8 dB	**42 dB(A)**
	Night	50 dB(A)	45 dB(A)	L_{Aeq}-10 dB	**40 dB(A)**
Hawkesbury Road Receivers	Day	49 dB(A)	60 dB(A)	ANL-0 dB	**60 dB(A)**
	Evening	46 dB(A)	50 dB(A)	ANL-2 dB	**48 dB(A)**
	Night	45 dB(A)	45 dB(A)	ANL-8 dB	**37 dB(A)**

* Table 2.1 INP

**Table 2.2 INP

12.3.3.3 Project-Specific Noise Criteria

The most stringent of the intrusiveness or amenity criteria for each time period forms the project-specific noise criteria for the WMI development, as summarised in Table 8:

Table 8: Project-Specific Environmental Noise Criteria, Westmead Millennium Institute

Receiver	Time Period	Intrusiveness Criterion	Amenity Criterion	Project-Specific Noise Criterion
Internal Hospital Receivers	Day	57 dB(A)	60 dB(A)	**57 dB(A)**
	Evening	56 dB(A)	42 dB(A)	**42 dB(A)**
	Night	55 dB(A)	40 dB(A)	**40 dB(A)**
Hawkesbury Road Receivers	Day	54 dB(A)	60 dB(A)	**54 dB(A)**
	Evening	51 dB(A)	48 dB(A)	**48 dB(A)**
	Night	50 dB(A)	37 dB(A)	**37 dB(A)**

12.3.4 Construction Noise Criteria

The DECCW *Interim Construction Noise Guideline*[6] (ICNG) provides recommended noise levels for airborne construction noise at sensitive land uses. The guideline provides construction management noise levels above which all feasible and reasonable work practices should be applied to minimise construction noise impacts.

6 NSW Department of Environment, Climate Change and Water (2009) *Interim Construction Noise Guideline*

The DECCW interim guideline sets out management levels for noise at noise sensitive receivers, and how they are to be applied. These management noise levels for residential receivers are reproduced below, in Table 9. Noise levels apply at the worst affected property boundary of the residence, at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residences, the noise levels apply at the most noise-affected point within 30 m of the residence.

Table 9: DECCW management levels for airborne construction noise at residences

Time of day	Management level, $L_{Aeq\ (15min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or Public Holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noise activities can occur, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences). • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

The DECCW interim guideline provides recommended noise levels for sensitive land uses other than residential receivers. The recommended limit for hospital buildings is reproduced below in Table 10:

Table 10: Recommended construction noise limits for hospital receivers

Sensitive Land Use	Management level, $L_{Aeq,15min}$ (applies when properties are being used)
Hospital wards and operating theatres	Internal noise level 45 dB(A)

The noise logger data from the Hawkesbury Road logger has been used to determine the project specific construction airborne noise goals for the residential receivers along Hawkesbury Road. Noise-sensitive land uses within Westmead Hospital are covered by the criteria in Table 10

A summary of the project specific construction noise targets for residential noise-sensitive receivers is included below in Table 11.

Table 11: Project specific airborne construction noise targets

Time period	Noise affected level, $dBL_{Aeq\ (15min)}$	Highly noise affected level, $dBL_{Aeq\ (15min)}$
Recommended standard hours:		
Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm	59 dB	75 dB
Outside recommended standard hours*		
Daytime Saturday 1 pm to 6 pm Sunday, Public Holidays 8 am to 6 pm	57 dB	62 dB
Evening Monday to Sunday 6 pm to 10 pm	56 dB	61 dB
Night-time Monday to Saturday 10 pm to 7 am Sunday, Public Holidays 10 pm to 8 am	50 dB	55 dB

* Time periods outside recommended work hours are as defined in NSW Industrial Noise Policy, 2000

12.3.5 Traffic Noise Criteria

Road traffic noise from additional vehicle traffic on public roads resulting from the Westmead Millennium Institute is subject to the Environmental Criteria for Road Traffic Noise (ECRTN[7]) noise criteria. The ECRTN provides several categories for types of

[7] NSW Department of Environment, Climate Change and Water (1999)*Environmental Criteria for Road Traffic Noise*

development and appropriate noise planning targets are given for each type of development.

The ECRTN “embodies a non-mandatory performance-based approach”. ECRTN noise criteria are planning goals for new development and as such are not legislative requirements which must be met by new developments.

Rather, these criteria should be used as design goals for the development; however the ECRTN recognises that ”the criteria are applied as targets, but recognise that there will be situations where planning strategies are not feasible [in reducing the road traffic noise impact]”.

Due to the surrounding geography of the Westmead Hospital area, access to and from the WMI will be largely restricted to Hawkesbury Road, which handles through-traffic as a collector road.

Accordingly, the WMI project is best characterised as a development of Type 8 – *Land use developments with potential to create additional traffic on collector roads*. Table 12 presents an extract from Table 1 of the ECRTN outlining the appropriate noise criteria.

Table 12: ECRTN Criteria for Westmead Millennium Institute

Type of Development	Noise Criterion Day (7 am – 10 pm)	Noise Criterion Night (10 pm – 7 am)
8. Land use developments with potential to create additional traffic on collector roads	60 dB $L_{Aeq(1hr)}$	55 dB $L_{Aeq(1hr)}$

In cases where existing traffic noise levels exceed these criteria, the ECRTN states that traffic noise from the development should not increase traffic noise levels by more than 2 dB(A), provided that “all feasible and reasonable” measures to reduce noise from the development have been implemented.

12.4 External Noise Sources Affecting the Development

12.4.1 Helipad

The helipad on the adjacent multi-storey carpark is expected to be the external noise source with the greatest potential to impact on the Westmead Millennium Institute building, due to the high noise levels from helicopter operations and the short distance between the helipad and the WMI building.

Noise impacts from helicopter operations are expected to be significant for the entire WMI building, due to the proximity of the helicopter flight paths to the building; however, impacts are expected to be greatest at the north-western end of the building, which is the closest end to the helipad.

The site planning of the WMI building is such that some of the most noise-sensitive area usages – the meeting/conference rooms are both located at the north-western end of the WMI building.

Noise impacts from the helicopter operations at the adjacent helipad are not expected to be able to be effectively controlled by standard façade glazing constructions.

Higher-performance glazing or non-glazed façade constructions are likely to be necessary to control helicopter noise impacts on the WMI buildings.

It is not considered feasible to achieve the recommended helicopter noise break-in targets with a naturally-ventilated façade.

12.4.2 Childrens Medical Research Institute (CMRI)

During site surveys on the proposed WMI site in the vicinity of the existing Chesalon and Marion Villa buildings, noise from mechanical plant at the adjacent CMRI was observed to be the dominant background noise source.

Mechanical plant noise from CMRI was approximately constant during the site surveys, and was observed to be the noise source contributing most to the measured L_{A90} background noise levels.

Noise impacts from the CMRI are expected to be able to be effectively controlled by standard façade glazing constructions.

It is considered feasible to achieve the recommended internal noise level targets from plant noise from the CMRI with a naturally-ventilated façade.

12.4.3 Traffic Noise

12.4.3.1 Hawkesbury Road

Traffic noise from Hawkesbury Road is expected to be present throughout the operating hours of the WMI buildings, and is expected to have the greatest impact on the south-eastern end of the WMI site.

Noise impacts from traffic noise from Hawkesbury Road are expected to be able to be effectively controlled by standard façade glazing constructions.

Subject to a traffic noise survey on site, it is not considered feasible to achieve the internal design levels from traffic noise using a naturally-ventilated façade for all areas of the WMI building, with a sealed façade likely to be required for the south-eastern areas of the buildings.

12.4.3.2 On-Site Traffic Noise

On-site traffic noise sources within Westmead Hospital are expected to mostly occur on the north-eastern and south-western façades of the WMI buildings. Noise impacts from on-site traffic noise are expected to be mainly from noise from vehicles accelerating from a standstill (e.g. at the boom gates) and impact noise from vehicles crossing speed bumps.]

Noise impacts from the on-site traffic noise are expected to be able to be effectively controlled by standard façade glazing constructions.

It is considered feasible to achieve the recommended internal noise level targets from on-site traffic noise with a naturally-ventilated façade.

12.5 Assessment of Effects

12.5.1 Construction Noise

At this stage of the WMI project, the construction methodology used for construction works has not been selected. Accordingly, a qualitative assessment of construction noise impacts from the Westmead Millennium Institute has been conducted at this stage, to be supplemented by a quantitative assessment once more detail of the construction process is available.

Noise levels from construction of WMI are considered likely to exceed the “noise affected” levels from the *Interim Construction Noise Guideline,* since the nearest noise-sensitive receivers are only ~30 m from the site.

Where the “noise affected” levels are exceeded, the ICNG states that “all feasible and reasonable” work practices should be applied to reduce noise levels below the “noise affected” level.

For the construction of the Westmead Millennium Institute, this means that noise control considerations should be included as part of planning the construction process and in selecting construction equipment and methods to be used on site.

A Construction Noise and Vibration Management Plan should be prepared for the construction of WMI. This should include quantitative construction noise predictions, which should be used to assist in selecting construction practices and equipment to be used.

12.5.2 Traffic Noise

Additional traffic noise impacts on Hawkesbury Road resulting from the construction of Westmead Millennium Institute are expected to be negligible.

12.5.3 Helicopter Noise

Indicative helicopter noise impacts on the WMI buildings have been predicted in order to assess the expected façade performance requirements to control helicopter noise.

Previous Arup measurements of noise levels from a Bell 407 helicopter have been used to predict external helicopter noise levels on the façades of the WMI building. Using these external noise levels and the varying noise-sensitivity of the space usage within the WMI building, the required façade performance to meet the recommended internal noise levels has been determined.

12.5.3.1 Laboratories

A façade performance of approximately R_w 40 is predicted to be required to meet the recommended internal noise levels for laboratories located at the north-western end of the WMI buildings. This would likely involve a high-performance commercial glazing system (e.g. 9 mm laminate|19 mm airgap|13 mm laminate).

A façade performance of approximately R_w 35 is predicted to be required to meet the recommended internal noise levels for laboratories located at the south-eastern end of the WMI buildings. This would likely involve a standard thermal glazing configuration, e.g. 6|12|10 double glazing.

12.5.3.2 Meeting/Seminar Rooms

To achieve the recommended design criteria in façade-located meeting/seminar rooms, a façade performance of approximately R_w 47 would be required. This would likely involve either a high performance commercial façade system or a bespoke façade glazing system with a large (~50-100 mm) airgap.

12.5.3.3 Office Areas

To achieve the recommended design criteria in office areas, a façade performance of approximately R_w 40 would be required. This would likely involve a high-performance commercial glazing system (e.g. 9 mm laminate|19 mm airgap|13 mm laminate).

12.5.4 Design Impact of Helicopter Noise

The location of the proposed Westmead Millennium Institute in the close vicinity of a helipad has had a significant impact on the acoustic requirements for the façade. Natural ventilation is not considered feasible acoustically for the WMI buildings, due to the high external noise levels, and the presence of helicopter noise has meant that the façade performance for some areas of the WMI would need to be significantly increased to achieve the criteria.

It is understood that the helipad on the adjacent carpark may be moved to an alternate location in the future. If the helipad is moved sufficiently far away from the WMI institute that helicopters are in “normal” flight (rather than on approach/departure to a helipad), then standard façade glazing would be considered suitable to control both traffic noise and helicopter noise impacts. As an example, with helicopters at the minimum legal cruising altitude of 1000 ft (~300 m), a 6|12|10 façade system is predicted to be sufficient to control helicopter noise levels to meet the recommended internal design criteria.

A summary of the design impacts associated with the presence of the helipad is given in :

Table 13: Design Impact of Helipad on Westmead Millennium Institute

Design Feature	Helipad Present	No Helipad
Façade glazing	Standard double glazing (base) with significant areas of high- performance glazing	Standard double glazing
Glazing systems	Significant areas of bespoke/high-performance glazing	Standard commercial glazing units
Natural ventilation	Not feasible	Feasible for some areas

12.5.5 Environmental Noise

At this stage of design, details of the mechanical plant and equipment to be installed at the Westmead Millennium Institute are not available. However, given the distance to the nearest residential receiver is approximately 30 m, noise control measures are considered highly likely to be required for the majority of items of plant.

Expected noise control requirements for various items of plant are given in .

These noise-control requirements may be subject to change once a background noise survey has been completed and once details of the proposed plant for the WMI are available.

Table 14: Expected Noise Control Requirements for Plant, Westmead Millennium Institute

Plant/Equipment	Expected Noise Control Requirements
Air-Handling Units/Large Fans	Medium/High-Performance Attenuators
Small Fans	None/Low-Performance Attenuators
Cooling Towers	Intake: Low-Medium Performance Attenuators Exhaust: Low-Medium Performance Attenuators
Boilers	None (if enclosed in plantroom)
Emergency Generators	Intake: Medium-High Performance Attenuators Exhaust Flue: Residential-grade silencers Radiator Fan Exhaust: Low-Medium Performance Attenuators
Air-Cooled Chillers	Not recommended for use
Water-cooled Chillers	None (if enclosed in plantroom)
Pumps	None (if enclosed in plantroom)

Appendix A

Generic Vibration Criteria For Sensitive Equipment

Table 1: Generic Vibration Criteria For Sensitive Equipment [1],[2],[3]

Facility, Equipment or Use	Max Velocity µm/s RMS	Response Factor
Office: Perceptible vibration appropriate to offices and other non sensitive areas	400-800	4.0 – 8.0
Residential Day Use: Barely perceptible vibration. Usually adequate for most computer equipment, probe test equipment and low power (up to 20x) microscopes	200	2.0
Operating Theatres: Threshold of perception. Suitable in most instances for microscopes to 100x and for other equipment of low sensitivity.	100	1.0
Vibration Curve-A: optical microscopes up to 100x, micro balances, optical balances, proximity and projection aligners, some surgery.	50	0.5
Vibration Curve -B: optical microscopes up to 1000x, inspection and lithography to 3 micron line widths. micro-surgery, neurosurgery	25	0.25
Vibration Curve -C: Electron microscopes up to 30,000x, Microtomes, MRI Scanners	12.5	0.125
Vibration Curve -D : Electron microscopes> 30,000x, Cell implant equipment, mass spectrometers.	6	0.0625
Vibration Curve -E: A difficult criterion to achieve in most instances. Unisolated long path laser and optical research systems; Some medical imaging equipment.	3	0.03125

[1] 2003 ASHRAE Handbook- HVAC Applications: Chapter 47 Sound and Vibration Control, ASHRAE

[2] The Control of Vibration in Buildings, BBN Laboratories 1988

[3] CCIP 016 A Design Guide for Footfall Induced Vibration of Structures, The Concrete Centre (UK), 2006

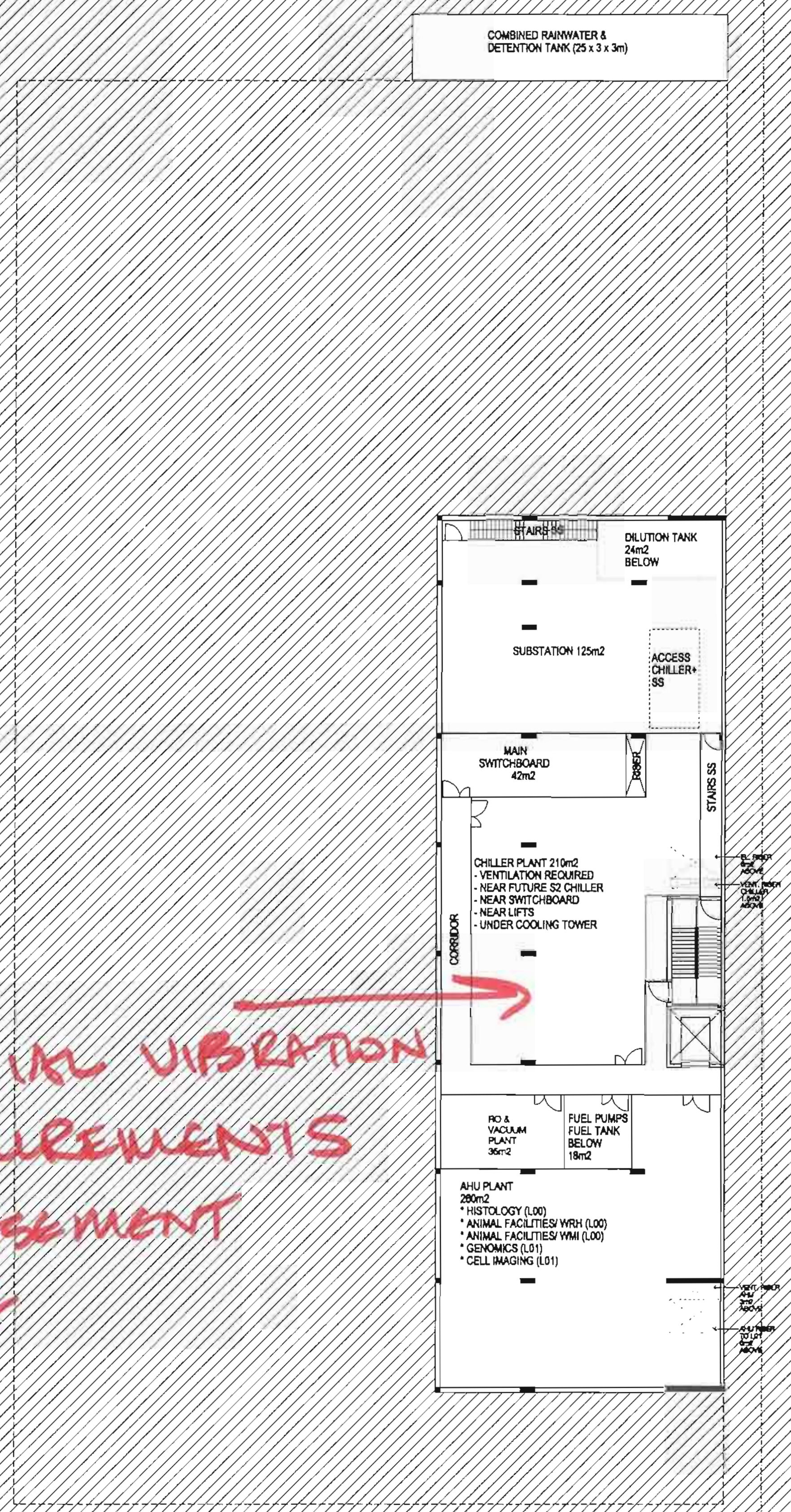
Appendix B

WMI Arup Mark up of Vibration Criteria

VIBRATION CRITERIA

BASED ON CURRENT
ARCH. AND DISCUSSIONS
WITH JEFF FREEMAN 22.07.2010

ARUP DON 28.07.2010
WMI 220131.



NO
SPECIAL VIBRATION
REQUIREMENTS
AT BASEMENT
LEVEL

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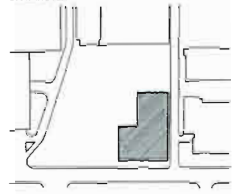

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DRAWING NUMBER	ISSUE
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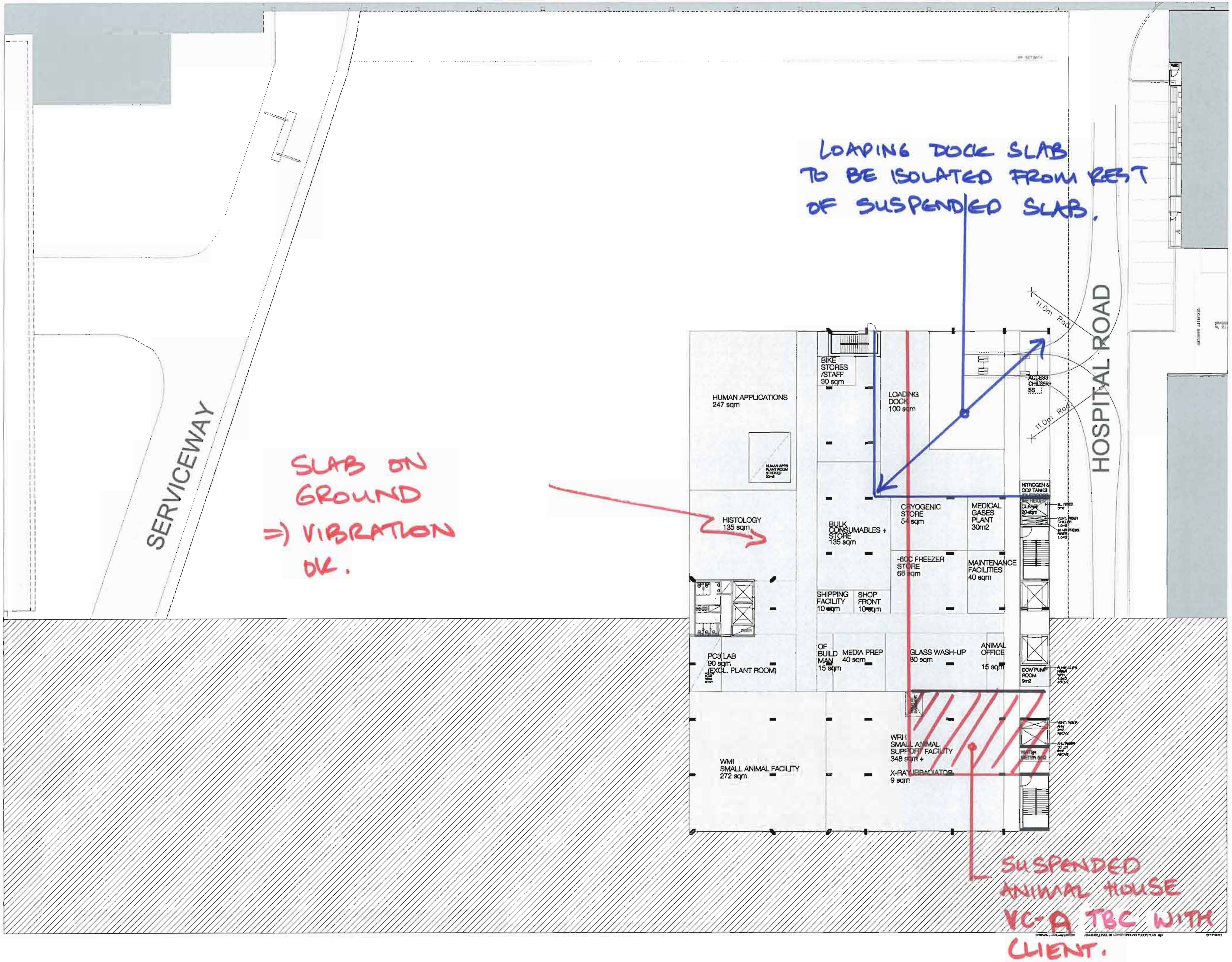

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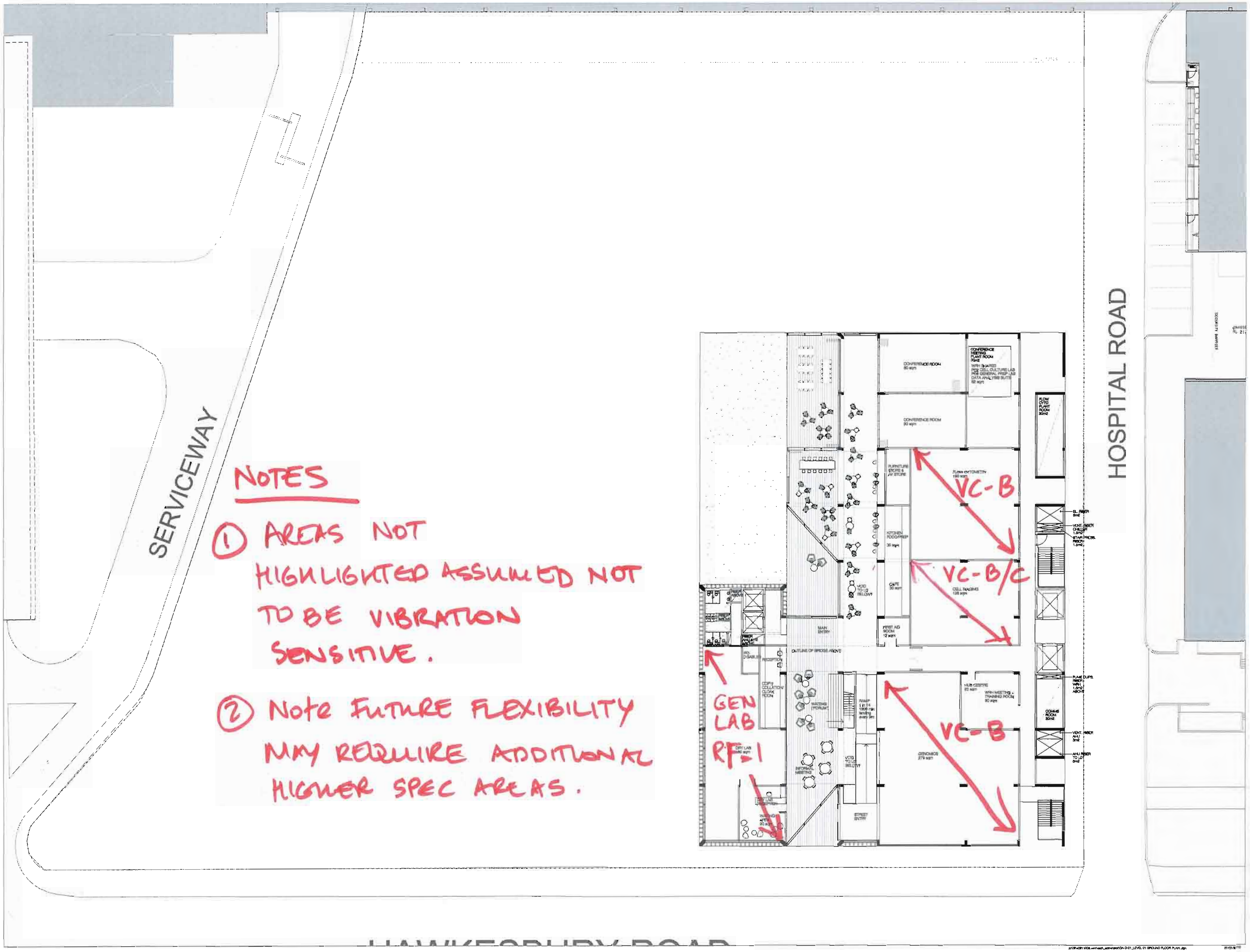

NOTES

① AREAS NOT HIGHLIGHTED ASSUMED NOT TO BE VIBRATION SENSITIVE.

② Note FUTURE FLEXIBILITY MAY REQUIRE ADDITIONAL HIGHER SPEC AREAS.

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DRAWING NUMBER

DA-D-01

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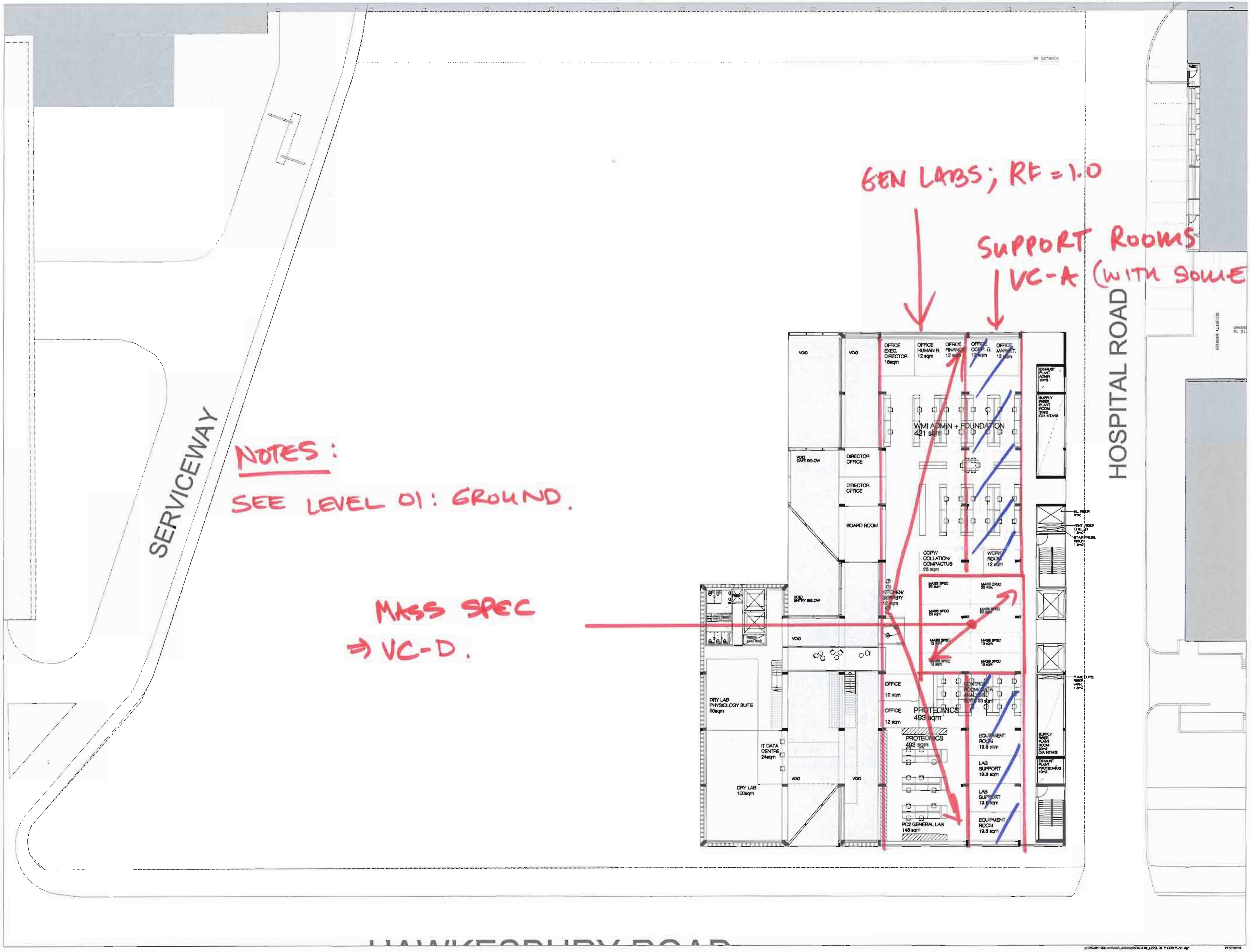

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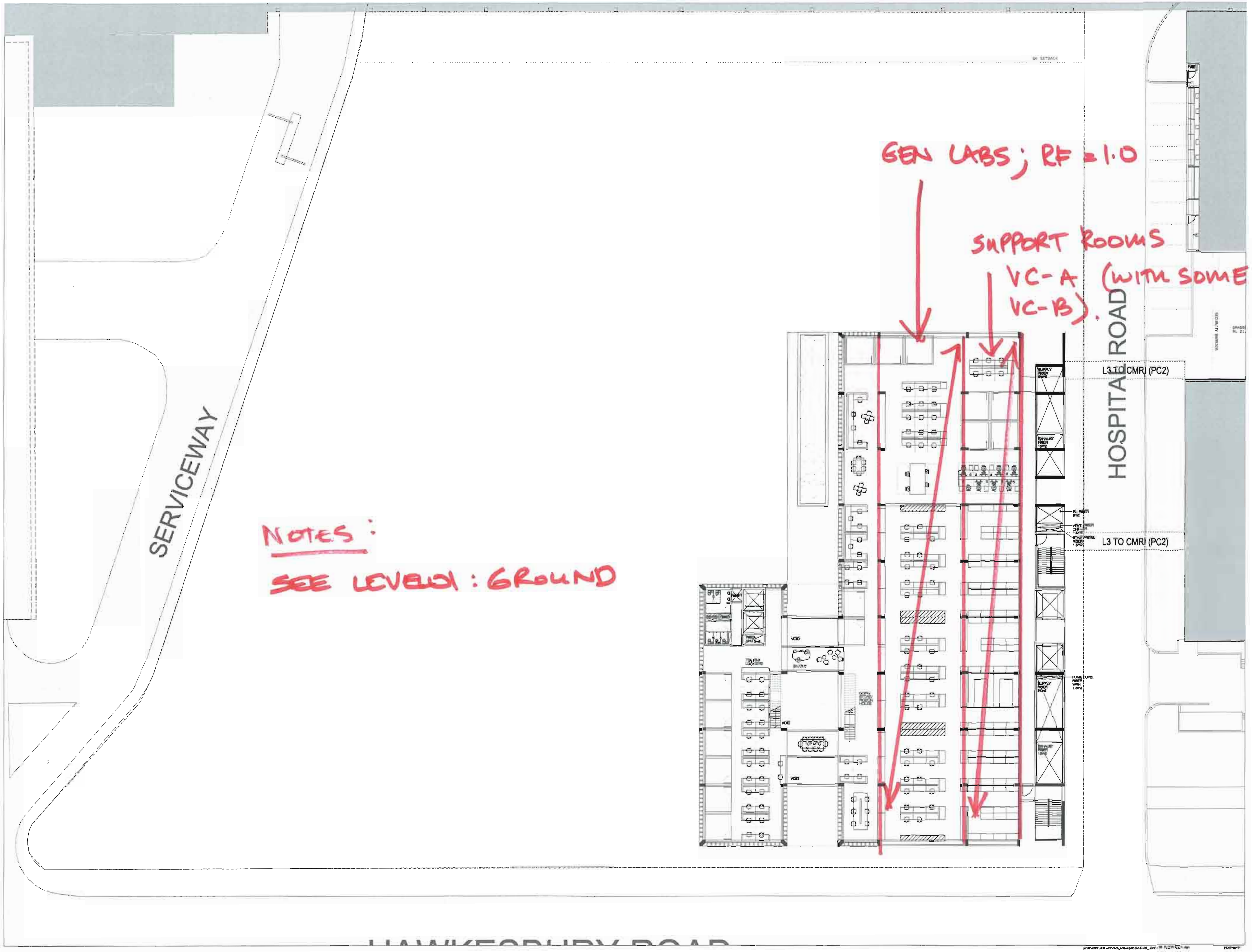

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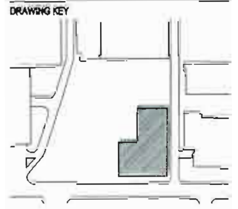

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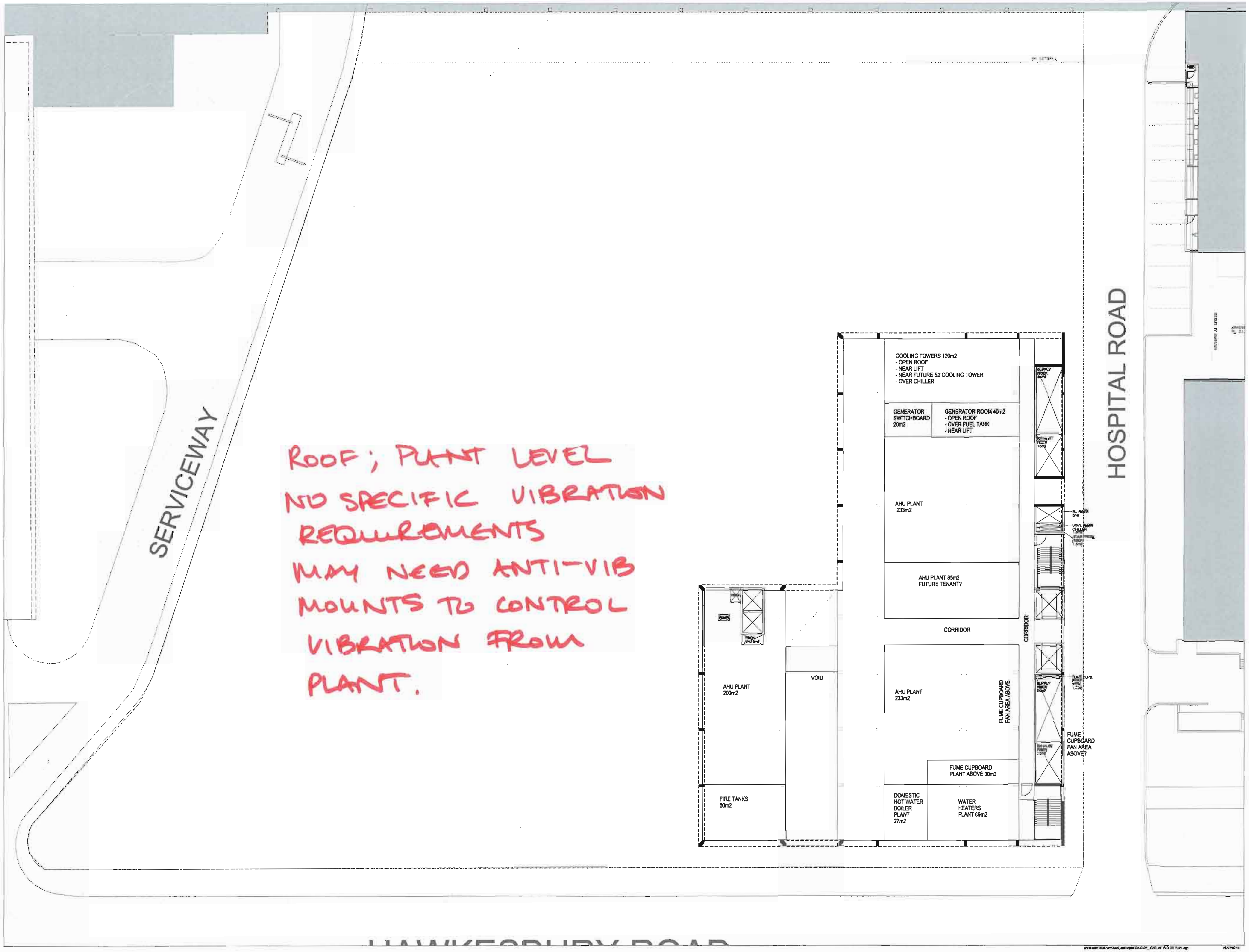

ROOF; PLANT LEVEL
NO SPECIFIC VIBRATION REQUIREMENTS
MAY NEED ANTI-VIB MOUNTS TO CONTROL VIBRATION FROM PLANT.

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PRELIMINARY

DRAWING

FLOOR PLAN
LEVEL 07 - ROOF

DRAWING NUMBER	ISSUE
DA-D-07	2