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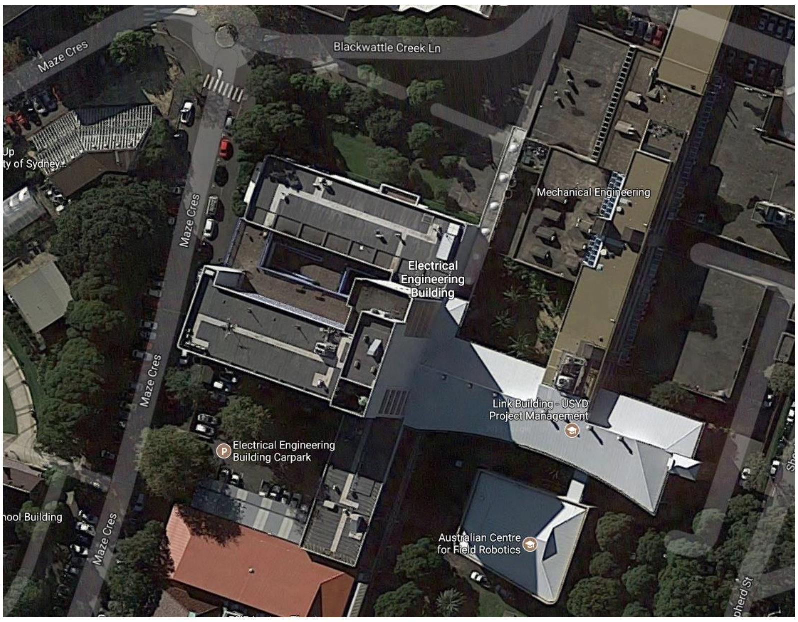
Preliminary Hazard Analysis of the Proposed new Engineering Precinct Building Following SEPP 33 Protocols

University of Sydney



Report Version – 1.3

CETEC Reference: CN171057

Date: 4 December 2018

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PROJECT:	**CETEC REF:**	**CLIENT REF:**	**ISSUE**
Preliminary Hazard Analysis of the Proposed new Engineering Precinct Building Following SEPP 33 Protocols University of Sydney	**CN171057**	**Contract Number:- SK33/0000**	**1.3**

AMD	**DESCRIPTION**	**INT**	**REVIEWED**	**DATE**
1.0	Preliminary report for the consideration of the DA application	PDS	AG / VG	14th November 2017
1.1	Finalised report incorporating client comments	PDS	AG / VG	30th November 2017
1.2	Updated drawing included within Appendix A	PDS	AG / VG	30th November 2017
1.3	Updated report incorporating requested clarification within Section 2.3.1 and Table 5.	PDS	VG	4th December 2018

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1. Introduction

1.1. Background

The University of Sydney is developing the Engineering and Technology Precinct which will incorporate a new Electrical Engineering Building located at the Darlington Campus which will be approximately ten levels in height, including mechanical plant rooms. The new building will incorporate teaching and research laboratories providing student with state of the art facilities to work within a safe and comfortable environment.

This report will form part the Environmental Assessment and details the Preliminary Hazard Analysis undertaken for the proposed building following the guidelines and approved methodology as detailed within NSW Planning & Environment document titled '*Hazardous and Offensive Development - Application Guidelines, Applying SEPP 33*'.[1]

1.2. Scope and Aim of Study

The objective of this assessment is to present the hazards and risks associated with the proposed development. Through the evaluation of the likelihood and consequences of the major identified hazards, the risks to the community associated with the proposed new building may be estimated and compared to the NSW Department of Planning risk criteria. These criteria are determined SEPP 33 document "Hazardous and Offensive Development Application Guidelines: Applying SEPP 33" (NSW Department of Planning, 2011) under the "Multi-Level Risk Assessment Approach". This is hereafter referred to as the "Applying SEPP 33" document. Any hazard analysis is to be conducted according to the Department of Planning's HIPAP No. 6 document entitled "Hazard Analysis".

The scope of this report includes the following:

- Systematic identification and documentation of conceivable hazards, based on information supplied and relevant experience from similar projects.
- Establishment of the consequence of each identified hazard and determination of any offsite effects. Note that this process is quantitative based on preliminary information and actual impacts could be finalised following design finalisation, plume modelling and calculations as appropriate.
- Where offsite effects are identified, the frequency of occurrence is determined based

1 http://www.planning.nsw.gov.au/Policy-and-Legislation/~/media/3609822D91344221BA542D764921CFC6.ashx

on historical data.

- Proposed risk reduction measures as deemed necessary.

1.3. How to Identify Potentially Hazardous Industry

The following points demonstrate how to determine if a proposed facility is hazardous using the risk screening method. The information required to determine this is highlighted below;

- A list of all the hazardous materials used in the proposed development and the quantity of each present. Note that if the proposed development is an addition or modification to an existing building, all hazardous materials on the site which are in proximity to the new development are to also be included in the assessment.
- Dangerous goods classification for each material, including subsidiary class(es) are to be determined and documented.
- The mode of storage used (bulk or packages/containers) and the maximum quantity stored or held on site.
- The distance of the stored material to the site boundary for any of the materials in dangerous goods Classes 1.1 (explosives with mass explosion hazard), 2.1 (flammable gases) and 3 (flammable liquids).
- The average number of annual and weekly road movements of hazardous material to and from the site, and the typical quantity in each load.

From the above collated information it is then possible to determine if the site will be considered to be a hazardous or offensive site under SEPP 33 methodology.

1.4. Identifying Maximum Chemical Storage Volumes to be Stored

Prior to applying the SEPP 33 methodology and analysis for determining if the site will be considered hazardous or offensive, determination of the chemical volumes proposed onsite will need to be considered. As this building will be considered to be a teaching facility housing laboratories for experimentation and analysis, guidance from *AS/NZS 2243.10:2004 Safety in laboratories Part 10: Storage of chemicals* will be sought as the above mentioned standard would be the most applicable Australian Standard for the storage of dangerous goods within the building in Bulk and Minor storage volumes for a teaching laboratory setting.

Following guidance from *AS/NZS 2243.10:2004*, three methods of chemical storage are identified for a building housing laboratories, these have been identified as;

- Minor storage – chemicals which are intended for the day to day use and generally would be stored on shelving above workbenches.
- Chemical cabinet storage – chemicals which are stored in larger volumes within a dedicated Dangerous Goods chemical cabinet.
- Bulk chemical Storage – chemicals which are stored in bulk within a dedicated enclosure either within the building or separate to the building.

Following *Table 1* of *AS/NZS 2243.10:2004* (*Chemicals permitted to be stored in a laboratory other than in a chemical storage cabinet*), the following maximum chemical volumes would be permitted to be stored within each 50 m^2 laboratory to a maximum of 200 L/Kg, refer to Figure 1.

Type of substance or Class of dangerous goods	Maximum per 50 m^2 kg or L	Maximum pack size kg or L	Conditions for storage	Alternative storage options
Class 3 primary or subrisk	10	5	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	AS 1940 or AS/NZS 3833
Combustible liquids	50	20	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	AS 1940 or AS/NZS 3833
Classes 4.1, 4.2, 4.3, 5.1 or 5.2 (see Note 1)	20 but less than 10 of any one Class	10	Labelled standard laboratory cupboard or, for Classes 4.1, 4.3 and 5.1, in small amounts throughout the laboratory	AS 2714 or AS/NZS 3833
Class 6.1	PG I 10 (Note 2) Other 50	PG I 10 (Note 2) Other 20	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	AS/NZS 4452 or AS/NZS 3833
Class 8	20 for liquids 50 for solids	20	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	AS 3780 or AS/NZS 3833
Class 9 and aerosols	50 for liquids 100 for solids	5 for liquids 20 for solids	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	AS/NZS 4681 or AS/NZS 3833
Maximum aggregate quantity	200	—	—	—
Hazardous substances	—	5 for liquids 20 for solids	Labelled standard laboratory cupboard or in small amounts throughout the laboratory	—

Figure 1: Screen clip of Table 1 from AS/NZS 2243.10

When considering chemical cabinet storage, the following Clause applies as referenced from *AS/NZS 2243.10:2004*.

4.4.3.2 *Separation*

Within a radius of 10 m, measured from any one cabinet, the cabinet storage capacity aggregated for all cabinets in that radius shall not exceed 250 L or 250 kg, including no more than 10 L or 10 kg each of dangerous goods of Classes 4.1, 4.2, 4.3, 5.1 or 5.2 that are classified as PG I. The radius shall be measured horizontally through intervening walls, unless those walls are able to prevent the spreading of a fire of the magnitude that could be expected to result from the contents of the cabinet(s).

Figure 2: Screen clip of Clause 4.4.3.2 from AS/NZS 2243.10

When considering chemicals in bulk storage *Table 2* of *AS/NZS 2243.10:2004* (*Maximum Storage Quantities*) specifies the allowable maximum quantity of dangerous goods within a bulk chemical store.

Type of goods	PG I	PG II and PG III	Other
Goods too dangerous to be transported	Not applicable (Note 3)	Not applicable (Note 3)	Risk assessment required
Class 2 aerosols (UN 1950)	Not applicable (Note 3)	100	Not applicable
Class 3 primary or subsidiary risk (except UN 3256)	200 but no more than 100 in any one cabinet	1000	Not applicable
Combustible liquids C1/C2	Not applicable (Note 3)	Not applicable (Note 3)	1000
Class 4.1 Class 4.2 Class 4.3 Class 5.1 Class 5.2	200 aggregate (includes Class 4.1 UN 3221 to 3240, Class 5.2 UN 3101, 3102 and 3111 to 3120 as well)	1000 aggregate No more than 50 of Class 5.2 in any one cabinet	Not applicable
Class 6.1 Class 8 Class 9 (except elevated temperature goods UN 3257 and 3258 and dry ice UN 1845)	500 aggregate No more than 100 of Classes 6.1 and 8 in any one cabinet	1000 aggregate Class 6.1 and Class 8 liquids in breakable containers of no greater than 1 L capacity, liquids in non-breakable containers of no greater than 5 L capacity, solids in packages of no greater than 10 kg and non-combustible articles such as batteries may be stored outside cabinets.	Not applicable
UN 3256 to 3258 UN 1845	Not applicable (Note 3)	See Note 4	Not applicable
Hazardous substances not otherwise classified as dangerous goods	Not applicable (Note 3)	Not applicable (Note 3)	2000 for hazardous substances not otherwise classified as dangerous goods
Aggregate maxima	500	2000	2000 (Note 2)

Figure 3: Screen clip of Table 2 from AS/NZS 2243.10

With the above preliminary data, it is possible to determine a maximum allowable volume of chemicals which would be held within the new building and from this data it will be possible to determine if SEPP 33 is applicable.

2. Site and Spatial Requirements

2.1. Site Location and Surrounding Areas

The proposed site is located on the main University of Sydney Darlington campus between Maze Crescent, Blackwattle Creek Lane and Shepherd Street. In the immediate surrounding area other university buildings to the north, south and west surround the proposed development. While to the east on the opposite side of Shepherd Street residential housing is present. These residences are approximately 60 metres away from the Link Building and 92 metres away from the Electrical Engineering Building, refer to Figure 4.

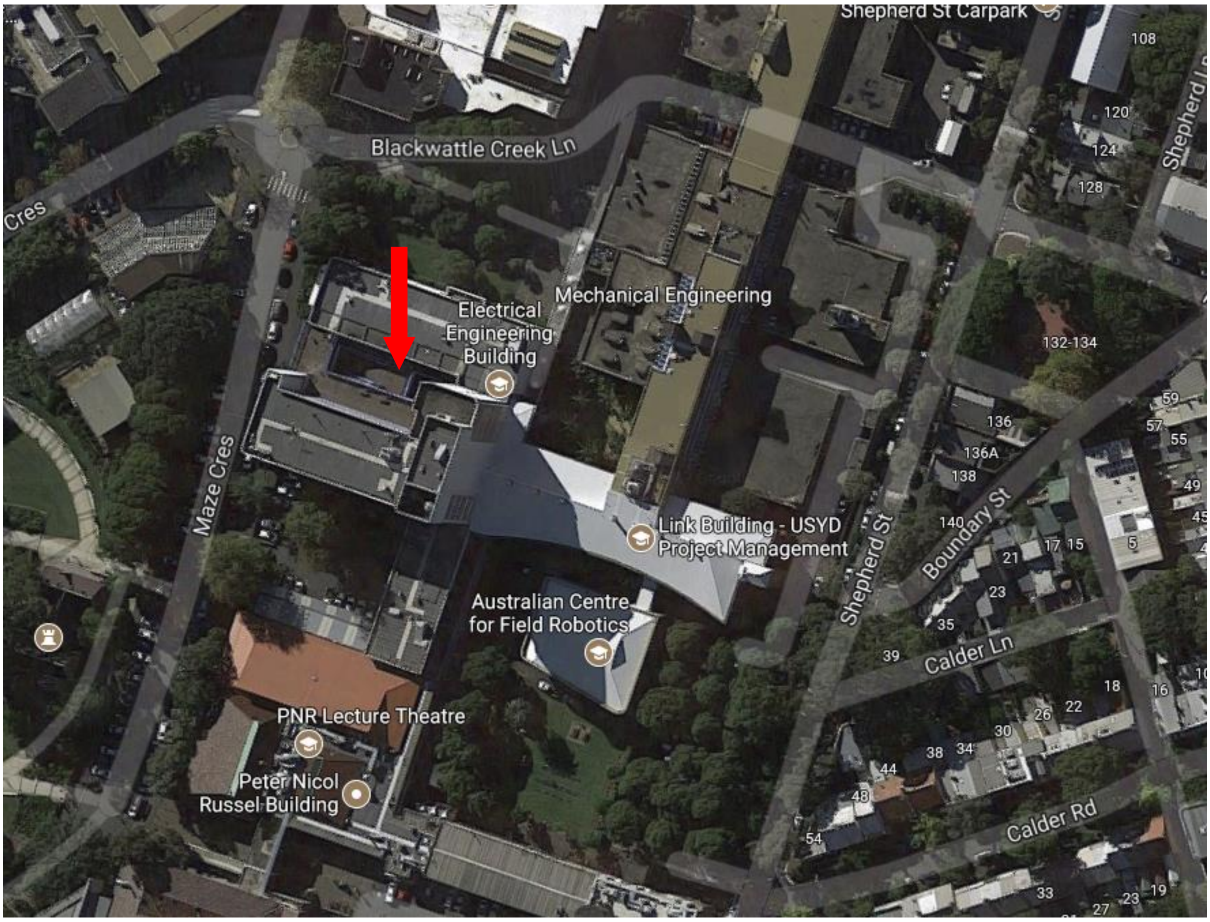


Figure 4: Location of the proposed development (red shaded area)

However the neighbouring buildings, although part of the same entity, could be considered to be ‘public’ places as they form part of the overall teaching institute. These neighbouring buildings have been identified as;

- PNR Lecture Theatre - ~34.5 metres away.

- Australian Centre for Field Robotics - ~32.7 metres away.
- Mechanical Engineering - ~ 13 metres away.
- Seymour Centre - ~ 35.4 metres away.
- Ground up - ~ 26.3 metres away.
- Old School Building - ~ 43.3 metres away.

2.2. SUMMARY OF BUILDING LAYOUT

2.2.1. LEVEL 1

Level 1 of the proposed building will house predominately back of house facilities such as;

- Bulk chemical stores.
- General stores.
- Facilities offices.
- Mechanical and electrical plant rooms.
- Research NMR rooms.

2.2.2. LEVEL 2

Level 2 of the proposed building will house;

- Laboratory
- Plant rooms.

2.2.3. LEVELS 3 TO 9

Levels 3 to 9 of the proposed building will house;

- Laboratory
- Office spaces.

2.2.4. LEVEL 10

Levels 3 to 9 of the proposed building will house;

- Plant rooms.
- Gas Store.

2.3. Manifested Quantitates of Dangerous Goods

Information received from the university indicates that currently onsite users hold the following volumes of chemicals within chemical storage locations which would be expected to be relocated into the new facility.

Building	Dangerous Goods Class	Current Maximum Storage Volume (L/Kg)
J01	2.1	650
	2.3	500
	3	850
J07	2.1	2000
J07A	3	2000

2.3.1. Breakdown of Information

As high pressure cylinders are supplied as a cylinder volume, CETEC has summarised the maximum volumes of each gas class which will be stored within the facility. From this the mass of each gas is the given. Therefore, the current manifested quantities indicate that the new facility may have up to;

- 2650 L of Class 2.1 gases of hydrogen of various mixtures, methane and acetylene (up to 276 Kg).
- 500 L of Class 2.3 gases of anhydrous ammonia and nitric oxide (up to 240 Kg).
- 2850 L/Kg of Class 3 flammable liquids (dependent on solvent density, assume up to 2850 Kg) .

Reviewing the information supplied, these volumes only cover chemicals stored within chemical stores which require manifesting under the NSW Dangerous Goods Legislation. It doesn't cover Dangerous Goods volumes do not meet the legislation's' threshold for reporting to SafeWork NSW.

Therefore based on the above information, CETEC will use the information as indicated in Section 1.4 and the table above to determine if this proposal qualifies as a 'Hazardous and Offensive Development' under SEPP 33.

3. Reviewing SEPP 33 to Determine Applicability

Since the 1980s, the New South Wales Department of Planning has promoted and implemented an integrated approach to the assessment and control of potentially hazardous development. The approach has been designed to ensure that safety issues are thoroughly assessed during the planning and design phases of a facility and that controls are put in place to give assurance that it can be operated safely throughout its life.

Applying SEPP 33 included a screening method, based on the quantities of Dangerous Goods on a site, to assist in determining if a development is likely to be potentially hazardous industry. However, the screening method was not intended to be applied in isolation.

3.1. Scope and Application

SEPP 33 applies to any proposals which fall under the policy's definition of '*potentially hazardous industry*' or '*potentially offensive industry*'. Certain activities may involve handling, storing or processing a range of substances which in the absence of locational, technical or operational controls may create an off-site risk or offence to people, property or the environment. Such activities would be defined as potentially hazardous or potentially offensive. These guidelines are to assist councils and proponents to establish whether a development proposal would fit into such definitions and hence, come under the provisions of the policy.

For development proposals classified as 'potentially hazardous industry' the policy establishes a comprehensive test by way of a Preliminary Hazard Analysis (PHA) to determine the risk to people, property and the environment at the proposed location and in the presence of controls. Should such risk exceed the criteria of acceptability, the development is classified as 'hazardous industry' and may not be permissible within most industrial zonings in NSW.

3.2. Does SEPP 33 Apply?

Firstly consideration whether the proposed use falls within the definition of 'industry' as adopted by the planning instrument applies to this proposal or whether it is a 'storage establishment'. To determine whether this proposal falls within the definition of 'industry' or 'storage establishment', collation of site chemical storage and usage data is collated and compared to the following tables. If the collated data agrees with any of the tabulated limits, then the proposal is considered to be a Hazardous and/or Offensive Development.

3.2.1. Screening Method

Table 1 below and within a series graphs and tables (refer to Figure 5, Table 2 and Table 3) provide the required information to which the facility is to be assessed against. Table 1 indicates the graph and/or table to be used in the assessment to determine if the proposal will be considered as a Hazardous and/or an Offensive Development. Quantities below those identified volumes in subsequent tables and graphs can be assumed to be an unlikely significant off-site risk and therefore will not make the proposed site a Hazardous and/or an Offensive Development.

Table 1: Screening Method to be Used

Class	Method to Use/Minimum Quantity
1.1	Use graph at Figure 5 if greater than 100 kg
1.2-1.3	Table 3
2.1 — pressurised (excluding LPG)	Figure 6 graph if greater than 100 kg
2.1 — liquefied (pressure) (excluding LPG)	Figure 7 graph if greater than 500 kg
LPG (above ground)	table 3
LPG (underground)	table 3
2.3	table 3
3PGI	Figure 8 graph if greater than 2 tonne
3PGII	Figure 9 graph if greater than 5 tonne
3PGIII	Figure 9 graph if greater than 5 tonne
4	table 3
5	table 3
6	table 3
7	table 3
8	table 3

Table 1: Screening Method to be Used (Screen clip taken from SEPP 33 – Table 1)

Figure 5 graphs the minimum acceptable distance the proposed site can be to the neighbouring properties for the development to not be considered a Hazardous and/or an Offensive Development.

Further to this, Table 2 offers another consideration which is required to be assessed to determine the site could be considered a Hazardous and/or an Offensive Development. This assessment is conducted by the assessment of the expected number of Dangerous Goods deliveries to the site over the year, week or load volumes.

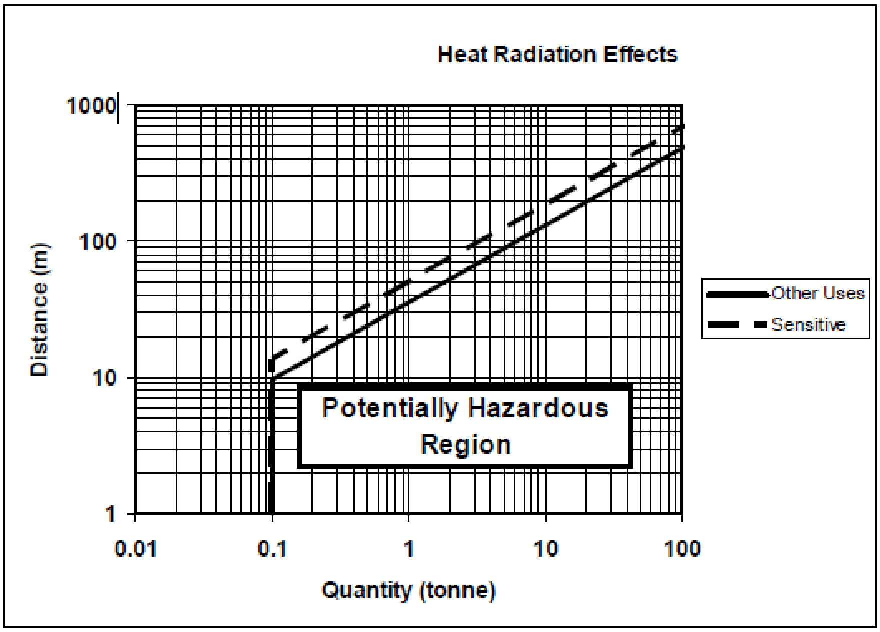


Figure 5: Class 2.1 Flammable Gases Pressurised (Excluding LPG) (Screen clip taken from SEPP 33 – Figure 6)

Table 2: Transportation Screening Thresholds

	Vehicle Movements		**Minimum quantity* per load (tonne)**	
	Cumulative	Peak		
Class	Annual *or*	Weekly	Bulk	Packages
1	see note	see note	see note	
2.1	>500	>30	2	5
2.3	>100	>6	1	2
3PGI	>500	>30	1	1
3PGII	>750	>45	3	10
3PGIII	>1000	>60	10	no limit
4.1	>200	>12	1	2
4.2	>100	>3	2	5
4.3	>200	>12	5	10
5	>500	>30	2	5
6.1	all	all	1	3
6.2	see note	see note	see note	
7	see note	see note	see note	
8	>500	>30	2	5
9	>1000	>60	no limit	

Table 2: Transportation Screening Thresholds (Screen clip taken from SEPP 33 – Table 2)

Table 3: General Screening Threshold Quantities

Class	Screening Threshold	Description
1.2	5 tonne	or are located within 100 m of a residential area
1.3	10 tonne	or are located within 100 m of a residential area
2.1	(LPG only — not including automotive retail outlets[1])	
	10 tonne or16 m^3	if stored above ground
	40 tonne or 64 m^3	if stored underground or mounded
2.3	5 tonne	anhydrous ammonia, kept in the same manner as for liquefied flammable gases and not kept for sale
	1 tonne	chlorine and sulfur dioxide stored as liquefied gas in containers <100 kg
	2.5 tonne	chlorine and sulphur dioxide stored as liquefied gas in containers >100 kg
	100 kg	liquefied gas kept in or on premises
	100 kg	other poisonous gases
4.1	5 tonne	
4.2	1 tonne	
4.3	1 tonne	
5.1	25 tonne	ammonium nitrate — high density fertiliser grade, kept on land zoned rural where rural industry is carried out, if the depot is at least 50 metres from the site boundary
	5 tonne	ammonium nitrate — elsewhere
	2.5 tonne	dry pool chlorine — if at a dedicated pool supply shop, in containers <30 kg
	1 tonne	dry pool chlorine — if at a dedicated pool supply shop, in containers >30 kg
	5 tonne	any other class 5.1
5.2	10 tonne	
6.1	0.5 tonne	packing group I
	2.5 tonne	packing groups II and III
6.2	0.5 tonne	includes clinical waste
7	all	should demonstrate compliance with Australian codes
8	5 tonne	packing group I
	25 tonne	packing group II
	50 tonne	packing group III

Note: *The classes used are those referred to in the Australian Dangerous Goods Code and are explained in Appendix 7.*

Table 3: General Screening Threshold Quantities (Screen clip taken from SEPP 33 – Table 3)

3.3. Preliminary Assessment to Determine if SEPP 33 Applies

Below CETEC has conducted a preliminary assessment in Table format to determine if SEPP 33 applies to this development and if it could be considered a Hazardous and/or an Offensive Development

3.3.1. Assessment – Chemicals in Bulk Storage

Class	Referencing Source	Minimum Quantity (Kg)	Proposed Storage (L) / Kg)	Exceeded?	Figure or Graph to be Used	Finding
2.1 (pressurised)	Table 1	100 Kg	2650 (L) (up to 276 Kg)	Yes	Figure 5	Buildings less than 60 metres will make this proposal *Potentially Hazardous*
2.3	Table 4	100 Kg	500 (L) (up to 240 Kg)	Yes	N/A	Greater than 100 Kg gas kept in or on premises.
3	Table 1	PGI – 2,000 PGII – 5,000 PGIII – 5,000	2,000	No	NA	Not considered *Potentially Hazardous*
Other Classes not on Manifest (maximum quantities taken from AS/NZS 2243.10 – Table 2, i.e. Figure 3 above)						
4	Table 4	4.1 – 5000 4.2 – 1000 4.3 – 1000	4.1 – 200 4.2 and 4.3 – 1000	No	NA	NA
5	Table 4	PGI – 2,000 PGII – 5,000 PGIII – 5,000	5.1 – 200 5.2 and 5.3 – 1000	No	NA	NA
6 (6.1 only)	Table 4	PGI – 500 PGII and PGIII– 2,500	PGI – 500 PGII and PGIII– 1,000	No	NA	NA
8	Table 4	PGI – 5,000 PGII – 25,000 PGIII – 50,000	PGI – 500 PGII and PGIII– 1,000	No	NA	NA

3.3.2. Assessment – Transportation Considerations

In conducting this assessment, CETEC is also required to assess the expected number of vehicles movements which could occur during for the proposed new development. Based on this and considering that no information has been provided on annual delivery volumes, usual bulk volume delivered per week or package size, this part of the assessment would has been estimated by CETEC considering the expected volumes a 'normal' research laboratory building would be expected to consume. Based on this CETEC has estimated the following information as detailed below.

Based on a normal delivery scenario, CETEC would expect the following deliveries to occur;

- At least one delivery every day for dangerous goods, aggregate volumes expected to be less than 5 L/Kg for liquids.
- Medium to Bulk deliveries once to twice a month, aggregate expected volumes to be 100 L/Kg for liquids.
- Gas deliveries as needed, expected 1 cylinder per week.

	Vehicle Movements				Minimum Quantity per Load (tonnes)			
Class	**Cumulative Annual**	**Expected to be Exceeded**	**Peek Weekly**	**Expected to be Exceeded**	**Bulk**	**Expected to be Exceeded**	**Package**	**Expected to be Exceeded**
2.1	> 500	No	> 30	No	2	No	5	No
2.3	> 100	Possible	> 6	No	1	No	2	No
3 - PGI	> 500	No	> 30	No	1	No	1	No
3 - PGII	> 750	No	> 45	No	3	No	10	No
3 - PGIII	> 1,000	No	> 60	No	10	No	No Limit	NA
4.1	> 200	No	> 12	No	1	No	2	No
4.2	> 100	No	> 3	No	2	No	5	No
4.3	> 200	No	> 12	No	5	No	10	No
5	> 500	No	> 30	No	2	No	5	No
6.1	All	Yes	All	Yes	1	No	3	No
8	> 500	No	> 60	No	2	No	5	No

3.3.3. FINAL EVALUATION

Therefore based on the preliminary assessment within Sections 3.3.1 and 3.3.2, a number of cut off limits have been exceeded or could be exceeded and based on this the proposed site will be considered to be a potentially Hazardous and/or Offensive Development requiring a full assessment as per the requirements as detailed within SEPP 33 documentation and now form part of the remainder of this document to risk assess an provide potential risk mitigating controls to minimise the impact of this development on the neighbouring infrastructure and population.

4. Study Methodology

4.1. Introduction to Methodology

The methodology for the PHA is well established and documented in Australia utilising the criteria as detailed in the Department of Planning's HIPAP No 6 (Guidelines for Hazard Analysis) and HIPAP No 4 (Risk Criteria for Land Use Planning, Ref 2). These documents describe the methodology and criteria to be used in PHAs, as required by the NSW Department of Planning for major 'potentially hazardous' developments.

As per HIPAP No 6, there are five (5) stages in the risk assessment, which are;

Stage 1: **Hazard Identification** – The review of potential hazards associated with all hazardous goods to be stored and used onsite, including their transportation to and from the site.

The hazard identification also includes identification of potential incidents and their impact on neighbouring areas, including public spaces and buildings and private buildings. Once identified, possible mitigating strategies to minimise the likelihood of the incident and/or decrease the impact on the public are then considered.

Stage 2: **Consequence and Effect Analysis** – The consequences of identified hazards are assessed using current risk assessment techniques with consideration of known exposure standards and known correlations between exposure and health effects. In addition, potential impacts on neighbouring properties and to the local environment are considered.

Stage 3: **Frequency Analysis –** In consideration of potential incidents for which significant effects have been identified, whether to people, property or the neighbouring external environment, the frequency of occurrence is estimated or evaluated based on historical data.

Stage 4: **Quantitative Risk Analysis –** The combination of a potential consequence (such as death or injury) combined with the estimated frequency of an event results in the risk from the event,

i.e. *Risk = Consequence x Frequency*

The risk is therefore obtained by adding together the results from the risk calculations for each incident and the results from the risk analysis are presented in three forms;

- Individual fatality risk.
- Injury or irritation risk.
- Societal risk.

The risk results are then assessed against the guidelines adopted by the NSW Department of Planning.

Stage 5: **Risk Reduction** – Where possible, risk reduction measures are identified throughout the course of the study in the form of recommendations. If adopted, future risk assessment calculations can be modified accordingly.

4.2. RISK CRITERIA

Having determined the risks from a proposed development, it must then be compared to acceptable criteria in order to assess whether or not the risk level is acceptable. If not acceptable, then specific risk mitigating measures must be developed and incorporated to reduce the risk to an acceptable level. Where no measures are found, then the development is not compatible with the surrounding environment and land uses.

5. HAZARD ANALYSIS

5.1. HAZARD IDENTIFICATION – SUMMARY OF HAZARDOUS GOODS ONSITE

For the nature of the building, the foreseeable dangerous goods that could be supplied, stored and used onsite are listed in Table 4. The list is comprehensive, as it's envisaged that several of the laboratories will used by research students while other will be used to teaching purposes, possibly resulting in a very wide range of hazardous substances being stored and used on site.

It should be noted that the Australian Standards cited in Table 4 are still current, and generally the current edition of the standard would be followed. The standards should not be considered in isolation from the current legislation in NSW. In any case, incompatibilities with the legislation are rare. The NSW Work Health and Safety Regulation (2011), hereafter referred to as the 'WHS Regulation', requires businesses or organisations to assess risk and to minimise risk accordingly. It includes specific provisions for chemicals, including "scheduled" chemicals, chemicals containing lead and specifically listed carcinogenic substances. The use of any of these substances triggers specific requirements in the legislation. Australian Standards are not part of the legislation, but their implementation represents best practice and would be expected to be looked on favourably in a court of law.

Table 4: Substances which could be stored and used within these laboratories

Building activity	Associated chemical and/or hazard class	Comments on requirements and storage restrictions
Natural gas: supply, storage & handling	Natural gas (a Class 2.1 gas)	If required for a laboratory application, natural gas will be reticulated from the gas supplier's lines into the building and distributed to the required location. Pipe dimensions and pressures as per applicable Australian Standards.
Compressed gases in laboratory spaces: supply, storage & handling	Classes 2.1, 2.2, and 2.3 (note: Class 2.2 includes gases with sub. class 5.1)	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 4332 (most requirements are in AS 4332).
Flammable liquids: supply, storage & handling	Class 3 liquids	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 1940.
Class 4 substances: supply, storage & handling	Class 4 substances comprise: 4.1: Flammable solids 4.2: Substances liable to spontaneous combustion 4.3: Substances which emit flammable gases when in contact with water.	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 5026. *Note: Class 4.1, 4.2 and 4.3 form three very distinct classes and should be considered individually. The GHS classifies them separately.*
Oxidising substances: supply, storage & handling	Class 5.1 substances	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 4326.
Organic peroxides: supply, storage & handling	Class 5.2 substances	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 2714.
Toxic substances: supply, storage & handling	Class 6.1 substances	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 4452, and with various state and federal regulations.
Radioactive materials: supply, storage & handling	Class 7 substances	Storage and handling on site will be dictated by the requirements of Australian Radiation Protection and Nuclear Safety Agency, with consideration of AS 2243.4.
Corrosive substances: supply, storage & handling	Class 8 substances	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 3780.
Miscellaneous dangerous goods: supply, storage & handling	Class 9 substances	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 4681.

Building activity	Associated chemical and/or hazard class	Comments on requirements and storage restrictions
Cryogenic liquids: supply, storage & handling	Examples: liquid helium, liquid nitrogen.	Storage and handling on site will be dictated by the requirements of AS 2243.10 and AS 1894. Flammable or toxic cryogenic liquids will require special provisions.

5.2. Summary of Risk due to Identified Hazards

Although there is a large number of identified hazards onsite, overall these hazards can be grouped into the following main categories assuming any incident occurs within the confines of the building;

- Reticulation services line rupture – Depending on the gases being reticulated, fire, explosion, asphyxiation, or varying levels of toxicity to people may result.
- Gases (Classes 2.1, 2.2 and 2.3) – Depending on where the gas usage is occurring or where the gas is being stored, fire, explosion, asphyxiation, or varying levels of toxicity to people may result. The use of highly toxic gases such as arsine may pose potential hazards even outside the building.
- Cryogenic liquids and dry ice – Cryogenic liquids mostly form non-toxic and non-flammable gases, but owing to their rapid boiling they're capable of rapidly depleting oxygen levels within confined areas, resulting in an asphyxiation risk. They can also cause burns of varying degrees of severity and their accidental ingestion can be fatal. Dry ice gives off carbon dioxide, which is capable of asphyxiation within confined areas and at lower concentrations creates a toxicity hazard.
- Class 3 substances (i.e. flammable liquids) – Depending on where storage or usage is occurring, fire, explosion or varying levels of toxicity to people may result. There are containment issues to be considered in the event of a flammable liquids fire, and
- Class 4 substances (flammable solids, self-reacting substances and substances which emit flammable gases when in contact with water) – Depending on where storage or usage is occurring, fire, explosion or varying levels of toxicity to personnel may result. The use of Class 4.2 and 4.3 substances in particular should be carefully controlled.
- Class 5.1 substances (oxidising agents) – Depending on where storage or usage is occurring, fire, explosion or varying levels of toxicity to people may result. Final outcomes will be dependent on the type of oxidising substances in use.
- Class 5.2 substances (organic peroxides) – these are generally only obtained for

specialised uses; they impart varying levels of danger ranging from fire to explosiveness.

- Class 6.1 (toxic) substances – Depending on where storage or usage is occurring, they confer varying levels of toxicity danger to personnel. Only acute toxicity counts towards this classification, but chronic toxicity also poses hazards when substances are handled regularly.
- Class 6.2 (infectious) substances – the storage and usage of infectious substances is regulated and appropriate regulations need to be followed within each state.
- Class 7 (radioactive) substances – Depending on where storage or usage is occurring, varying levels of harm to people may be caused. In the case of radioactive isotopes used for medical research, half-lives of are generally short, with the result that the radioactivity deteriorates to safe levels within a matter of days.
- Class 8 (corrosive) substances – Depending on where storage or usage is occurring, varying levels of danger to personnel may result, depending on the degree of corrosiveness towards human tissue and on the toxicity of the substance. Final outcomes will depend on the types of corrosive agents being used. Class 8 substances are subject to a wide range of incompatibilities both with other corrosive substances and with other dangerous goods classes.
- Class 9 substances – these are described as miscellaneous dangerous goods, and include a high proportion of substances that are environmentally hazardous, of which a high proportion of those are aquatic or marine pollutants and would constitute an environmental hazard in the event of a major loss of containment.
- Laboratory, chemical stores and fume cupboard exhausts – Depending on the location from which the exhausted air is being drawn, the fugitive emissions from these sources may lead to varying levels of toxicity towards people; normally the emissions would be released to the environment at roof level.

5.3. Hazard Identification and Mitigation

Table 5 below provides a summary of the hazardous incidents identified onsite and potential initial mitigating features which may be implemented to reduce their overall risk outcome.

Table 5: Risk Assessment of Foreseeable Scenarios

Event	Cause/Comment	**Category of consequence (bold);** Description of hazards(s)	Likelihood of Event
Gas Reticulation and Storage: flammable and toxic gases			
Leakage of gas to the atmosphere from reticulated pipelines <u>outside</u> of the building.	Mechanical impact from vehicles Weld or joint failure. Operational error. Corrosion. Sabotage.	**Consequence: Moderate** Release of gas at high or moderate pressure. Flammable gas: if ignition source available, flash fires or jet fire possible Toxic gas: health of personnel affected by diluted gas	**Likelihood: Unlikely** All pipes are pressure tested upon commissioning and maintenance schedules are followed, including visual inspection of exposed pipes for corrosion. All piping will be protected within locked risers or enclosures.
Flammable gas: Operational error by user resulting in over-pressuring of gas line or accidental dislodging of cylinders, possibly resulting in cylinder valve shearing off or opening and sudden gas release.	Maintenance work by untrained staff Incorrect shutdown of cylinders Installation of incorrect cylinder to gas manifold. Cylinders not being stored in appropriate location and/or holders.	**Consequence: Moderate** Release of flammable gas at high or moderate pressure with possible "torpedo effect", NO IGNITION, possible injuries	**Likelihood: Moderate** Human error and/or user inexperience may result in a human induced event.
As above	**As above**	**Consequence: Catastrophic** Release of flammable gas at high or moderate pressure, GAS IGNITES, resulting in flash fire, jet fire or explosion, with possible severe injuries or death	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event. Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor storage areas.
Highly toxic gas: Operational error by user resulting in over-pressuring of gas line or accidental dislodging of cylinders, possibly resulting in cylinder head shearing off and sudden toxic gas release.	Maintenance work by untrained staff Incorrect shutdown of cylinders Installation of incorrect cylinder to gas manifold. Cylinders not being stored in appropriate location and/or holders.	**Consequence: Catastrophic** Release of highly toxic gas at high or moderate pressure, resulting in severe health consequences or death for personnel within area; possible health consequences for personnel within wider area *Note: there's no suggestion that highly toxic gases will be used in these laboratories, e.g. Arsine, phosphine, chlorine, fluorine, etc.*	**Likelihood: Rare** As above, and in addition: Detailed risk assessment necessary before any highly toxic gas can be brought into the building. Only trained staff would install or use the gas

Event	Cause/Comment	Category of consequence (bold); Description of hazards(s)	Likelihood of Event
Flammable gas: Venting of gas (whether intentional or unintentional), resulting in significant release of gas	Maintenance work Incorrect shutdown or purging of gas lines.	**Consequence: Major** Limited-volume release gas at high or moderate pressure, GAS IGNITES, resulting in flash fire or jet fire, with serious injury.	**Likelihood: Rare** Any maintenance work will require system shutdown, pressure release and degassing. Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor storage areas.
All gases: Gas release within laboratories.	Valve left open unintentionally, steady flow of gas into laboratory	**Consequence: Major** Build-up of gas within laboratory causing oxygen depletion, with serious health effects	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event. Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor storage areas.
Flammable gas: Gas release within laboratories.	As above	**Consequence: Catastrophic** Build-up of gas within laboratory, GAS IGNITES.	**Likelihood: Rare** As above
Oxidising gas: Gas release within laboratories.	As above	**Consequence: Major** Build-up of oxygen or oxidising gas within laboratory causing oxygen enrichment, SPONTANEOUS IGNITION OF COMBUSTIBLE MATERIALS, with serious injuries	**Likelihood: Rare** As above
Highly toxic gas: Gas release within laboratories.	As above	**Consequence: Catastrophic** Build-up of highly toxic gas within laboratory causing DEATH or SERIOUS INJURY	**Likelihood: Rare** As above
Cryogenic Liquid Usage / Storage			
Non-toxic cryogenics: Vessel rupture within indoor setting or sudden loss of containment	Mechanical impact from vehicle Weld or joint failure Corrosion Sabotage.	**Consequence: Catastrophic** Sudden release of cryogenic liquid into neighbouring area causing sudden oxygen depletion, DEATH(s)	**Likelihood: Rare** Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor areas.

Event	Cause/Comment	**Category of consequence (bold);** Description of hazards(s)	Likelihood of Event
Liquid Oxygen: Vessel rupture within indoor setting	As above	**Consequence: Catastrophic** Sudden release of liquid oxygen into neighbouring area causing combustible materials to catch fire , DEATH(s) *Note: there's no suggestion that liquid oxygen will be used in these laboratories.*	**Likelihood: Rare** Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor areas, and further mitigating action would be taken when using liquid oxygen.
Flammable cryogenics: Vessel rupture within indoor setting	As above	**Consequence: Catastrophic** Sudden release of flammable vapours into neighbouring area leading to explosion: DEATH(s) *Note: there's no suggestion that flammable cryogenics will be used in these laboratories.*	**Likelihood: Rare** Likelihood is "Rare" based on assumption that mitigation would include use of effective natural or mechanical ventilation in indoor areas, and further mitigating action would be taken when using flammable cryogenics.
Cryogenic liquids in general: Spillage of vessel contents within indoor setting	Human error, degradation of carrying equipment.	**Consequence: Moderate** Sudden release of cryogenic liquid into neighbouring area causing brief oxygen depletion, personnel contract burns and suffer moderate health effects	**Likelihood: Unlikely** Human error and/or user inexperience may result in a human induced event.
Chemical Storage and Laboratory Areas/ Usage (Classes 3 to 9, excluding 6.2 & 7, including sub. classes)			
Class 3 or Class 4.3: Accidental spillage or breakage of containers	Human error, shelving failure.	**Consequence: Catastrophic** Spillage results in generation of flammable vapours, or Class 4.3 material contacts water and gives off flammable vapours: FIRE OR EXPLOSION, resulting in severe injury or death.	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event. Likelihood is "Rare" based on assumption that mitigation would include use of mechanical ventilation within store, and hazardous zone assignments within store would further reduce probability of ignition.

Event	Cause/Comment	**Category of consequence (bold);** Description of hazards(s)	Likelihood of Event
All classes, but particularly Class 5.1 and Class 8: Accidental breakages resulting in spillage and mixing of 2 or more incompatible chemicals within chemical storage area.	Human error, shelving failure.	**Consequence: Major** Spillage results in incompatible chemicals reacting, with generation of toxic and corrosive fumes; SERIOUS INJURIES	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event; this would require incompatible chemicals to be spilt together, "Rare" assumes that mechanical ventilation would greatly reduce the probability that resulting vapours would reach highly toxic or hazardous levels. The change of mixing of chemicals #would be further reduced by storing incompatible chemicals within dedicated chemical cabinets or different stores.
As above, but with consequences outside of building	Delivery vehicle accident, accidental dropping of containers within loading dock area.	**Consequence: Moderate** Spillage results in complaints from personnel in neighbouring surrounding building	**Likelihood: Rare** Complaints would be likely only in the event that the reaction products generate strong odours
Class 6.1 and Class 8: Accidental spillage or breakage of containers	Human error, shelving failure.	**Consequence: Moderate** The corrosiveness and/or toxicity of the spilt liquid and any vapours produced lead to toxic health effects and damage to human tissue; INJURIES REQUIRING HOSPITALISATION	**Likelihood: Unlikely** Mixing of chemicals resulting in undue risk would be low because chemicals would be stored within dedicated chemical cabinets or stores.
Class 5.1: Accidental spillage of chemical within laboratories, liquid contacts organic material such as fabric or an oxidisable substance	Human error, shelving failure.	**Consequence: Moderate** Spillage not fully cleaned up and organic material later catches fire, resulting in building fire. INJURIES REQUIRING HOSPITALISATION, PROPERTY DAMAGE	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event. Fires of this nature are rare but known to occur.
Class 5.1, 6.1 or 8: Accidental breakage of glass container within laboratories, with injury to person and contact with substance that's corrosive to skin,	Human error, shelving failure.	**Consequence: Moderate** Person ruptures skin while trying to clean up spillage, neglecting to use appropriate PPE due to inexperience; INJURY REQUIRING HOSPITALISATION	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event.

Event	Cause/Comment	**Category of consequence (bold);** Description of hazards(s)	Likelihood of Event
Multiple classes: Two chemicals are deliberately mixed, leading to unintended and violent reaction	Human error, shelving failure.	**Consequence: Moderate** The sudden nature and violence of the reaction lead to injury and property damage. INJURIES REQUIRING HOSPITALISATION, PROPERTY DAMAGE	**Likelihood: Unlikely** Human error and/or user inexperience may result in a human induced event.
As above, but with consequences outside of building	Delivery vehicle accident, accidental dropping of containers within loading dock area.	**Consequence: Moderate** Unintentionally violent chemical reaction results in complaints from personnel in neighbouring surrounding building	**Likelihood: Rare** Complaints would be likely only in the event that the reaction products generate strong odours
Storage or usage of Class 7			
Accidental spillage or breakage of containers within storage areas.	Human error, shelving failure.	**Consequence: Moderate** Release of radioactive material.	**Likelihood: Unlikely** Human error and/or user inexperience may result in a human induced event. However, radioactive material would be stored onsite in small volumes and within a secondary container.
Accidental spillage of chemical within laboratories.	Human error, shelving failure.	**Consequence: Moderate** Mixing of chemicals may result in undue risk because of unwanted reactions, e.g. fire, explosion, toxic fumes.	**Likelihood: Rare** Human error and/or user inexperience may result in a human induced event.
Transportation of Dangerous Goods to and from the building			
Accident onsite while goods are being delivered to site	Human error.	**Consequence: Major** Gas cylinders, cryogenic liquid vessels may become damaged. Breakage of glass containers holding chemicals. Release of toxic, flammable or oxygen depleting gases into the surrounding area.	**Likelihood: Unlikely** The dangerous goods transport company would follow their procedures and protocols which would be in compliance to the ADG Code.
Transportation of Dangerous Goods between the Store and Laboratory			
Transportation of gases or cryogenic liquids between building levels resulting contents spillage.	Human error, equipment failure.	**Consequence: Major** Personal injury or asphyxiation.	**Likelihood: Unlikely** Human error and/or user inexperience may result in a human induced event. However, any human induced event may result in death.

5.4. Calculation of Risk

Risk is the likelihood of any defined adverse outcome due to a hazardous event. Risk can be defined for any of the final outcomes of an event as detailed in Table 5 by the effect of the consequences coupled with the associated likelihood. As the adverse outcome can take many forms, particularly in the case of effects on the biophysical environment, risks can be expressed in a number of different ways. Within this report, the Risk has been documented in Table 7 using the risk assessment table in Table 6.

Based on the risk assessment results as detailed in Table 7, result greater than ‘LOW’ will require further risk mitigating hardware to mitigate any potential adverse event or reduce its impact.

Table 6: Risk Assessment Table

Likelihood \ Consequences	**Insignificant** Minor problem, easily handled by normal day to day process.	**Minor** Some disruption possible. Injuries may result, hospitalisation generally not required, can be treated with first aid onsite.	**Moderate** Significant time & resources required. Moderate injuries, may require hospitalisation.	**Major** Operations severely damaged. Severe injuries.	**Catastrophic** Business survival at risk. Death.
Almost Certain (>90%)	High	High	Extreme	Extreme	Extreme
Likely (50 - 90%)	Moderate	High	High	Extreme	Extreme
Moderate (10 - 50%)	Low	Moderate	High	Extreme	Extreme
Unlikely (3 - 10%)	Low	Low	Moderate	High	Extreme
Rare (<3%)	Low	Low	Moderate	High	High

Table 7: Risk Assessment Outcome

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
Gas Reticulation and Storage: flammable and toxic gases				
Leakage of gas to the atmosphere from reticulated pipelines outside of the building.	**Moderate**	**Unlikely**	**Moderate**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install collision bollards to protect the cylinders or piping locations. • Conduct plume modelling to confirm safe dispersion of contaminants.
Flammable gas: Operational error by user resulting in over-pressuring of gas line or accidental dislodging of cylinders, possibly resulting in cylinder valve shearing off or opening and sudden gas release. **NO IGNITION**	**Moderate**	**Moderate**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges.
As above, but GAS IGNITES	**Catastrophic**	**Rare**	**High**	As above, but additionally: • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for explosive levels of the gas being reticulated, with automatic shut-off valves connected to the gas sensor.

Highly toxic gas: Operational error by user resulting in over-pressuring of gas line or accidental dislodging of cylinders, possibly resulting in cylinder head shearing off and sudden toxic gas release.	**Catastrophic**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges. • Install specific gas warning sensors that are coupled to the pressure regulator and will shut off the gas supply a specified concentration of the toxic gas.
Flammable gas: Venting of gas (whether intentional or unintentional), resulting in significant release of gas, **GAS IGNITES**	**Major**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for explosive levels of the gas being reticulated, with automatic shut-off valves connected to the gas sensor.
All gases: Gas release within laboratories, leading to hazardous oxygen depletion, NO IGNITION	**Major**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Install oxygen depletion sensors to monitor for explosive levels of the gas being reticulated, with automatic shut-off valves connected

Flammable gas: Gas release within laboratories, GAS **IGNITES**	**Catastrophic**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges. • Identify hazard zones (as per AS 60079.10.1) and install appropriate electrical fittings complying with the enclosure's classification, i.e. ZONE type, Gas Group, Temperature Class. • Install gas sensors to monitor for explosive levels of the gas being reticulated, with automatic shut-off valves connected to the gas sensor.
Oxidising gas: Gas release within laboratories, SPONTANEOUS IGNITION OF COMBUSTIBLE MATERIALS	**Major**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges. • Restrict as far as possible the quantity of any material that may be combustible. • Install oxygen sensors (or specific sensor for oxidising gas or gases) to monitor for elevated levels of the gas being reticulated, with automatic shut-off valves connected to the gas sensor.
Highly toxic gas: Gas release within laboratories, causing DEATH OR SERIOUS INJURY	**Catastrophic**	**Rare**	**High**	• For enclosed areas (i.e. gas stores), design enclosure as per the requirements of AS 4332. • Use fully welded pipework. • Locate over-pressure release valves at appropriate locations to minimise the release of gases into an enclosed location, i.e. vent to atmosphere. • Locate structurally sound cylinder holders within the enclosure with ample space for cylinder movements between cylinder exchanges. • Install specific gas warning sensors that are coupled to the pressure regulator and will shut off the gas supply a specified concentration of the toxic gas.

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
Cryogenic Liquid Usage / Storage				•
Non-toxic cryogenics: Vessel rupture within indoor setting or sudden loss of containment, RESULTING IN FATALATY	**Catastrophic**	**Rare**	**High**	• Locate vessel as per the requirements of AS 1894. • Ensure pressure release valve is appropriate and working correctly for vessel requirements. • Ensure all separation distances, as per AS 1894, are met. • Direct pressure release valves to areas away from public spaces. • Ensure release valve meets separation requirements as per AS 1894.
Cryogenic liquids in general: Spillage of vessel contents within indoor setting, LEADING TO BURNS & MODERATE HEALTH EFFECTS	**Moderate**	**Unlikely**	**Moderate**	• For closed vessels which are transporting cryogenic liquids internally, ensure dewars with a maximum volume of 250 L are used. • For open vessels, ensure maximum dewar volume is based on risk assessment taking into consideration room volume, fresh air ventilation and volume of cryogenic liquid.
Chemical Storage and Laboratory Areas/ Usage (Classes 3 to 9, excluding 6.2 & 7, including sub. Classes)				
Class 3 or Class 4.3: Accidental spillage or breakage of containers, resulting in fire or explosion with FATALITY	**Catastrophic**	**Rare**	**High**	• Design chemical storage areas as per the requirements of AS 2243.10, incorporating further requirements from AS 1940, i.e. fire separation, ventilation requirements, etc. • Incorporate minimum firefighting requirements as per AS 1940. • Ensure flammable liquids store has containment area that's designed as per the requirements of AS 1940, thus supplying minimum bunding requirements so that all foreseeable spills are contained • For areas where flammable vapours may result, ensure hazard zoning as per the requirements of AS 60079.10.1 are incorporated clearly documenting ZONE type, Gas Group, Temperature Class. • Ensure that all flammable liquids are suitably stored, even those which are only subsidiary Class 3

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
All classes, but particularly Class 5.1 and Class 8: Accidental breakages resulting in spillage and mixing of 2 or more incompatible chemicals within chemical storage area. SERIOUS INJURIES	**Major**	**Rare**	**High**	• Design chemical storage areas incorporating segregation and separation to minimise unwanted chemical mixing, i.e. Class 3 chemicals to be separated from Class 8 and 6.1. Class 6.1 chemicals to be segregated from Class 8 chemicals. • Ensure that all potential incompatibilities are checked when assigning storage locations, including acids/alkalis, acids/cyanides, hypochlorites/acids and Class 4.3/water.
As above, but with consequences outside of building COMPLAINTS FROM PERSONNEL IN SURROUNDING BUILDINGS	**Moderate**	**Rare**	**Moderate**	As above, but additionally: • Ensure exhaust from chemical storage areas exhaust at an appropriate location, ideal locations may require investigation through AERMOD, AUSPLUME or physical modelling of wind and building infrastructure
Class 6.1 and Class 8: Accidental spillage or breakage of containers, leads to INJURIES REQUIRING HOSPITALISATION	**Moderate**	**Unlikely**	**Moderate**	• Careful assessment of each course of action and use of appropriate PPE to minimise probability of a spillage of toxic and corrosive chemicals
Class 5.1: Accidental spillage of chemical within laboratories, liquid contacts organic material such as fabric or an oxidisable substance, resulting in INJURY REQUIRING HOSPITALISATION	**Moderate**	**Rare**	**Moderate**	• Training of all personnel to increase awareness of the potential of oxidising agents to lead to fires, with reference to AS 4326.
Class 5.1, 6.1 or 8: Accidental breakage of glass container within laboratories, with injury to person and contact with substance that's corrosive to skin,	**Moderate**	**Rare**	**Moderate**	• Careful assessment of each course of action and use of appropriate PPE to minimise probability of the breakage of a glass vessel containing of toxic, oxidising or corrosive chemicals

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
Multiple classes: Two chemicals are deliberately mixed, leading to unintended and violent reaction, resulting in INJURY REQUIRING HOSPITALISATION & PROPERTY DAMAGE	**Moderate**	**Unlikely**	**Moderate**	• Careful assessment of risk of uncontrolled reaction prior to mixing chemicals; of appropriate PPE to minimise probability of injury
As above, but with consequences outside of building COMPLAINTS FROM PERSONNEL IN SURROUNDING BUILDINGS	**Moderate**	**Rare**	**Moderate**	As above, but additionally: • Ensure exhaust from chemical storage areas exhaust at an appropriate location, ideal locations may require investigation through AERMOD, AUSPLUME or physical modelling of wind and building infrastructure
Storage or usage of Class 7				
Accidental spillage or breakage of containers within storage areas.	**Moderate**	**Unlikely**	**Moderate**	• Design the entire radiochemistry laboratory and associated storage areas as per the requirements of AS 2243.4, ensuring that no other activities are carried out within that area • Ensure that full training is provided to all personnel working with radioactive materials • Ensure that disposal of radioactive materials is carried out with the requirements of AS 2243.4 and within the applicable legislation

Event	Consequence Rating	Likelihood Rating	Overall Risk	Required Mitigating Strategies
Transportation of Dangerous Goods to and from the building				
Loss of containment of dangerous goods onsite while goods are being delivered to site	**Major**	**Unlikely**	**High**	• Ensure that all deliveries to site are conducted by approved suppliers which hold all relevant licensing as per the Australian Dangerous Goods Code, Dangerous Goods (Road and Rail Transport) Act 2008 and Dangerous Goods (Road and Rail Transport) Regulation 2014. • Ensure appropriate spill kits are available and that all university staff who may be in attendance are trained in their use, and in how to react to a loss of containment • Ensure the design of the loading dock provides ample space for ease of truck movements. • Ensure that spilt material is not allowed to enter waterways and that it's not somehow flushed or moved into a public place where members of the public may be exposed to it. • Ensure that the company delivering the dangerous goods has a safety management system that includes procedures for clean-ups and incident management; where spills occur on university premises, the university staff should be in control of the clean-up process.
Transportation of Dangerous Goods within the building				
Transportation of gases or cryogenic liquids between building levels resulting contents spillage.	**Major**	**Unlikely**	**High**	• Prevent personnel from occupying lifts while they are being used to transport cryogenic liquids between floors • Implement lift controls for unattended lift usage. • Transport goods on purpose-designed trolleys to minimise the possibility of spillage of dangerous goods.

6. Potential Hazardous Incidents and their Controls

As detailed in the risk assessment above (Table 7), safety management systems have been recommended to reduce the risk from potentially hazardous installations, these mitigating strategies will employ design requirements as detailed in various Australian Standards and a combination of engineered solutions including, hardware and software packages. It is essential to ensure that hardware systems and software procedures used are reliable and of the highest quality in order to ensure safe operation of the facility under all circumstances.

6.1. General Hardware Safeguards

Hardware safeguards include factors such as laboratory design, layout of equipment and instrumentation, and compliance with relevant codes, technical standards and industry best practice.

All systems handling dangerous goods will comply with the following Acts, Regulations and Codes and Australian Standards in their latest editions. Below are listed some of the most relevant for laboratory design and construction:

- NSW Work Health and Safety Act (2011) and NSW Work Health and Safety Regulation (2011)
- NSW Dangerous Goods (Road and Rail Transport) Act 2008 and NSW Dangerous Goods (Road and Rail Transport) Regulation 2014
- Gene Technology Act (2000) and Gene Technology Regulations (2001)
- AS/NZS 2982 Laboratory design and construction.
- AS/NZS 2243.1 Safety in laboratories – Planning and operational aspects.
- AS/NZS 2243.2 Safety in laboratories – Chemical aspects.
- AS/NZS 2243.3 Safety in laboratories - Microbiological safety and containment.
- AS/NZS 2243.4 Safety in laboratories - Ionizing radiations.
- AS/NZS 2243.5 Safety in laboratories - Non-ionizing radiations—Electromagnetic, sound and ultrasound.
- AS/NZS 2243.8 Safety in laboratories -. Fume cupboards
- AS/NZS 2243.10 Safety in laboratories - Storage of chemicals.

- AS/NZS 5601.1 Gas Installations – General Installations
- AS 4332 The storage and handling of gases in cylinders
- AS/NZS 60079.10.1 Explosive atmospheres - Classification of areas - Explosive gas atmospheres.
- AS/NZS 60079.17 Explosive atmospheres - Electrical installations inspection and maintenance.
- AS/NZS 60079.14 Explosive atmospheres - Electrical installations design selection and erection.

6.2. Specific Hardware Safeguards

6.2.1. Gas Leakage

Various Australian Standards set out minimum standards for pipelines in which flammable, oxidising, toxic or non-hazardous gases are reticulated. These give detailed requirements for the design, construction and operation of the pipelines for the various classes of gases.

The proposed safeguards for the supply pipelines are detailed below. The safeguards have been grouped together under the potential hazardous events associated with the pipeline.

- External Interference – Such interference may be due to collisions from vehicles or sabotage of the pipeline installation. This potential is minimised through the fact that all reticulated services, e.g. natural gas (which would generally be supplied by an underground pipeline at high pressure) or other gases for laboratory use will be clearly labelled and protected by collision bollards or within service risers. Further to this, any external installation will be protected by security fencing or within a dedicated secure enclosure.
- Construction Defects / Material Failure – These events may be due to poor workmanship or quality of material. Gas leaks due to material failure are minimised by initially testing gas lines as per the requirements of AS 4037 (these tests include the stability and quality of joints). The potential for gas leaks is further minimised by the installation of pressure release valves which are designed to release pressure at a known level below the failure pressure of the pipeline.
- Corrosion of piping – Although corrosion of piping may be possible in the lifetime of the installation, all exposed piping would be subject to ongoing monitoring and maintenance regimes as per manufacturer’s requirements or as detailed in relevant

Australian Standards.

- Oxygen depletion / Toxic and/or Flammable gas accumulation – In areas where gas accumulation can occur, appropriate oxygen depletion or toxic/flammable gas sensing devices are to be installed. An appropriate risk assessment must be conducted to elucidate appropriate sensors, alarming levels and location for installation.
- Oxygen enrichment or build-up of oxidising gases – Oxygen enrichment can greatly increase the risk of fires, as can the build-up of oxidising gases such as nitrous oxide. Where oxygen is used the sensors should also be capable of warning against oxygen enrichment; in the case of oxidising gases, appropriate sensors should be installed.

6.2.2. CRYOGENIC VESSEL OR CYLINDER RUPTURE / FALL

Australian Standards AS 1894 and AS 4332 set out minimum design and construction requirements for these types of enclosures which are to house cryogenic liquids (AS 1894) or compressed gases in storage (AS 4332). The proposed safeguards for these enclosures are detailed below when considering potential hazardous events associated with the type of storage.

- External Interference – Such interference may be due to collisions from vehicles or sabotage of the storage area. This potential is minimised through construction of enclosures which are protected by either collision bollards or collision barriers. Further to this, these enclosures will be protected by security fencing or solid construction which will be lockable by a secure gate/door.
- Construction Defects / Material Failure – These events may result due to poor workmanship or quality of material. However, the main gas suppliers such as Coregas and BOC supply compressed gases in cylinders or cryogenic cylinders construct and test these items to relevant Australian Standards to confirm the quality of the items and compliance to specifications. Therefore such an event would be unlikely to occur. This risk is further reduced by the installation of pressure release valves on cylinders and cryogenic tanks which are set to release gas in the event of pressure build-up.
- Corrosion of cylinders or tanks – Although corrosion of cylinders and tanks is possible over the lifetime of the items, cylinders are pressure-tested by the gas suppliers to confirm integrity as per their procedures and protocols. The cryogenic

tanks will also be pressure-tested following similar protocols.

- Oxygen depletion /Oxygen enrichment / Toxic and/or Flammable gas accumulation – In areas where gas accumulation can occur, appropriate oxygen depletion or toxic/flammable gas detection devices are to be installed. An appropriate risk assessment must be conducted to determine the appropriate sensors, alarming levels and location for installation.

6.2.3. Chemical Storage, Use, Spills or Fires

The appropriate Australian Standards include the AS 2243 series (several of which are already listed in Section 6.1) as well as various storage and handling standards and other appropriate standards listed below:

- AS/NZS 1940 The storage and handling of flammable and combustible liquids.
- AS/NZS 1894 The storage and handling of non-flammable cryogenic and refrigerated liquids.
- AS/NZS 4332 The storage and handling of gases in cylinders.
- AS/NZS 1596 The storage and handling of LP Gas
- AS/NZS 5026 The storage and handling of Class 4 dangerous goods
- AS/NZS 4326 The storage and handling of oxidizing agents
- AS 2714 The storage and handling of organic peroxides
- AS/NZS 4452 The storage and handling of toxic substances
- AS 3780 The storage and handling of corrosive substances
- AS/NZS 4681The storage and handling of Class 9 (miscellaneous) dangerous goods and articles
- AS/NZS 1216 Class labels for dangerous goods.
- AS 1668.2 The use of ventilation and air-conditioning in buildings. Part 2: Mechanical ventilation in buildings

The above standards set out storage requirements for dangerous goods; including constructions requirements for chemical stores, ventilation requirements, maximum allowable volumes in storage and in use, recommended procedures to mitigate spills and minimum firefighting requirements.

The proposed safeguards for these storage and usage areas are detailed below when considering potential hazardous events associated with the type of storage or use.

- Human error, spills and vapour generation – For volatile chemicals which are accidently spilt due to human error (e.g. accidental dropping of containers) the resulting spilt liquids can generate vapours which may be toxic or flammable in nature. The vapour pressure of many liquids (ethanol for instance) will lie within the explosive range of that vapour and in the absence of effective ventilation the spillage can create a hazardous atmosphere above the liquid. A means to mitigate the risk to occupants is to ventilate the area to maintain an environment which is suitable for personnel to implement corrective actions to either clean up the spill or alert others to the incident. As detailed in the standards above, safety devices that are implemented in laboratory or chemical store design include:
  - Emergency buttons to alert security or safety officers.
  - Gas or vapour sensors, which when triggered, alert security or safety officers.
  - Emergency ventilation.
  - Spill kits to aid in clean-up.
- Flammable vapour generation – For areas where flammable liquids are used, spills of these chemicals can generate flammable vapours which can cause flash fires or explosions. However when considering the 'fire triangle', the three items that are required to cause a fire or explosion are oxygen, fuel and an ignition source. The two items above which can be controlled through engineering mitigating devices are flammable vapour generation and ignition sources. Therefore these areas will be ventilated as per AS 1940 and AS 1668.2 and all ignition sources will be assessed following the requirements of AS 60079.10.1. That is all areas where flammable liquids are used will be mapped in terms of their flammable areas (known as hazardous zones, as defined in AS 60079.10.1) and all electrical items which fall within the defined hazard zones will be engineered to meet the requirements of the applicable standards of the AS 60079 series.
- Fires from spills – All areas where chemicals are being used may possess a small potential for fires. This risk is mitigated through the installation of various firefighting devices as per relevant codes and Australian Standards, these firefighting devices will include:
  - Fire sprinklers.
  - Fire hose reels.
  - Fire extinguishers.

  - Fire blankets.

  Therefore, although a risk of fire is always present there will be a number of mitigating strategies which will be applied to meet BCA requirements such as fire compartmentation, firefighting devices, etc.

- Containment of flammable liquid spills – areas where flammable liquids are stored will require appropriate containment of any flammable liquid spill and will need to be constructed to the requirements of AS 1940. Areas where these chemical are used will need to comply with the requirements of AS/NZS 2243.10.
- Containment of corrosive liquid spills – areas where flammable liquids are stored will require appropriate containment of any flammable liquid spill and will need to be constructed to the requirements of AS 3780. Areas where these chemical are used will need to comply with the requirements of AS/NZS 2243.10.
- Containment of flammable solids (Class 4 dangerous goods) – areas where flammable solids are stored will require appropriate containment of any flammable gases which could be generated due to spills and will need to be constructed to the requirements of AS 5026. Areas where these chemical are used will need to comply with the requirements of AS/NZS 2243.10.
- Storage of Class 5.1 dangerous goods (i.e. oxidising substances) – areas where oxidising agents are stored will require appropriate containment and will need to be constructed to the requirements of AS 2714 and/or AS/NZS 2243.10. Areas where these chemical are used will need to comply with the requirements of AS/NZS 2243.10.
- Storage of Class 6.1 dangerous goods (i.e. toxic substances) – areas where oxidising agents are stored will require appropriate containment and will need to be constructed to the requirements of AS/NZS 4452 and/or AS/NZS 2243.10. Areas where these chemical are used will need to comply with the requirements of AS/NZS 2243.10.

6.2.4. Class 7 Substances – Spills and Discharges

If Class 7 (i.e. radioactive) substances are to be used in this facility then procedures and protocols as detailed by ARPANSA will need to be followed prior to relevant licensing being issued.

The proposed safeguards for safe use and storage of such substances are detailed in

AS 2243.4, where design construction requirements are also detailed.

- Spills – All surfaces where these substances will be used will be designed so as to be easy to clean and non-absorbent.
- Legislative requirements in relation to design and construction for areas where radioactive materials are used will be adhered to minimise the risk to occupants, and to neighbouring establishments as a result of general ventilation discharges.

6.2.5. Chemical Vapour Release from the Building

As a scientific building where a number of processes and tasks will generate various vapours which can be toxic or harmful to users, the AS 2243 series of standards sets out minimum design and construction requirements for laboratories and how to expel their emissions to minimise the impact and risk to the public. Currently AS 2982 and AS 1668.2 define how ventilation exhaust is to be discharged into the atmosphere to minimise the impact on the general public and neighbouring building.

The proposed safeguards for safe exhaust discharge are:

- Design exhaust stacks to meet the requirements of AS 1668.2 meeting minimum separation distances from building fresh air intakes and other openings within the same building or neighbouring buildings.
- Conduct plume modelling for stack emissions to confirm that all contaminants discharged from stacks are diluted to acceptable levels before reaching locations where people are likely to be present for significant periods. “Acceptable” would be defined in terms of potential odours and in terms of levels that have the potential to cause health effects from regular exposure. Such discharge locations will be modified if required to minimise the risk of neighbouring complaints.

7. Conclusion

In reviewing the new proposal and the conditions as detailed within the 'Department of Planning's Hazardous and Offensive Development Application Guidelines - Applying SEPP 33', CETEC believes that SEPP 33 applies to this proposal based on the following items exceeding limits as described within the SEPP 33 documentation, these exceedances are;

- Pressurised Class 2.1 gases, i.e. > 100 Kg to be held onsite.
- Pressurised Class 2.3 gases, i.e. > 100 Kg to be held onsite.
- Possible number of allowable vehicle delivery exceedances.

Therefore the following conclusions and recommendations have been attained following this risk assessment.

The main hazard associated with the proposed project is associated with the production and handling of Dangerous Goods of Classes 2 to 9, including Class 7 items. A number of hazards will always be present onsite due to the nature of work which will be conducted within this building. Although its impact to the internal and external environments will be dependent on volumes present and staff training, the impact from any incident onsite can be further reduced through the implementation of construction requirements as detailed within various Australian Standards, the Building Code of Australia and other local government construction requirements.

As documented in Table 7, the *Risk Assessment Outcomes*, there are a number of risk scenarios which have been found to be Moderate to Extreme in this assessment (assuming no engineering controls are implemented), however practically it would be expected that the impact to the external environment, i.e. the neighbouring environment, would be small given that chemical volumes onsite would be relatively small. Further impacts to the local environment, building occupants and building structure can be further reduced by the implementation of appropriate design requirements as detailed in Table 7. However, the major social impact from an incident onsite would be through the injury of staff and/or students within the classrooms or laboratories. This risk and impact on the surrounding community will need to be addressed and mitigated based on the following recommendations.

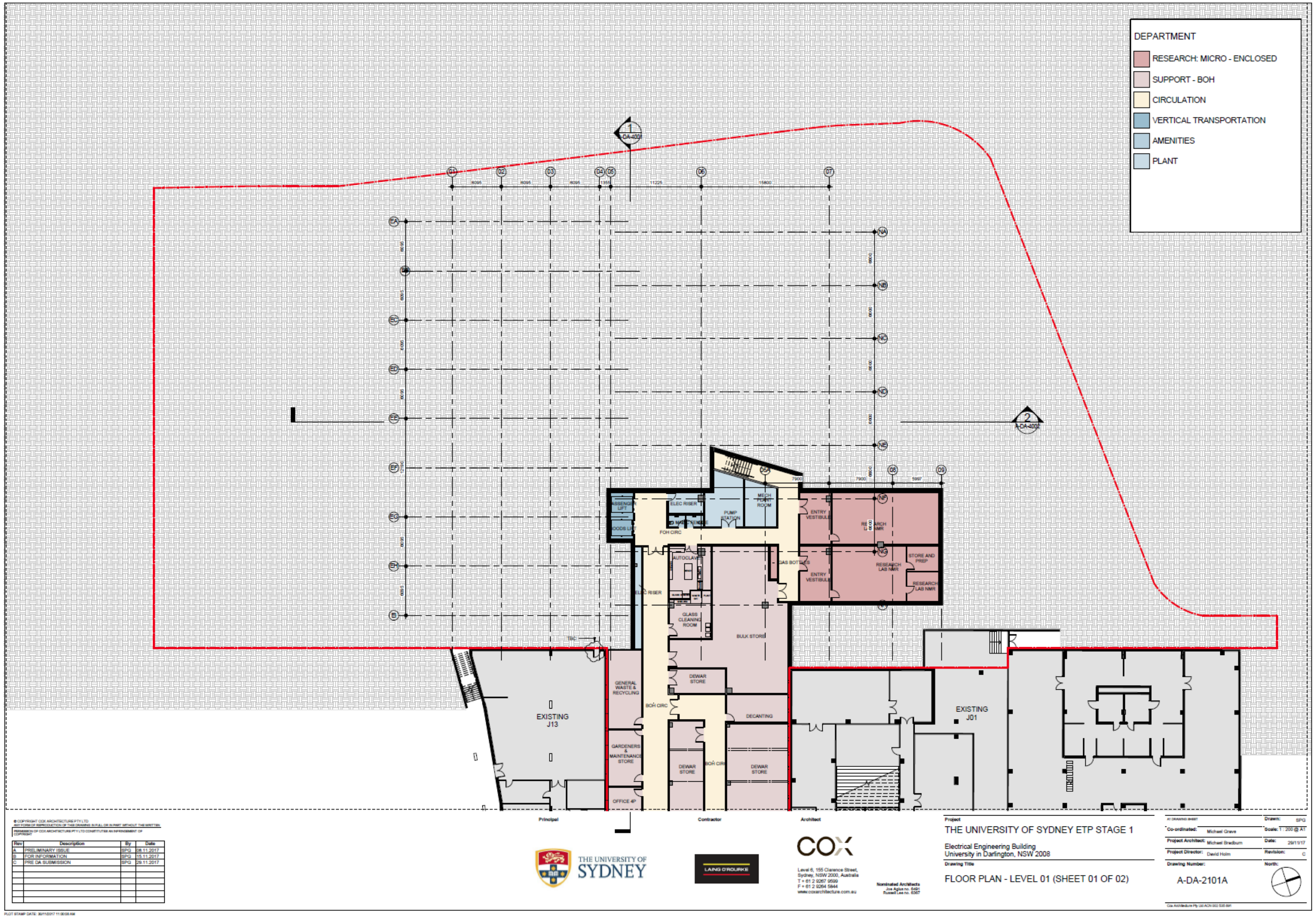
7.1. RECOMMENDATIONS POST-DEVELOPMENT CONSENT

This report documents a number of risks and hazards associated with the identified chemicals which will be used within the building and broadly identifies potential risk mitigating strategies which can be applied to decrease the risk. This report doesn't risk assess user requirements, chemical usage within laboratories or any other engineering risk mitigating controls that may be required to mitigate the hazards associated with the nature of the work to be conducted within the building.

Therefore following development consent by local authorities and as a condition imposed on the project by the SEPP 33 study, a risk assessment will be required in the future to determine the most appropriate mitigation available and generally speaking would include the following reviews and audits, as detailed below, by a suitably qualified Dangerous Goods and Laboratory Design expert;

- Conduct an assessment to determine laboratory design compliance against *AS/NZS 2982:2010 – Laboratory design and construction*.
- Conduct a detailed study of current chemical usage to determine expected stack discharge rates and plume dispersal in compliance to *AS/NZS 2243.8 – 2014 Safety in Laboratories Part 8: Fume cupboards*.
- Conduct a detailed review of chemicals to be used onsite to determine;
    - If allowable chemical volumes are exceeded against *AS/NZS 2243.10:2004 Safety in Laboratories Part 10: Storage of chemicals*.
    - Chemicals and activities which will generate hazardous flammables zones.
    - Determine dimensions of hazardous zones following the requirements of *AS/NZS 60079.10.1 - Explosive atmospheres - Classification of areas - Explosive gas atmospheres*.
    - Elucidate the hazardous zones Temperature Class and Gas Grouping for electrical item installation in compliance to *AS/NZS 3000:2007 Wiring rule*s and the *Electrical Act*.
- Review areas of gas usage and determine appropriate gas sensors to be used for the hazards which are identified.
- Any other hazards identified at the time of the risk assessment.

APPENDIX A – PLANS USED FOR THIS ASSESSMENT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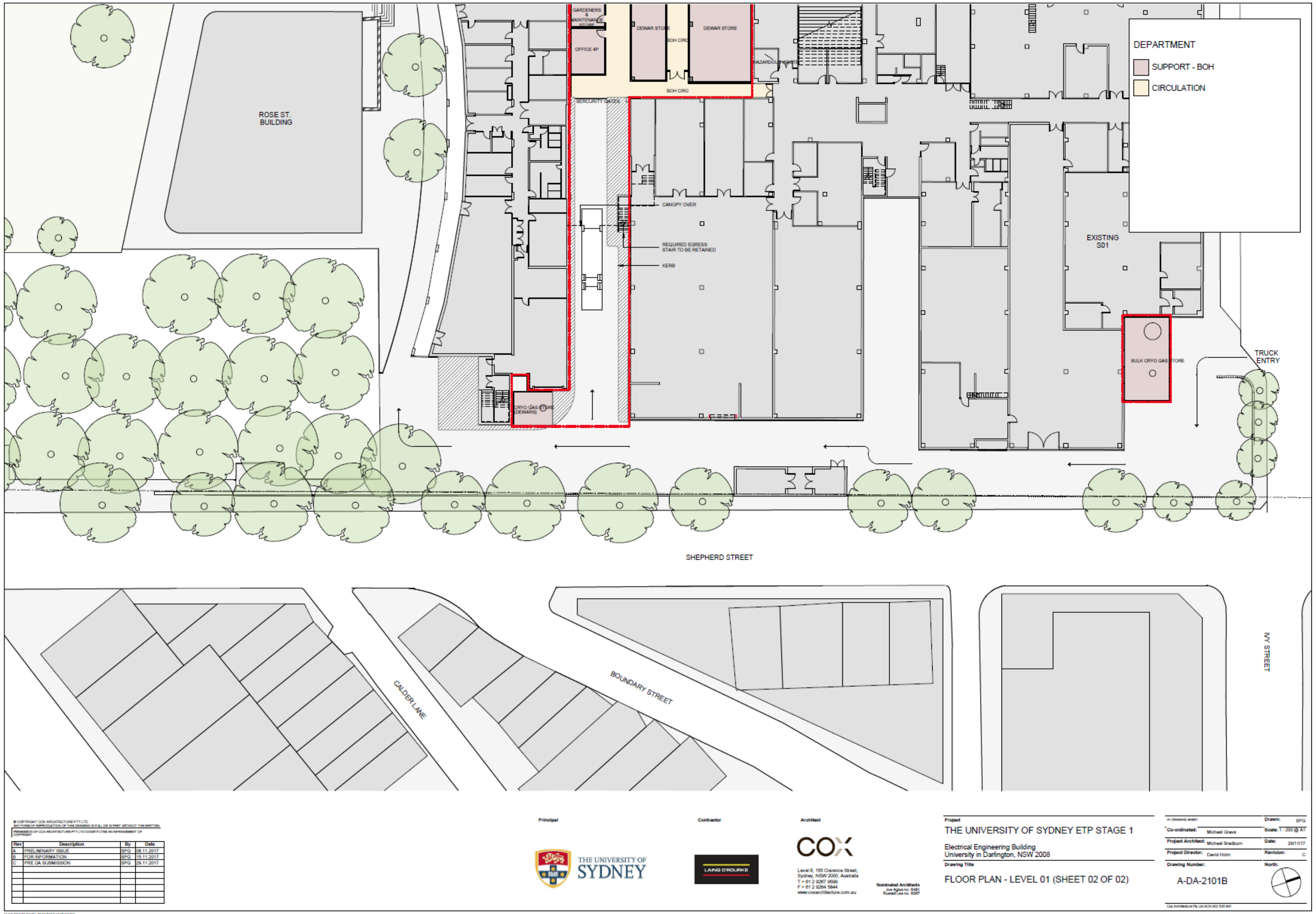
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Project Director: David Holm
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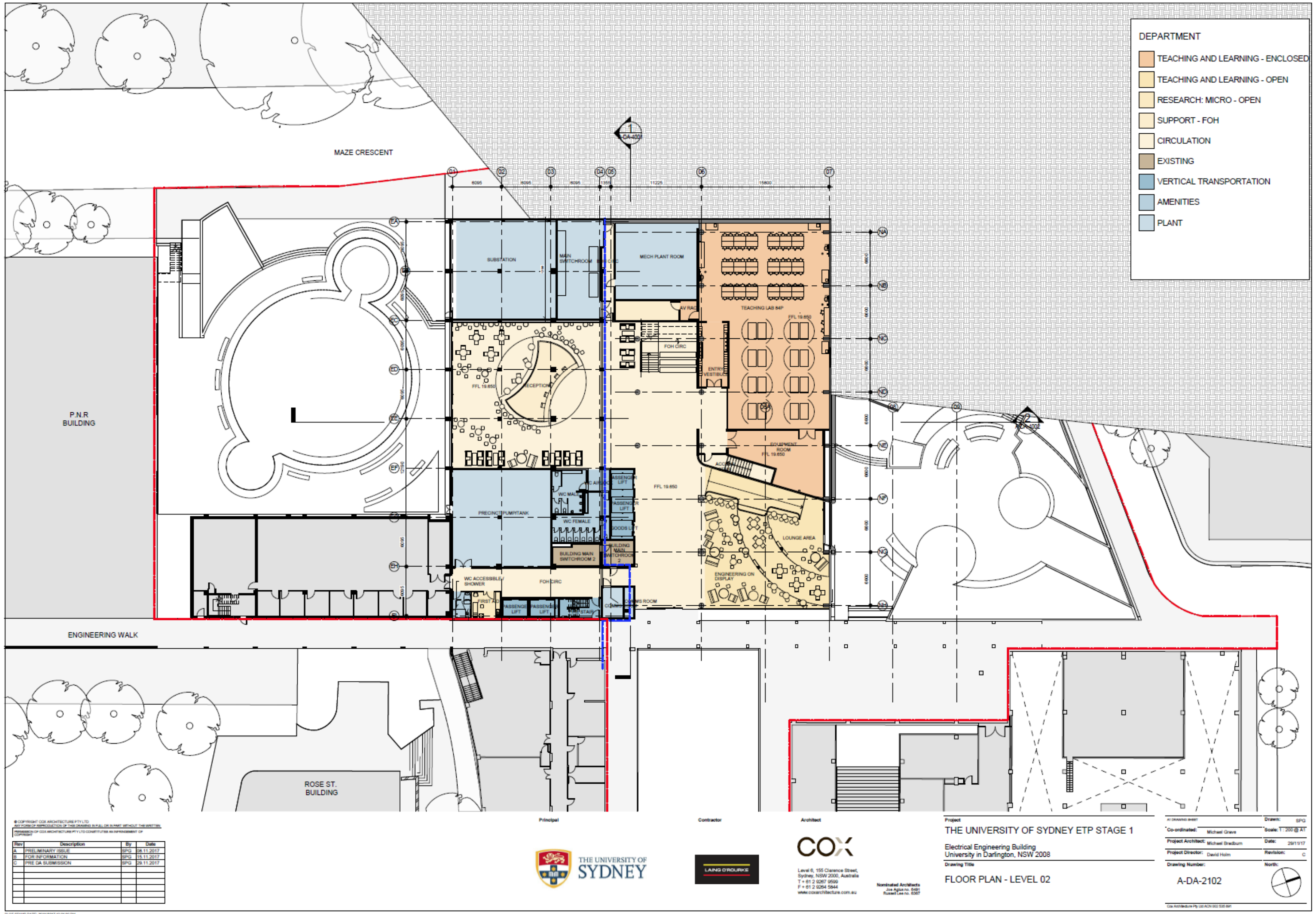
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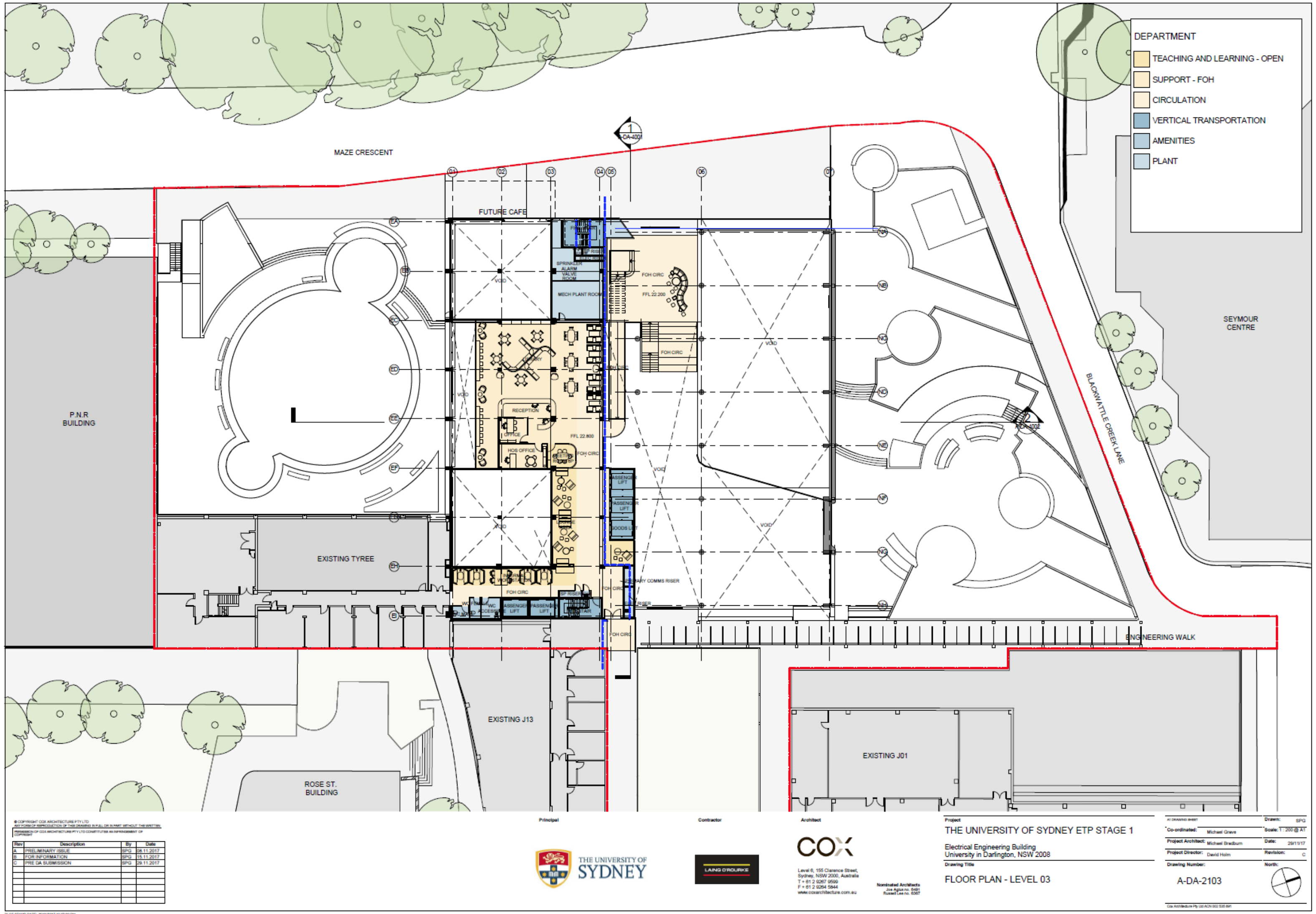
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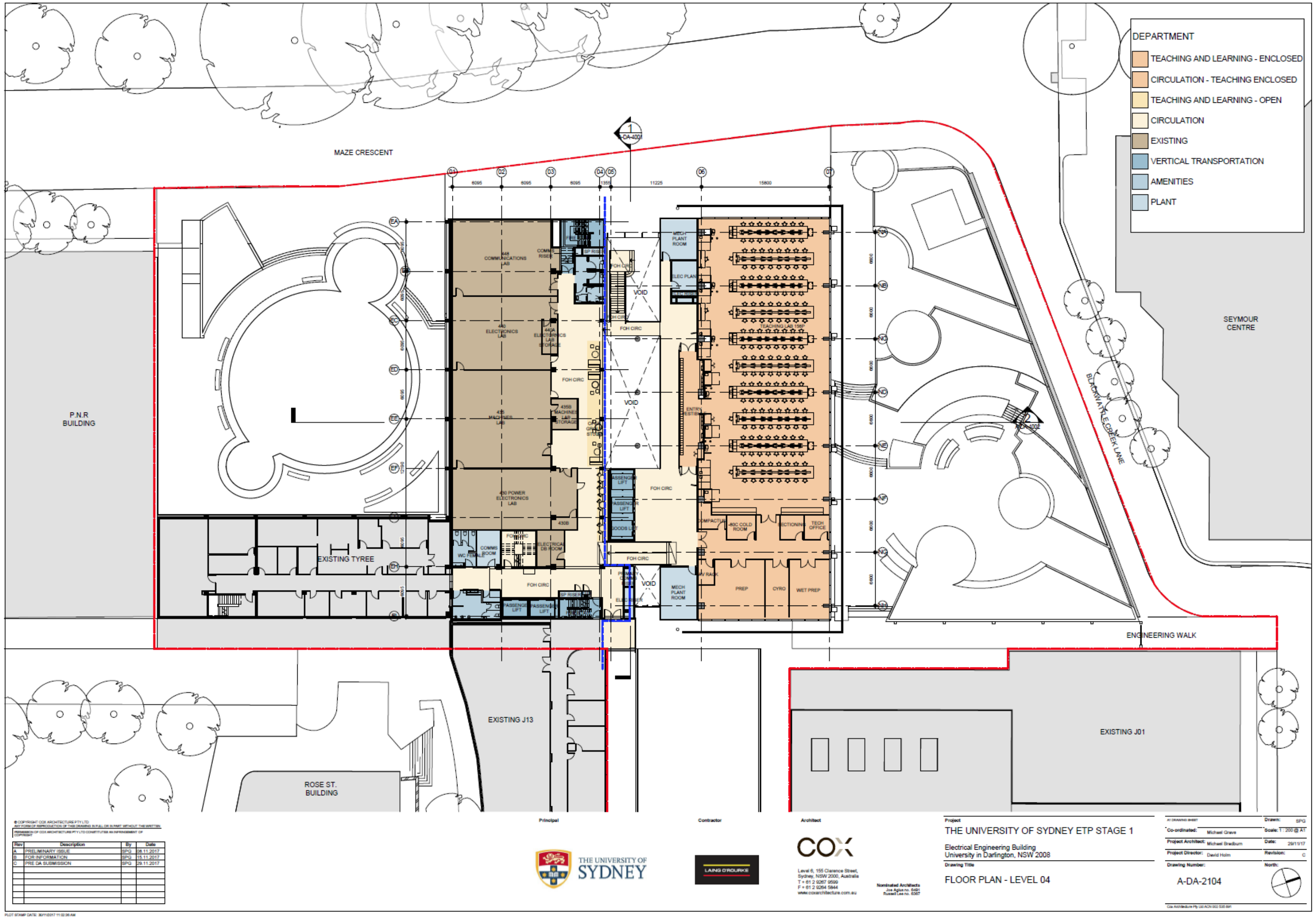
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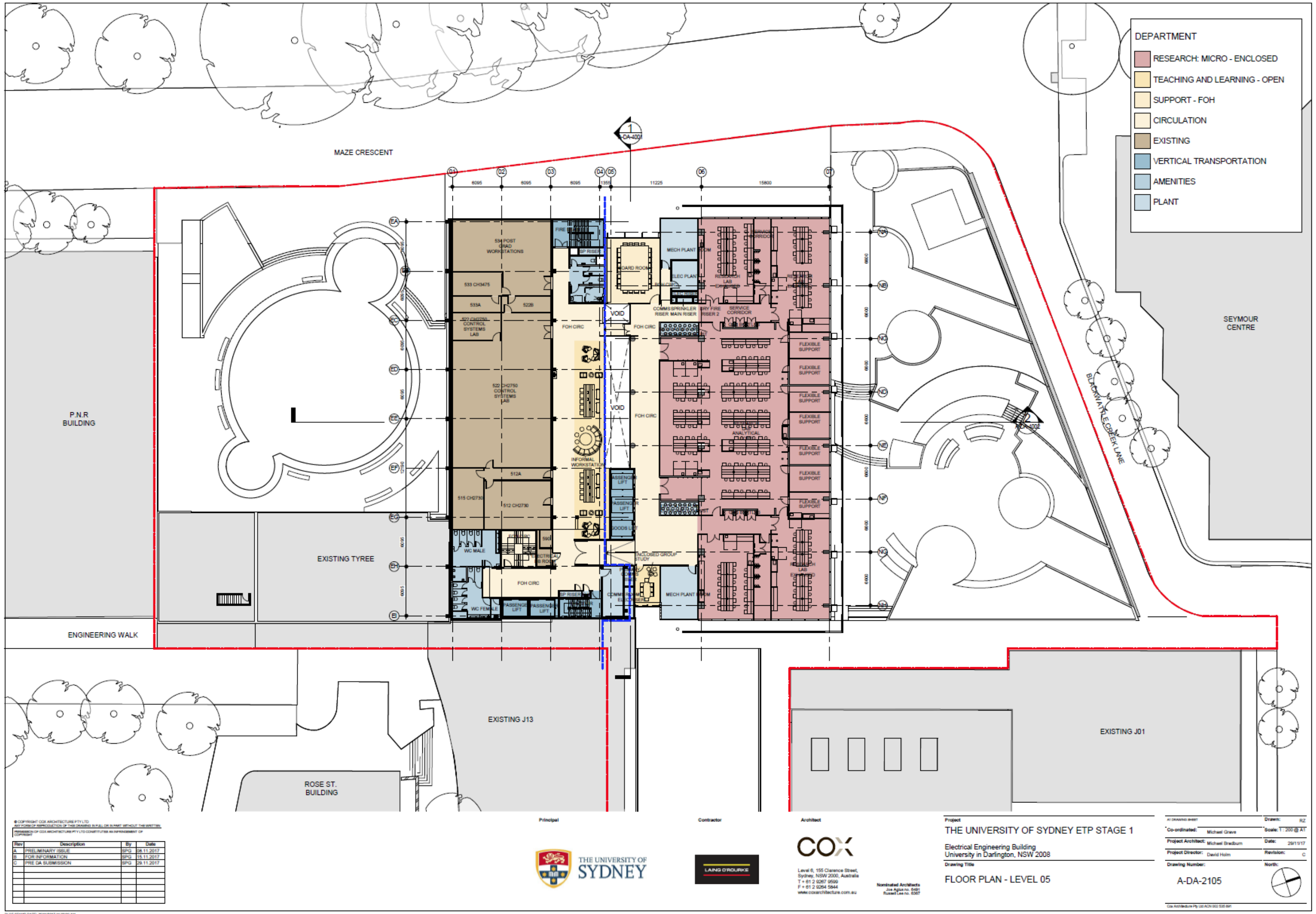
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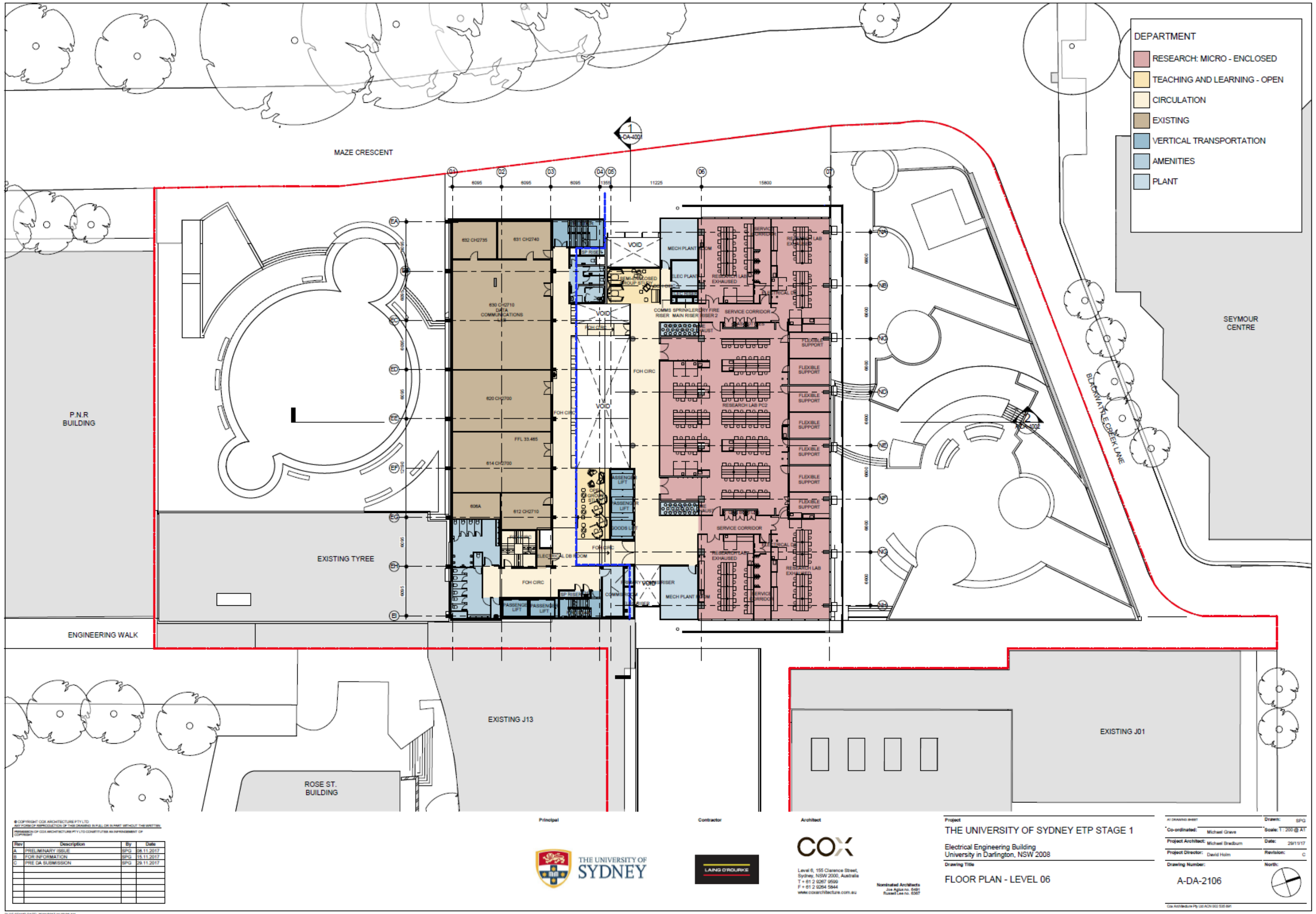
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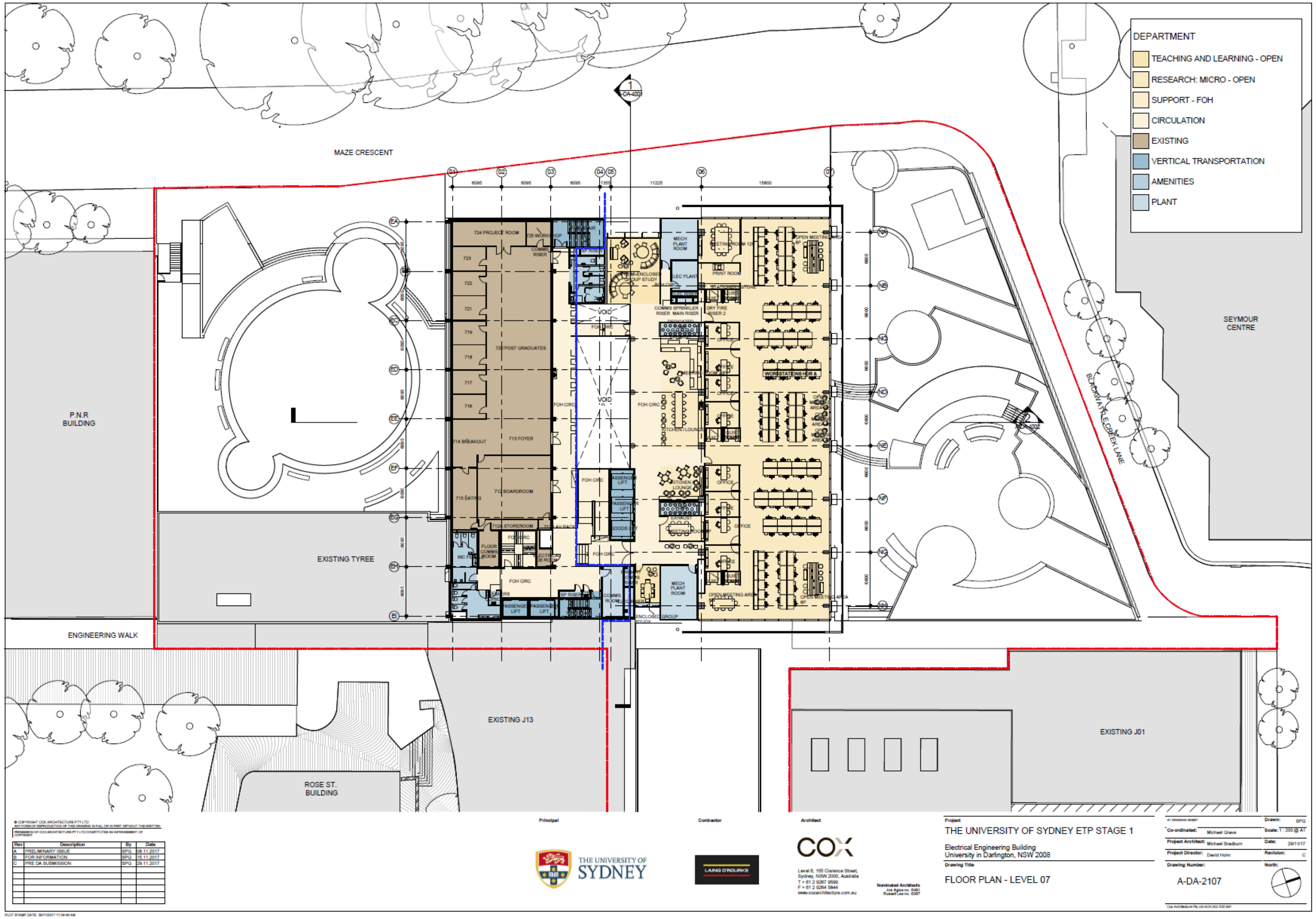
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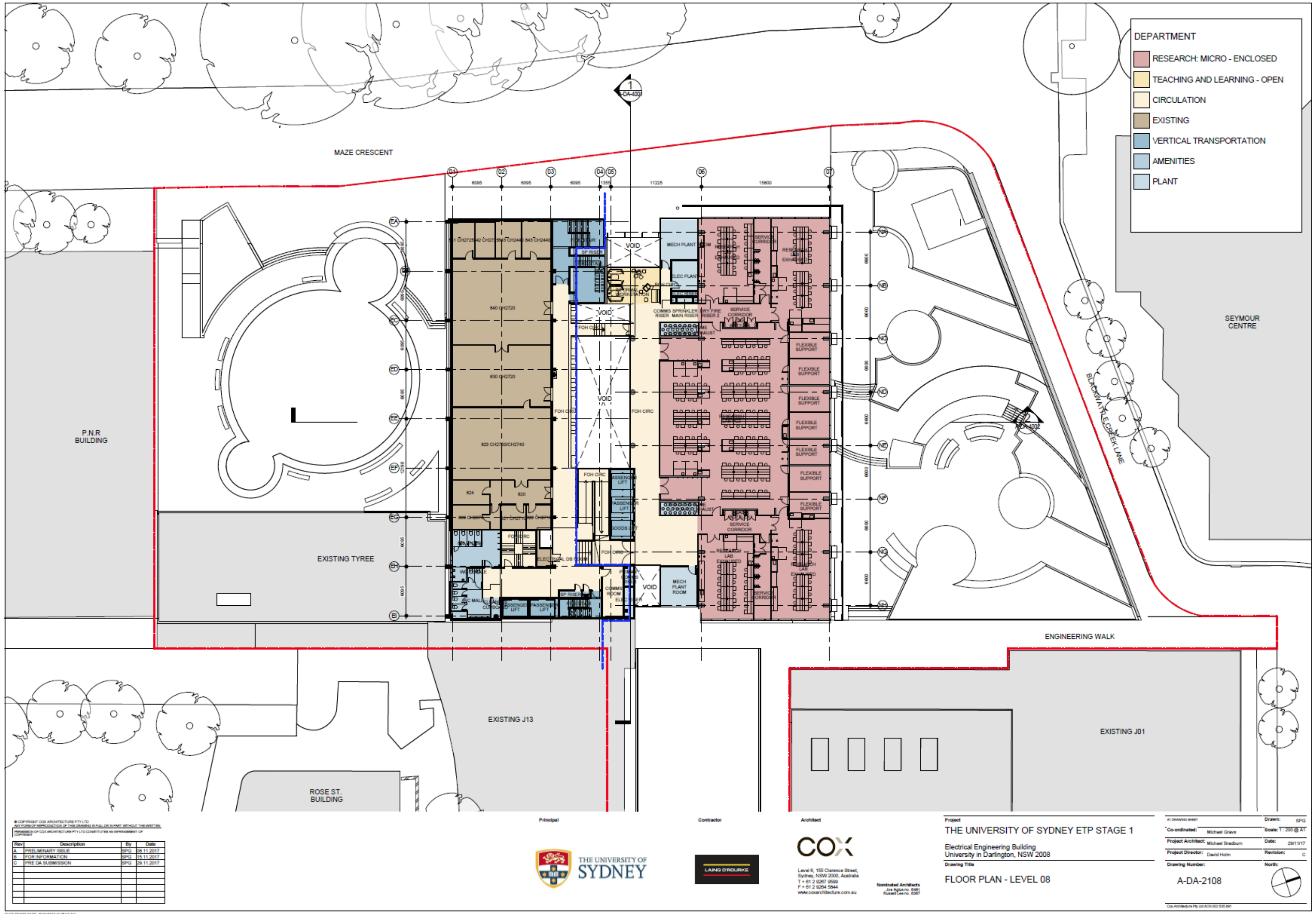
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Rev | Description | By | Date
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B | FOR INFORMATION | SPG | 15.11.2017
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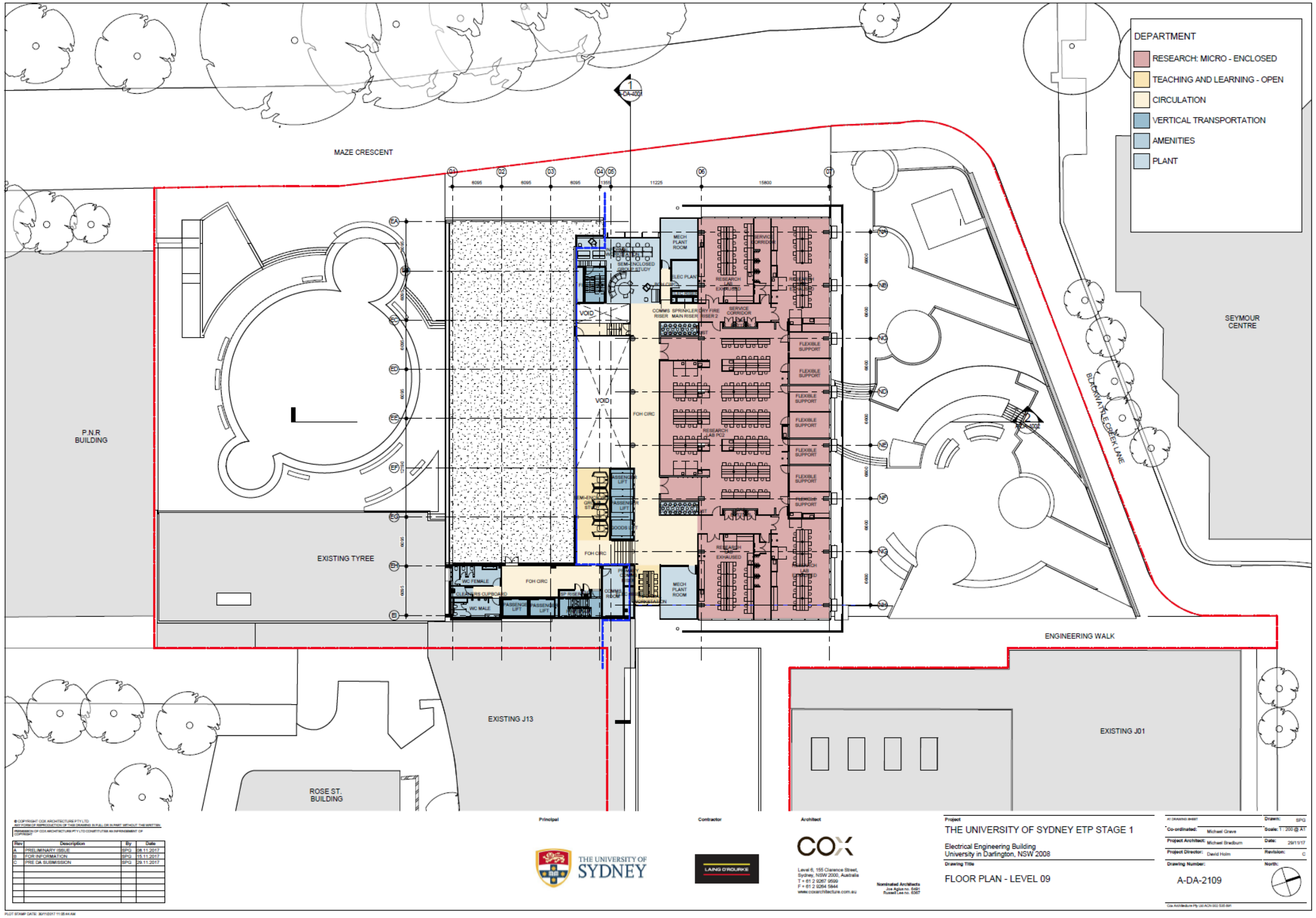
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Joe Agius no. 6491
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Project
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Project Architect: Michael Bradburn
Date: 29/11/17
Project Director: David Holm
Revision: C
Drawing Number:
A-DA-2109
North:
Rev | Description | By | Date
A | PRELIMINARY ISSUE | SPG | 08.11.2017
B | FOR INFORMATION | SPG | 15.11.2017
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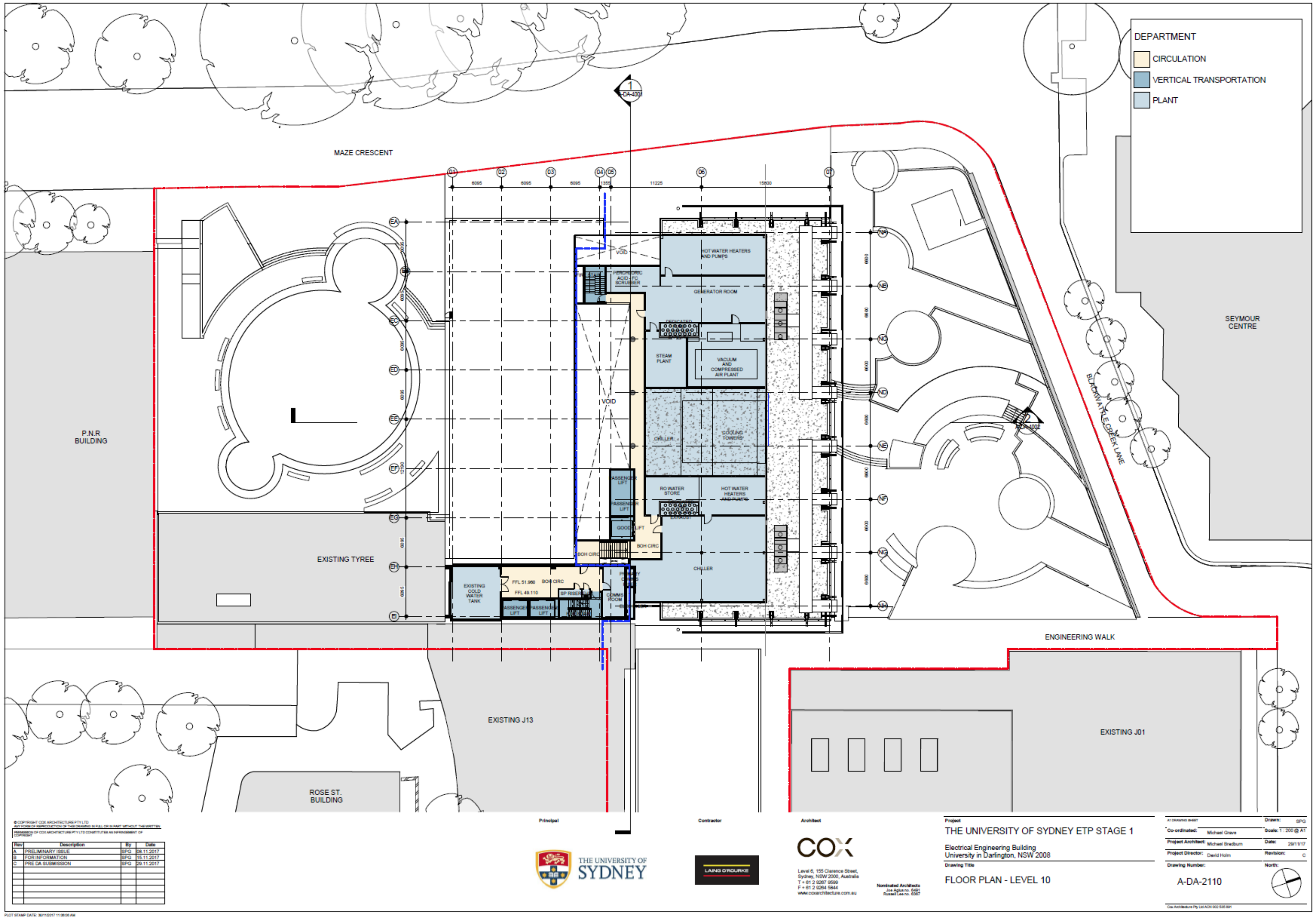
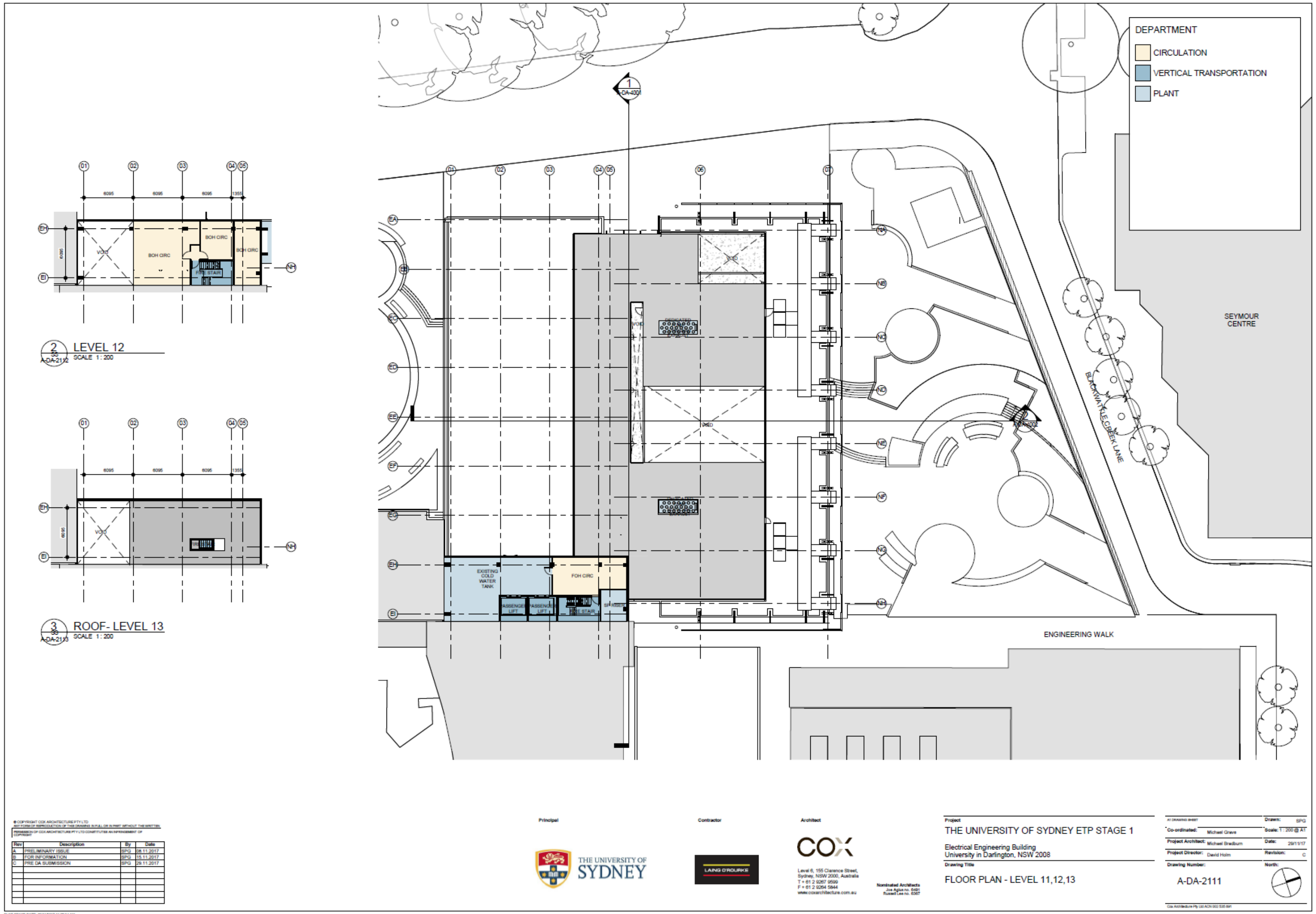
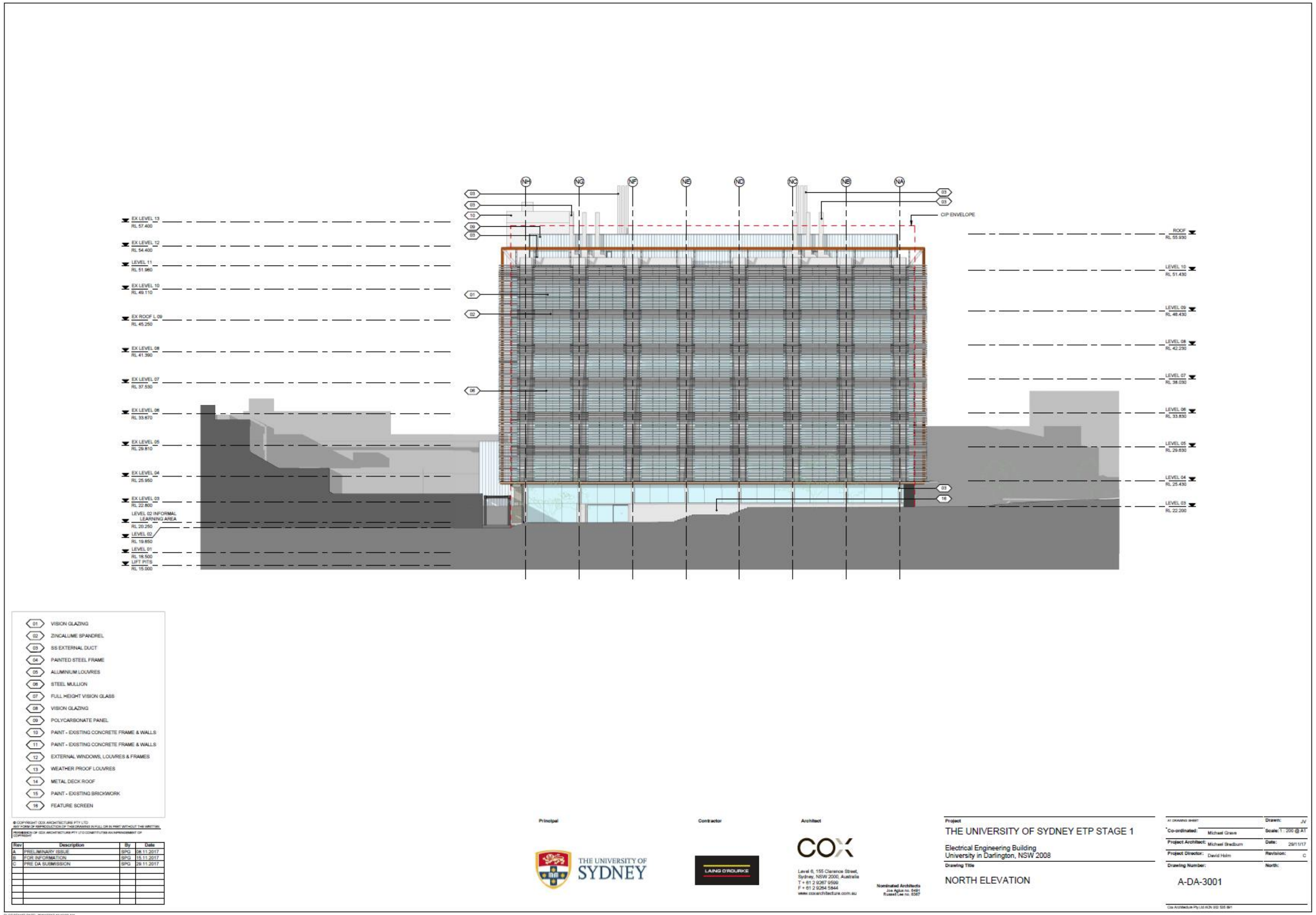

DEPARTMENT
CIRCULATION
VERTICAL TRANSPORTATION
PLANT
MAZE CRESCENT
P.N.R BUILDING
EXISTING TYREE
SEYMOUR CENTRE
ENGINEERING WALK
EXISTING J13
EXISTING J01
ROSE ST. BUILDING
HOT WATER HEATERS AND PUMPS
GENERATOR ROOM
STEAM PLANT
VACUUM AND COMPRESSED AIR PLANT
CHILLER
COOLING TOWERS
RO WATER STORE
CHILLER
VOID
EXISTING COLD WATER TANK
BOH CIRC
THE UNIVERSITY OF SYDNEY
LAING O'ROURKE
COX
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
FLOOR PLAN - LEVEL 10
A-DA-2110


DEPARTMENT
CIRCULATION
VERTICAL TRANSPORTATION
PLANT
LEVEL 12
SCALE 1 : 200
ROOF- LEVEL 13
SCALE 1 : 200
SEYMOUR CENTRE
ENGINEERING WALK
BLACKWATTLE CREEK LANE
EXISTING COLD WATER TANK
FOH CIRC
BOH CIRC
VOID
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
FLOOR PLAN - LEVEL 11,12,13
Co-ordinated: Michael Grave
Project Architect: Michael Bradburn
Project Director: David Holm
Drawn: SPG
Scale: 1 : 200 @ A1
Date: 29/11/17
Revision: C
Drawing Number:
A-DA-2111
North:
THE UNIVERSITY OF SYDNEY
LAING O'ROURKE
COX


01 VISION GLAZING
02 ZINCALUME SPANDREL
03 SS EXTERNAL DUCT
04 PAINTED STEEL FRAME
05 ALUMINIUM LOUVRES
06 STEEL MULLION
07 FULL HEIGHT VISION GLASS
08 VISION GLAZING
09 POLYCARBONATE PANEL
10 PAINT - EXISTING CONCRETE FRAME & WALLS
11 PAINT - EXISTING CONCRETE FRAME & WALLS
12 EXTERNAL WINDOWS, LOUVRES & FRAMES
13 WEATHER PROOF LOUVRES
14 METAL DECK ROOF
15 PAINT - EXISTING BRICKWORK
16 FEATURE SCREEN
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THE UNIVERSITY OF SYDNEY
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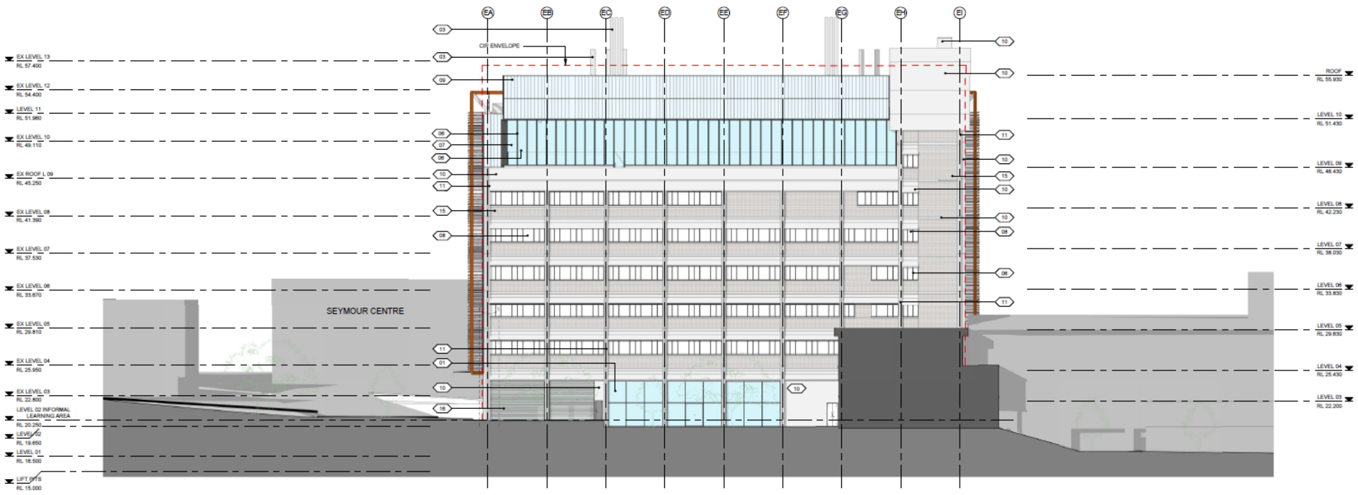
LAING O'ROURKE
Architect
COX
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
NORTH ELEVATION
Drawn: JV
Co-ordinated: Michael Grave
Scale: 1 : 200 @ A1
Project Architect: Michael Bradburn
Date: 29/11/17
Project Director: David Holm
Revision: C
Drawing Number:
North:
A-DA-3001



01	VISION GLAZING
02	ZINCALUME SPANDREL
03	SS EXTERNAL DUCT
04	PAINTED STEEL FRAME
05	ALUMINIUM LOUVRES
06	STEEL MULLION
07	FULL HEIGHT VISION GLASS
08	VISION GLAZING
09	POLYCARBONATE PANEL
10	PAINT - EXISTING CONCRETE FRAME & WALLS
11	PAINT - EXISTING CONCRETE FRAME & WALLS
12	EXTERNAL WINDOWS, LOUVRES & FRAMES
13	WEATHER PROOF LOUVRES
14	METAL DECK ROOF
15	PAINT - EXISTING BRICKWORK
16	FEATURE SCREEN

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Architect: COX

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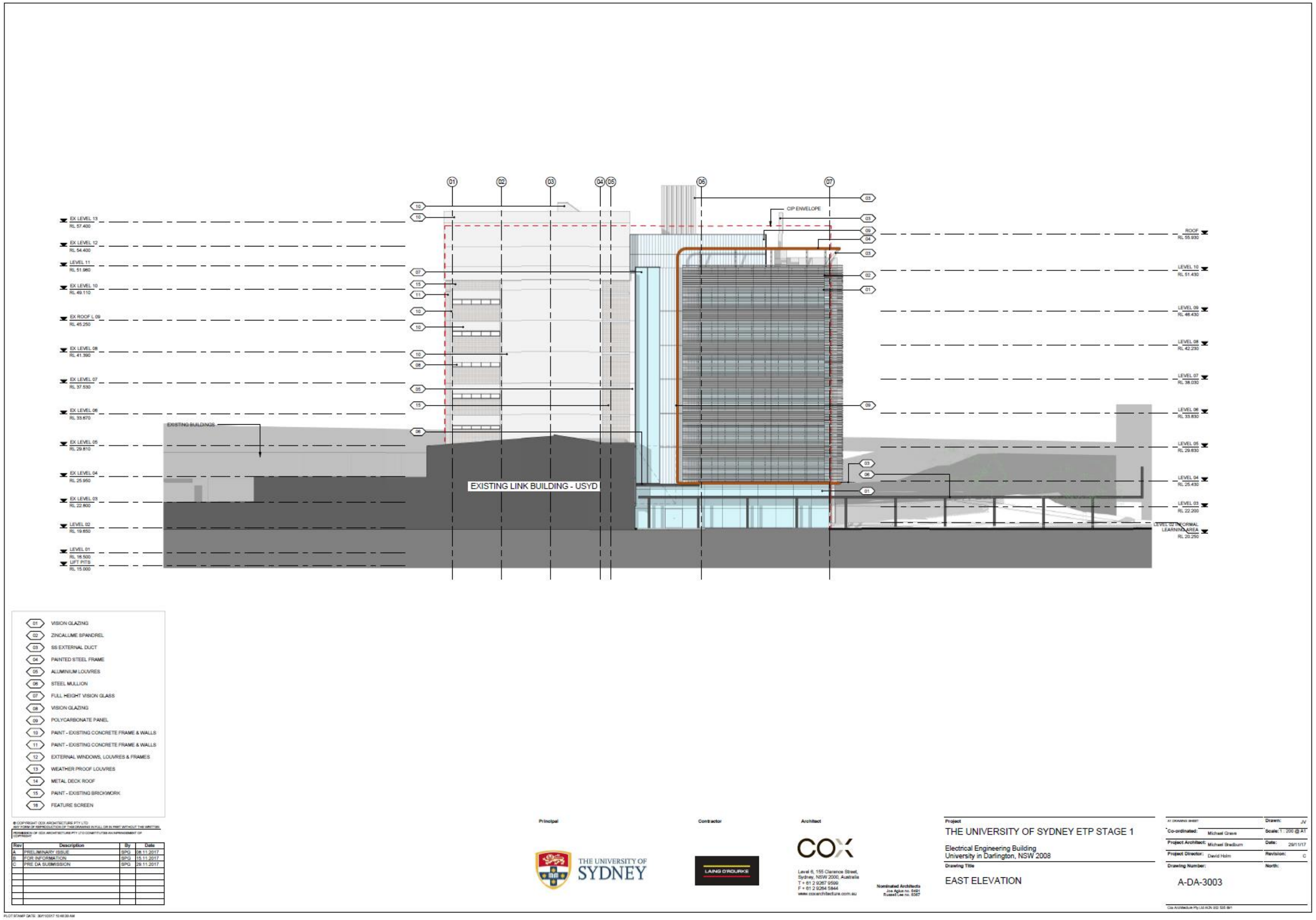
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008

Drawing Title
SOUTH ELEVATION

Co-ordinated:	Michael Grave	Drawn:	JV
Project Architect:	Michael Bradburn	Scale:	1 : 200 @ A1
Project Director:	David Holm	Date:	29/11/17
Drawing Number:	A-DA-3002	Revision:	C


EXISTING LINK BUILDING - USYD
LEVEL 01
RL 16.500
LIFT PITS
RL 15.000
01 VISION GLAZING
02 ZINCALUME SPANDREL
03 SS EXTERNAL DUCT
04 PAINTED STEEL FRAME
05 ALUMINIUM LOUVRES
06 STEEL MULLION
07 FULL HEIGHT VISION GLASS
08 VISION GLAZING
09 POLYCARBONATE PANEL
10 PAINT - EXISTING CONCRETE FRAME & WALLS
11 PAINT - EXISTING CONCRETE FRAME & WALLS
12 EXTERNAL WINDOWS, LOUVRES & FRAMES
13 WEATHER PROOF LOUVRES
14 METAL DECK ROOF
15 PAINT - EXISTING BRICKWORK
16 FEATURE SCREEN
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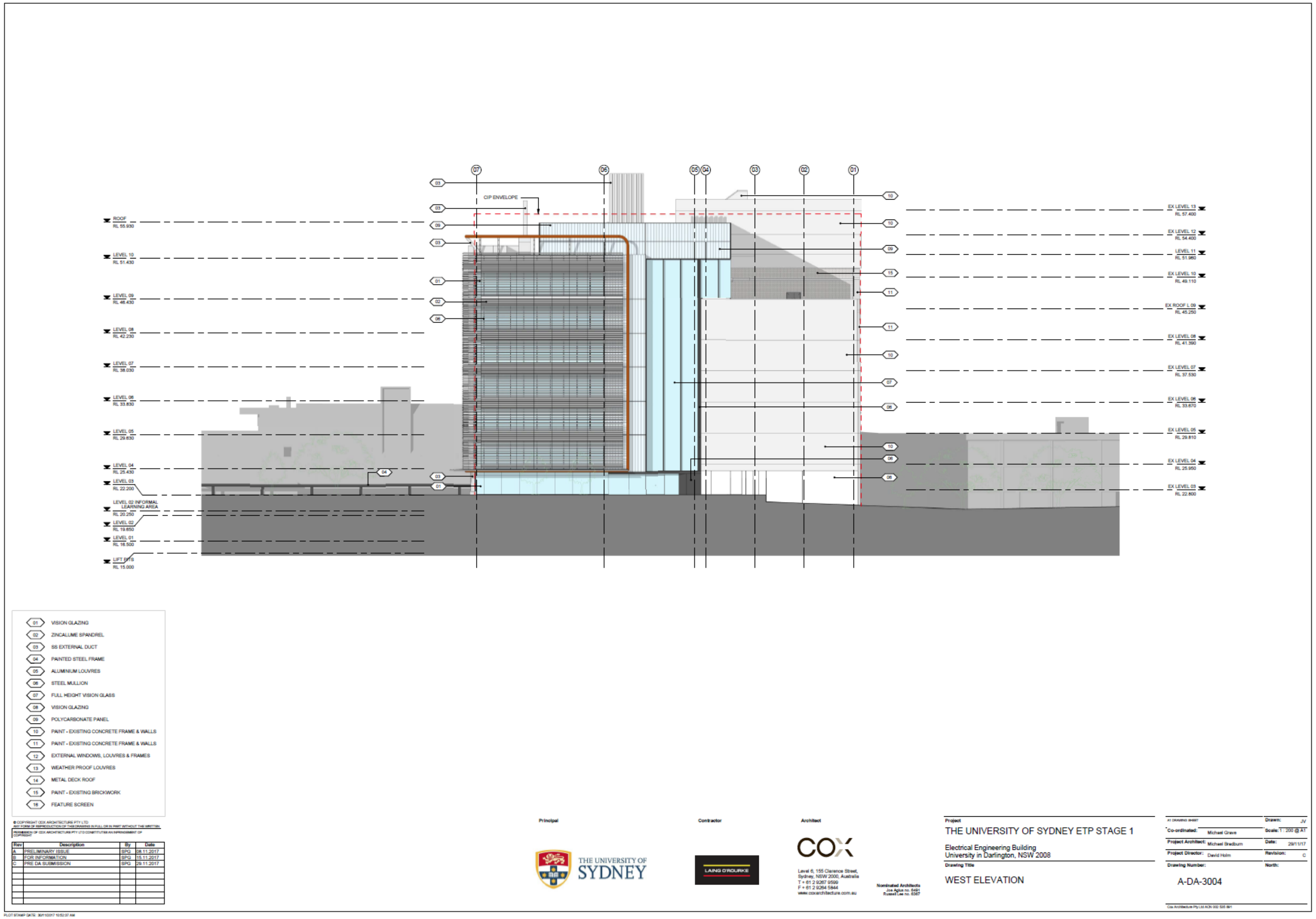
Contractor
Architect
COX
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
EAST ELEVATION
Drawn: JV
Co-ordinated: Michael Grave
Scale: 1 : 200 @ A1
Project Architect: Michael Bradburn
Date: 29/11/17
Project Director: David Holm
Revision: C
Drawing Number:
North:
A-DA-3003


01 VISION GLAZING
02 ZINCALUME SPANDREL
03 SS EXTERNAL DUCT
04 PAINTED STEEL FRAME
05 ALUMINIUM LOUVRES
06 STEEL MULLION
07 FULL HEIGHT VISION GLASS
08 VISION GLAZING
09 POLYCARBONATE PANEL
10 PAINT - EXISTING CONCRETE FRAME & WALLS
11 PAINT - EXISTING CONCRETE FRAME & WALLS
12 EXTERNAL WINDOWS, LOUVRES & FRAMES
13 WEATHER PROOF LOUVRES
14 METAL DECK ROOF
15 PAINT - EXISTING BRICKWORK
16 FEATURE SCREEN
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Architect
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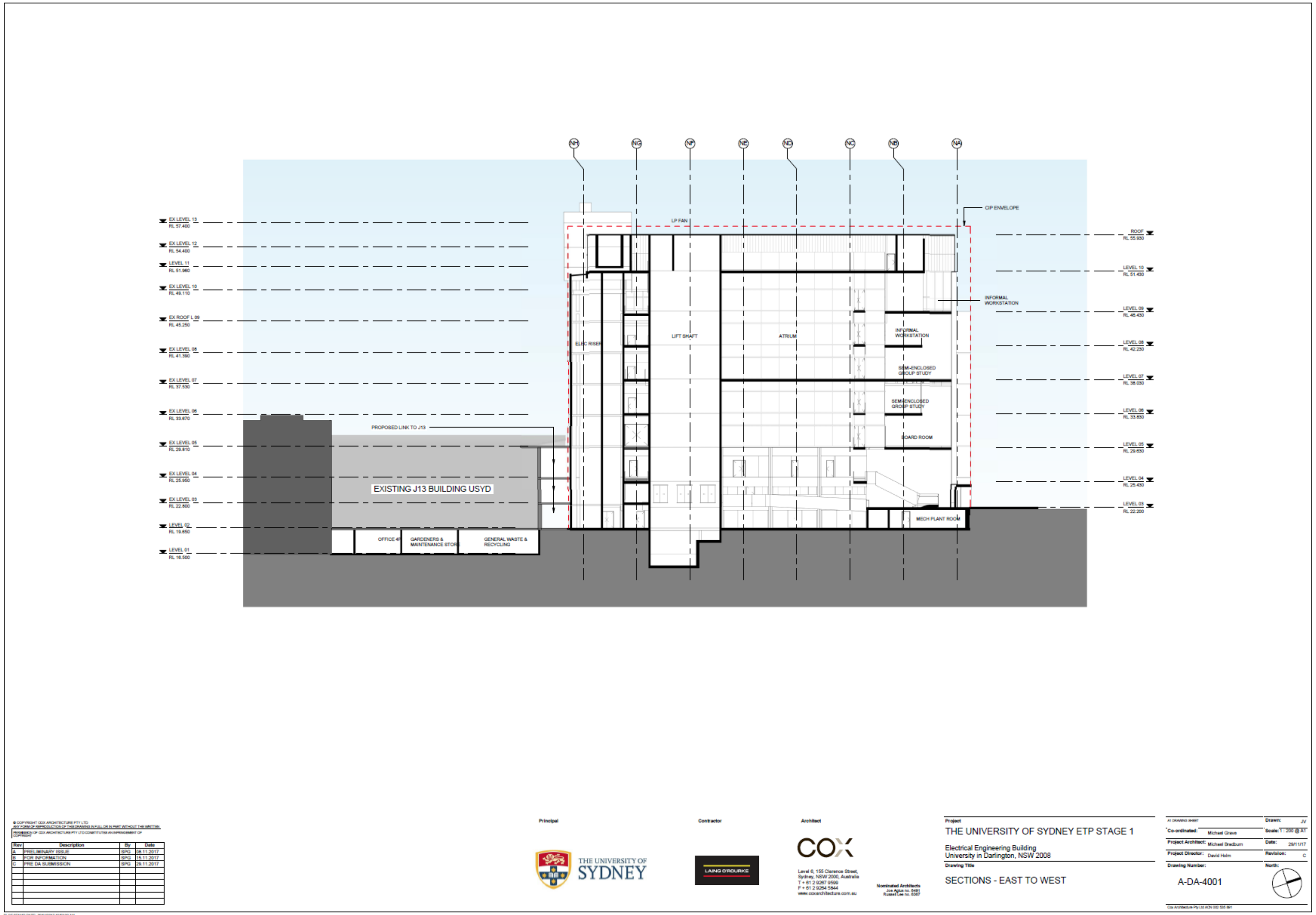
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
WEST ELEVATION
Co-ordinated: Michael Grave
Project Architect: Michael Bradburn
Project Director: David Holm
Drawn: JV
Scale: 1 : 200 @ A1
Date: 29/11/17
Revision: C
Drawing Number:
A-DA-3004
North:


EXISTING J13 BUILDING USYD
PROPOSED LINK TO J13
LIFT SHAFT
ATRIUM
INFORMAL WORKSTATION
SEMI-ENCLOSED GROUP STUDY
BOARD ROOM
MECH PLANT ROOM
OFFICE
GARDENERS & MAINTENANCE STORE
GENERAL WASTE & RECYCLING
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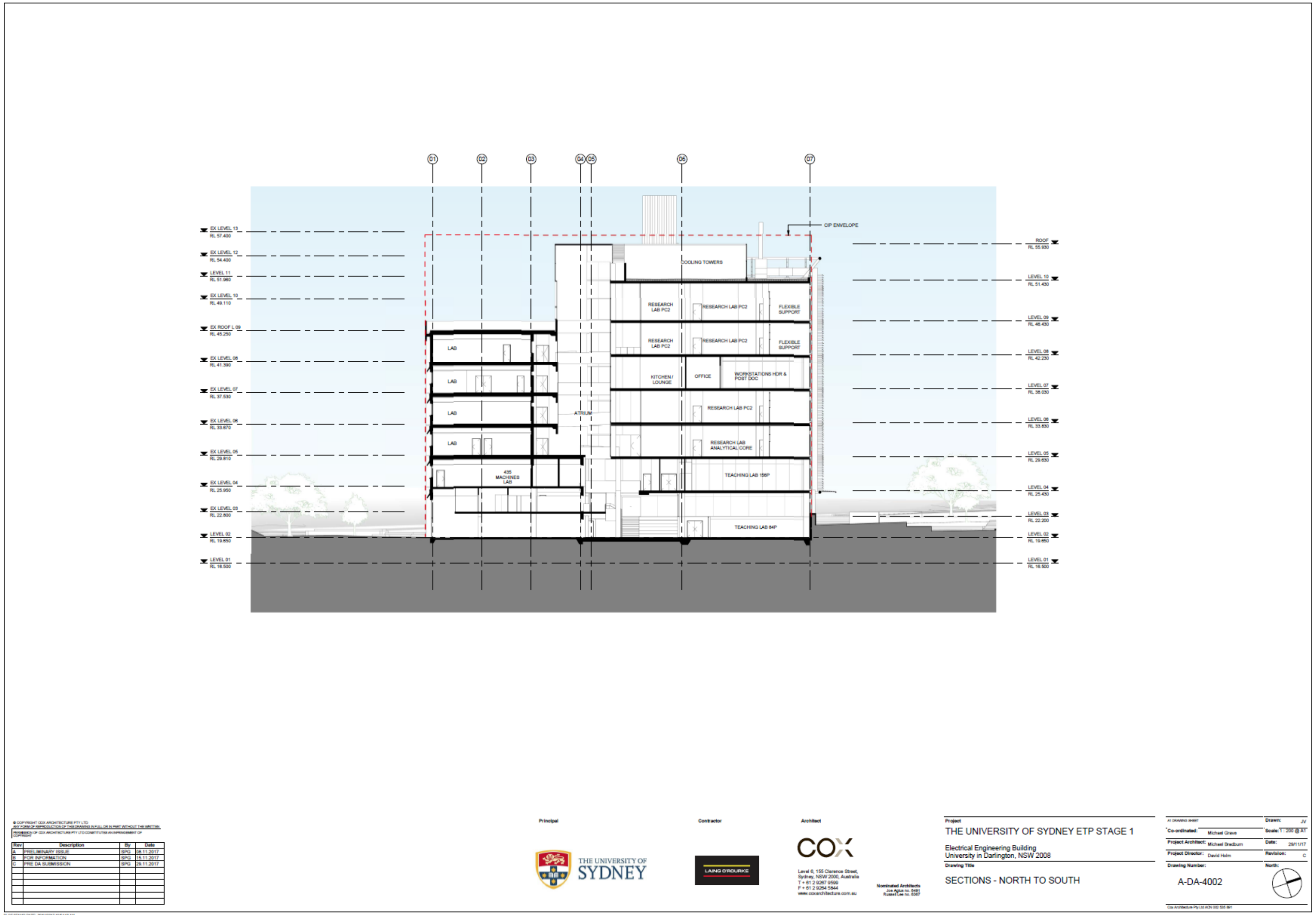
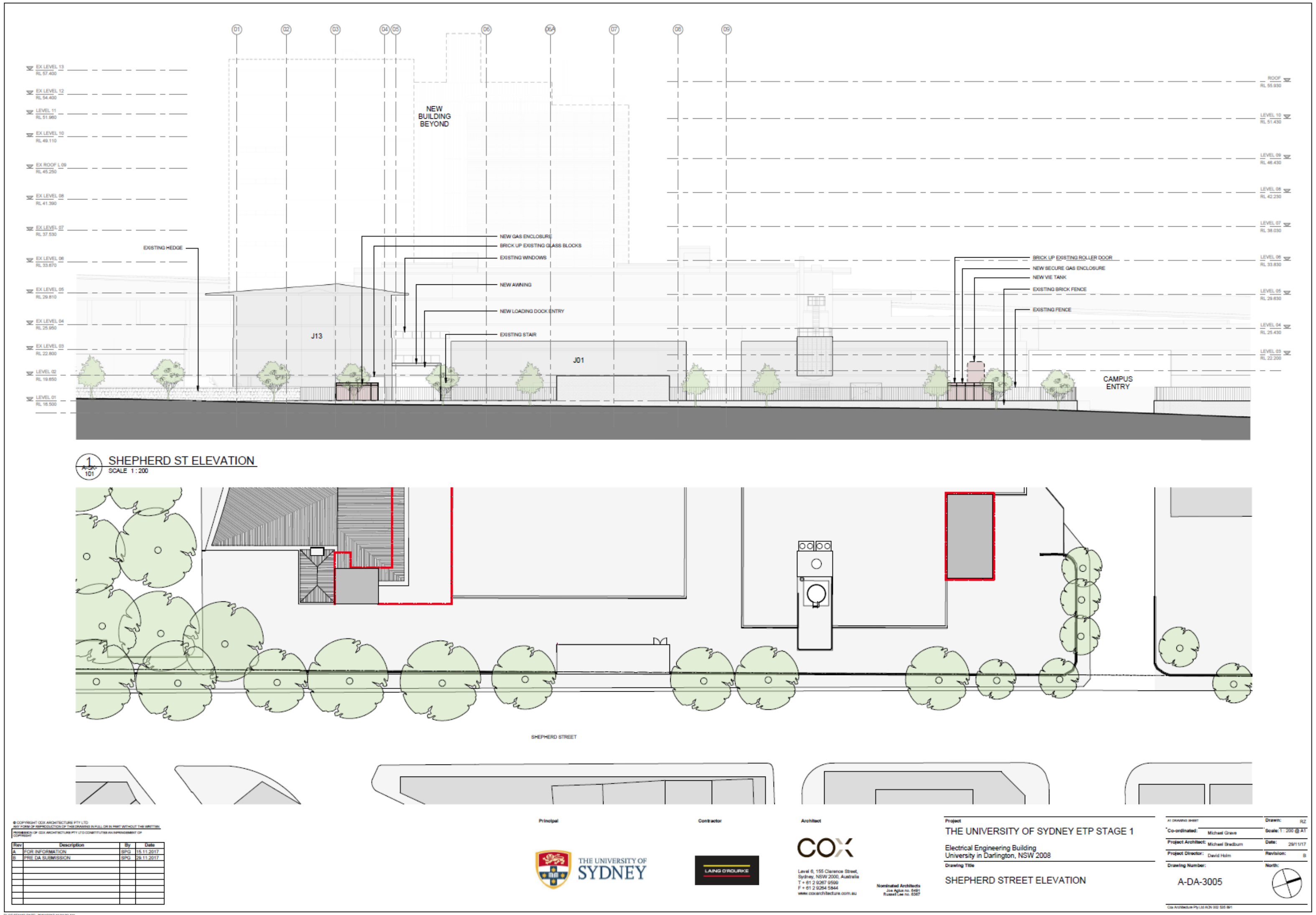
THE UNIVERSITY OF SYDNEY
Contractor
LAING O'ROURKE
Architect
COX
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
SECTIONS - EAST TO WEST
Co-ordinated: Michael Grave
Project Architect: Michael Bradburn
Project Director: David Holm
Drawn: JV
Scale: 1 : 200 @ A1
Date: 29/11/17
Revision: C
Drawing Number:
A-DA-4001
North:


COOLING TOWERS
CIP ENVELOPE
RESEARCH LAB PC2
FLEXIBLE SUPPORT
KITCHEN/ LOUNGE
OFFICE
WORKSTATIONS HDR & POST DOC
RESEARCH LAB ANALYTICAL CORE
TEACHING LAB 156P
TEACHING LAB 84P
LAB
435 MACHINES LAB
ATRIUM
Principal
THE UNIVERSITY OF SYDNEY
Contractor
LAING O'ROURKE
Architect
COX
Project
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
University in Darlington, NSW 2008
Drawing Title
SECTIONS - NORTH TO SOUTH
Co-ordinated: Michael Grave
Project Architect: Michael Bradburn
Project Director: David Holm
Drawn: JV
Scale: 1 : 200 @ A1
Date: 29/11/17
Revision: C
Drawing Number:
A-DA-4002
North:


NEW BUILDING BEYOND
NEW GAS ENCLOSURE
BRICK UP EXISTING GLASS BLOCKS
EXISTING WINDOWS
NEW AWNING
NEW LOADING DOCK ENTRY
EXISTING STAIR
EXISTING HEDGE
J13
J01
BRICK UP EXISTING ROLLER DOOR
NEW SECURE GAS ENCLOSURE
NEW VIE TANK
EXISTING BRICK FENCE
EXISTING FENCE
CAMPUS ENTRY
SHEPHERD ST ELEVATION
SCALE 1 : 200
SHEPHERD STREET
THE UNIVERSITY OF SYDNEY ETP STAGE 1
Electrical Engineering Building
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SHEPHERD STREET ELEVATION
A-DA-3005
THE UNIVERSITY OF SYDNEY
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