SKELLY&COUCH

Client

Birkbeck University

Project

1354 - Cambridge House Building

Rainwater Harvesting Feasibility Assessment and Design Proposal

Revision 2.0 - 04/02/2019 - Planning

Skelly & Couch Ltd

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Contents

Audit History

Rev	Date of Issue	Status	Issued By	Checked By	Summary of Changes
2.0	**04/02/2019**	**Planning**	**DH**	**DH**	
1.0	09/10/2018	Information	JA	DH	DRAFT

1.0 Introduction

Birkbeck University have expressed a wish to investigate ways to capture and use rainwater locally in the building. Introducing a rainwater harvesting system to the development would contribute towards the minimising the need for further water infrastructure in the area, in line with policies CC2 and CC3 of the London Borough of Camden Local Plan. The inclusion of the rainwater harvesting system will also contribute towards reducing the stress on local drainage systems associated with the development.

This report has been prepared in order to discharge pre-commencement condition no. 19 of the planning approval for the development dated 15.04.2018, relating to rainwater recycling. The report provides a brief description of the development and the constraints the rainwater harvesting system would have to address, as well a summary of the feasibility assessment that was completed as part of the design process, and the design proposal that was developed as a result of it.

2.0 Background

Development Description

The development consists of a five-storey existing building that is to be refurbished to provide teaching space for Birkbeck University, with a two-storey extension at roof level to provide a new lecture theatre and other teaching and support accommodation. The teaching building is to accommodate up to 600 students.

The teaching building will in large part be occupied on weekdays, with a large number of people using toilet facilities during short periods of time between lectures. The high occupancy and the transient nature of the building means that the non-potable water use in the building will be highly variable and impossible to accurately predict.

The roof area of the building is relatively small compared to the building volume, which means that the captured rainwater yield is low in proportion to the consequential non-potable water demand.

Rainwater Harvesting System Integration

As the roof area is small and the building footprint fits the entire site, there is no external space available for locating the rainwater harvesting tank.

Initially, the intention was to locate the rainwater harvesting tank within the existing car lift pit below the basement slab, however, following survey measurements it was found that the car lift pit was shallower than anticipated. In addition to this, the existing foundations are located close to the car lift pit and the proposed new foundations encroach on the area available within it, further reducing the available space. Due to the proximity of the foundations, there is not sufficient space within the existing car lift pit to practically fit a rainwater harvesting tank. It also is not feasible to further excavate the car lift pit to increase the available space as this risks undermining the foundations.

A number of other possible locations within the basement area were evaluated and weighted up against other uses, and as a result the rainwater harvesting tank was located in the B-18 plant room

shown below. This location within the plant area provides easy access for installation and maintenance, is located close to the drainage outlet, and was deemed to be the location that best meet the operational needs of the building as it does not conflict with other space uses.

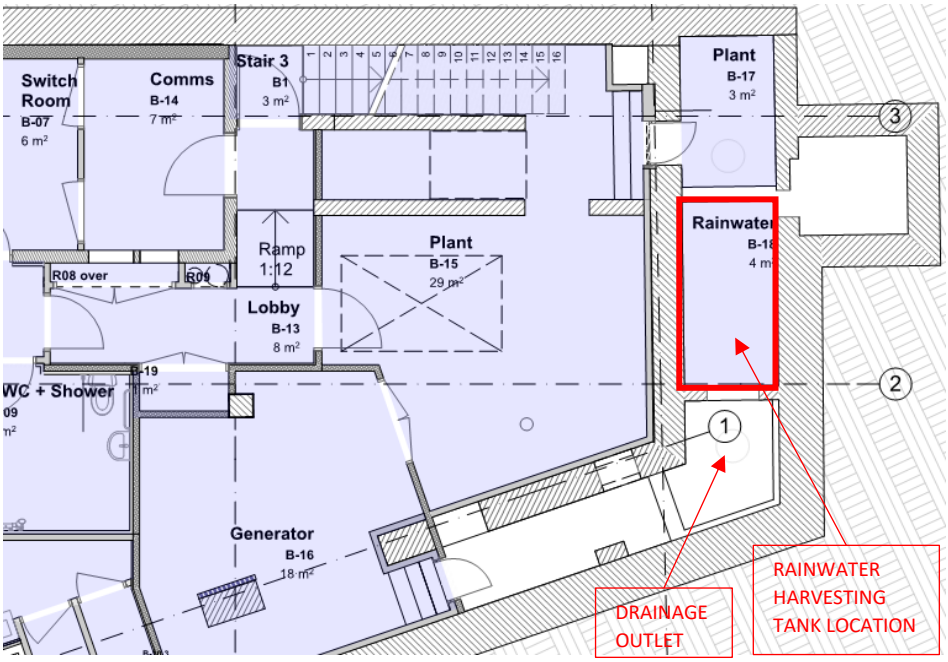

Figure 1. Rainwater harvesting tank location.

3.0 Feasibility Assessment

3.1 Introduction

The following sections detail the feasibility assessment of the rainwater harvesting system, with the tanks located in the B18 plant room, that is to serve the building. This assessment also considered the performance of the proposal in terms of reducing the amount of mains cold water required for WC and urinal flushing associated with the development.

3.2 Tank Properties

Due to the space constraints and the limited potential for capturing rainwater discussed above, the rainwater harvesting tank was sized based on available space for installation and maintenance rather than the storage volume recommendation given in BS 8515:2009. The resulting rainwater harvesting proposal was produced in conjunction with a rainwater harvesting specialist, and consists of 5 no. 500

litre MDPE storage tanks as detailed in Table 1. This provides a space efficient solution with easy access for installation and maintenance.

Table 1. Tank Properties

	Tank properties
Description	5 no. 500 litre tanks
Dimensions	700mm Ø x 1500mm H
Total storage volume	2500 l

3.3 Analysis

The performance of the rainwater harvesting proposal was evaluated by investigating the percentage of annual WC and urinal flushing that could be met using rainwater and the percentage of available rainwater used over the course of a year.

3.3.1 Method

The % of annual WC and urinal flushing met using rainwater and the % of available rainwater used over the course of a year were established by comparing available rainwater captured with the non-potable water use in the building, which were modelled as described below.

The projected daily rainwater yield was estimated based on historical rainfall data for the site, presented in Figure 2., and the collection area, yield coefficient and hydraulic filter efficiency given in Table 2. below:

Table 2. Roof Properties

Collection area	Yield coefficient	Hydraulic filter efficiency
337m²	91%*	90%

*From Table 1. BS 8515:2009 - Combination of pitched, metal roof and flat roof without gravel

Rainfall data

Daily rainfall data for the site location, based on historical rainfall data from a two-year time period, was retrieved from the Centre for Ecology and Hydrology (https://eip.ceh.ac.uk/apps/rainfall/gb.html). The daily rainfall data used for the analysis is shown below.

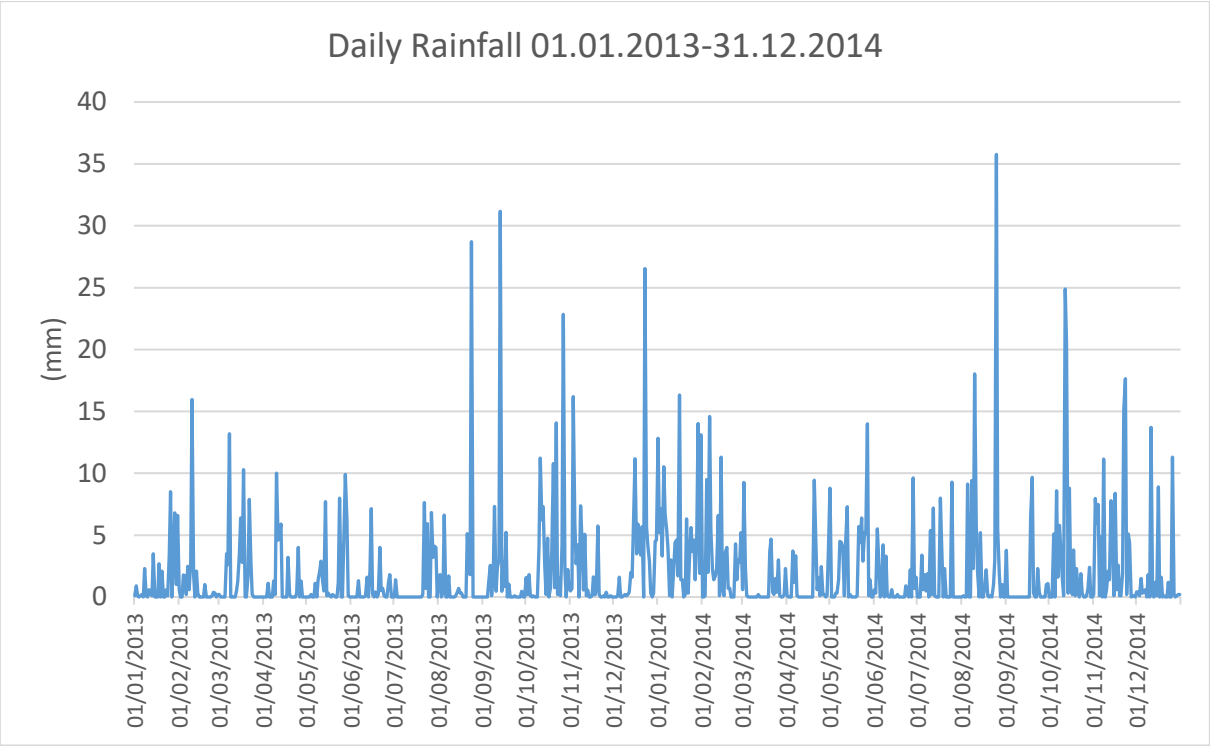

Figure 2. Daily rainfall data for the site location (x:528948 y:182163) for 2013 and 2014 from the Centre for Ecology and Hydrology.

Occupancy

The daily non-potable water demand was calculated for three different occupancy scenarios with associated water use, these are detailed below. A number of assumptions were made about the occupancy in the building in order to estimate the occupancy pattern over the course of a year:

- Building occupancy – 695 people
- 12h occupancy per day
- Total building population replaced every 3h
- Typical absenteeism: 20%
- Realistic occupancy of building on weekdays in term time: 50%
- Building occupancy during non-term time: 20%
- Occupancy on weekends: 5%
- No occupancy when Birkbeck is closed

This resulted in three occupancy scenarios that were used in the analysis:

Table 3. Occupancy Scenarios

Scenario 1	Scenario 2	Scenario 3

• Total building occupancy per day: 695*
• Term time occupancy:
  ○ Weekdays: 80%
  ○ Weekends: 5%
• Non-term time occupancy:
  ○ Weekdays: 20%
  ○ Weekends: 5%
• Birkbeck Closed:
  ○ No occupancy
	• Total building occupancy per day: 2780
	• Term time occupancy:
	  ○ Weekdays: 80%
	  ○ Weekends: 5%
	• Non-term time occupancy:
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	• Birkbeck Closed:
	  ○ No occupancy
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		• Non-term time occupancy:
		  ○ Weekdays: 20%
		  ○ Weekends: 5%
		• Birkbeck Closed:
		  ○ No occupancy

*Note: Scenario 1 assumes a building population of 695 people staying all day

Non-potable Water Use

The Plumber's Guide gives the daily water demand for an educational building as 20 l/p/day, and CIBSE Guide G suggest that 63% of water used in office buildings is used for WC and urinal flushing (note: no values given for educational buildings). This results in daily non-potable water use of 12.6 l/p. However, this is not representative of the transient nature of a university teaching building, and an average of one low-volume WC flush per person has therefore been assumed for occupancy Scenarios 2 and 3. Scenario 1 which assumes a lower daily building population staying all day uses 12.6 l/p/day.

Non-potable water demand per day used in analysis:

Table 4. Non-potable Water Demand

Scenario 1	Scenarios 2 & 3
12.6 l/p	2.5 l/p

Estimation of Rainwater Capture and Use

The daily rainwater yield and daily non-potable water demand were used to find the daily balance, which in turn was used to find the volume of water in the rainwater harvesting tank per day. As the available rainfall data was only in daily increments, a factor of 2/3 was applied to the rainwater yield in the cases where the rainwater harvesting tank was full on the previous day to account for any rainfall that would not be captured before water was drawn off the next day.

The volume in the tank on the previous day and the daily balance were used to find the amount of mains top-up required per day and the % of rainwater used for WC and urinal flushing per day.

The daily values from the two- year time period the rainfall data covered were used to find the annual non-potable water demand, the annual mains top-up required, and the amount of rainwater used per year. These were used to find the % of WC and urinal flushing using rainwater per year. In addition

this, the % of available rainwater used per year was found from the daily rainwater yield and daily rainwater used over the two-year period.

3.3.2 Results

The results of the analysis is given below in the form of a comparison between the three occupancy scenarios, and shows that 13.3-24.1% of annual WC and urinal flushing could be met using rainwater. This equate to which equates to using 80.9-82.7% of the available rainwater, dependent on the occupancy scenario selected.

It should be noted the amount of rainwater used is highly dependent on the actual non-potable water use and rainfall patterns, and will vary from the amount calculated.

Table 5. Results

Scenario	Tank Volume (l)	Annual non-potable water demand (l)	MCW top-up per year (l)	Rainwater used per year (l)	Annual % WC & urinal flushing using rainwater (%)	Available rainwater used (%)
1	2500	1273702	1104678	169024	13.3	82.7
2	2500	1021172	854668	166504	16.3	81.4
3	2500	687572	522110	165462	24.1	80.9

3.4 Conclusion

The results of the analysis show that a large proportion of the available rainwater would be used regardless of the occupancy scenario. It is also unlikely that a larger tank would increase the % available rainwater used as the storage potential is limited by the collection area, the rainfall pattern and how it coincides with the occupancy of the building and the associated draw-off from the tank.

The proposal for the rainwater harvesting system, consisting of several small tanks, have the benefit of easier installation and easier access for maintenance, and make good use of the available rainwater. The proposal achieves the aim to reduce the stress on the water and drainage infrastructure, and is feasible within the constraints of the scheme.

4.0 Design Proposal

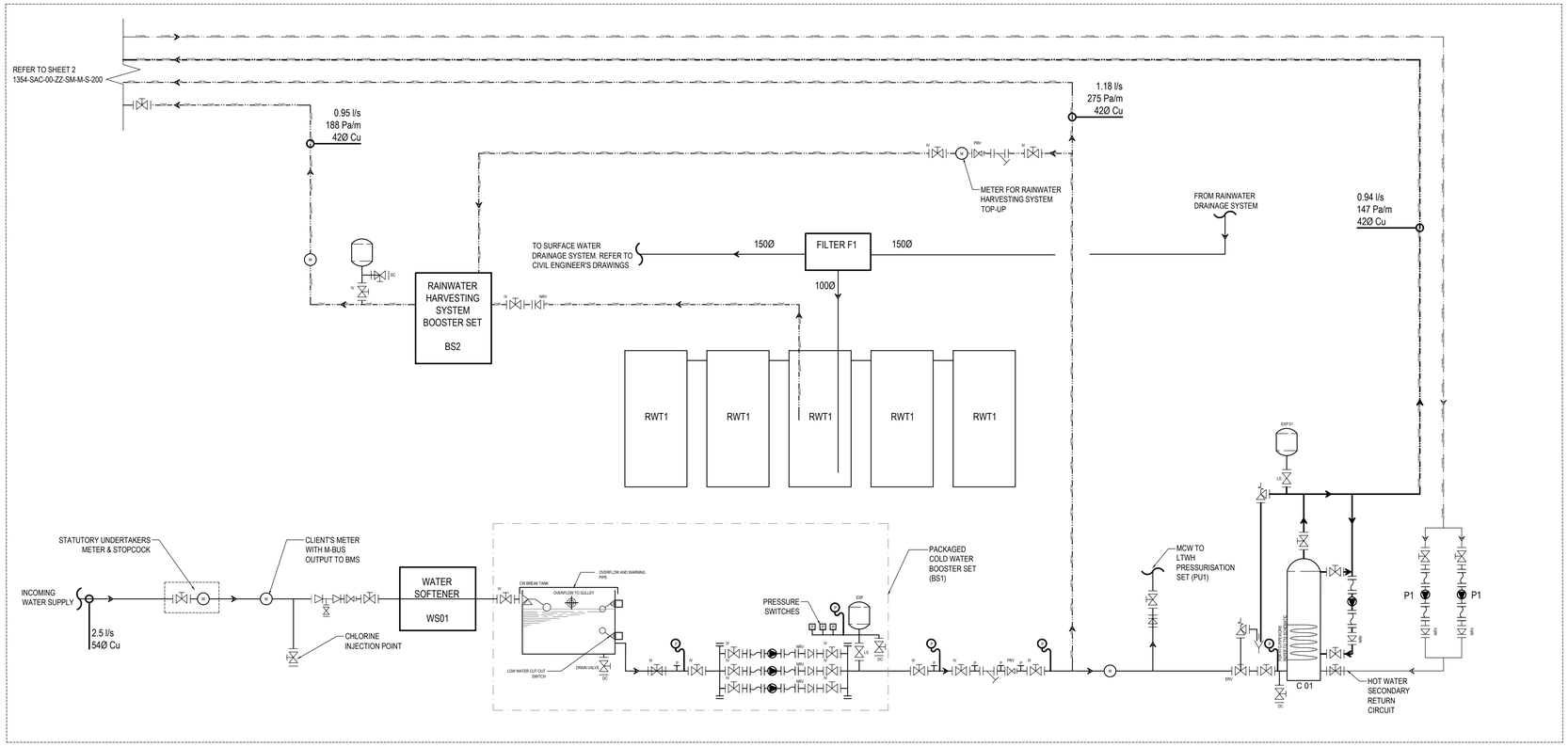
The Hot & Cold Water Schematics and Layouts given in Appendix I and Appendix II respectively, provide the details of the rainwater harvesting system.

The proposed design for the rainwater harvesting system consists of 5 no. 2500 litre cylindrical tanks that are to be located in the B-18 plantroom at basement level, which will collect rainwater from all roof areas. The overflow from the tanks will be connected to the drainage outlet at basement level. The storage tanks are to be connected to a dedicated break tank and booster set, with a mains water connection for top-up when required, which will provide water to the WCs and urinals.

Appendix I – Hot & Cold Water Schematics

Skelly & Couch drawing numbers:

- 1354-SAC-00-ZZ-SM-M-S-200 Hot & Cold Water Schematic Sheet 1
- 1354-SAC-00-ZZ-SM-M-S-201 Hot & Cold Water Schematic Sheet 2



B-15 PLANT ROOM

NOTES

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5. CONTRACTOR TO ALLOW FOR 10% MORE TEES ON EACH SERVICE TO ALLOW FOR UNFORESEEN SERVICES CONNECTIONS
6. ALLOW FOR DRAIN POCKETS AT THE BASE OF ALL RISERS
7. FIT ARROW VALVES FLOW LIMITING VALVES TO ALL WASH HAND BASINS, SHOWERS AND SINK

LEGEND

- MAINS COLD WATER
- DOMESTIC HOT WATER FLOW
- DOMESTIC HOT WATER RETURN
- GREY WATER
- COLD WATER OUTLET
- HOT WATER OUTLET
- MIXED WATER OUTLET
- EXTERNAL TAP/ GREY WATER OUTLET
- 3 PORT THERMOSTATIC MIXING VALVE
- FLOW DIRECTION
- MV01 SANITARY SHUT OFF SOLENOID VALVE
- BALL VALVE
- ISOLATING VALVE
- DOUBLE REGULATING VALVE
- DC DRAIN COCK
- NON RETURN VALVE
- PRESSURE REDUCING VALVE
- STRAINER
- WM WATER METER
- WM77
- PUMP
- FLEXIBLE CONNECTIONS
- BALL COCK
- TUNDISH
- DOUBLE CHECK VALVE
- PRESSURE GAGUE

S12 SCHEDULE

EQUIPMENT REF.	QUANTITY	DESCRIPTION	MANUFACTURER/MODEL	CAPACITY	NOTES
BS1	1	COLD WATER BOOSTER SET AND BREAK TANK	AQUATECH Aquamatic AMV2-FB 6 SERIES	2.5 L/S @ 3 BAR	640L x 960W x 890H
BS2	1	RAINWATER HARVESTING SYSTEM BOOSTER SET	AQUALITY Aqua-Control 1600 H VSD 9-80	1 L/S	800W x 1690H x 725D WEIGHT: 320kg (DRY: 150kg)
BS3	1	HOT WATER BREAK TANK AND BOOSTER SET	ARROW VALVES "Midi-Break" BTMIDI-HS		CAT 5. 400L x 500H x 190D. WALL MOUNTED
C01	1	HOT WATER CALORIFIER	RYCROFT	1200L	STEEL. 1100Ø x 2100H
EXP01	1	EXPANSION VESSEL	FLAMCO FLEXCON 100	100L	
F1	1	RAINWATER HARVESTING TANK FILTER	AQUALITY RAINWATER FILTER FOR BASEMENT TANK		380L x 240W x 260H OPERATIONAL WEIGHT: 40kg
WS01	1	WATER SOFTENER	GM Autoflow	SIZE FOR 2.5 L/S PEAK FLOW	
P1	2	HOT WATER CIRCULATION PUMP	GRUNDFOS ALPHA 2N 15-50	0.95 L/S	
P2	1	SUPPLY PUMP	AQUALITY SUPPLY PUMP PACKAGE FOR AC 1600 - 16-36	1 L/S	STAINLESS STEEL SUBMERSIBLE PUMP
PU1	1	PRESSURISATION UNIT	TBC	TBC	LTHW
PU2	1	PRESSURISATION UNIT	TBC	TBC	CHW
PV1	1	PRESSURE VESSEL	AQUALITY	100L (10 bar)	
RWT1	5	RAINWATER HARVESTING TANK	AQUALITY	500 L	700Ø x 1560H

REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

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STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
SCHEMATIC
SHEET 1

SCALE	DATE	DWN BY	CHCKD BY
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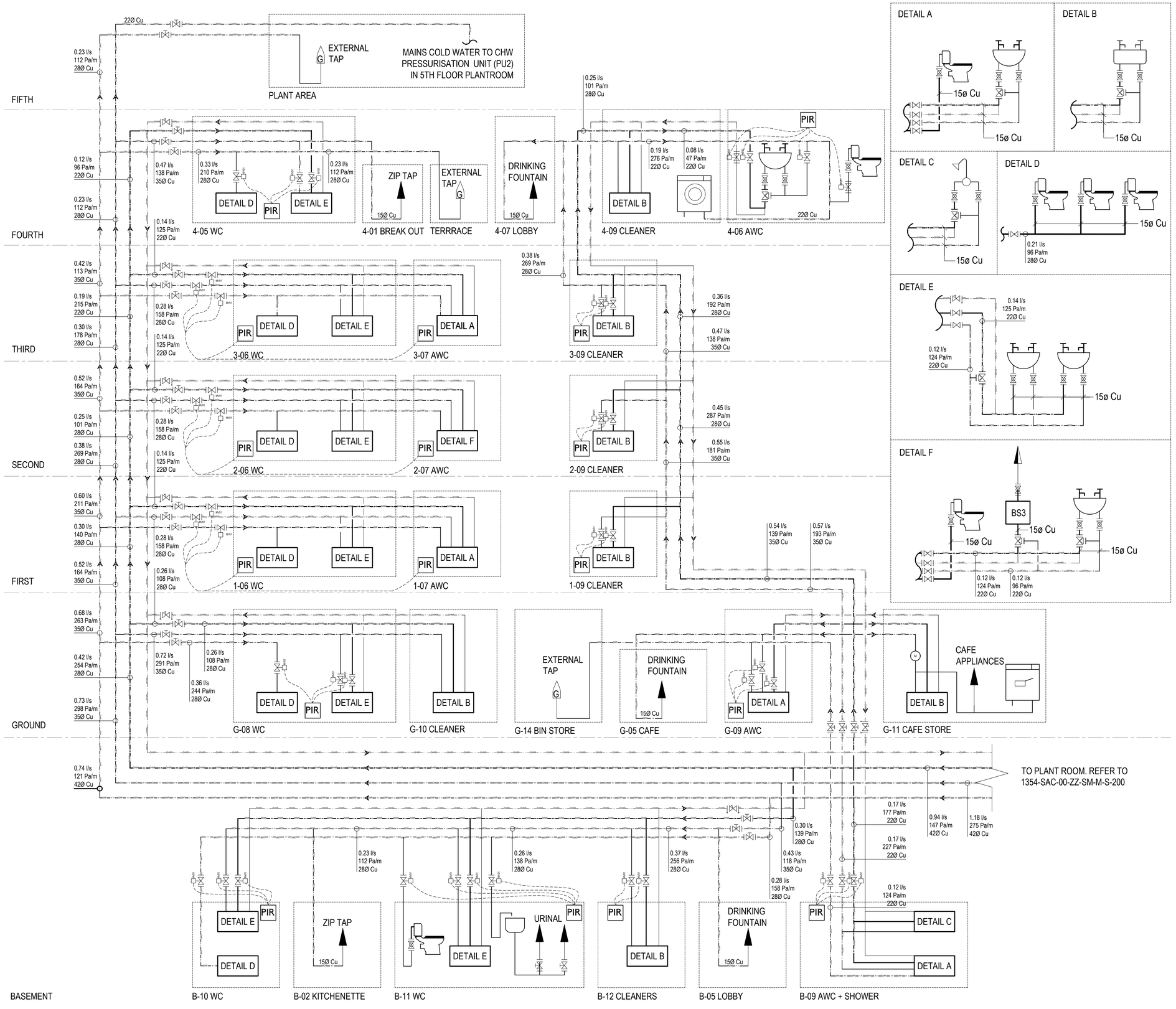
S_200_HOT & COLD WATER



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- M WM?? WATER METER

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SCHEMATIC
SHEET 2

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1354	SAC	00	ZZ	SM	M	S	201	T1

S-201 - HOT & COLD WATER

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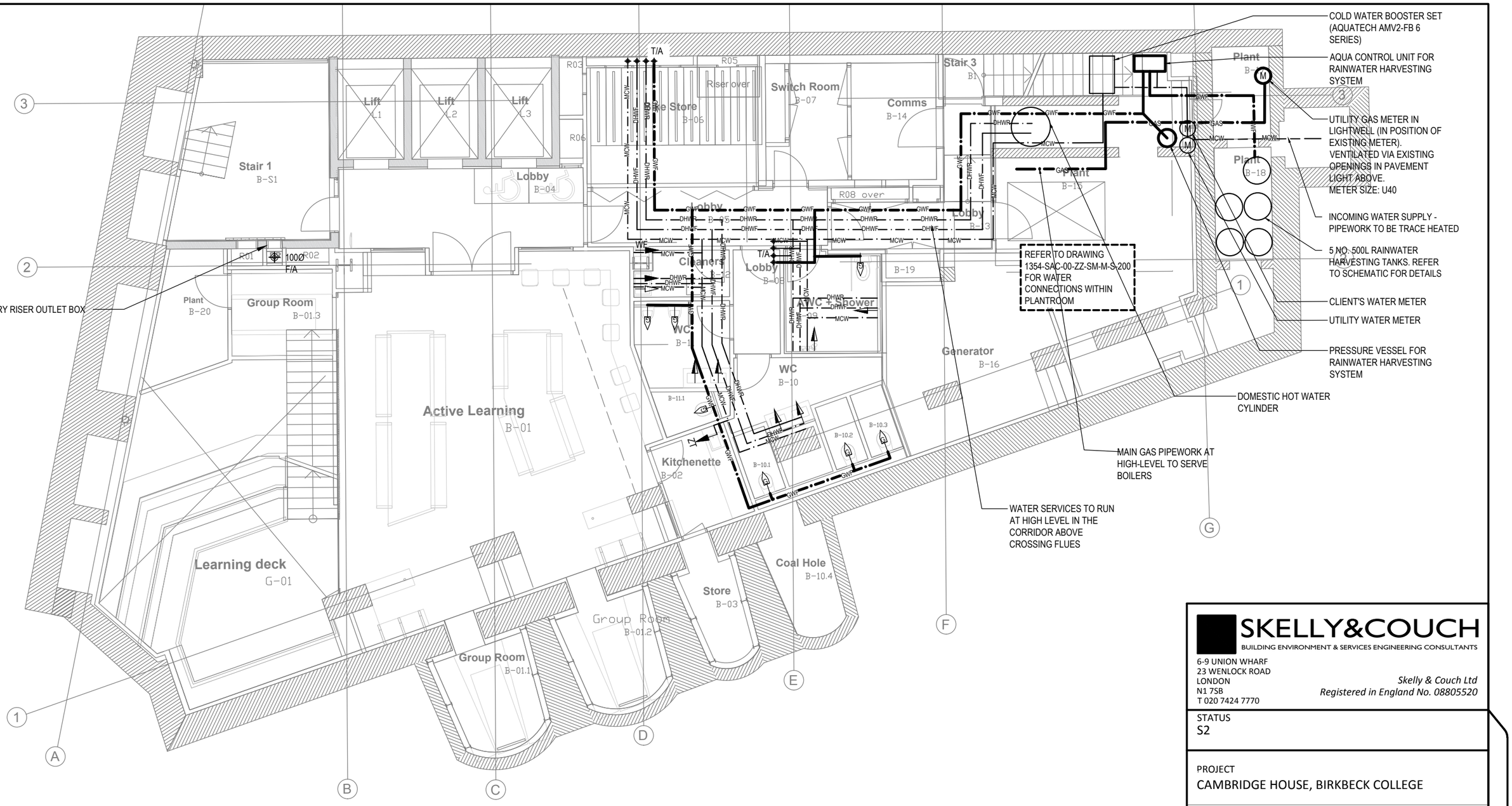
Appendix II – Hot & Cold Water Layouts

Skelly & Couch drawing numbers:

- 1354-SAC-00-B1-PL-M-S-000 Hot & Cold Water Basement Layout
- 1354-SAC-00-B1-PL-M-S-001 Hot & Cold Water Ground Floor Layout
- 1354-SAC-00-B1-PL-M-S-002 Hot & Cold Water First Floor Layout
- 1354-SAC-00-B1-PL-M-S-003 Hot & Cold Water Second Floor Layout
- 1354-SAC-00-B1-PL-M-S-004 Hot & Cold Water Third Floor Layout
- 1354-SAC-00-B1-PL-M-S-005 Hot & Cold Water Fourth Floor Layout
- 1354-SAC-00-B1-PL-M-S-006 Hot & Cold Water Fifth Floor Layout



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- DHWR — DOMESTIC COLD WATER FLOW HIGH LEVEL
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- GWF — GREY WATER HIGH LEVEL
- COLD WATER OUTLET
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APPLIANCES

B -	BATH
DW -	DISHWASHER
ET -	EXTERNAL COLD WATER TAP
HWB -	HAND WASH BASIN
S -	SINK
SH -	SHOWER
U -	URINAL
WC -	WC
WF -	WATER FOUNTAIN
WM -	WASHING MACHINE
ZT -	ZIP TAP

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HOT & COLD WATER
BASEMENT LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
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PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
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S -000 -HOT & COLD WATER

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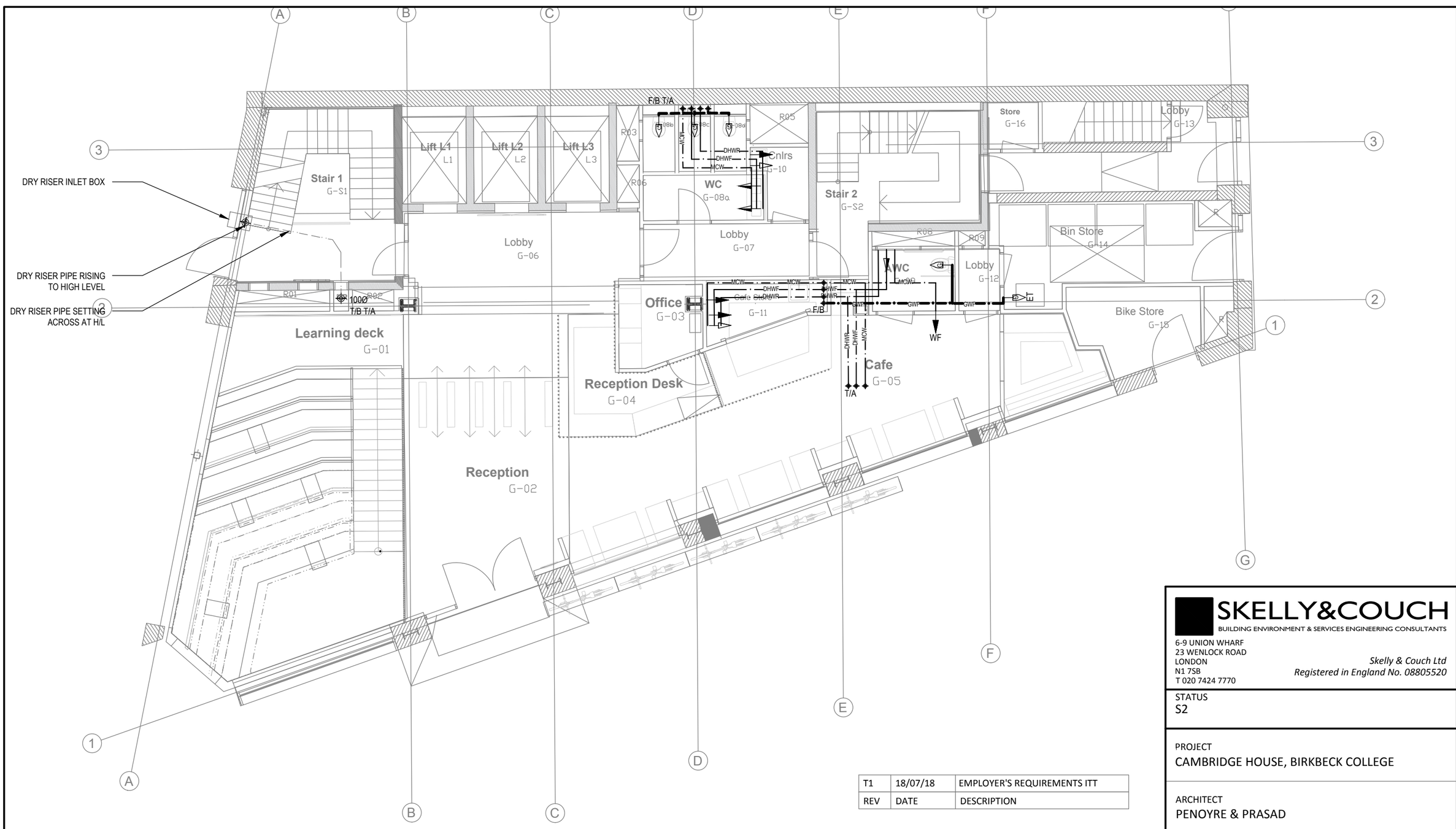

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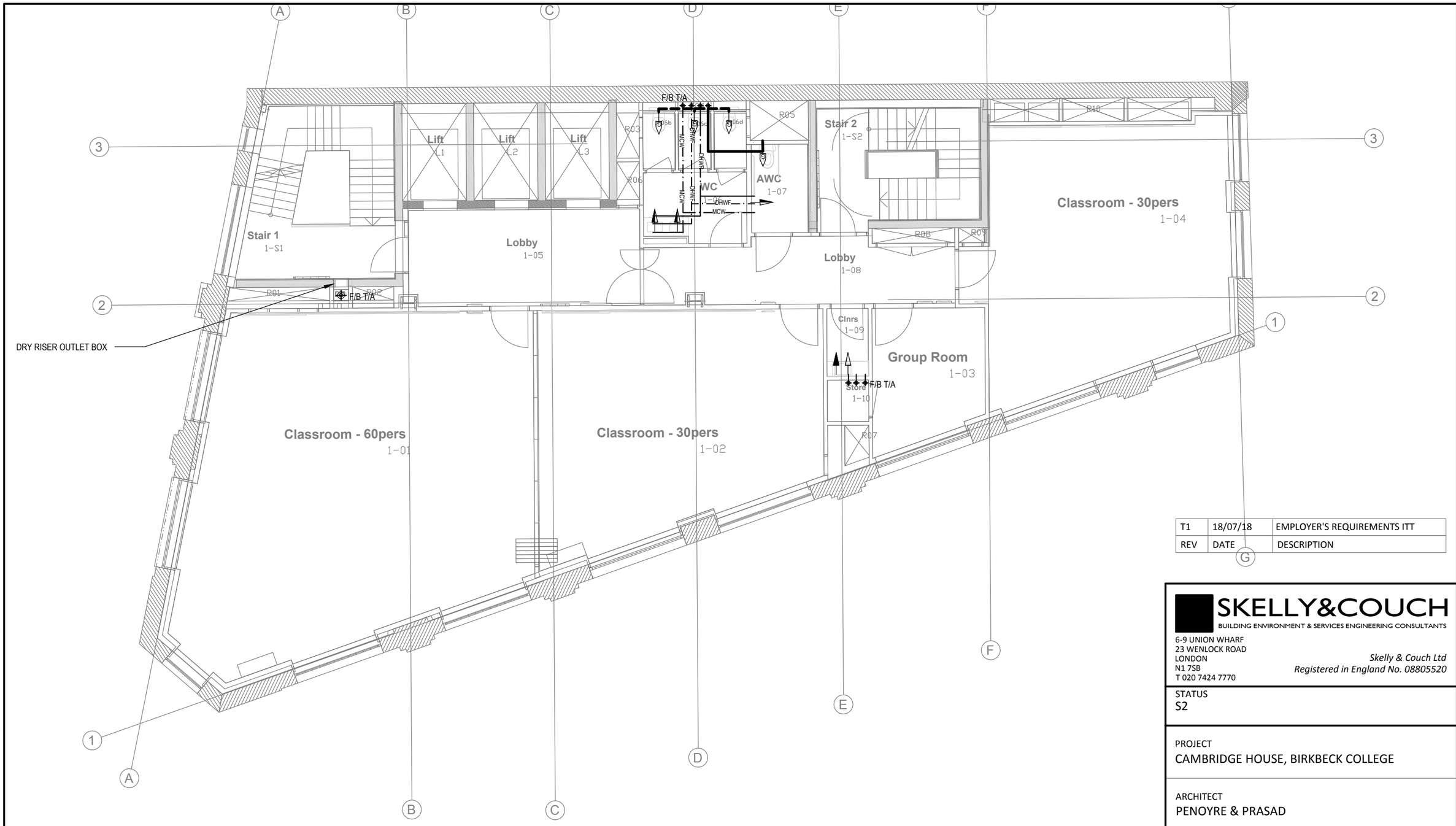
1354	SAC	00	00	PL	M	S	001	T1

S -001 -HOT & COLD WATER



REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

NOTES

1. DO NOT SCALE FROM THIS DRAWING
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5. ALL PIPEWORK RUNNING THROUGH UNHEATED OR EXTERNAL AREAS IS TO BE INSULATED AGAINS FROST AND MAY BE TRACE HEATED: REFER TO SPECIFICATION FOR DETAILS
6. FINAL CONNECTIONS TO ALL SANITARY APPLIANCES ARE TO BE 15mm UNLESS OTHERWISE NOTED. FINAL CONNECTIONS TO SINKS ARE TO BE 22mm FOR BOTH HOT AND COLD WATER SERVICES UNLESS OTHERWISE NOTED.
7. ALL COLD WATER PIPEWORK TO BE CWS UNLESS OTHERWISE NOTED.
8. ALL HOT WATER PIPEWORK TO BE HWS UNLESS OTHERWISE NOTED
9. CONTRACTOR TO ALLOW FOR 10% MORE TEES ON EACH SERVICE TO ALLOW FOR UNFORESEEN SERVICES CONNECTIONS
10. ALLOW FOR DRAIN POCKETS AT THE BASE OF ALL RISERS
11. FIT ARROW VALVES FLOW LIMITING VALVES TO ALL WASH HAND BASINS, SHOWERS AND SINKS
12. SANITARY SHUT OFF SYSTEMS WITH PIR CONTROL ARE TO BE PROVIDED IN ALL WC/SHOWER AREAS. REFER TO SCHEMATIC AND SPECIFICATION

LEGEND

- MCW — MAINS COLD WATER HIGH LEVEL
- DHWR — DOMESTIC COLD WATER FLOW HIGH LEVEL
- DHWF — DOMESTIC COLD WATER RETURN HIGH LEVEL
- GWF — GREY WATER HIGH LEVEL
- COLD WATER OUTLET
- HOT WATER OUTLET
- MIXED WATER OUTLET
- EXTERNAL TAP/ GREY WATER OUTLET

APPLIANCES

B -	BATH
DW -	DISHWASHER
ET -	EXTERNAL COLD WATER TAP
HWB -	HAND WASH BASIN
S -	SINK
SH -	SHOWER
U -	URINAL
WC -	WC
WF -	WATER FOUNTAIN
WM -	WASHING MACHINE
ZT -	ZIP TAP

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Skelly & Couch Ltd
Registered in England No. 08805520

STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

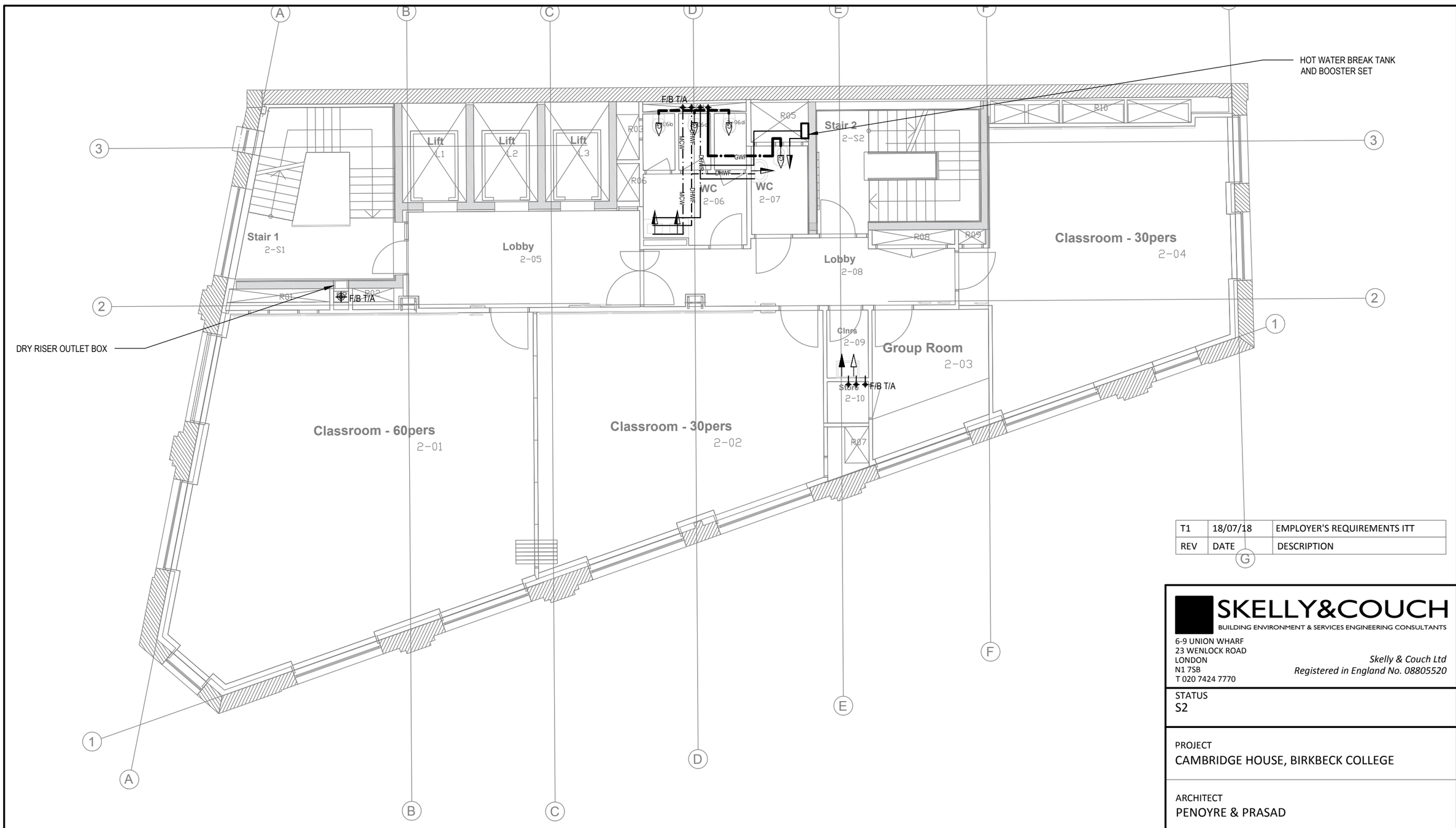
ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
FIRST FLOOR LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
1:100 *(@ A3)*	NOV 17	NJ	DH

PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
1354	SAC	00	01	PL	M	S	002	T1

S -002 -HOT & COLD WATER



REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

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- DHWR — DOMESTIC COLD WATER FLOW HIGH LEVEL
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- GWF — GREY WATER HIGH LEVEL
- COLD WATER OUTLET
- HOT WATER OUTLET
- MIXED WATER OUTLET
- G — EXTERNAL TAP/ GREY WATER OUTLET

APPLIANCES

B -	BATH
DW -	DISHWASHER
ET -	EXTERNAL COLD WATER TAP
HWB -	HAND WASH BASIN
S -	SINK
SH -	SHOWER
U -	URINAL
WC -	WC
WF -	WATER FOUNTAIN
WM -	WASHING MACHINE
ZT -	ZIP TAP

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Registered in England No. 08805520

STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

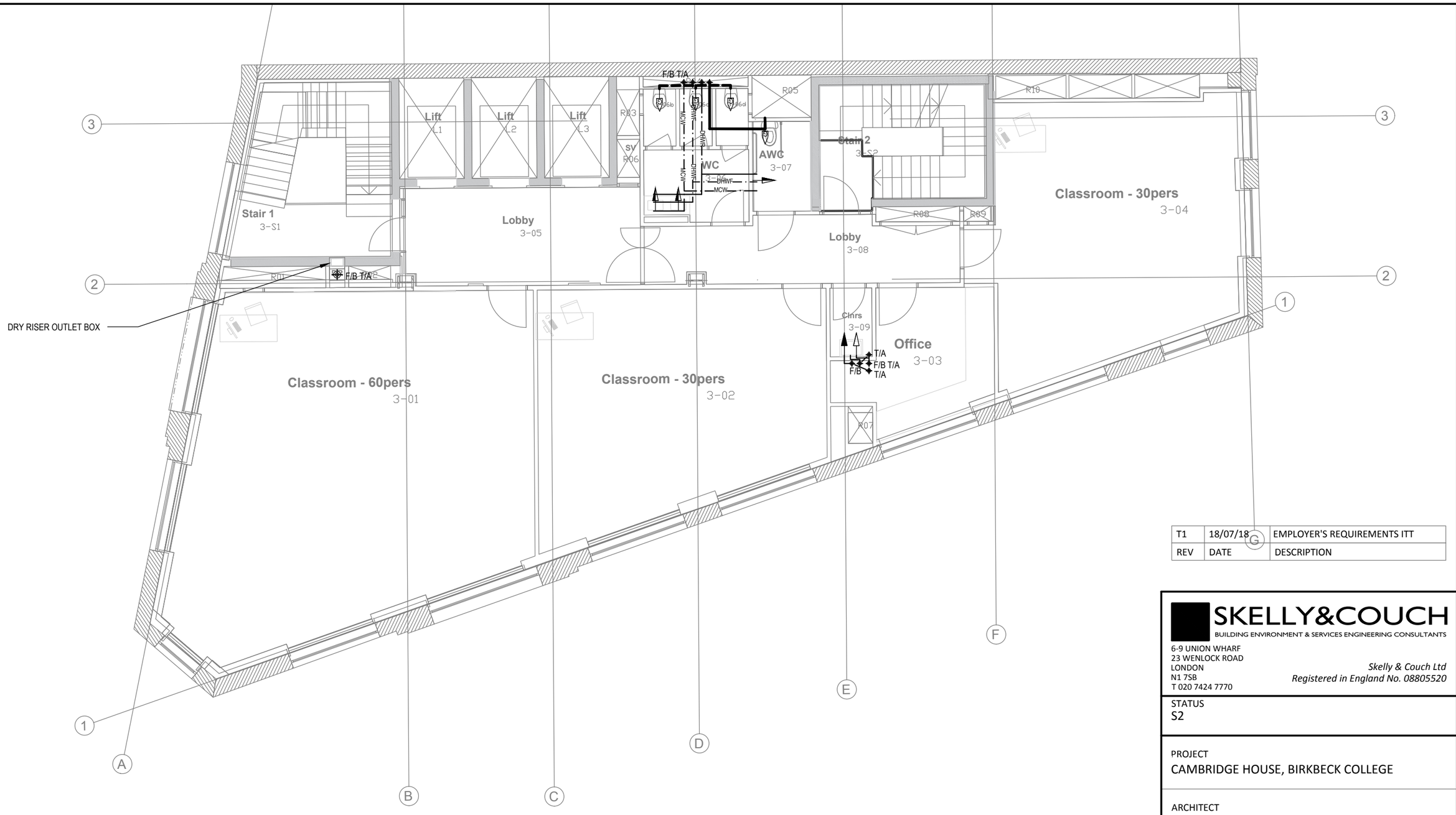
ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
SECOND FLOOR LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
1:100 *(@ A3)*	NOV 17	NJ	DH

PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
1354	SAC	00	02	PL	M	S	003	T1

S -003 -HOT & COLD WATER



REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

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STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
THIRD FLOOR LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
1:100 *(@ A3)*	NOV 17	NJ	DH

PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
1354	SAC	00	03	PL	M	S	004	T1

S -004 -HOT & COLD WATER

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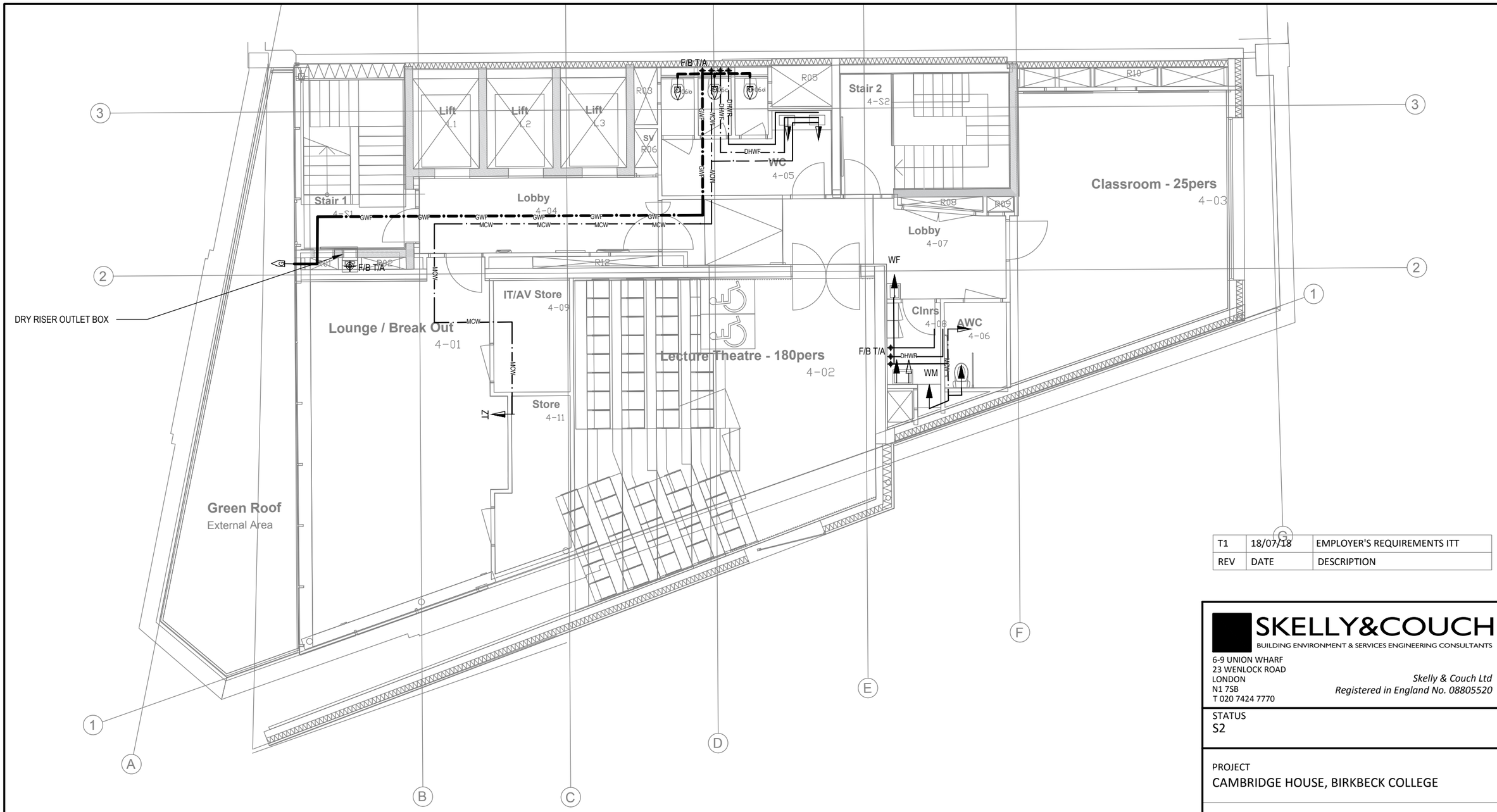

REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

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STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

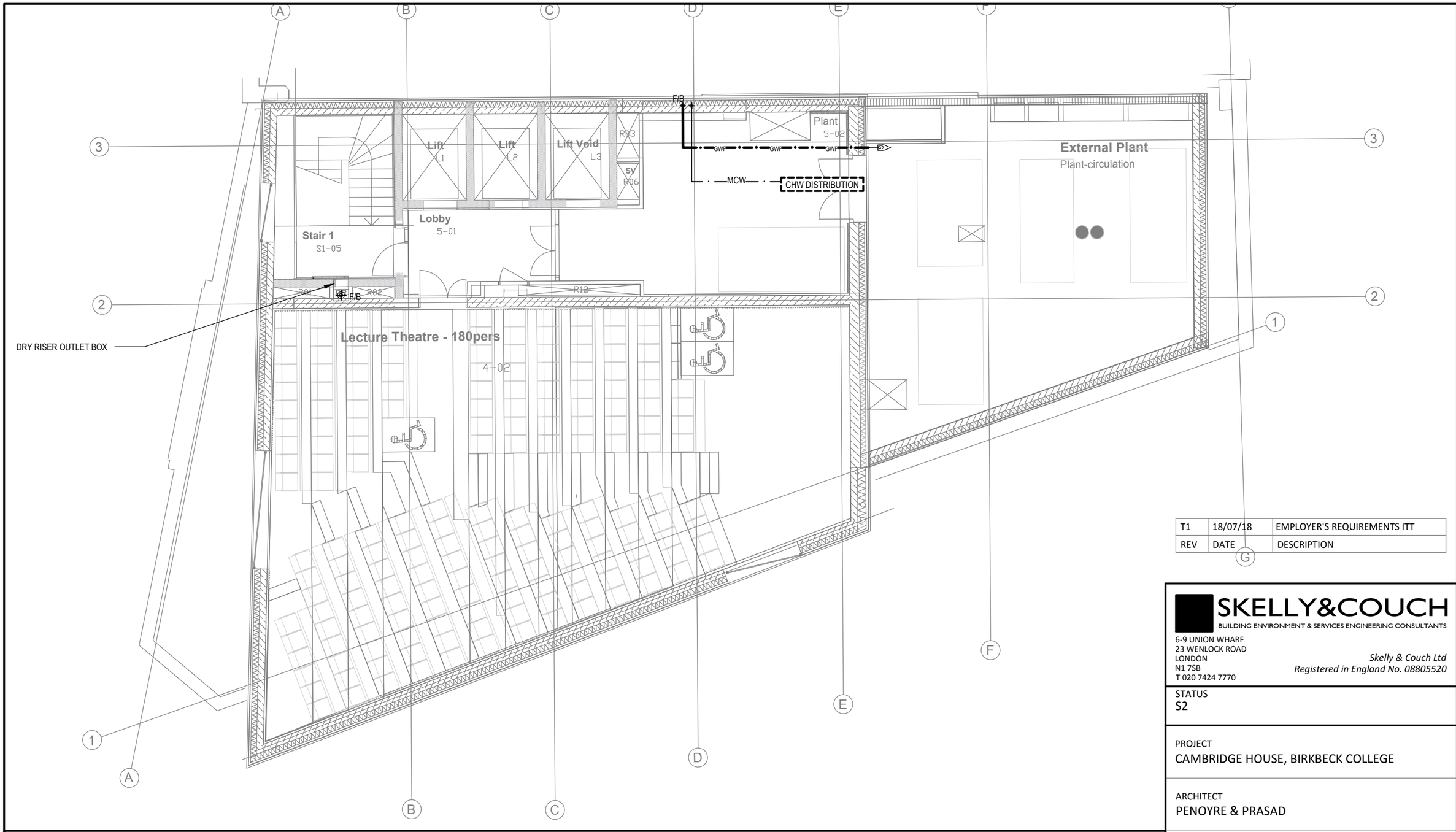
ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
FOURTH FLOOR LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
1;100 *(@ A3)*	NOV 17	NJ	DH

PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
1354	SAC	00	04	PL	M	S	005	T1

S -005 -HOT & COLD WATER



REV	DATE	DESCRIPTION
T1	18/07/18	EMPLOYER'S REQUIREMENTS ITT

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LONDON
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STATUS
S2

PROJECT
CAMBRIDGE HOUSE, BIRKBECK COLLEGE

ARCHITECT
PENOYRE & PRASAD

DRAWING
HOT & COLD WATER
FIFTH FLOOR LAYOUT

SCALE	DATE	DWN BY	CHCKD BY
1:100 *(@ A3)*	NOV 17	NJ	DH

PROJ.	ORIG.	ZONE	LEVEL	TYPE	ROLE	CLASS	NO.	REV
1354	SAC	00	05	PL	M	S	006	T1

S -006 -HOT & COLD WATER

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