SANDY BROWN

*Consultants in Acoustics, Noise & Vibration*

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# Phoenix Theatre, Charing Cross Road

*Theatre bar refurbishment*

*Noise assessment report*

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# Summary

Sandy Brown has been commissioned by the Ambassador Theatre Group to provide acoustic design advice for the refurbishment and fit-out of a new theatre bar and supporting spaces at Phoenix Theatre, Charing Cross Road, London.

The works include refurbishment of existing retail units located on the ground floor of the premises into a new theatre bar, merchandising shop and ancillary spaces. The future use of the new theatre bar includes pre-show immersive experiences, supported by amplified music.

Residential flats are located above the ground floor premises, and tests of the sound insulation afforded by the existing building structure were carried out to inform on the necessary upgrade measures. The sound insulation tests carried out indicated an airborne sound insulation performance of $D_{nT,w}+C_{tr}$ 47 dB between the ground and first floor.

An acoustic survey was carried out within the Kit Kat Club at The Playhouse to understand sound levels that may be typically associated with the proposed pre-show immersive experiences. The average measured entertainment sound level was $L_{Aeq}$ 85 dB.

Design advice has been provided to enhance existing levels of sound insulation so that the future theatre bar may have amplified music and pre-show immersive experiences with sound levels similar to those observed at The Kit Kat Club.

Sound system limits have been proposed based on the expected improvements to sound insulation and the London Borough of Camden's typical requirement for entertainment music noise ingress, ie, NR25. A further 5 NR point tolerance has been included to account for potential fluctuations in sound level.

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# 1 Introduction

Sandy Brown has been commissioned by The Ambassador Theatre Group to provide acoustic design advice in relation to the new bar/foyer extension at Phoenix Theatre, London WC2H 0JP.

The new ground floor theatre bar will be located directly below residential dwellings on the first floor.

Tests of sound insulation afforded by the existing building structure between the vertically separated premises were carried out at the site on 2 March 2023. As it will be desirable for pre-show entertainment and immersive experiences to take place within the new theatre bar, an activity sound level survey was carried out at the Kit Kat Club on 8 March 2023 to measure levels associated with a pre-show immersive experience.

This report presents the results of the surveys and provides an outline of the measures to be adopted to enhance the sound insulation between the new theatre bar and residential premises above.

Sound system limits have also been defined based on the anticipated improvement in airborne sound insulation taking into account the London Borough of Camden's typical requirement for entertainment music noise to be limited to ≤ NR25.

# 2 The site

The Phoenix Theatre is located on Charing Cross Road, close to the heart of London's West End. The theatre's current ground floor demise includes an entrance lobby, box office, theatre access stairs and store.

It is proposed that several of the existing ground floor retail units are refurbished to form a new and expanded front of house box office, bar, merchandise shop/lounge, with associated kitchen, WCs and store.

Residential flats are located on the first floor above.

The airborne sound insulation between the ground floor and the residential flats above is of key interest. The existing separating floor is understood to consist of a ridge beam concrete slab of 80 mm depth.

# 3 Criteria

The following acoustic criteria are recommended for the new theatre bar and its supporting spaces. These form the basis of recommendations contained within this report.

## 3.1 Airborne sound insulation

### *3.1.1 Camden Local Plan*

The London Borough of Camden's Local Plan, Appendix 3 provides noise thresholds for entertainment music noise and stipulates:

> *"Assessments for noise from entertainment and leisure premises must include consideration to amplified and unamplified music, human voices, footfall and vehicle movements and other general activity. Appropriate metrics must be used to measure and assess the noise impact including $L_{Aeq}$ and $L_{Amax}$ metrics and appropriate frequency spectrum. Planning permission will not be granted in instances where it is not possible to achieve suitable and sufficient internal noise levels with reference to the most up to date and appropriate guidance within proposed noise sensitive receptors despite appropriate mitigation proposals due to the totality of noise from existing entertainment venues.*
>
> *For entertainment and plant noise rating curves should be measured as a 15 minute linear $L_{eq}$ at the octave band centre frequencies."*

Noise Rating curves stipulated within Camden's Local Plan for entertainment noise are reproduced in Table 1.

Table 1 Recommended maximum internal noise levels due to building services

| Room | Noise rating curve | Design period |
|---|---|---|
| Bedrooms | NR25 | 23:00 – 07:00 hrs |
| All habitable rooms | NR35 | 07:00 – 23:00 hrs |

### *3.1.2 Airborne sound insulation, bar to residential*

The design is targeting an airborne sound insulation between the new bar and first floor dwellings of ≥ $D_{nT,w}$ +$C_{tr}$ 55 dB.

Camden's Local Plan requires that amplified music noise ingress into dwellings does not exceed NR25. A 5 NR point tolerance to the Local Authority target has been allowed for to take into account potential variations in sound levels that may occur. Therefore, music noise ingress into dwellings of ≤ NR20 is being targeted.

As the new bar will have the facility to playback amplified music, and future uses may include pre-show immersive experiences, recommendations are for the sound insulation to be maximised as far as possible within the site's constraints.

## 3.2 External noise

The potential for entertainment music noise break out via the new glazed facade is also being designed to ≤ NR20, to allow for variation in sound level while continuing to meet Local Authority criteria.

It is noted that the residential windows on Charing Cross Road are exposed to relatively high residual sound levels due to road traffic, and occupants may be likely to keep windows closed.

# 4 Sound insulation tests

To inform recommendations for sound insulation upgrade measures at the site, a survey of the airborne sound insulation afforded by the existing building structure was carried out on 2 March 2023.

## 4.1 Methodology

Tests of airborne sound insulation were carried out between the ground floor Stub Hub shop and Flat 4 directly above.

An existing lathe and plaster ceiling, and secondary acoustically absorptive ceiling were partially removed within the shop, so that tests would be approximately representative of the current separating 80 mm concrete ridge beam slab to the flat above.

## 4.2 Results

Results of the airborne sound insulation tests carried out between the ground floor shop and first floor flat are summarised in Table 2.

Table 2 Airborne sound insulation measurement results

| Ref | Source room | Receiver room | Measurement result, $D_{nT,w}+C_{tr}$ (dB) |
|---|---|---|---|
| 1 | GF Stub Hub | 1F Flat 4 | 47 |

Test results indicate an airborne sound insulation performance of $D_{nT,w} + C_{tr}$ 47 dB between the ground floor shop and first floor.

It is noted that this level of sound insulation would not provide suitable sound system limits that would meet NR25 within the apartments above.

# 5 Activity noise level survey

A survey of activity sound levels was carried out at The Kit Kat Club at The Playhouse on 8 March 2023 to understand noise levels that are typically associated with a pre-show immersive experience.

## 5.1 Methodology

With a show start time of 19:30, pre-show entertainment began from approximately 18:15 and took place in the basement Red Bar and ground floor Gold Bar. Sound generating activity included live and amplified music. Live music comprised actors playing piano, clarinet, violin and accordion.

Sound level measurements were generally carried out at approximate 3 m distances from musicians and loudspeakers. Measurements were made over 5 minute intervals.

## 5.2 Results

Measured sound levels along with comments of the dominating sound source(s) are presented in Table 3.

Table 3 Sound levels and key noise sources from attended measurements

| Position | Start time | Sound pressure levels (dB) | | | | Noise sources |
|---|---|---|---|---|---|---|
| | | $L_{Aeq,5min}$ | $L_{AFmax,5min}$ | 63 Hz $L_{eq,5min}$ | 125 Hz $L_{eq,5min}$ | |
| Red Bar | 18:23 | 85 | 93 | 64 | 75 | Live music only |
| Gold Bar | 18:31 | 85 | 94 | 79 | 84 | Live and amplified music |
| Gold Bar | 18:37 | 90 | 102 | 82 | 88 | Live and amplified music, musicians move to within 1m distance of microphone, round of applause, door to theatre opened, giving rise to additional low frequency[1] |
| Gold Bar | 18:41 | 91 | 101 | 81 | 76 | Live and amplified music, musicians within 1m distance, door to theatre open[1] |
| Gold Bar – entry doors | 18:46 | 83 | 92 | 74 | 89 | Amplified music only |
| Gold Bar – entry doors | 18:52 | 85 | 93 | 73 | 89 | Live and amplified music |
| Red Bar | 19:00 | 86 | 96 | 69 | 73 | Live and amplified music |
| Red Bar | 19:05 | 86 | 99 | 72 | 86 | Live and amplified music |
| Red Bar | 19:13 | 84 | 91 | 70 | 77 | Live music and crowd noise |

[1] Live musicians played within 1 m of the microphone. Theatre doors were also opened, and higher levels of low-frequency energy were noted to enter the bar from the theatre.

Measured sound levels were due to either live musicians only or a combination of live and amplified music. The main pre-show event took place in the Gold Bar from 18:30 and concluded at 18:40, accompanied by a round of applause. Shortly after, the theatre lobby doors were opened to allow patrons access to their seats. Patrons were generally quiet until the experience had concluded, after which crowd noise began to rise.

A combination of live and amplified music continued from 18:40 until showtime.

The overall average entertainment sound level was $L_{Aeq}$ 85 dB, with average energy in the 63 Hz and 125 Hz octave bands of $L_{eq}$ 72 dB and $L_{eq}$ 82 dB respectively. These averages do not include measurements in which musicians were in very close proximity to the microphone or when additional low-frequency energy entered the Gold Bar due to the opening of the theatre lobby doors.

# 6 Design proposals

This section presents a high level summary of the design recommendations provided to enhance the sound insulation performance between the ground and first floor.

## 6.1 Sound insulation

Advice has been provided on the following design elements:

- Sound insulating ceiling
- Isolated floor construction
- Independent wall linings.

The precise design measures are still to be developed and detailed, though the following sections outline the works advised to achieve $D_{nT,w}$ +$C_{tr}$ 55 dB or higher.

### *6.1.1 Party floor/ceiling construction*

A high performance plasterboard ceiling is be installed across all the newly proposed ground floor spaces. The ceiling is to include the use of high performance acoustic rubber hangers and high density boards.

The following ceiling specification is to be installed:

- Low profile resilient ceiling hangers
- 200 mm void with mineral wool in the cavity
- Plywood
- Boards achieving a minimum surface mass of ≥ 34 kg/m$^2$

### *6.1.2 Floor construction*

An isolated flooring construction is to be installed above the base concrete slab. The primary purpose of this measure is to maximise sound insulation to dwellings above by controlling flanking sound entering the building structure via the floor slab.

The following flooring build-up is to be installed:

- 17 mm isolation mat, installed dimpled side down
- T&G product with minimum surface mass ≥ 57 kg/m$^2$.

### *6.1.3 Independent wall linings*

To control flanking noise transmission to the dwellings via structural walls and columns, independent wall linings are also to be installed.

Independent wall linings will be installed to all front of house spaces and a number of back of house spaces. This is to ensure the level of sound insulation provided to the flats above is not compromised each time a door to one of these spaces is opened. This also reduces the need for managing of the opening/closing of doors.

A markup showing the location of independent wall linings is shown in Appendix A. It is noted that residential flats are located between above gridlines B and C only.

The following specification of wall linings will be installed:

- 90 mm void to structural elements
- 50 mm mineral wool in the cavity
- Boards achieving a minimum surface mass of ≥ 34 kg/m$^2$.

Independent wall linings will not be fixed to the structural soffit.

### *6.1.4 Internal walls*

Internal walls within the new theatre bar's demise will not be fixed to the structural soffit.

### *6.1.5 Riser walls, bar area*

Masonry risers will be adopted in the bar area. This is due to masonry constructions providing significantly higher levels of insulation against low-frequency sound when compared to lightweight partitions. These masonry risers will also be drylined using a resiliently connected frame.

The following specification of riser walls are to be installed in the front of house theatre bar:

- 100 mm dense concrete blockwork
- Resilient isolated channel fixings
- 25 mm mineral wool in the cavity
- Board achieving a minimum surface mass of ≥ 17 kg/m$^2$.

Masonry risers will not be fixed to the structural soffit.

### *6.1.6 Riser doors, bar area*

Riser doors located within the bar area are to provide a minimum sound insulation rating of ≥ $R_w$ 40 dB.

#### *6.1.7 Treatment of common services within risers*

Common services within risers such as pipework and soil vent pipes will be externally acoustically lagged to minimise the risk of sound flanking via this pathway.

#### *6.1.8 Firestopping of risers*

The horizontal section of the risers that abut the separating concrete slab will be firestopped using 2 x 60 mm intumescent batts with minimum density ≥ 140 kg/m$^3$.

#### *6.1.9 Resilient head detail*

A resilient head detail is to be installed to all internal walls, independent wall linings and masonry riser walls. This is to enable restraint of these partitions at the head, while minimising the risk of flanking sound entering the ceiling structure.

#### *6.1.10 General arrangement drawing markup*

A markup of the recommended acoustic performance ratings for all internal walls is provided in Appendix A.

### 6.2 Doors

A markup of acoustic door performance requirements for internal doors is provided in Appendix A.

Where acoustically rated door-sets are required, they would need to close onto a frame and have perimeter acoustic seals (eg single / double batwing type). Drop-down threshold seals and a self-closing mechanism are recommended for all acoustically rated doors sets.

Gaps between door frames and the walls in which they are fixed should be not more than 10 mm. Where there are gaps between door frames and the walls in which they are fixed close to this size, the gaps should be packed to the full depth of the wall with mineral wool. In all cases frames should be sealed on both sides of the wall with sealant.

### 6.3 Building envelope

Existing glazing systems are to be replaced to control music noise egress from the bar and to limit external noise ingress into the new space.

Ambient noise levels along the Charing Cross Road are noted to be relatively high and are dominated by road traffic noise and pedestrians. It can be inferred that due to the relatively high residual noise levels along Charing Cross Road, residents on the first floor would generally keep windows closed.

### *6.3.1 Glazing*

The glazing is to achieve a minimum acoustic rating of ≥ $R_w$ +$C_{tr}$ 37 dB. An example glazing specification that meets this requirement is Pilkington 9 mm glass / 16 mm void / 9 mm glass.

### *6.3.2 Glazed entry doors*

The glazed doors in the facade providing direct access from the street into the bar be double glazed are to achieve a minimum acoustic rating of ≥ $R_w$ 37 dB.

The acoustically rated door sets should have suitable acoustic seals at all perimeters including threshold and perimeter meeting stiles.

# 7 Amplified music

## 7.1 Sound system limits

Sound systems in the new theatre bar are to be limited to the maximum octave band noise levels presented in Table 4.

Table 4 Maximum sound system limits, theatre bar

| Maximum octave band sound pressure levels (dB) | | | | | | | | Overall |
|---|---|---|---|---|---|---|---|---|
| 63 Hz | 125 Hz | 250 Hz | 500 Hz | 1 kHz | 2 kHz | 4 kHz | 8 kHz | $L_{Aeq,15min}$ |
| 80 | 85 | 82 | 81 | 82 | 82 | 85 | 85 | 90 |

[1] $L_{max}$ octave bands levels must be within 5 dB of values presented above at a distance of 1 m from any loudspeaker

The sound system limits presented in Table 4 have been predicted based on the expected airborne sound insulation performance of the enhanced floor/ceiling construction and meeting NR20 within residential dwellings.

These limits will be confirmed once the sound enhancement measurements have been installed.

### *7.1.1 Distributed sound systems*

It is recommended that a distributed sound system is installed in the theatre bar, rather than a smaller number of larger loudspeakers.

### *7.1.2 System limiting*

A sound system limiter is to be installed to ensure sound system remains within the calculated limits.

### 7.2 Live music

Some live instruments may be capable of generating higher sound levels than the predicted limits permit. Should the new theatre bar have the provision for live music entertainment, the use of drums and drumkits is not recommended unless measures are taken to reduce the sound level from these instruments to ensure they operate within the limits shown in Table 4.

## 8 Conclusion

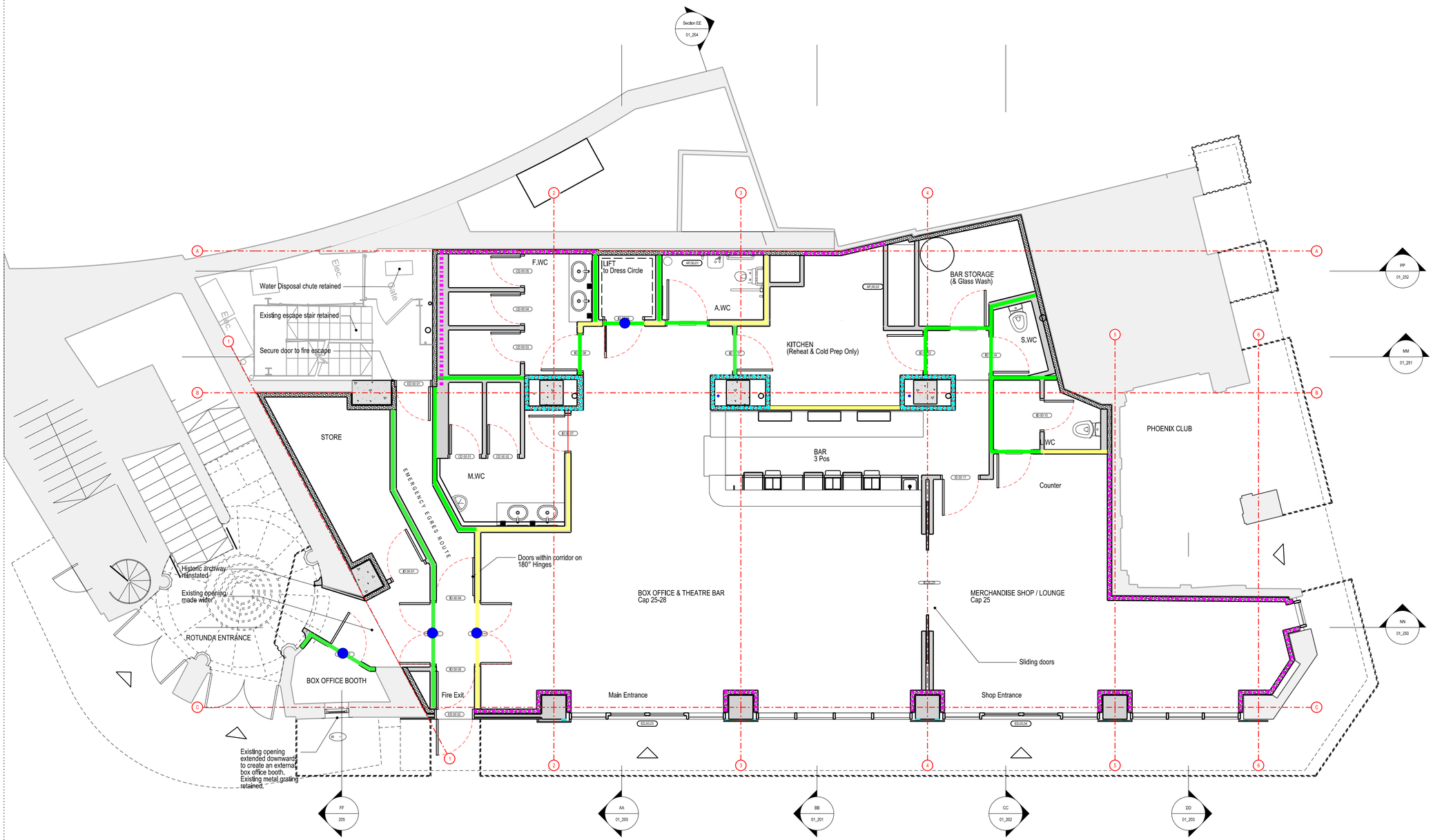
Sandy Brown has been commissioned by the Ambassador Theatre Group to provide acoustic design advice for the refurbishment and fit-out of a new theatre bar at Phoenix Theatre.

The works include refurbishment of existing retail units located on the ground floor of the premises into a new theatre bar which may include pre-show immersive experiences, supported by amplified music.

The studies completed indicate that with the sound insulation enhancements and by limiting sound systems, that suitable conditions can be achieved within the apartments above.

# Appendix A

## Markup of internal wall and door sound insulation performance




| | |
|---|---|
| Title | Partitions and doorsets mark-up |
| Project | Phoenix Theatre |
| Project no. | 23077 |
| Version | B |
| Marked-up by | Nitin Katiyar |
| Reviewed by | Stephen Stringer |
| Date | 03 April 2023 |

**Mark-up key laboratory ratings**

- $R_w$ 50 dB drywall partition - full height (slab-to-slab)
- $R_w$ 45 dB drywall partition - full height (slab-to-slab)
- 100 mm concrete blockwork riser walls
- Independent wall lining
- $R_w$ 38 dB doorset
- $R_w$ 30 dB doorset

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| Rev | Date | Reason For Issue | Chk |
|---|---|---|---|
| P5 | 17.03.2023 | Stage 3 | NP |
| P4 | 24.01.2023 | Note Removed | NP |
| P3 | 02.12.2022 | Planning Issue | NP |
| P2 | 03.11.2022 | Plan Revisions | NP |
| P1 | 12/10/2022 | General Plan Development | NP |

Key Plan


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Client
Phoenix Theatre
Charing Cross Road
Ambassador Theatre Group

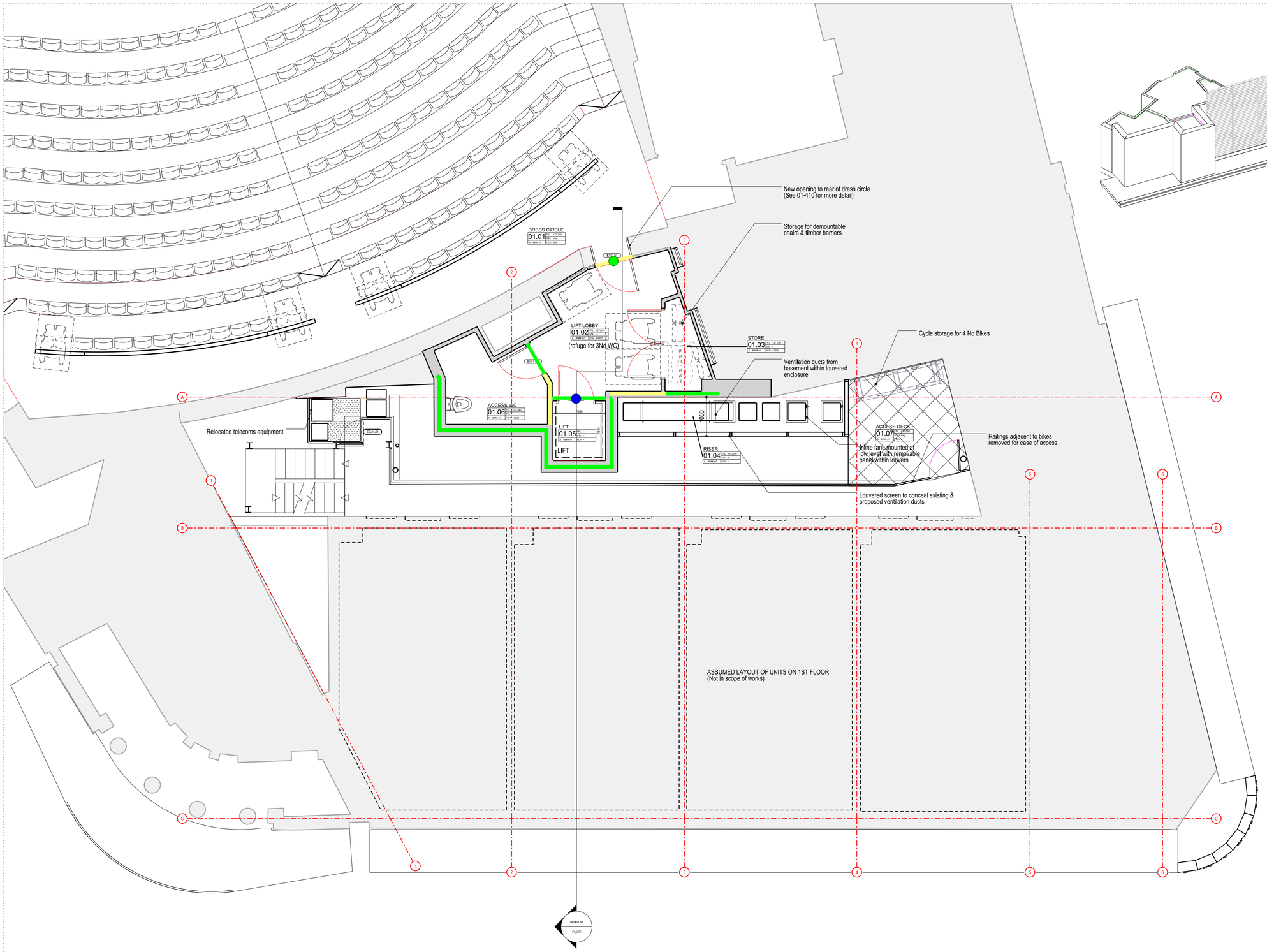
Project
Project Ash
Phoenix Theatre
Charing Cross Road
-

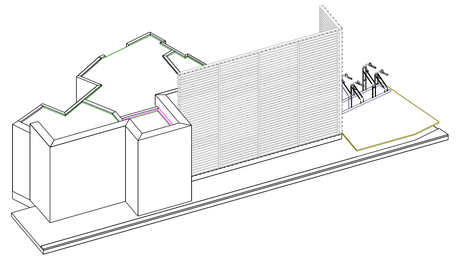
Title
Ground Floor
Plan
Proposed

Status
INFORMATION

| Project Number | Date | Checked By |
|---|---|---|
| 559 | SEPT 2022 | - |
| Revision | Scale @ ISO A1 | Approved By |
| P5 | 1:50@A1 | - |

Drawing Number
559-PWL-ZZ-ZZ-DR-A-01_100



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| P3 | 17.03.2023 | Stage 3 | NP |
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-

Title
Dress Circle
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Status
INFORMATION

| Project Number | Date | Checked By |
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| 559 | SEPT 2022 | - |
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