MACH ACOUSTICS

PRIMROSE HILL SCHOOL, ARP PROVISION

Acoustic Design Report Rev01

Haverstock Architects

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1.0 INTRODUCTION

This report sets out the acoustic performance requirements for Primrose Hill Primary School, London, to allow the client, design team and contractor to work towards a clear set of design requirements.

The acoustic performance standards that Primrose Hill Primary School must achieve are listed below:

Acoustic Design of Schools: Performance Standards. Building Bulletin 93 (V17 - February 2015)

As the development is a refurbishment of an existing building, BB93 is not mandatory to comply with Part E of the Building Regulations, therefore, the performance targets detailed within this report, unless otherwise stated, have been provided for guidance purposes only, though MACH Acoustics would strongly recommend these be met to ensure the building is fit for purpose and satisfy the School Premises Regulations, Independent School Standards and the Equality Act 2010.

1.1 Special Educational Needs

Pupils with special educational needs are usually more sensitive to acoustic environment than other pupils. Consequently, required indoor ambient noise levels (and the capacity for distraction) is lower than for other pupils, the required sound insulation between adjacent spaces are higher, and the required reverberation time is lower than that required for other pupils. This increase in acoustic requirements for SEN pupils are reflected in the subsequent sections.

2.0 INDOOR AMBIENT NOISE LIMITS

Maximum noise levels for spaces within this development are provided within the table below. The levels provided within this table are the sum of building services noise and external noise within the unoccupied, fully operational building.

BB93 Classification	$L_{Aeq,30min}$ (dB) (Refurb)
Primary School: Classroom, Class Base, General Teaching Area, Small Group Room	40
Recording Studio	35
Teaching space intended specifically for students with special hearing and communication needs	35
SEN Calming Room	35
Study Room (Individual Study, Withdrawal, Remedial Work, Teacher Preparation)	40
Assembly Hall, Multi-Purpose Hall (Drama, PE, Audio/Visual Presentations, Assembly, Occasional Music)	40
Gymnasium/Activity Studio	45
Dining Room	50
Office, Medical Room, Staff Room[1]	45
[1] Considered administration or ancillary, therefore, guidance only	

Table 2.1: Maximum Indoor Ambient Noise Level Targets

The above table provides generic targets based on BB93 room classifications. If a particular space has not been included within the above table, MACH Acoustics should be consulted with respect to the noise levels within this space.

BB93 also sets a maximum "L1" noise level of 60 dB LA1,30min in teaching spaces. This only requires assessment in spaces with indoor ambient noise level targets of 45dB LAeq,30min or greater.

2.1 Relaxations

2.1.1 Natural/Hybrid Ventilation

Where a natural or hybrid ventilation strategy is to be employed, the indoor ambient noise limits can be relaxed by 5dB $L_{Aeq,30min}$. However, this does not apply to spaces with an indoor ambient noise limit of 45dB $L_{Aeq,30min}$ or higher.

For hybrid ventilation systems, the mechanical system noise component cannot be relaxed.

BB93 states that the normal condition for a natural or hybrid ventilation mode is defined as when the system is operating to limit the daily average carbon dioxide concentration to no more than 1,500ppm with the maximum concentration not exceeding 2,000ppm for more than 20 consecutive minutes on any day. This would normally equate to a minimum ventilation rate of approximately 5l/s per person.

2.1.2 Summertime/Intermittent Boost Ventilation

BB93 also permits a further relaxation during the summertime or for intermittent locally controlled boost. Summertime is defined as the hottest 200 hours in peak summertime. During summertime, natural and hybrid ventilation systems are permitted to relax indoor ambient noise limits to an upper limit of 55 dB $L_{Aeq,30min}$.

Mechanical ventilation systems are permitted to relax indoor ambient noise limits by 5dB $L_{Aeq,30min}$. Again, this does not apply to spaces with an indoor ambient noise limits of 45 dB $L_{Aeq,30min}$ or higher.

Note: however, the summertime ventilation relaxation does not apply to spaces intended specifically for students with special hearing and communication needs.

3.0 FAÇADES

3.1 Environmental Noise Assessment

An environmental noise survey, and subsequent assessment, was undertaken conducted between 05/02/2019 and 06/02/2019 at the site of the proposed new development.

The primary source of environmental noise in the area was from the general city ambience, which was of higher noise level at the North West façade.

Table 3.1 below provides a summary of the noise levels at the façades making up this development.

Affected Façade	Highest Measured Noise Levels $L_{Aeq, 30min}$
Façade 1 – North West Ground Floor	59 dB
Façade 2 – North West First Floor	58 dB
Façade 3 – North West Second Floor	55 dB
Façade 4 – South East Ground, First, Second, & Basement Floor	53 dB

Table 3.1: Noise Levels Measured Onsite

Further details on the environmental noise levels and assessment can be found within MACH Acoustics' Environmental Noise Assessment Report.

3.2 Natural Ventilation Feasibility

PPG24 guidance states that a window typically provides between 10 to 15 dBA of sound attenuation. Therefore, MACH Acoustics typically take 15 dBA as the sound attenuation provided by an open window. Subtracting this figure from the highest measured external noise level gives a predicted internal noise level.

Affected Façade	Considered Teaching Spaces	Highest Measured Noise Levels $L_{Aeq, 30min}$	Attenuation Provided by an Open Window	Predicted Internal Noise Level	Ventilation Strategy
Façade 1 – North West Ground Floor	-	59 dB	-15 dB	44 dB	Unrestricted openable windows
Façade 2 – North West First Floor	-	58 dB	-15 dB	43 dB	Unrestricted openable windows
Façade 3 – North West Second Floor	Soft Play, Hall (PE), Class Herons/Woodpeckers, Music, Hall (Assembly), Class Bats/Hedgehog	55 dB	-15 dB	40 dB	Unrestricted openable windows

Affected Façade	Considered Teaching Spaces	Highest Measured Noise Levels $L_{Aeq, 30min}$	Attenuation Provided by an Open Window	Predicted Internal Noise Level	Ventilation Strategy
Façade 4 – South East Ground, First, Second, & Basement Floor	1st Floor - Record, Group Room, Class (Y2) 2nd Floor - ASD Hub EY & KS1, ASD Hub KS2, Math, Class Blackbird/Kestral, Class squirrel/Foxes/Beetles	53 dB	-15 dB	38 dB	Unrestricted openable windows

Table 3.2: Natural Ventilation Feasibility

Based on the noise exposure categories and the tables above, all rooms can be naturally ventilated with unrestricted openable windows.

3.3 Façade Sound Insulation

The elements making up the façade should achieve the following minimum sound reduction indices:

- Glazing 32dB R_w
- Solid Façade 45dB R_w
- Roof 45dB R_w

3.4 Rain Noise

Under 'Heavy' rainfall conditions, as defined by BS EN ISO 140-18, internal noise due to rain impact, upon roof elements, must not exceed the limits in Table 2.1 by more than 25dBA. This performance requirement includes any glazing or lightweight structure and shall be demonstrated through laboratory test and/or calculation.

It is generally considered a roof construction with a surface mass less than 150kg/m^2 to be lightweight.

Note; Any repairs to existing roofs are exempt from this requirement; however, any new roofing elements within the refurbishment must comply.

3.4.1 Demonstration of Compliance

As the roof construction is not currently available, MACH Acoustics has estimated the existing roof construction to be:

- Slate Roofing Tiles
- Rigid Insulation
- Cavity
- Plasterboard lining

The amount of rain noise data available is limited, therefore a similar roof construction with known laboratory data has been used in calculations. This construction is:

- Slate Tiles (17kg/m^2)
- 80mm Rigid Insulation
- 200mm Cavity
- 12.5mm Wallboard

The table below provides a summary of the calculation results.

Room	Internal Ambient Noise Limit, $L_{Aeq,30min}$ (dBA)	"Heavy" Rain Noise Limit , $L_{Aeq,30min}$ + 25 (dBA)	Calculated "Heavy" Rain Noise Level, L_{Aeq} (dBA)	Pass / Fail
ASD Hub Class 1	30	55	52	Pass
ASD Hub Class 2	30	55	52	Pass
Therapy	30	55	52	Pass
Softplay	30	55	52	Pass
Sensory	30	55	52	Pass

Table 3.3: Rain Noise Calculation Results

As can be seen from Table 3.3, the proposed roof construction is sufficient and indoor ambient noise levels will not be exceeded by more than 25dBA during “Heavy” rainfall.

4.0 EXTERNAL PLANT NOISE

4.1 Background Noise Levels

BS4142: 2014 states that '*in using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods.*'

BS4142 further states that '*a representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either minimum or modal value'.* Hence BS4142 does not provide a black and white method of obtaining the assessment level for background noise.

For the purposes of assessment, MACH Acoustics has taken the modal L_{A90} occurring during the survey.

Time Period	L_{A90} (dB)
Day Time (07:00 – 19:00)	49
Evening (19:00 – 23:00)	47
Night Time (23:00 – 07:00)	40

Table 4.1: Assessment Background Noise Levels

4.2 Design Criteria

MACH has been in contact with the London Borough of Camden Council and they have provided Appendix 3: Noise Thresholds to achieve a LOAEL, which states a design target of 10dB below background noise level (and no events exceeding 57dB L_{Amax} for night time) to be an acceptable level. Where the plant noise is tonal, 10dB should be increased to 15dB.

Based on this information, plant noise limits have been set at 10dB below background noise levels at the nearest noise sensitive receivers.

4.3 Plant Noise Limits

In addition to not affecting nearby noise sensitive receivers, plant noise should also not adversely affect the development itself. Therefore, plant noise should not exceed the following limits. Please note that plant noise break out must meet both of these requirements.

Measurement Period	Assessed Background Noise Level	Plant Noise Limits	
		At Nearest Noise Sensitive Receiver	At Nearest Teaching Window
	(dB L_{A90})	(dB $L_{Aeq,T}$)	(dB $L_{Aeq,T}$)
Day time (07:00 -19:00)	49	39	48
Evening (19:00 – 23:00)	47	37	48
Night time (23:00 -07:00)	40	30	48

Table 4.2: Plant Noise Limits

4.1 Proposed Plant Noise Review

4.1.1 Noise Level

The following noise levels have formed the basis of assessment.

External Mechanical Plant Units		Type	Attenuator	Noise Data								SWL/SPL/ Insertion Loss
Code	Model			63	125	250	500	1000	2000	4000	dB(A)	
EF05	Vent-Axia Lo-Carbon Solo Plus P (Sentinel 100 Single Fan)	Extract Fan	No	57	63	71	72	66	62	55	72	SWL
EF01	Vent-Axia ACM150	Extract Fan	No	36	48	54	60	58	61	54	64.9	SWL
EF 02	Vent-Axia ACM125	Extract Fan	No	36	47	51	54	55	50	46	58	SWL
EF 03	Vent-Axia Sentinel D-Box single (Sentinel 125 Single Fan)	Extract Fan	No	58	70	71	73	70	67	60	74.7	SWL
EF 04	Vent-Axia ACM125	Extract Fan	No	36	47	51	54	55	50	46	58	SWL
HRU 02	Mitsubishi LGH25RVX-E	Intake	No	** Data Not Available **								
		Exhaust	No									
HRU 03	Mitsubishi LGH25RVX-E	Intake	No									
		Exhaust	No									
HRU 01	Mitsubishi LGH25RVX-E	Intake	Yes									
		Exhaust	Yes									

Table 4.3: Noise Source – From Data Sheet

Note: the spectral noise data for HRU 1 – 3 and the spectral insertion loss data for the attenuator were not provided by the M&E engineers, therefore, was unavailable for the noise break-out assessment. Due to the absence of some of the data, MACH has provided the maximum sound power levels of HRU 1 – 3 in order to comply with the plant noise limit at the nearest noise sensitive receptors.

4.1.2 Assessment – BS 4142: 2014

Using the sound power data acquired from data sheets as shown above have been used in a desktop assessment to calculate the predicted noise levels at the nearest noise sensitive receptor.

Acoustic Feature Correction: Acoustic feature correction for intermittency has been applied to all ventilation units. However, no other acoustic feature corrections have been applied.

It is understood that all proposed plant units will be operational during occupied hours of the school. Therefore, in the day time and evening periods.

Due to the absence of the noise data for HRU 1 – 3, MACH has provided below the maximum sound power level of the three units in order to meet the plant noise rating level limit at the nearest noise sensitive receptors outlined in Table 4.2.

External Mechanical Plant Units		Type	Octave Band Sound Power Level Limit							
Code	Model		63	125	250	500	1000	2000	4000	dB(A)
HRU 1 - 3	Mitsubishi LGH25RVX-E	Intake	65	65	65	65	65	65	65	71.3
		Exhaust	65	65	65	65	65	65	65	71.3

Table 4.4: Maximum Sound Power Levels

It is assumed that the HRU units are not tonal, intermittent or impulsive.

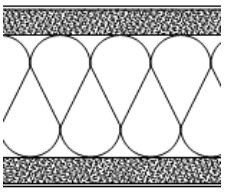
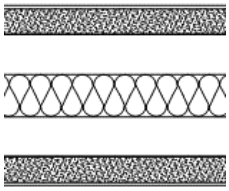
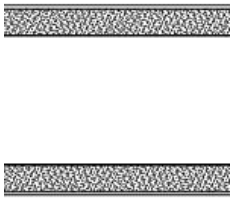
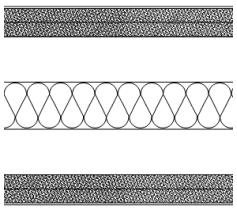
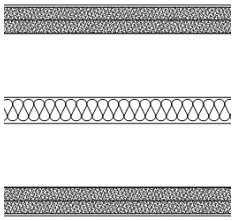
Please note that the maximum sound power levels shown in Table 4.4 is indicative figures only and a further assessment is required to confirm compliancy. In addition, spectral distribution of noise level and the difference in noise levels between the intake and exhaust will influence the assessment outcome, which is further reasons why another assessment is required.

Note: The proposed attenuator insertion loss for AHU 01 has not been accounted for in presenting the maximum sound power levels in Table 4.4.

5.0 SOUND INSULATION – WALLS

5.1 Proposed Wall Constructions

Table 5.1 provides proposed wall constructions and their corresponding R_w ratings.

Wall Ref.	Extracted from Drawing Number	R_w Rating	Illustration of Construction	Description	Thickness (mm)
IW-01	1161-3000_P1	50dB R_w		• 15mm Duraline Plasterboard with 2mm skim finish • 70 S 60 'C' studs at 600mm centres with 80mm isover modular roll in the cavity • 15mm Duraline Plasterboard with 2mm skim finish	102
IW-02	1161-3000_P1	47dB R_w		• 15mm Duraline Plasterboard with 2mm skim finish • 70 S 60 'C' studs at 600mm centres with 25mm isover modular roll in the cavity • 15mm Duraline Plasterboard with 2mm skim finish	102
IW-03	1161-3000_P1	42dB R_w		• 15mm Duraline Plasterboard with 2mm skim finish • 70 S 60 'C' studs at 600mm centres • 15mm Duraline Plasterboard with 2mm skim finish	102
IW-04	1161-3000_P1	61dB R_w		• 2x 15mm SoundBloc Plasterboard with 2mm skim finish • 146 S 50 'C' studs at 600mm centres with 50mm isover modular roll in cavity • 2x 15mm SoundBloc Plasterboard with 2mm skim finish	208
IW-05	1161-3000_P1	56dB R_w		• 2x 12.5mm SoundBloc Plasterboard with 2mm skim finish • 146 S 50 'C' studs at 600mm centres with 25mm isover modular roll in cavity • 2x 12.5mm SoundBloc Plasterboard with 2mm skim finish	198

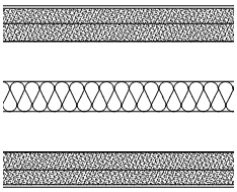
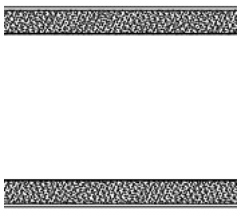
Wall Ref.	Extracted from Drawing Number	R_w Rating	Illustration of Construction	Description	Thickness (mm)
IW-06	1161-3000_P1	57dB R_w		• 15mm Duraline and 12.5mm SoundBloc Plasterboard with skim finish • 90 AS 50 'C' studs at 600mm centres with 25mm isover modular roll in cavity • 15mm Duraline and 12.5mm SoundBloc Plasterboard with skim finish	147
IW-07	1161-3000_P1	46dB R_w		• 15mm Duraline Plasterboard with 2mm skim finish • 90 AS 50 'C' studs at 600mm centre • 15mm Duraline Plasterboard with 2mm skim finish	122

Table 5.1: Proposed Wall Constructions and Corresponding R_w Ratings

5.2 Room to Room

5.2.1 New Partitions

The following table provides the required D_{nTw}, calculated R_w and simplified R_w in accordance with BB93 for new partitions only.

Room 1	Room 2	Minimum On-site Requirement $D_{nT(Tmf,max)w}$ (dB)	Calculated SRI for partition R_w (dB)	Proposed Partition type	Pass / Fail
Basement					
B2 WC	B3 Plant	35	48	IW-01	Pass
Second Floor					
2F3 Calm	2F4 Hygiene	50	57	IW-04	Pass
2F5 Sensory	2F6 Soft Play	50	58	IW-04	Pass
2F13 Maths	2F11 PPA	45	54	IW-05	Pass

Table 5.2: Calculated R_w Requirements for Separating Partitions

Note: See Table 5.1 for details of proposed wall constructions.

5.2.2 Retained Partitions

The airborne sound insulation of the partition between the two rooms which will become ASD Hub Class 1 and 2 on second floor were measured to be 58dB $D_{nT,w}$. It is considered that the other separating partitions on the lower floors are of the same construction. After corrections for separating partition area and

reverberation time is applied, it is seen that this partition will achieve 59dB R_w. Therefore, this is seen to be sufficient to achieve the most onerous specification required to achieve by retained walls.

There is an existing wall which will form a partition the existing plant room in the basement and the proposed group room. This wall has been observed to be 580mm solid brick construction. The sound reduction of this partition is predicted to be 68dB Rw and will therefore be sufficient in meeting the sound insulation requirements with or without a plasterboard lining.

5.3 Rooms to Circulation Spaces

Due to the difficulties in accurately measuring the sound insulation between cellular areas, and large/irregular spaces such as circulation spaces or atriums, $D_{nT(Tmf,max),w}$ levels are not required across partitions from teaching spaces to circulation spaces. Therefore, the airborne sound insulation for walls and doorsets to circulation spaces are provided in terms of R_w.

The table below, Table 5.3, provides the performance standards for all walls, glazing and doors to teaching spaces.

Type of Space	Composite R_w of wall and glazing (Refurb)	Doorset R_w
Control Room for Recording Teaching space specifically for students with special hearing or communication needs	45 dB	35 dB
All other rooms used for teaching or learning	40 dB	30 dB

Table 5.3: Sound Insulation Requirements to Circulation Spaces

5.3.1 Ventilators

If ventilators are to be included within partitions between teaching spaces and circulation spaces, these should not compromise the overall sound insulation. Therefore, BB93 provides minimum performance requirements for when ventilators will be present in partitions to circulation spaces.

Type of Space	Composite R_w of wall, glazing and ventilators (Refurb)	Ventilators Minimum $D_{n,e,w}$ – 10LogN
Control Room for Recording Teaching space specifically for students with special hearing or communication needs	38 dB	37 dB
All other rooms used for teaching or learning	33 dB	32 dB

Table 5.4: Sound Insulation Requirements to Circulation Spaces with Ventilators

Table 5.4 provides two methods of determining a suitable performance standard for partitions. The first is a minimum composite R_w that the wall, glazing and ventilator must meet. Alternatively a minimum $D_{n,e,w}$ – 10LogN is provided for the ventilators where N is the number of ventilators with airborne sound insulation $D_{n,e,w}$. With this approach, the wall and glazing must meet the minimum performance requirements set out in Table 5.3.

5.4 Exceptions

Within BB93 there are a number of sound insulation exceptions to the acoustic design that are still considered acceptable.

5.4.1 Interconnecting Doors between Teaching Spaces

> *Where it is essential to link a teaching space with another occupied room via an interconnecting door for operational or safety purposes, a doorset should be used with a rating of at least 35 dB R_w. The surrounding wall (including any glazing) should have a composite sound insulation rating of at least 45 dB R_w.*

As such, all adjacent separating doors and walls are rated at 35dB R_w, and 45 dB R_w respectively.

5.5 Doors

BB93 provides guidance on typical door constructions capable of achieving different levels of sound insulation.

R_w 30 doors typically have a minimum surface density of 27kg/m^2 and are at least 44mm thick.
R_w 35 doors typically have a minimum surface density of 29kg/m^2 and are at least 54mm thick.

Both doors would typically have the following features:

- Solid core or laminate door leaf,
- Perimeter seals, including the threshold
- A latching mechanism ensuring adequate compression of all door seals
- The latching mechanism shall ensure gentle contact with the door frame, without causing noise or structural impact

Where vision panels can be installed in doors, the size of the glazing and performance of the glazing must be such that it has an equal performance to that of the door slug.

5.6 Glazing

Table 5.5 provides example of glazing configurations for different R_w requirements. Constructions provided are based on data published by Saint Gobain, but other manufacturers may provide similar systems.

R_w Rating	Description
35 dB	4mm Glass / 20mm Void / 6mm Glass
40 dB	6mm Glass / 27mm Void / 10mm Glass
45 dB	10mm Glass / 16mm Void / 8.4mm Laminated Glass
50 dB	8.8mm Laminated Glass / 24mm Void / 12.8mm Laminated Glass

Table 5.5: Glazing Configurations and Corresponding R_w Ratings

5.6.1 Corridor Glazing

It is understood that there are corridor glazing to rooms such as Record room Lobby. These corridor glazing are not to be opened as it will compromise the sound insulation of these partitions.

6.0 SOUND INSULATION – FLOORS

6.1 Airborne Sound Insulation

Since the sound insulation of the floor is likely to be uniform across its surface, the highest levels of sound insulation required across the floors specified within the table below should be designed to.

Room 1	Room 2	Minimum On-site Requirement $D_{nT(Tmf,max)w}$ (dB) (Refurb)	Calculated SRI for partition R_w (dB) (Refurb)
Ground Floor to Basement Floor			
GF9 Dining	B1 Group Room	50	55
GF5 Group Room	B4 Classroom - Yr 1	40	42
First Floor to Ground Floor			
1F1 WC M	GF12 Office/Reflections	40	48
1F9 Classroom - Yr4 (Hedgehog)	GF8 Reception Quiet Dining	50	52
1F7 Classroom Yr2 (Grasshoppers)	GF7 Community Room	40	47
1F4 Record	GF5 Group Room	50	52
1F5 Group Room	GF6 Head Office	40	46
Second Floor to Ground Floor			
2F16 ASD Hub Class 1	1F4 Record	50	45
2F16 ASD Hub Class 1	1F5 Group Room	40	42
2F15 ASD Hub Class 2	1F7 Classroom Yr2 (Grasshoppers)	40	42
2F3 Calm	1F1 WC M	40	47
2F2 Therapy/Group Rm	1F10 Art Therapy	40	45
2F5 Sensory	1F3 Music	50	52
2F6 Soft Play	1F3 Music	50	52
2F11 PPA	1F11 Classroom - Y2 (Beetles)	40	47
2F7 The Cabin (Gymnasium)	1F8 Hall (Assembly)	50	56

Table 6.1: Calculated R_w Requirements for Separating Floors

6.2 Impact Sound Insulation

Impact sound insulation of floors above all teaching spaces must meet the requirements within Table 6.2.

BB93 Classification	$L'_{nT(Tmf,max),w}$ (dB) (Refurb)
Primary School: Classroom, Class Base, General Teaching Area, Small Group Room	65
Secondary Music Classroom	60
Teaching space intended specifically for students with special hearing and communication needs	60
SEN Calming Room	65
Study Room (Individual Study, Withdrawal, Remedial Work, Teacher Preparation)	65
Libraries: Resource Areas	65
Assembly Hall, Multi-Purpose Hall (Drama, PE, Audio/Visual Presentations, Assembly, Occasional Music)	65
Sports Hall	65
Gymnasium/Activity Studio	65
Dining Room	65
Office, Medical Room, Staff Room[1]	65

Table 6.2: Impact Isolation Requirements

6.3 Existing Floor Construction

The existing floor construction for Primrose Hill Primary School between second and first floor is measured to be 48dB $D_{nT,w}$. It is assumed that the construction of the other separating floors is the same. The level of airborne sound insulation achieved by this floor construction is seen to be sufficient - after correcting for the respective reverberation time and dimensions – to meet the required sound insulation shown in Table 6.1.

6.3.1 Impact Isolation

The measured impact sound insulation between second and first floor was 56dB $L'_{nT,w}$. From this, it can be seen that it does not achieve the required impact sound insulation for 1F Record and 2F ASD Hub Class 1. The floor finish for these three rooms must have a weighted sound reduction of no less than 1 dB and 4 dB ΔL_w respectively. This can either be a soft floor covering such as a carpet or rubber floor, or a resilient layer between the floor boards and any hard floor finish.

Please see Appendix C for the impact sound insulation mark-up drawings for the illustrations of areas where additional impact sound reduction is required.

6.4 Hall Pod Construction

It is understood that the Cabin (Gymnasium) will be built as a pod construction within the existing Hall (PE). As both the ceiling and the separating wall are considered to be separating elements between the two rooms and the Hall, which would sum to a larger than usual separating element area, gives a high rating requirement for the separating elements. However, as there is an interconnecting door between the Cabin and the Hall (PE), the separating element (the ceiling and the wall) are now rated at 45dB Rw as BB93 exception for interconnecting doors will be applicable in this context.

MACH has been in touch with the structural engineer for Primrose Hill Primary School refurbishment and understand that the proposed ceiling construction will be of timber joist construction with secondary ceiling. The ceiling element will therefore have to achieve a rating of 45dB Rw.

7.0 BUILDING SERVICES

7.1 Internal Services Noise Limits

Internal plant noise levels need to be considered in line with environmental noise break in levels. The following table outlines the maximum noise limits for noise contributions from building services.

BB93 Classification	$L_{Aeq,30min}$ (dB) Refurb	NR
Primary School: Classroom, Class Base, General Teaching Area, Small Group Room	37	31
Secondary Music Classroom	37	31
Teaching space intended specifically for students with special hearing and communication needs	32	26
SEN Calming Room	32	26
Assembly Hall, Multi-Purpose Hall (Drama, PE, Audio/Visual Presentations, Assembly, Occasional Music)	37	31
Gymnasium/Activity Studio	42	36
Dining Room	47	41
Office, Medical Room, Staff Room[1]	42	36
[1] Considered administration or ancillary, therefore, guidance only		

Table 7.1: Maximum Services Noise Targets

8.0 REVERBERATION CONTROL

8.1 Teaching and Study Spaces update

The performance requirements for all refurbished teaching spaces within this development are to be in accordance with the targets set out in BB93. Such to comply with these requirements an assessment table is provided below, which considers the acoustic performance of the proposed finishes and includes the different levels of additional finishes required.

Please note that only one of the suggested treatment areas needs to be taken forwards i.e. Class A OR Class C etc. Alternatively, a combination of different types of treatment can be used. MACH Acoustics can advise on the exact areas required should this be the preferred option. The table below represents the proposed ceiling treatments with their predicted reverberation times and any additional required treatment.

Room	Floor Area (m^2)	Floor Finish	Proposed Ceiling Treatment		T_{mf} Target (s)	Predicted T_{mf} (s)	Additional Treatment Required Area (m^2)		
			Ceiling Finish	Ceiling Baffles*			Class A	OR	Class C
B1 Group Room	12	Carpet	Plasterboard	-	0.4	0.9	10		16
GF5 Group Room	11	Carpet	Plasterboard	-	0.4	1.3	19		30
GF8 ARP / Quiet Dining	36	Hard	-	-	1.5	4.2	* See Section 8.1.1 *		
1F4 Record	9	Carpet	-	7	0.6	0.6	-		-
1F5 Group Room	16	Carpet	-	9	0.4	0.6	14		19
1F7 Classroom Yr2 (Grasshoppers)	56	Carpet	-	35	0.4	0.7	53		75
1F Music	42	Hard	-	10	1.0	1.2	-		-
1F Hall (Assembly)	131	Hard	-	42	1.0	1.3	-		-
1F Class Y3 (Bats)	59	Hard	-	44	0.4	1.2	48		70
1F Class Y4 (Hedgehog)	58	Hard	-	39	0.4	1.1	53		75
1F Class Y4 (Foxes)	56	Hard	-	39	0.4	1.1	49		72
1F Class Y3 (Squirrel)	57	Hard	-	44	0.4	1.2	47		69
1F Class Y2 (Beetles)	68	Hard	-	48	0.4	1.2	60		88
2F2 Therapy/Group Rm	13	Carpet	-	-	0.4	0.8	9		13
2F3 Calm	7	Carpet	Plasterboard	-	0.8	1.0	2		3
2F5 Sensory	12	Carpet	Plasterboard	-	0.4	1.2	23		36
2F6 Soft Play	23	Carpet	-	15	0.4	0.7	24		33
2F7 The Cabin (Gymnasium)	22	Hard	Heradesign Superfine	-	2.0	1.1	-		-
2F10 Maths	50	Carpet	-	33	0.4	1.0	53		77
2F11 Inclusion Office]	19	Carpet	-	-	1.2	1.9	5		8
2F12 ASD Hub Class 2	43	Carpet	-	27	0.4	0.6	41		57

Room	Floor Area (m^2)	Floor Finish	Proposed Ceiling Treatment		T_{mf} Target (s)	Predicted T_{mf} (s)	Additional Treatment Required Area (m^2)		
			Ceiling Finish	Ceiling Baffles*			Class A	OR	Class C
2F13 ASD Hub Class 1	44	Carpet	-	27	0.4	0.6	41		57
2F Class Y6 Herons	62	Hard	-	44	0.4	1.1	61		89
2F Class Y5 Woodpeckers	60	Hard	-	42	0.4	1.1	64		93
2F Class Y5 Blackbird	58	Hard	-	42	0.4	1.1	61		89
2F Y6 Kestral	60	Hard	-	44	0.4	1.1	58		85
* 1200x600x40 (600) Ecophon Solo Raft									

Table 8.1: Reverberation Treatment Requirements

8.1.1 (Quiet) Dining

MACH has measured the existing reverberation time in the section of the dining room that is to become the quiet dining and it is clear that sufficient reverberation treatment is already present in the room. Therefore, no additional treatment is required.

8.1.2 Rafts and Baffles

Rafts and baffles should be located such that they meet the manufacturers requirements in terms of spacing and position. Where this is not available MACH suggest that raft and baffle layouts be spaced apart such that gaps between them and any walls is at least the smallest dimension of the raft or baffle.

For example, 2400mm x 1200mm rafts should be at least 1200mm from any other rafts or walls

Note; in the provided table, the suspension height also has a bearing on the acoustic performance of suspended treatment. If this spacing is reduced, then the performance of the rafts/baffles will be diminished. These dimensions should not be altered without first consulting MACH Acoustics.

Any free hanging acoustic treatment should comply with Functional requirement B2 of the Building Regulations.

8.2 Music Spaces

8.2.1 Recording Areas

It is often desired, particularly when recording, that the reverberation time of the space may be altered by the users, such to suit the requirements for different music styles. This can be achieved with flexible acoustic treatment, for example, a simple absorptive curtain which can be drawn over a reflective plasterboard wall surface, allowing the users of the space to control over the balance between reflective and absorptive surfaces.

8.3 Ancillary Spaces

As there are no mandatory requirements for the control of reverberation within non-teaching spaces, there is no mandatory requirement to place acoustic absorption within these spaces. However, the given table provides recommended reverberation time targets, and the required levels of acoustic treatment needed for these spaces.

As a minimum MACH Acoustics advises that at least 50% of the proposed levels of treatment are taken forward.

8.4 Corridors and Circulation Spaces

For circulation spaces, a level of absorption is required to mitigate any noise build-up, and reduce noise break in, to adjacent classrooms. As a minimum, an area equal to the floor area should be covered with a Class C absorber or better. Should a higher performing absorber be preferred, then MACH Acoustics should be consulted in regard to the required areas.

ACOUSTIC TERMINOLOGY

Absorption Classes	The sound absorption of a material is rated from Class A to Class E, where Class A materials provide the highest levels of sound absorption.
Ambient Noise Levels	Noise levels measured in the absence of noise requiring control, frequently measured to determine the situation prior to the addition of a new noise source.
dB	Decibel. The logarithmic unit of sound level.
dBA	A-weighted decibel. The A-weighting approximates the response of the human ear.
$D_{nT,w}$	Weighted standardized level difference. A single number quantity of the sound level difference between two rooms. $D_{nT,w}$ is typically used to measure the on-site sound insulation performance of a building element such as a wall, floor or ceiling. Measured in accordance with BS EN ISO 16283-1 and weighted in accordance with BS EN ISO 717-1.
$D_{n,e,w}$	The weighted element-normalized level difference. A single number rating of the sound reduction provided by a sound passing through an individual element. $D_{n,e,w}$ is typically used to define the sound insulation provided by ventilators. Measured in accordance with BS EN ISO 10140-2:2010 and rated in accordance with BS EN ISO 717-1.
Flanking	Transmission of sound energy through paths adjacent to the building element being considered. For example, sound may be transmitted around a wall by travelling up into the ceiling space and then down into the adjacent room.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4kHz, roughly equal to the range of frequencies on a piano.
Impact Sound	Sound produced by an object impacting directly on a building structure, such as footfall noise or chairs scrapping on a floor.
$L_{Aeq,t}$	The equivalent continuous sound level measured in dBA. This is commonly referred to as the average noise level. "t" is the interval time for the measurement which is most often 30 minutes when demonstrating compliance with BB93.
$L_{A90,t}$	The noise level exceeded for 90% of the measurement period, measured in dBA. This is commonly referred to as the background noise level.
$L'_{nT,w}$	Weighted, standardized impact sound pressure level. A single number rating of the impact sound insulation of a floor/ceiling when impacted on by a standard 'tapper' machine. The lower the $L'_{nT,w}$, the better the acoustic performance. Measured in accordance with BBS EN ISO 140-7 and rated in accordance with BS EN ISO 717-2.
NR	Noise Rating. A single number rating which is based on the sound level in the octave bands 31.5Hz – 8kHz inclusive, generally used to assess noise from mechanical services in buildings.
Octave band	Frequencies are often grouped together into octaves for analysis. Octave bands are labelled by their centre frequency which are: 63Hz, 125Hz, 250Hz, 500Hz 1kHz, 2kHz and 4kHz.
Reverberation time (T_{mf})	Reverberation time is used for assessing the acoustic qualities of a space. It is defined as the time it takes for an impulse to decay by 60dB. T_{mf} is the arithmetic average of the reverberation time in the mid frequency bands (500Hz, 1k Hz and 2 kHz).
R_w	Weighted sound reduction index. A single number rating of the sound insulation performance of a specific building element. R_w is measured in a laboratory. R_w is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete. Measured in accordance with BS EN ISO 10140-2:2010 and rated in accordance with BS EN ISO 717-1
Sound Absorption	When sound hits a surface, some of the sound energy is absorbed by the surface material. Sound absorption refers to the ability of a material to absorb sound, rated from 0, complete reflection, to 1, complete absorption.
Sound Insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to the ability of a material to prevent the travel of sound.
Structure-borne transmission	Transmission of sound energy as vibrations via the structure of a building.

APPENDIX A – ROOM CLASSIFICATIONS

The list below shows all of the rooms used within calculations within the development. When assigning room classifications, MACH Acoustics has made assumptions on the classification of each space based on the room names and experience from previous projects. Should any of these assumptions be incorrect then MACH Acoustics should be notified as soon as possible to amend this.

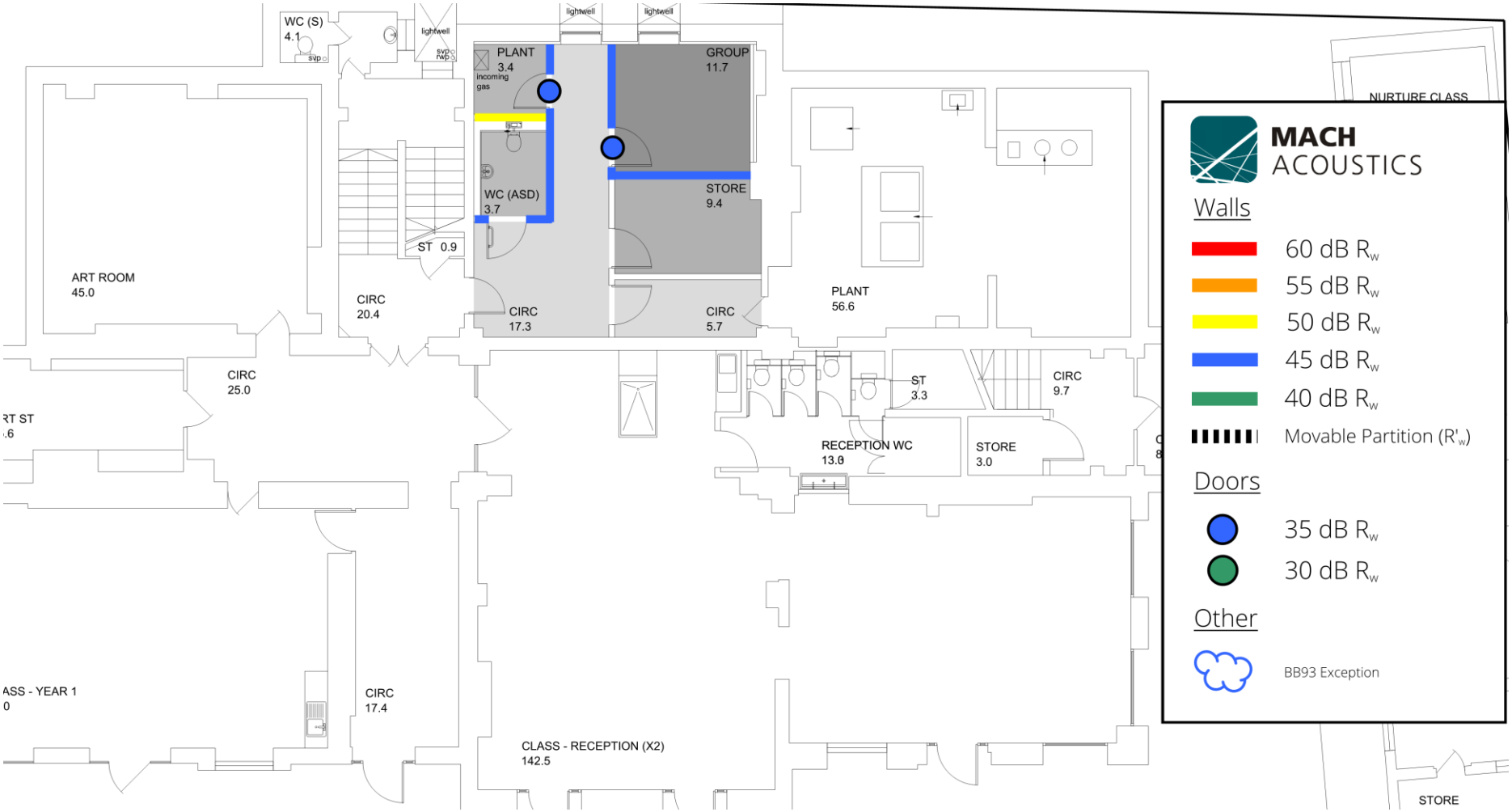
Please note that any changes to room classifications are likely to result in changes to the performance requirements.

Room	BB93 Classification	Area (m^2)	Height (m)	Floor Finish
B1 Group Room	Teaching space intended specifically for students with special hearing and communication needs	11.70	2.75	Carpet
GF5 Group Room	Teaching space intended specifically for students with special hearing and communication needs	11.20	4.59	Carpet
GF8 ARP / Quiet Dining	Dining Room	37.20	4.59	Hard
1F4 Record	Recording Studio	9.00	4.71	Carpet
1F5 Group Room	Teaching space intended specifically for students with special hearing and communication needs	15.50	4.71	Carpet
1F7 Classroom Yr2 (Grasshoppers)	Teaching space intended specifically for students with special hearing and communication needs	55.60	4.71	Carpet
1F13 Music	Primary Music Room	41.80	4.67	Hard
1F14 HALL (Assembley)	Assembly Hall, Multi-Purpose Hall (Drama, PE, Audio/Visual Presentations, Assembly, Occasional Music)	130.80	4.67	Hard
1F15 Class Y3 (Bats)	Teaching space intended specifically for students with special hearing and communication needs	58.90	4.62	Hard
1F16 Class Y4 (Hedgehog)	Teaching space intended specifically for students with special hearing and communication needs	58.20	4.62	Hard
1F17 Class Y4 (Foxes)	Teaching space intended specifically for students with special hearing and communication needs	56.40	4.62	Hard
1F18 Class Y3 (Squirrel)	Teaching space intended specifically for students with special hearing and communication needs	57.20	4.62	Hard
1F19 Class Y2 (Beetles)	Teaching space intended specifically for students with special hearing and communication needs	68.40	4.65	Hard
2F2 Therapy/Group Rm	Teaching space intended specifically for students with special hearing and communication needs	13.30	2.57	Carpet
2F3 Calm	SEN Calming Room	6.90	3.30	Carpet
2F5 Sensory	Teaching space intended specifically for students with special hearing and communication needs	12.20	5.19	Carpet
2F6 Soft Play	Teaching space intended specifically for students with special hearing and communication needs	23.00	5.19	Carpet
2F7 The Cabin (Gymnasium)	Gymnasium/Activity Studio	22.40	3.51	Hard
2F10 Maths	Primary School: Classroom, Class Base, General Teaching Area, Small Group Room	49.90	5.15	Carpet
2F11 PPA	Study Room (Individual Study, Withdrawal, Remedial Work, Teacher Preparation)	18.60	5.15	Carpet
2F12 ASD Hub Class 2	Teaching space intended specifically for students with special hearing and communication needs	42.70	5.17	Carpet
2F13 ASD Hub Class 1	Teaching space intended specifically for students with special hearing and communication needs	44.00	5.17	Carpet
2F20 Class Y6 (Herons)	Teaching space intended specifically for students with special hearing and communication needs	61.80	4.98	Hard

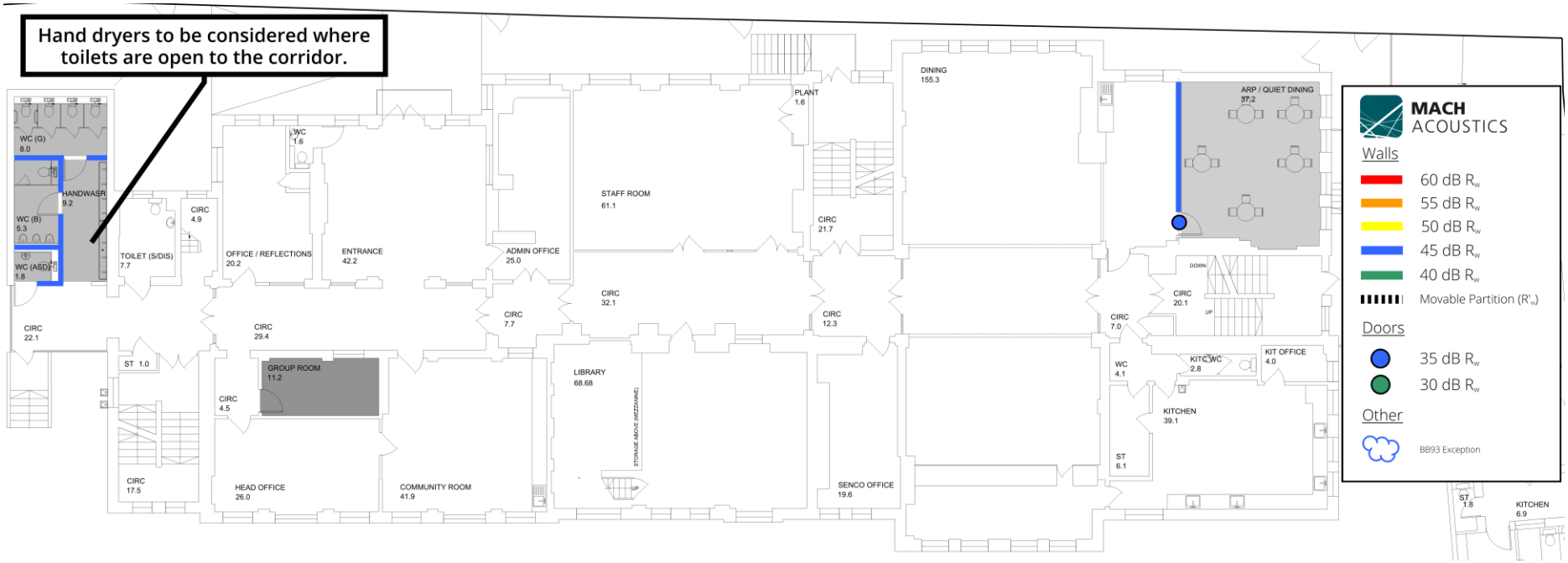
Room	BB93 Classification	Area (m^2)	Height (m)	Floor Finish
2F21 Class Y5 (Woodpeckers)	Teaching space intended specifically for students with special hearing and communication needs	59.60	5.25	Hard
2F22 Class Y5 (Blackbird)	Teaching space intended specifically for students with special hearing and communication needs	57.70	5.25	Hard
2F23 Class Y6 (Kestral)	Teaching space intended specifically for students with special hearing and communication needs	60.00	4.98	Hard

APPENDIX B – SOUND INSULATION MARKED UP DRAWINGS

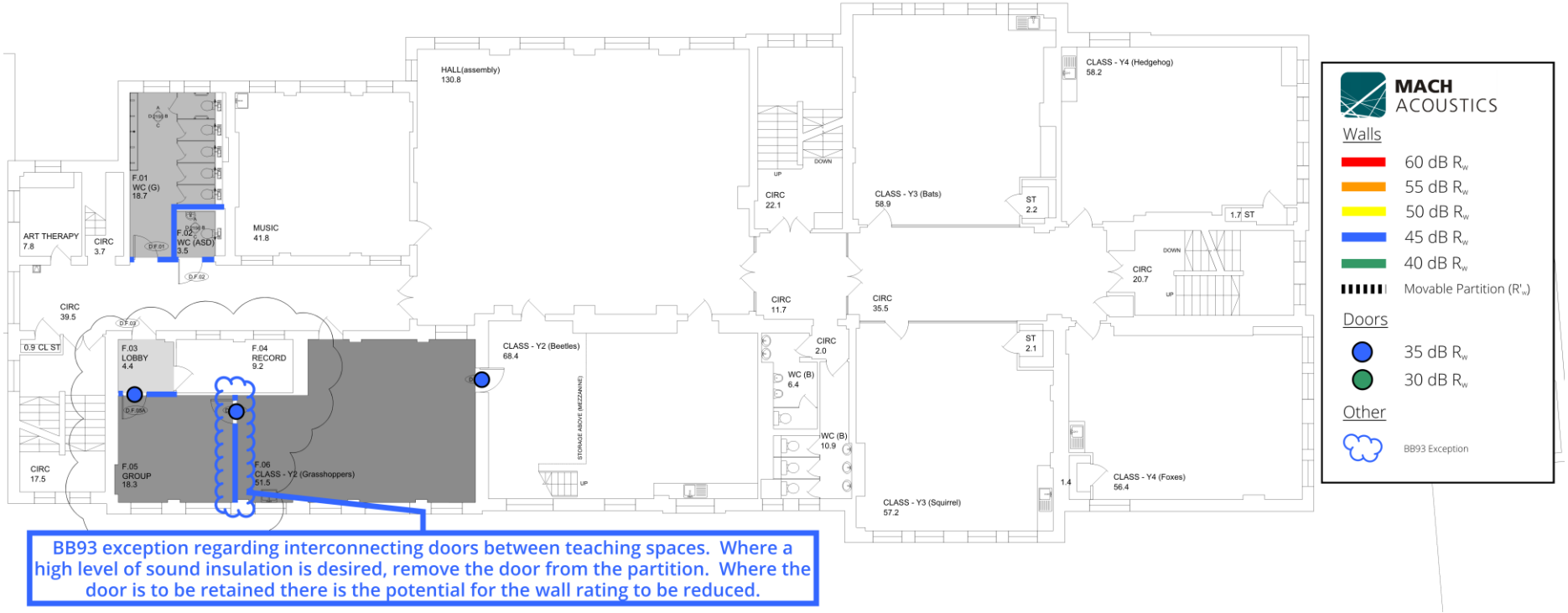
Basement Floor



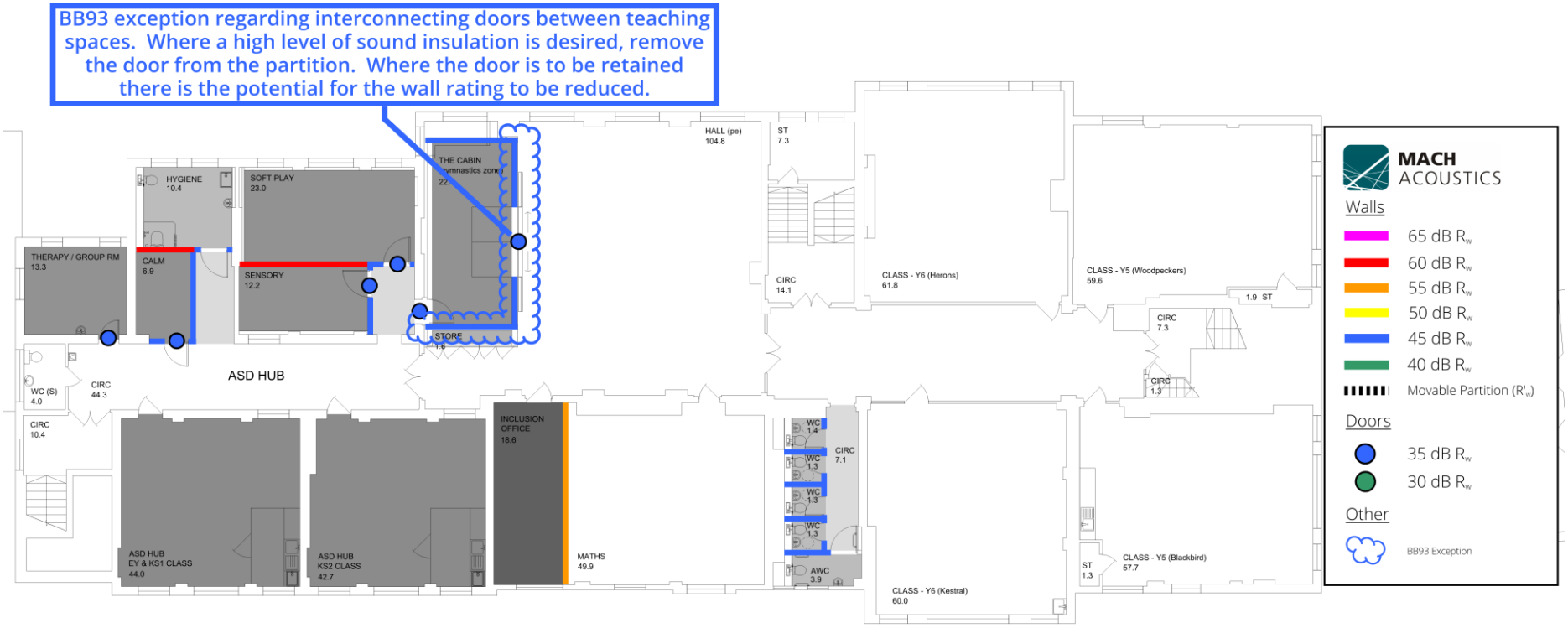
Ground Floor



First Floor

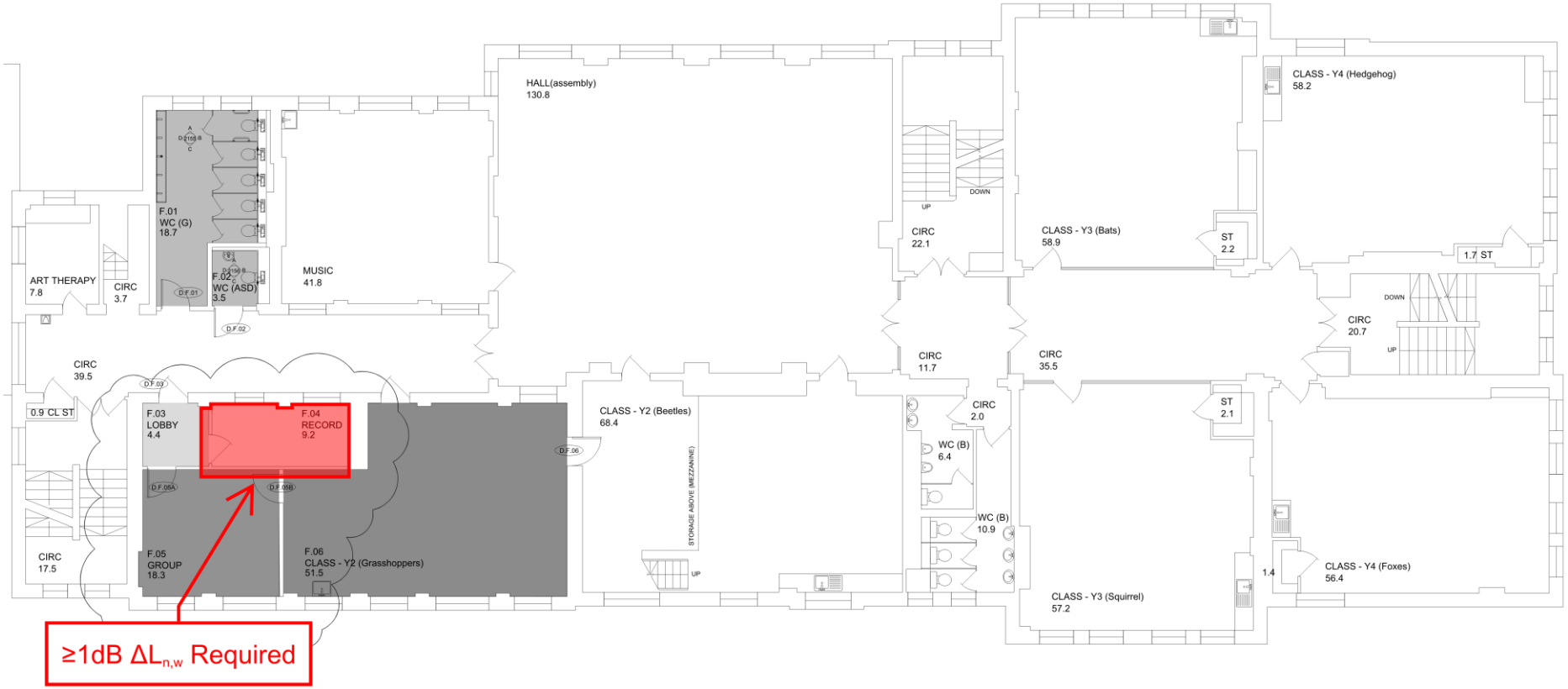

HALL(assembly)
130.8
CLASS - Y4 (Hedgehog)
58.2
CLASS - Y3 (Bats)
58.9
CIRC
22.1
ST
2.2
1.7 ST
CIRC
20.7
F.01
WC (G)
18.7
F.02
WC (ASD)
3.5
MUSIC
41.8
ART THERAPY
7.8
CIRC
3.7
CIRC
39.5
0.9 CL ST
F.03
LOBBY
4.4
F.04
RECORD
9.2
CIRC
11.7
CIRC
35.5
CLASS - Y2 (Beetles)
68.4
CIRC
2.0
WC (B)
6.4
WC (B)
10.9
ST
2.1
F.05
GROUP
18.3
F.06
CLASS - Y2 (Grasshoppers)
51.5
CIRC
17.5
CLASS - Y3 (Squirrel)
57.2
CLASS - Y4 (Foxes)
56.4
1.4
STORAGE ABOVE (MEZZANINE)
BB93 exception regarding interconnecting doors between teaching spaces. Where a high level of sound insulation is desired, remove the door from the partition. Where the door is to be retained there is the potential for the wall rating to be reduced.
MACH ACOUSTICS
Walls
60 dB Rw
55 dB Rw
50 dB Rw
45 dB Rw
40 dB Rw
Movable Partition (R'w)
Doors
35 dB Rw
30 dB Rw
Other
BB93 Exception

Second Floor



APPENDIX C – IMPACT SOUND INSULATION MARKUP DRAWINGS

First Floor



Second Floor