chapter 07

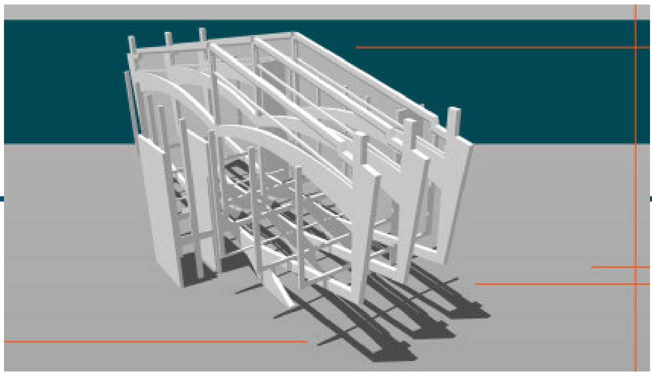
the technical resolution

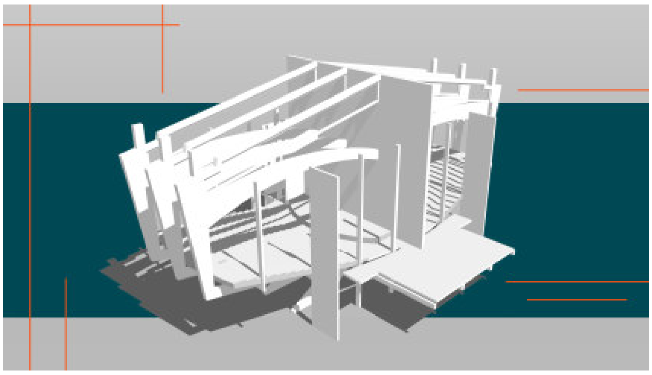
The technological resolution of the building is an effort to further clarify the design intentions and indicate in detail the converted architectural languages of the precinct. The scope of the technology of the building will cover three major aspects: the first is the structural systems incorporated in the design and the skins or envelopes to the spaces, the second is the materiality of the intervention in relation to the existing materials used in the precinct buildings and the third aspect is the environmental systems employed in the new music school. These systems are categorised as natural systems, artificial systems and hybrid systems.
The acoustic requirements and fitment of the studios will also be explained as part of the technological resolution of the building.

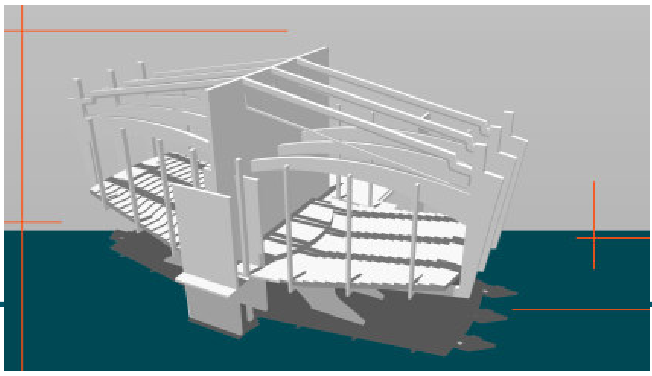
fig. 7.1 : 3D impression of the structural development of the building.

7.1. structural & technological systems

7.1.1 lecture halls auditoria







- shell construction
- cast in-situ reinforced concrete

Main Support
- 3x 460mm thick rc fins, 5165mm wide, @ 4205mm c/c
- internal span between supports = 12 350mm
- cantilever = 11 000mm
- depth of beams = 850 - 1025mm
- width of columns = 1165-1950mm
- depth of overhead arched beam = 1000 - 2000mm

Roof Support
- overhead arched beam (part of concrete fins)
- steel girder truss depth = 2050mm

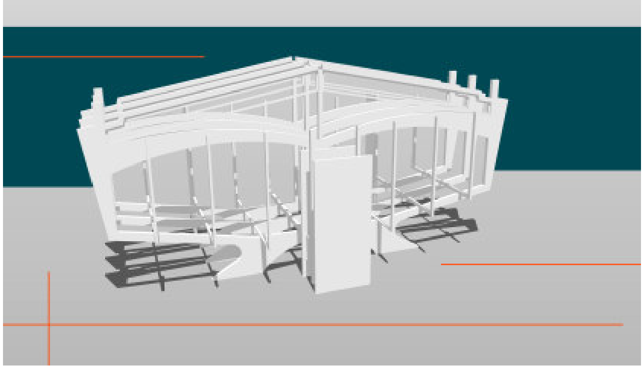
Roof Slab
- rc 1-way slab, 255mm thick
- integrated downstand beam depth = 460mm

Floor to Auditoria
- cast in-situ rc stepped slab 255mm thick
- stage = 185mm thick rc slab with 340mm upstand beams

Secondary Support
- 230x500 rc columns and beams @ max. 4940mm c/c

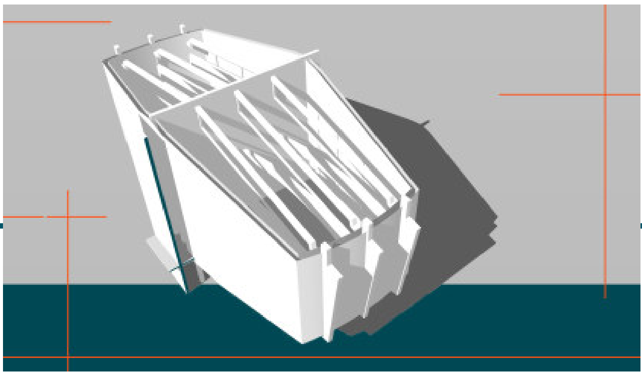
External Skin
- tripple layer, 550mm thick, consisting of:
- 230mm thick external brick skin
- 205mm sound insulation cavity
- 115mm internal brick skin
- additional sound insulation = 50mm mineral wool blanket = 8mm perforated commercial plywood panels

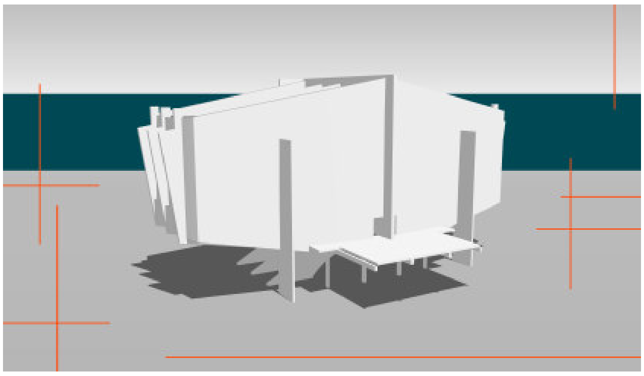
Freestanding Walls
- 330mm thick rc walls read as freestanding planes, act as support to main structure & define entrances & spaces

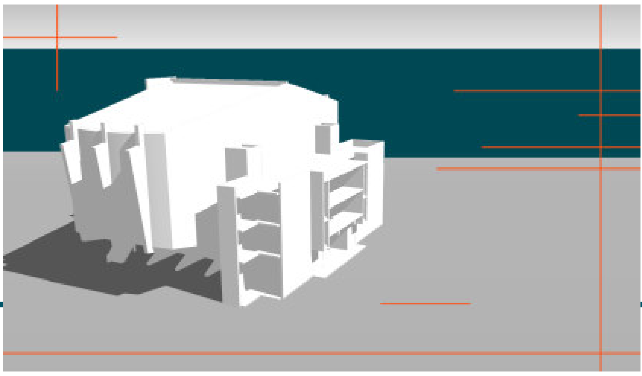


7.1.2

services block & circulation







Services Block

Main Support
- solid load-bearing brick structure
- 230mm thick brick walls
- external brick skin to be red face brick

Floor Slabs
- cast in-situ rc slabs, 255mm thick

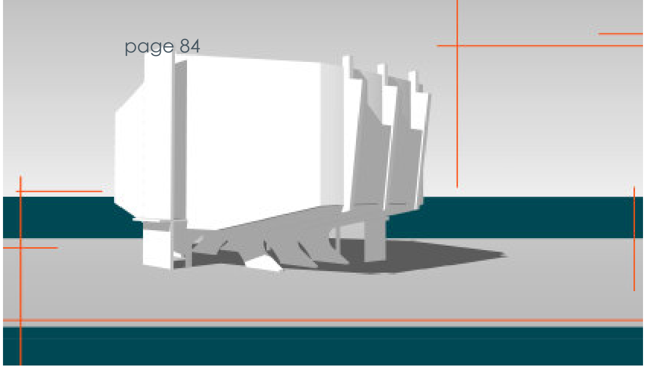
Roof
- cast in-situ rc slab, 255mm thick
- 460mm downstand beam on perimeter
- 230mm thick brick parapet, 1315mm high

Circulation Towers

Main Support
- 230mm thick LiTraCon load-bearing blocks

Floor Slabs / Landings
- cast in-situ rc slabs, 170mm thick

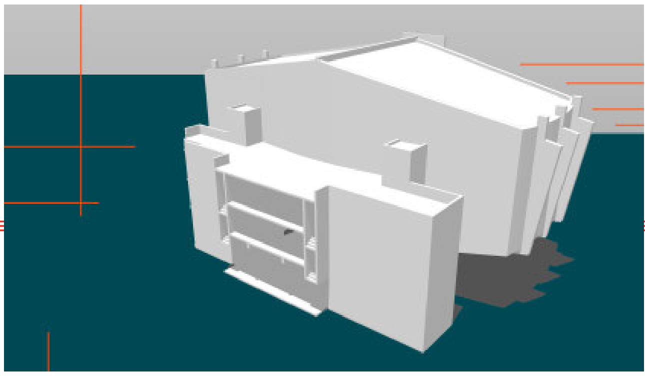
Roof
- cast in-situ rc slab, 255mm thick
- 230mm upstand beam on perimeter

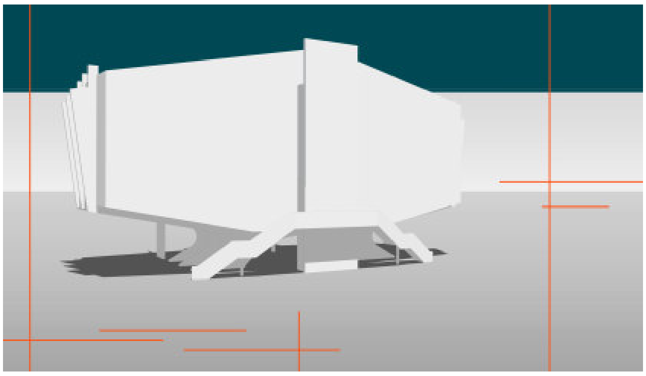


7.1.3

ablution block

core facilities

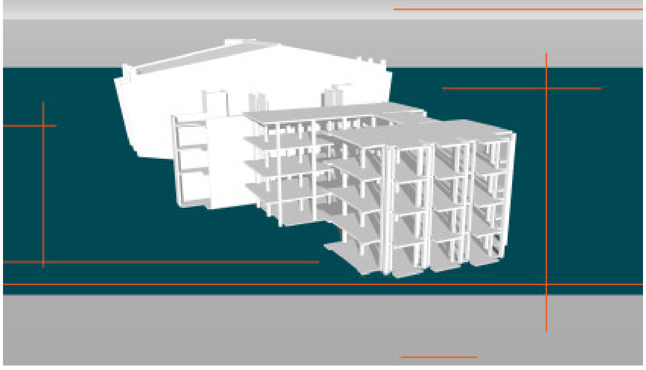




Main Support
- solid load-bearing brick structure
- 230mm thick brick walls

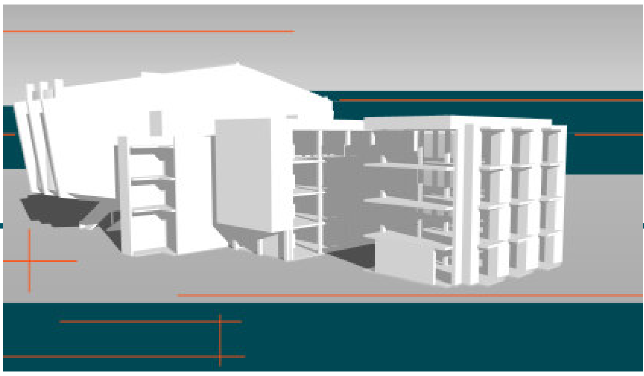
Floor Slabs
- cast in-situ rc slabs, 255mm thick, 1-way span

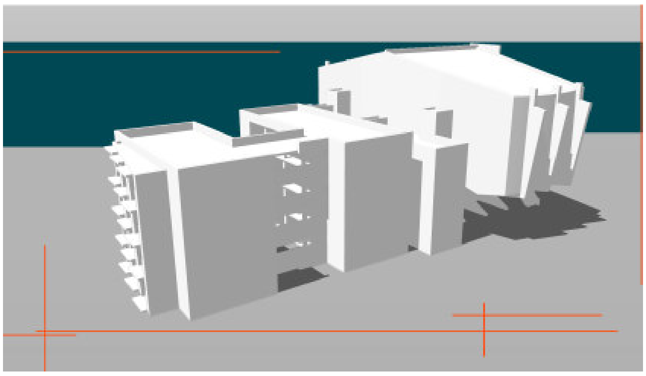
Roof
- cast in-situ rc slab, 255mm thick
- 460mm upstand beam on perimeter & at openings

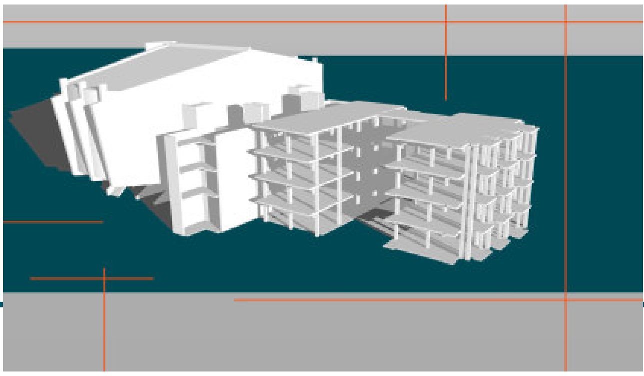


7.1.4

practise block
studio spaces





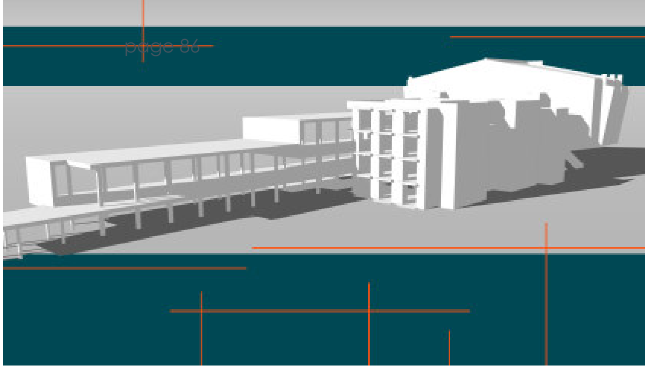


Main Support
- rc columns on a grid of 4205mm x 4940mm max.
- 340 x 340mm columns or 340 x 440mm columns (with rwp included)

Floor Slabs
- cast in-situ 1 way rc slabs, 255mm thick
- integrated downstand beams, 255mm deep

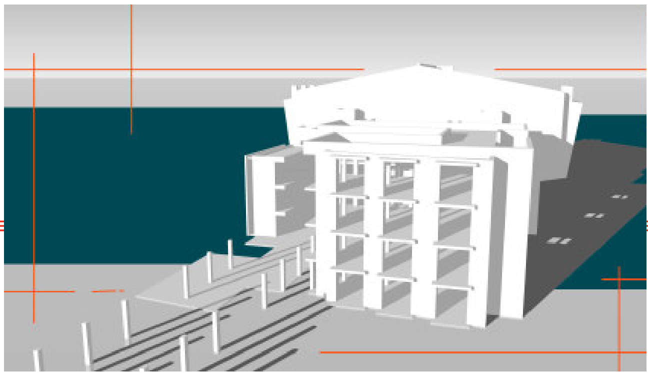
Roof
- cast in-situ rc slab, 255mm thick
- 900mm upstand beam on perimeter to create deep parapet

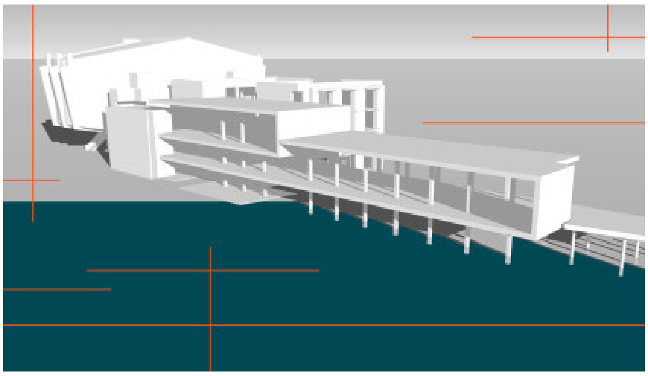
External Skin
- tripple layer, 355mm thick, consisting of:
- 115mm external brick skin
- 100mm sound insulation cavity
- 115mm internal brick skin
- additional sound insulation
  = 50mm mineral wool blanket
  = 8mm perforated commercial plywood panels

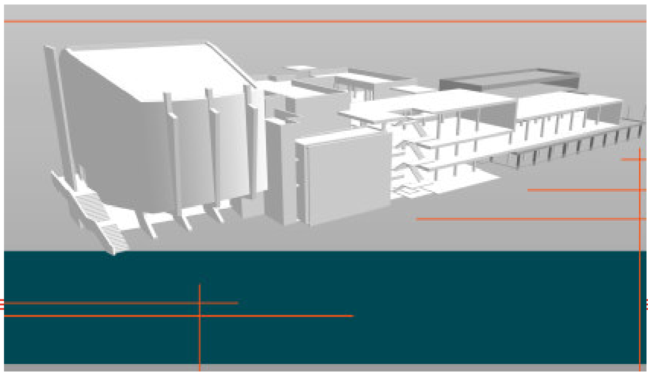


7.1.5

media centre
& research lounge







Main Support
- rc columns on a grid of 4205mm x 7840mm
- 340 x 340mm columns or 340 x 440mm columns (with rwp included)

Floor Slabs
- cast in-situ rc slabs, 255mm thick, 1-way span
- 255mm downstand beams (510mm total slab thickness)
- chamfered edges, 700mm wide
- cantilever (south) = 2500mm
- cantilever (north) = 2000mm

Roofs
- cast in-situ rc slabs, 255mm thick, 1-way span
- 255mm upstand beams (510mm total slab thickness)
- chamfered edges, 700mm wide

Infill
- glass & aluminium curtain wall / windows
- brickwork

7.2. materiality & composition

The selection of building materials and finishes are primarily inspired by the materials of the context. However, in some instances these modern elements have been converted by the use of a similar but more contemporary material. The general material palette of the building is neutral colours, textures and a contrast between light, smooth materials and solid, rough materials. Red brick, synonymous with Pretoria Regionalism and used extensively across Campus, was the choice of material for the services areas. The 'stage tower' and free-standing walls to the refuse areas are red brick and create a pleasant contrast to the rest of the functional blocks' neutral colour scheme.

The adjacent collage of material samples illustrate the existing materials of the context (analysed in Chapter 2) as well as the more contemporary materials used in the new music school. Reinforced cast in-situ concrete is used comprehensively in the creation of the structural elements where the finish remain off-shutter concrete. In some areas the concrete structure extends from a series of columns to a solid wall. In this case the concrete is treated in numerous ways to distinguish the elements and to ensure that the surface finish maintains an acceptable appearance, for the béton brut finish does not weather so well over the years. Variations to the off-shutter concrete appearance are sandblasted concrete (exposed aggregate), stucco plaster / daubing, patterned pre-cast concrete panels, white pigmented plaster to create a dry shake finish and the LiTraCon concrete blocks.

As previously explained, LiTraCon is a light-transmitting concrete due to the large amount of very small glass fibres and particles within the concrete mixture. It thus has the same compression properties as conventional concrete, but with the ability to appear lighter and less solid. The inclusion of the glass fibres and particles do however add a level of complexity to the composition of the concrete and therefore the LiTraCon blocks are pre-manufactured in customised sizes. On site construction with the blocks are similar to building with bricks and a normal cement mixture is used to 'glue' the blocks together.

Due to the fact that large amounts of concrete are used in the construction of the building, more sustainable alternatives were investigated. A material called Syndecrete proved to have been the most suitable option. Syndecrete is regarded as a "sustainable concrete" (Ryker, 2007:88) made with a combination of discarded recycled glass chips, computer products and vinyl records as the aggregate. It has exactly the same properties as conventional concrete and can be used for in-situ applications.

Apart from concrete various other materials are included in the composition of the building. Materials such as the red face brick, glass, timber decks and screens, light-grey pigmented power floated floors, laminated timber floors, wedge-shaped concrete tiles, suspended ceilings in gypsum plasterboard, stainless steel balustrades with timber handrails and natural stone tiles are materials included in the specifications.

When viewed in relation to the existing buildings of the precinct the proposed intervention will read more contemporary, yet relating in every sense of the architectural character to its contextual counterparts.

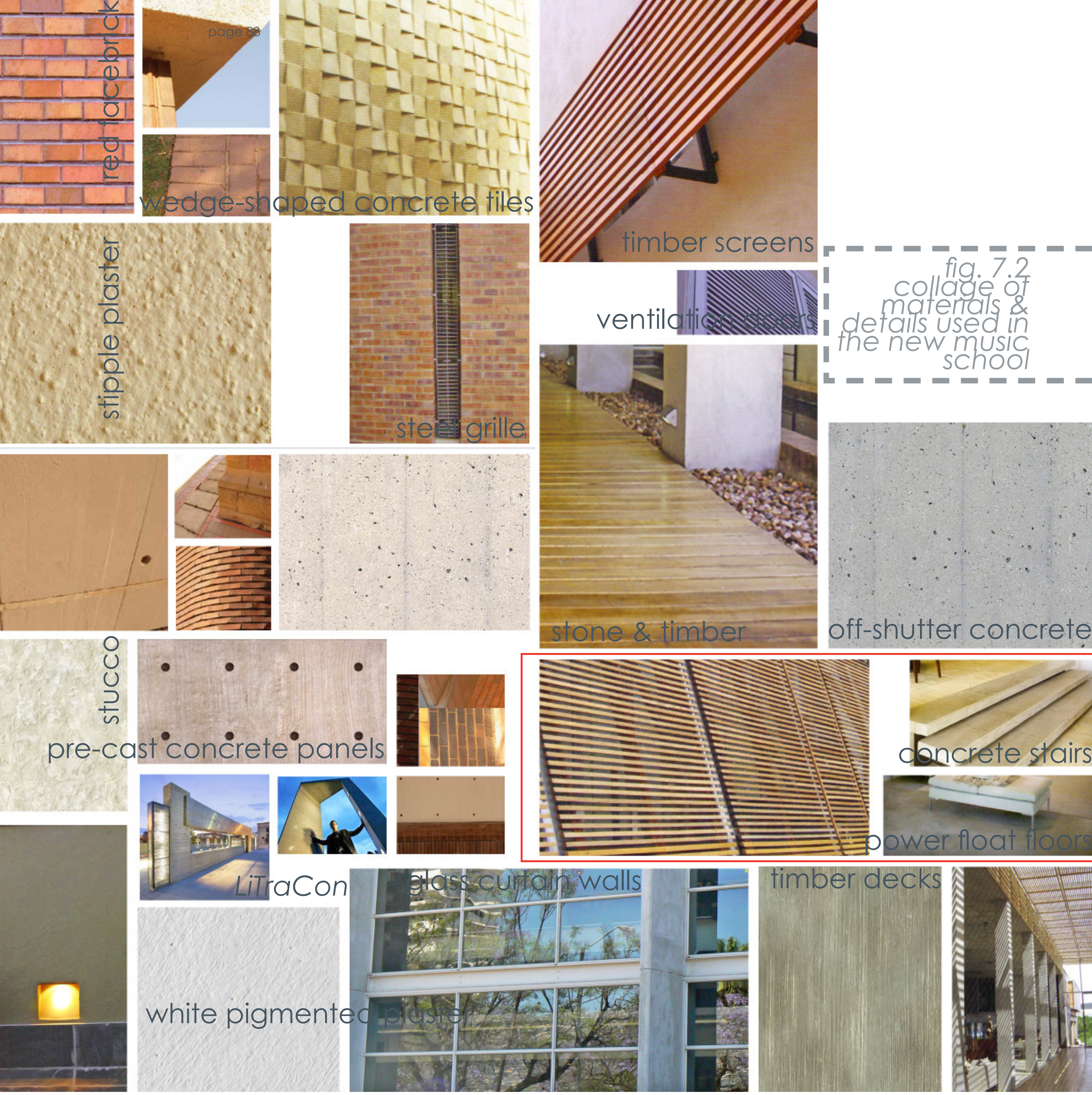


fig. 7.2 collage of materials & details used in the new music school

7.3. environmental systems

7.3.1.1 natural systems
sun study & shading devices

The contextual design generators enabled the building to have a primary east-west orientation with a secondary north-south orientation. Due to the large volumes of the intervention to the north and west, most areas are bathed in their shadows and thus protected from the harsh Highveld summer sun in the afternoons. Additional sun control measures were however required, especially on the north facades. When analysing each elevation of the building individually, a clear understanding is formed regarding the sun's influence on the internal spaces and the resultant shading devices.

The east and west elevations are reduced in length due to the rectangular shape of the building along the south edge of the precinct. On the east elevation openings are kept to a minimum and those introduced are protected by roof overhangs, canopies, balconies and horizontal timer screens.

Problems associated with western sun are eliminated on the west elevation by the internal orientation of the auditoria. The volume accommodating the auditoria / lecture halls is a framed structure with 'conditioned walls' wrapped around it. This implies that the internal auditorial spaces are artificially controlled and acoustically sound. Minimum to zero punctures are thus required for this double-layered envelope. The emergency access points however occur on the west façade in this envelope. These openings have been turned in a north-south direction, recessed into the auditorial volume and have been provided with a free-standing wall on the exterior for further protection. In the foyer space below the lecture halls, the west elevation is also sheltered by the free-standing wall and the emergency staircase that acts as a canopy to the glass facades of the foyer. Soft landscaping elements on the exterior of the foyer space further protect and cool the space.

The south façade has been blessed with the beautiful avenue of evergreen 'fever trees' along the Ring Road. This landscaping element, together with the southern orientation allowed for the desired design of the media centre: a light, seemingly hovering rectangle wrapped in a concrete ribbon with glass infill edges providing clarity, transparency and relationships between the interior and exterior. On the south edge a glass curtain wall from floor to ceiling provides unhindered views of the green landscape and draws the tranquillity of nature into the media centre space.

Service and circulation spaces were allocated to the rest of the south façade between the media centre and the foyer to the lecture halls. Balconies to the foyer space surrounding the circulation tower have been punctured into the south façade to create focal views and relationships with the natural elements. The ablution block on the south façade is also punctured with openings on this side. These openings and the services from the ablution block have however been enclosed with a steel and timber screen for aesthetic purposes.

The north façade of the media centre required more care with regards to sun control. With the introduction of the external walkway with additional timber screen over, the façade of the media centre was pushed back. This created the first part of the sun control system. The second measure is the jagged interaction edge. Structural ducts and glass infill are orientated diagonally to reduce the filtration of direct sunlight into the study spaces. The nooks created by the jagged edge provide social spaces with integrated seating along the external walkway, making the space more versatile than a mere circulation route.

The remainder of the north façade is allocated to the practise block. Here the private, acoustic internal spaces required few small openings. Windows were introduced to the north and south facades of the block as slender rectangular strips, running vertically and horizontally in an l-shaped form. The narrow windows are recessed into the double-layered wall with the recesses extending vertically and horizontally to create contemporary concrete bands across the facade. The rigid, solid appearance of the façade was softened by the introduction of square-shaped, light timber louvers on a steel frame. The timber slats run horizontally and serve as fixed shading devices to portions of the windows.

In general, the shading devices of the building were designed as integrated components of the façade treatments. The articulation of spatial volumes however remains a major aspect of the sun control to the building.

sun study & shading devices


fig. 7.3 : East elevation - January morning


fig. 7.4 : East elevation - June morning


fig. 7.5 : South elevation - January morning

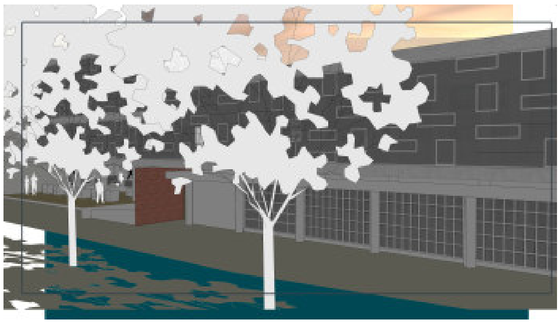


fig. 7.6 : South elevation - June morning


fig. 7.7 : West elevation - January afternoon


fig. 7.8 : West elevation - June afternoon

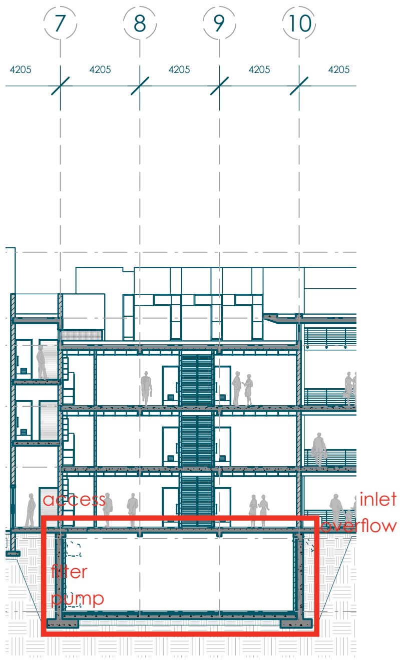

fig. 7.9 : North elevation - January afternoon


fig. 7.10 : North elevation - June afternoon

natural systems

7.3.1.2 rainwater harvesting & stormwater

fig. 7.11 :
Section of storm water storage tank below ablution block.



Due to a global restricted natural supply of fresh water, the proposed building is adapted to make use of precipitation that is stored in a 252,22m³ tank situated beneath the ablution block. All the roof areas are designed to collect storm water. Hard surfaces around the building are provided with storm water catch pits while other surfaces are permeable to allow for ground penetration.

Rainwater pipes of 110mm dia. are located in the structural columns of the building and connect the full-bore outlets at roof level with the underground storm water network consisting of 160mm dia. pipes that discharge the water into the storage tank.

The tank is supplied with a fully submersible pump and filtration system, driven by solar energy. After passing through the filter, the storm water is used to supply all water closets and refuse areas. Surplus water can be used for irrigation of the greenery around the building.

An overflow is provided to the municipal storm water system to prevent flooding of the tank during heavy thunderstorms.

The water supply to the ablution block is also connected to the municipal source in order to supplement daily demands.

Rainwater Calculations

Roof areas:

Auditoria:	552m²
Services block:	184m²
Ablution block:	45m²
Practise block:	398m²
Circulation towers:	42m²
Research lounge:	270m²
Media centre:	319m²
Total catchment area:	**1810m²**

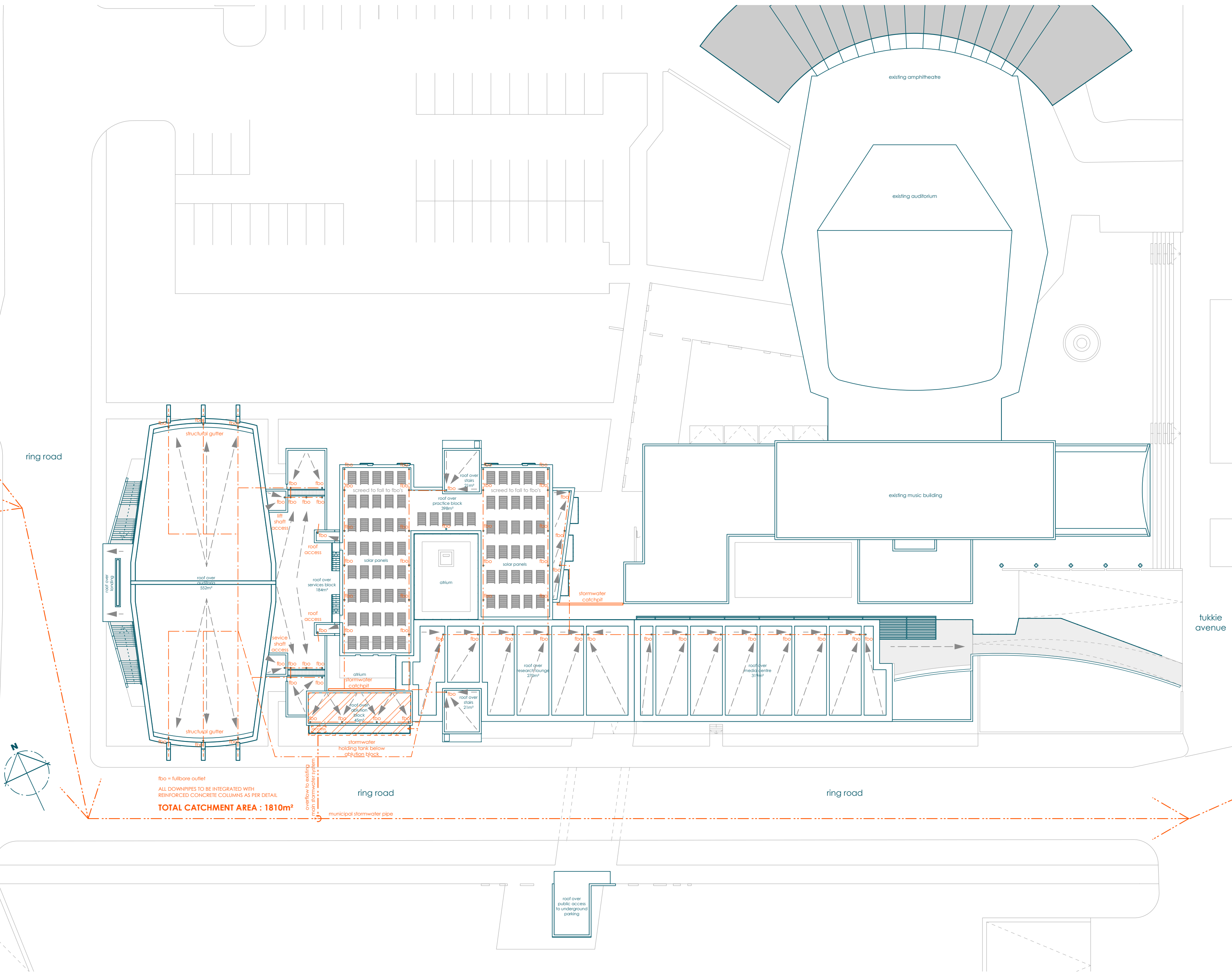
Tank size:	252,22m³
Tank storage capacity:	**252 220l**

Capacity design population +/- 300 persons/ day
wc usage = 300x3x8 l x 20(week days)
= 144 000 l / month

Precipitation:
Max monthly (January) 136mm
= 0.136x1810 = 246 160 l x 0.85
(15% evaporation) = 209 236 l
Min monthly (July) 3mm
= 0.003x1810 = 5 430 l x 0.85
(15% evaporation) = 4 615 l

Thus at maximum rainfall there is an excess of 65 236 l.
At minimum rainfall there is a shortage of 139 385 l.

fig. 7.12 : Roof plan indicating rainwater catchment areas and storm water network.



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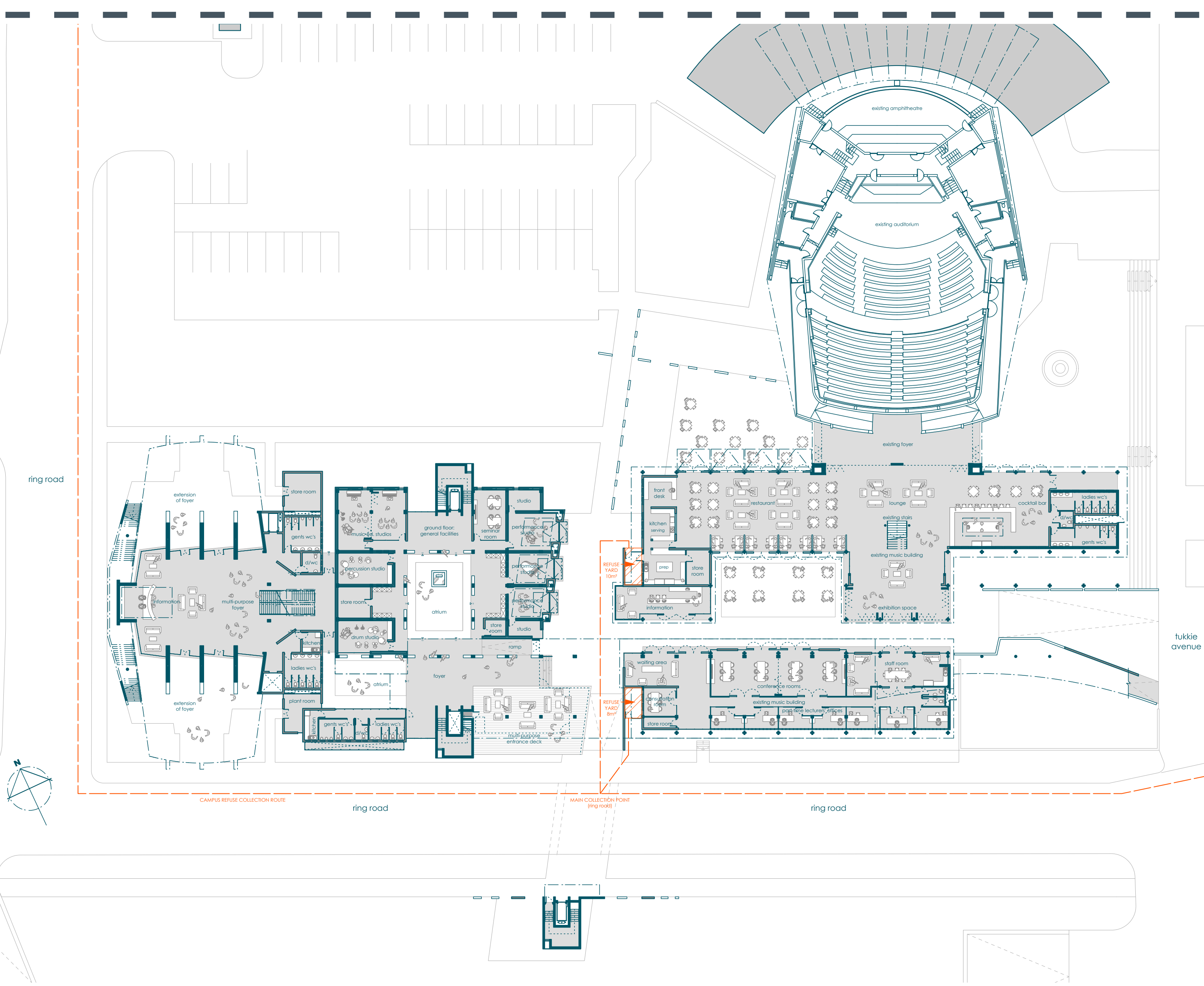
7.3.2.1 artificial systems refuse

Due to the educational nature of the building, the production of refuse is moderate and thus the two refuse areas provided will suffice for the needs of the intervention. The back kitchen to the restaurant has direct access to a refuse area for easy discard of refuse produced by the restaurant. The second refuse yard is situated on the south-west corner of the existing Music Building and serves as a general waste area for the intervention. Throughout the building waste bins are provided which are to be cleaned on a daily basis. The refuse is then stored in the general refuse yard next to the Ring Road south for easy collection by the Campus waste services twice weekly. Both refuse areas are fitted with a floor trap and tap and secured by a timber screen and matching gate. The areas are also screened from the performance walkway by high walls in red face brick, expressing the service function of the spaces.

fig. 7.13 : Ground floor plan indicating the refuse removal strategy.



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7.3.2.2

artificial systems
fire protection

fig. 7.14 : Ground floor plan indicating the fire protection strategy.

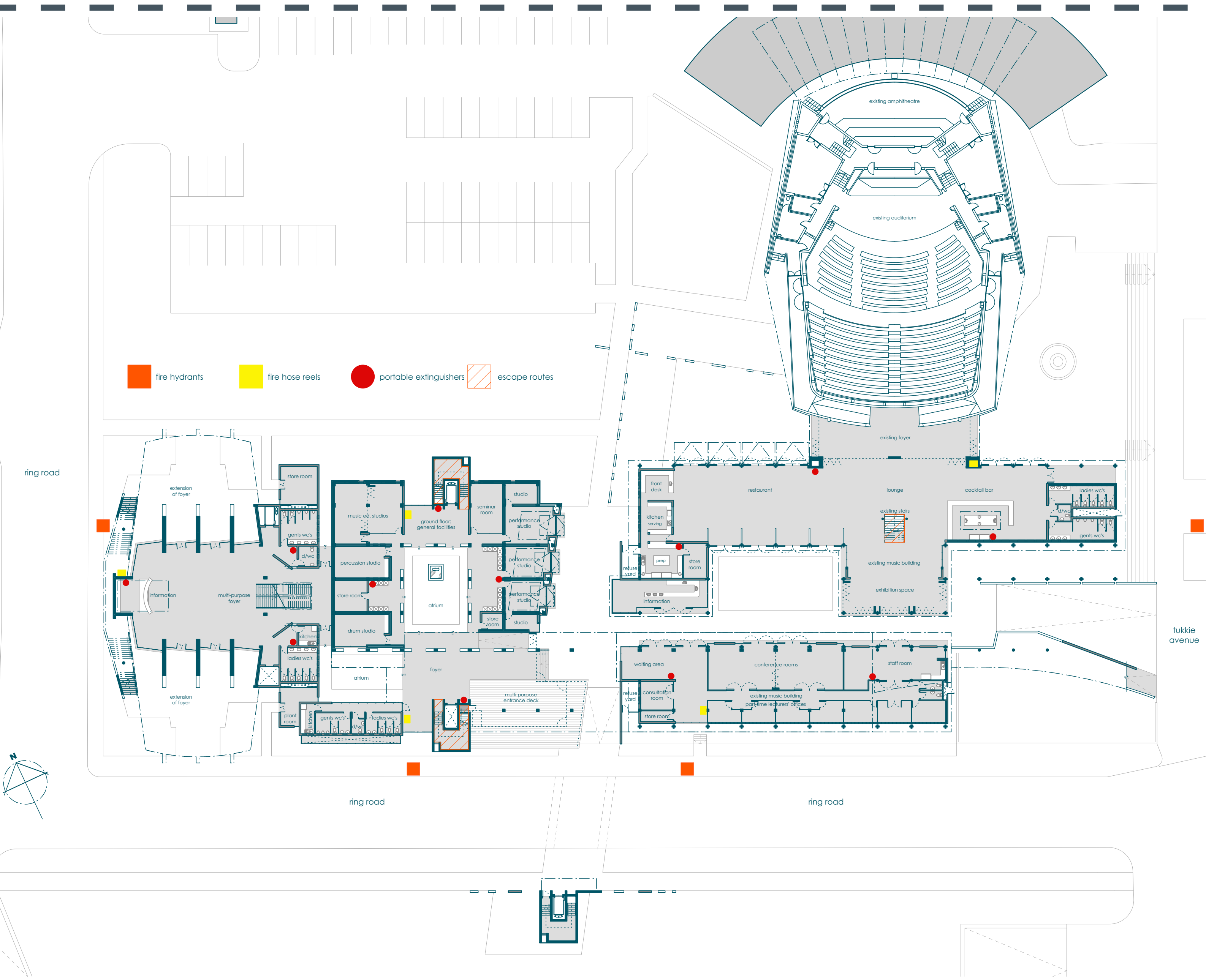
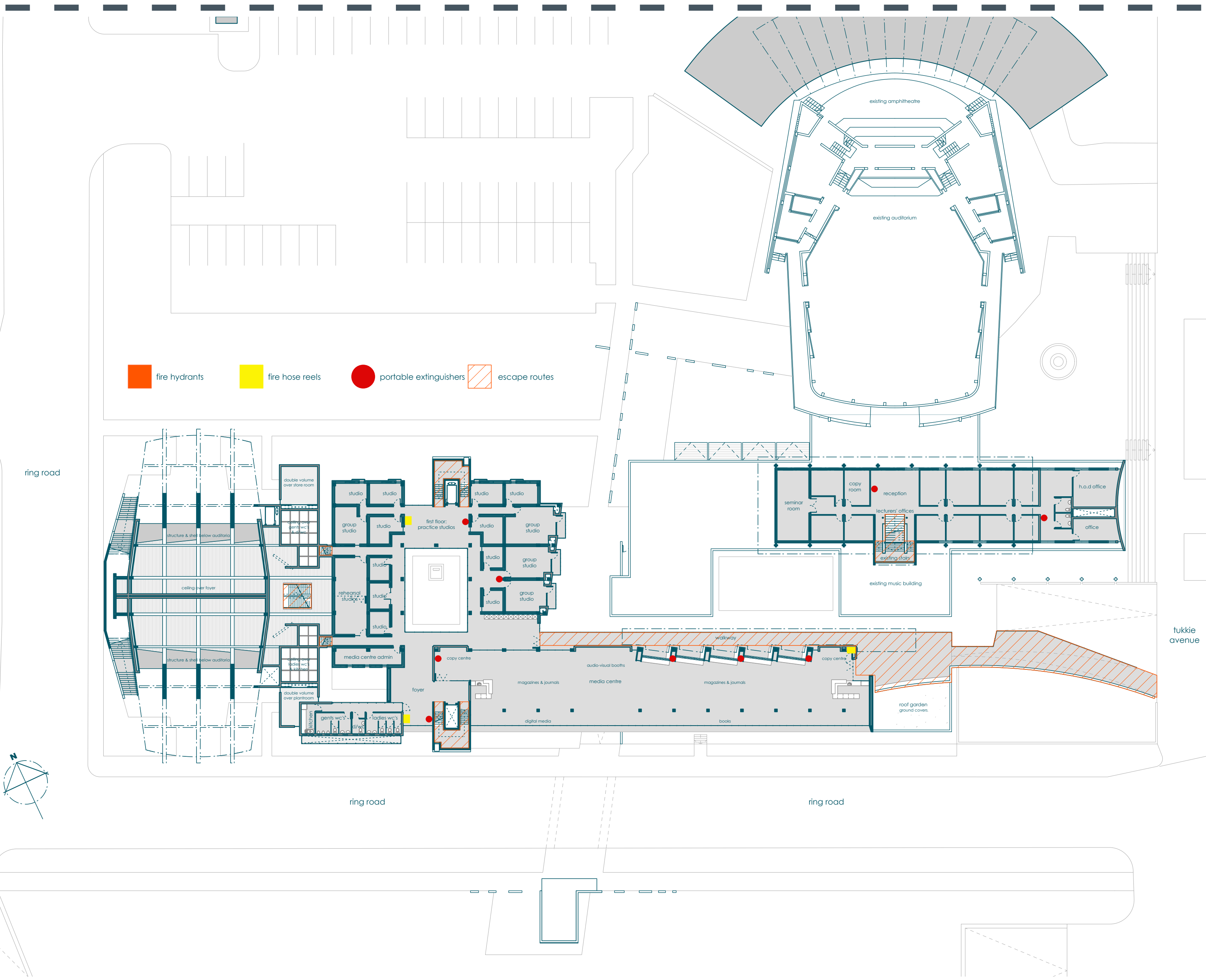


fig. 7.15 : First floor plan indicating the fire protection strategy.



Fire protection forms part of the artificial systems of the building and are in compliance with SANS 0400 Part T.
The proposed building is a non-smoking area except for the external balcony areas where smoking will be permitted. Waste bins with sand-filled ashtrays on top will be provided on the balconies.
Safety distances to adjacent buildings (except for Music Building and Musaion) are as follows:
East side: 49,443m
South side: 67,444m
West side: 27,433m
North side: 57,313m

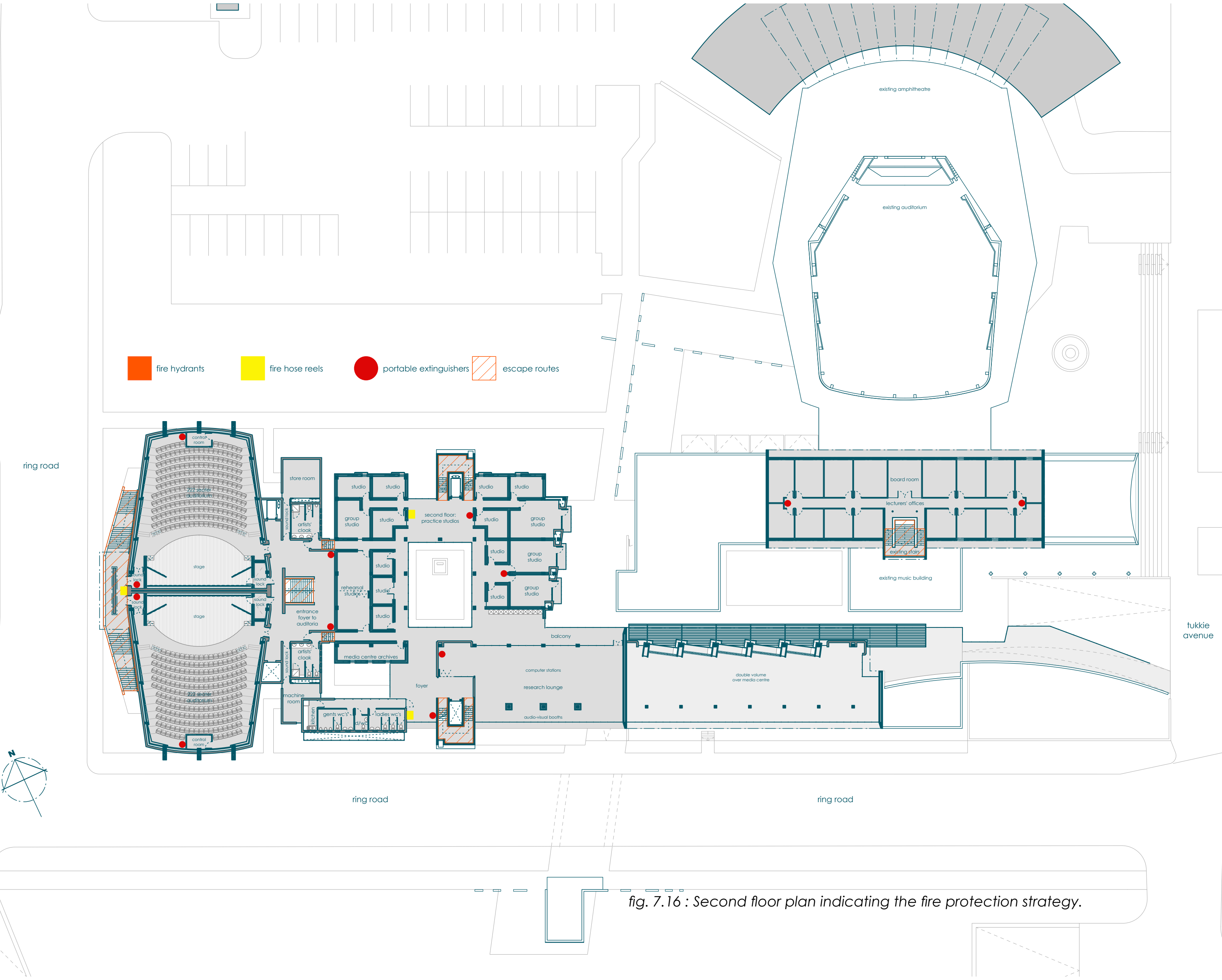


fig. 7.16 : Second floor plan indicating the fire protection strategy.

Structural members will have a fire-rating of 120 minutes and all structural steel will be treated with minimum 38mm Pearlite spray on plaster to comply with Part TT7.

Lighting to emergency routes will be 0.3 – 0.5 lux.

The building is provided with an alarm system that can be manually operated in case of emergency. Automatic smoke detector alarms are also fitted throughout the intervention.
All areas and emergency routes are fitted with safety signage and evacuation diagrams are located in strategic areas throughout the building.

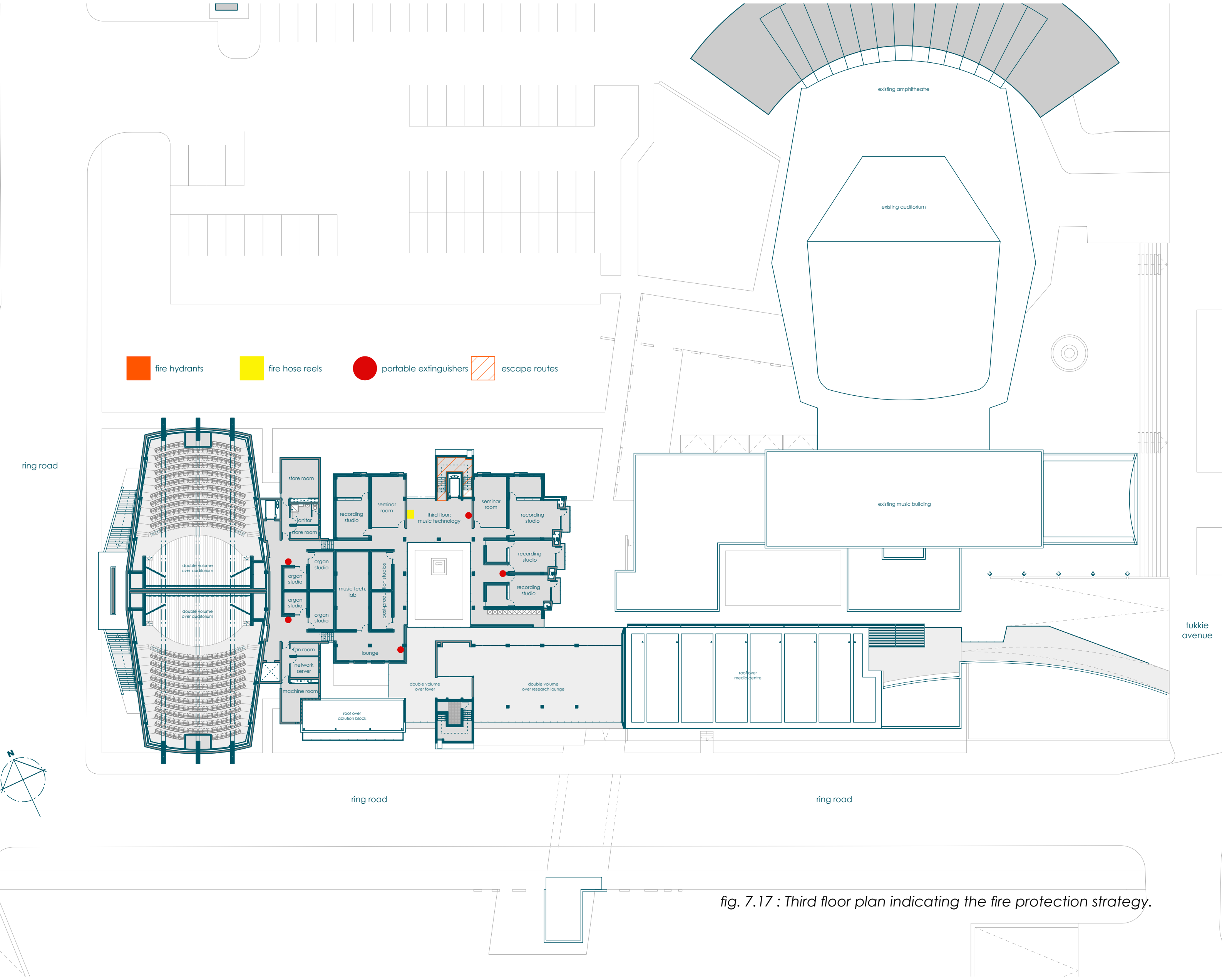


fig. 7.17 : Third floor plan indicating the fire protection strategy.

7.3.2.3

artificial systems
drainage

fig. 7.18 : Ground floor plan indicating the drainage layout.

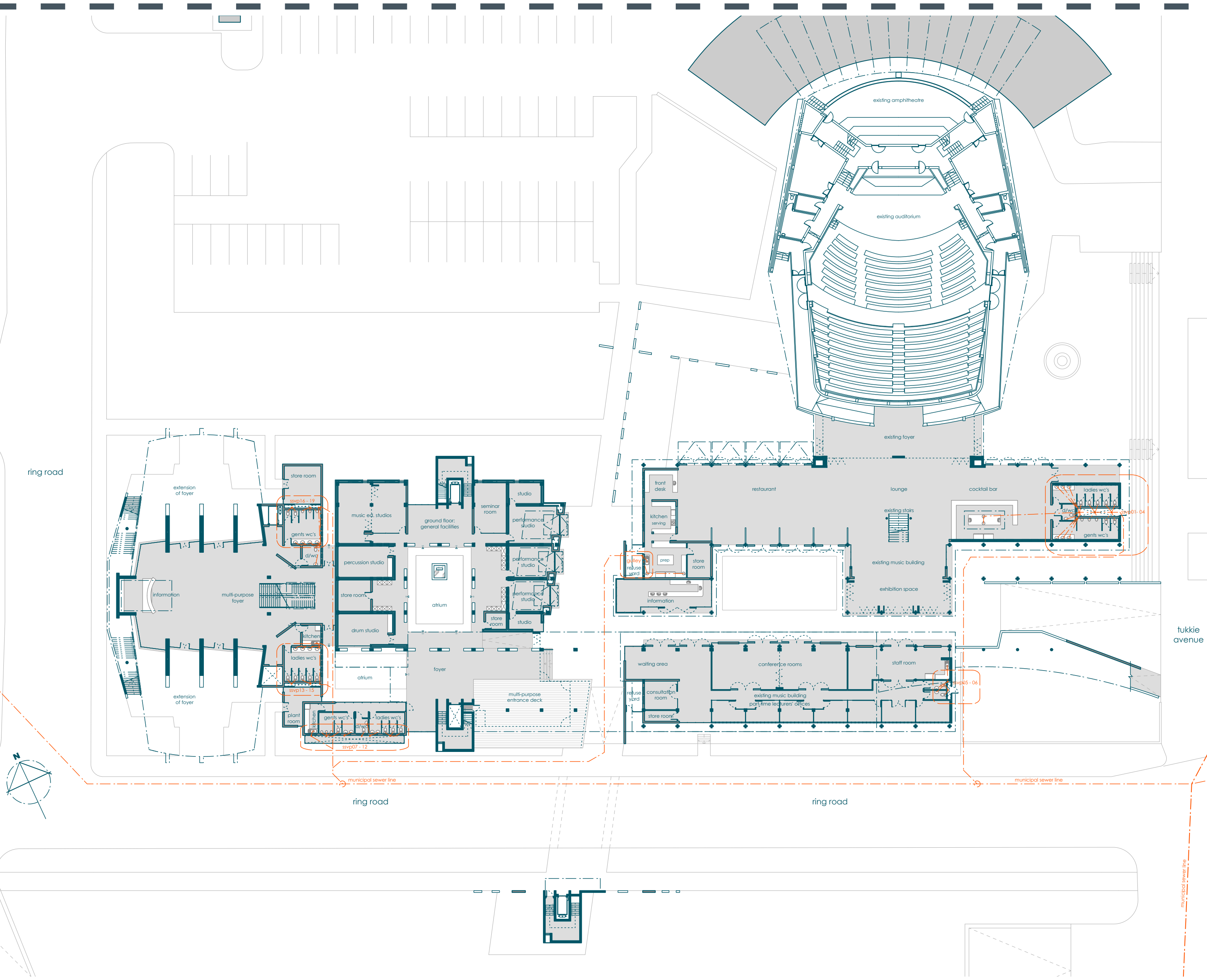


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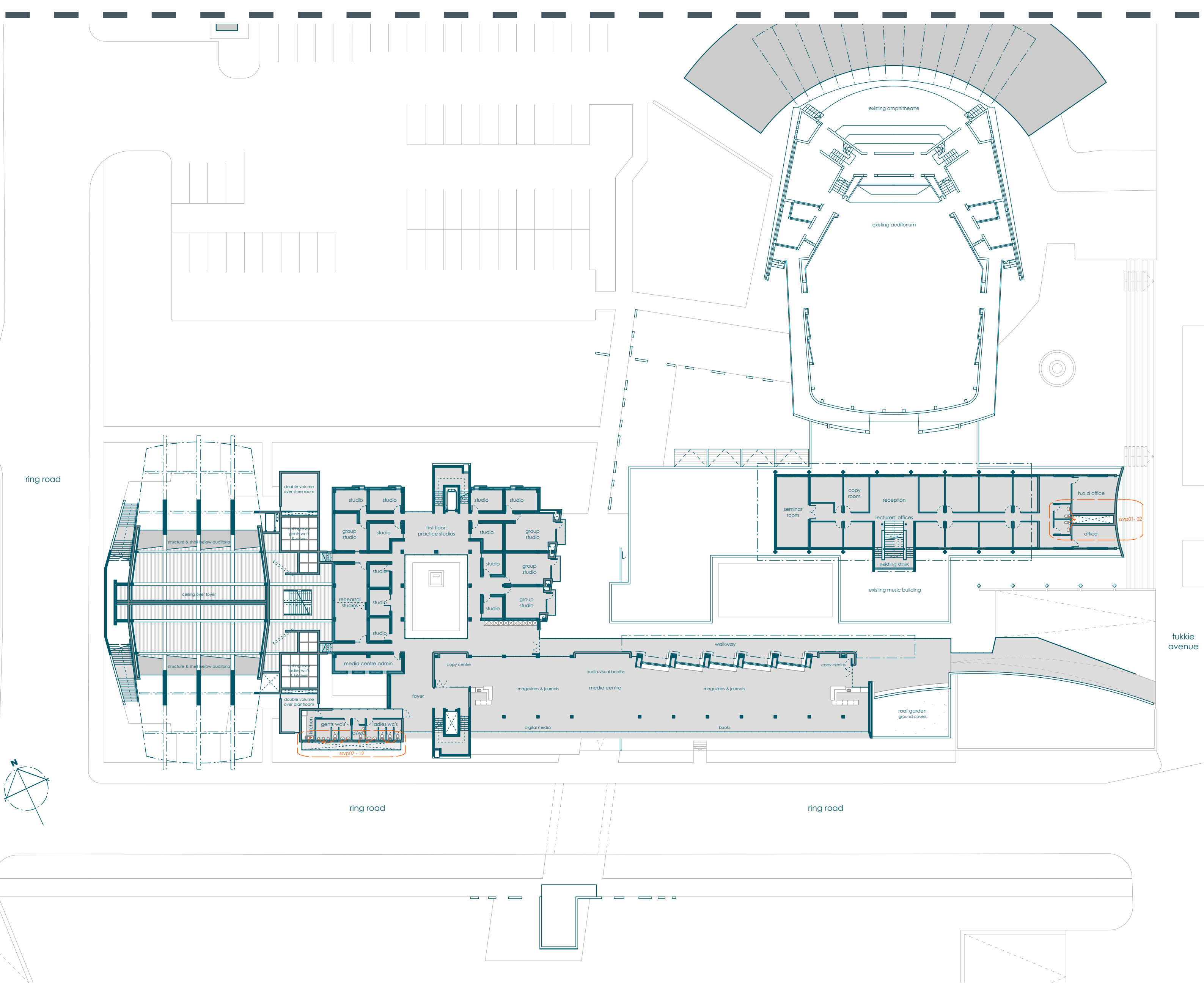
fig. 7.19 : First floor plan indicating the drainage layout.



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By grouping similar functions together, the service cores of the building remain concentrated and easily accessible. Drainage areas are placed on top of each other at each level which requires only five drainage stacks throughout the new and old music facilities combined. Each of these areas is provided with an accessible service duct for pipe work and ventilation to prevent any visible drainage pipes on the facades.

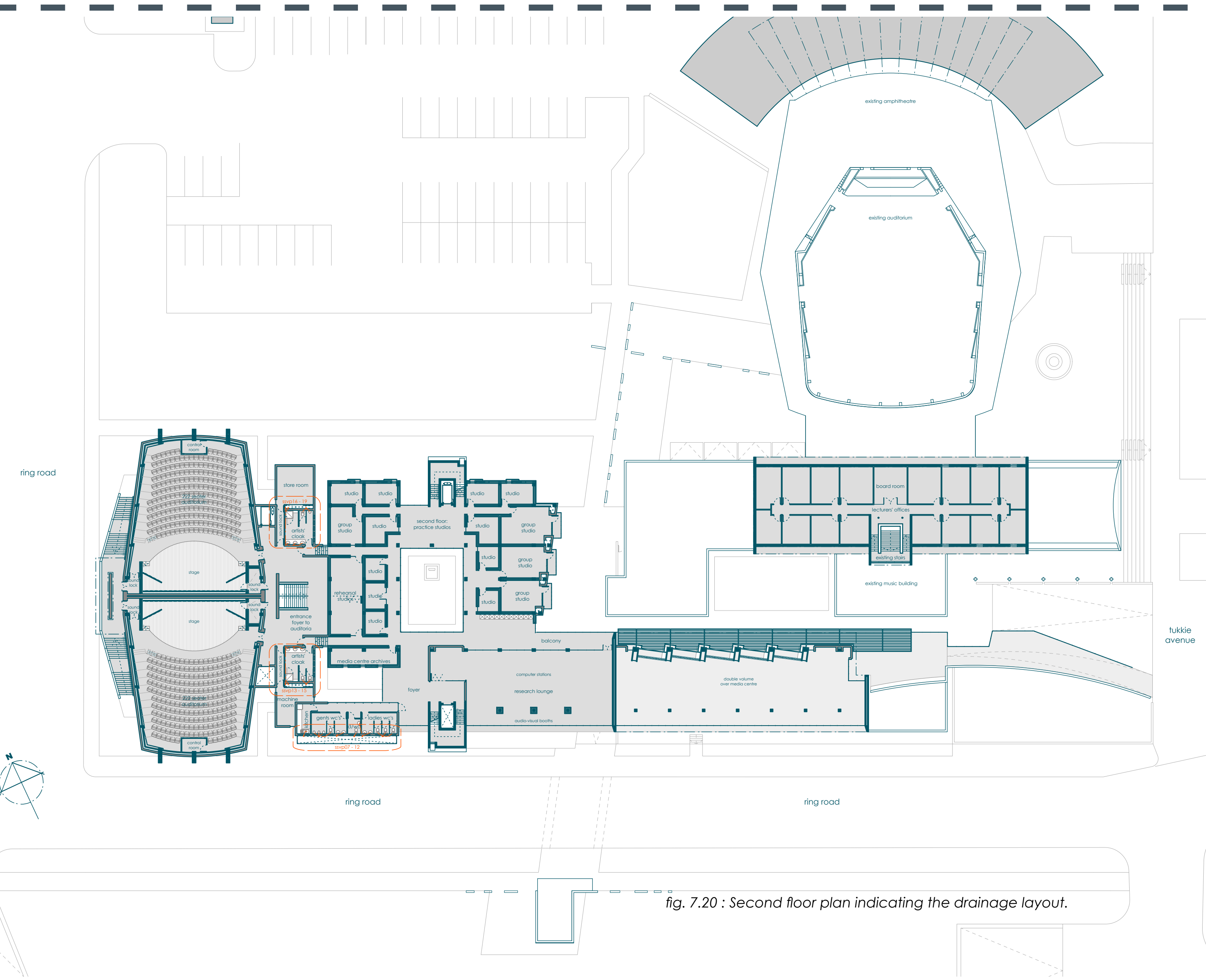


fig. 7.20 : Second floor plan indicating the drainage layout.

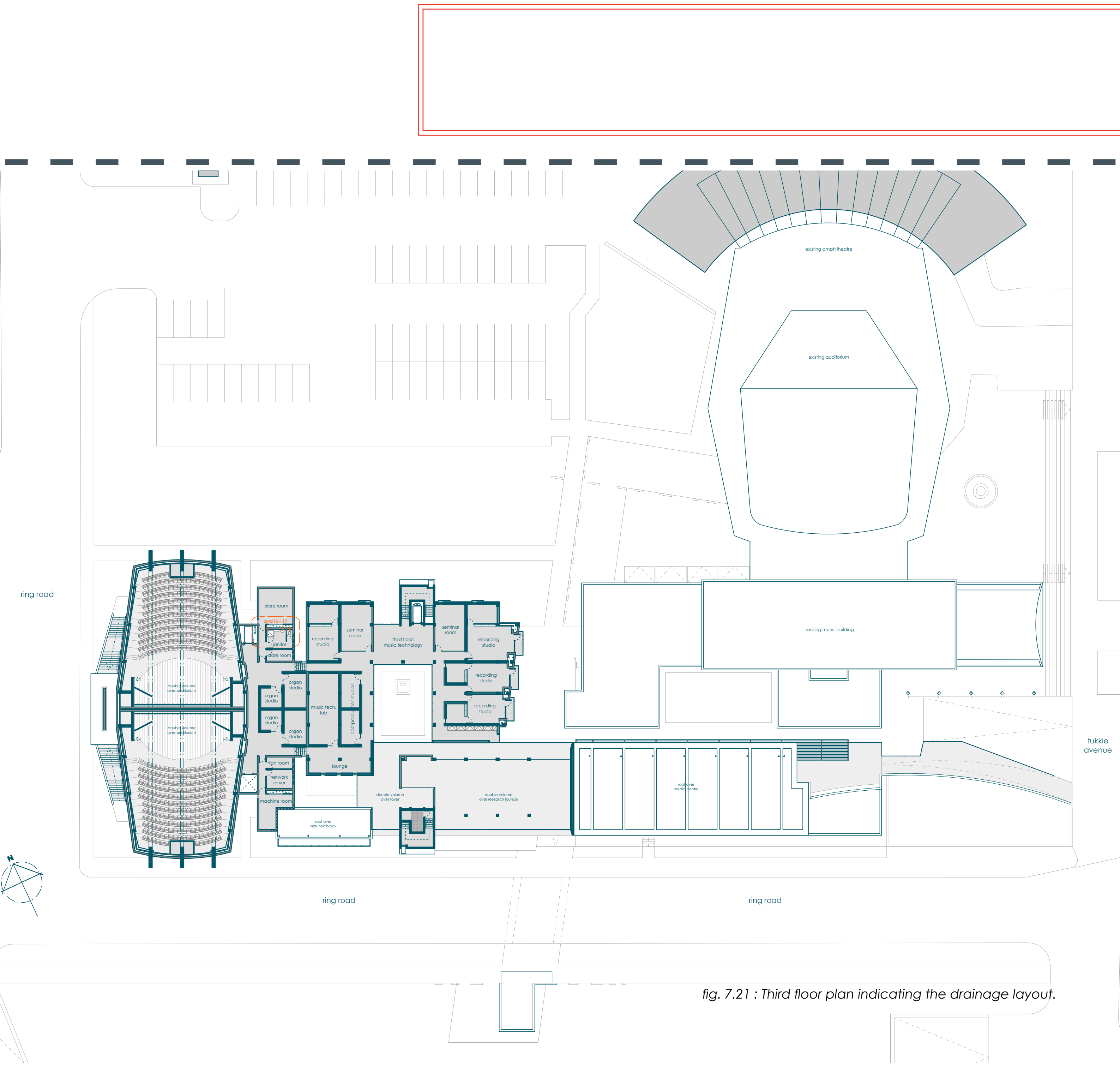


fig. 7.21 : Third floor plan indicating the drainage layout.

7.3.3.1 hybrid systems

The term "hybrid systems" refers to systems that employ natural conditions to supply artificial conditions. Photovoltaic panels and air-conditioning systems are the main hybrid systems implemented in the building and will be discussed in this part of the chapter.

The chosen photovoltaic system is a Dual Axis Photovoltaic-Grid Intertie. This system consists of an array of panels (990x1610mm, 170kW generating capacity each) that is manually set to one of two settings. The first is flat on the roof of the practise block at 3° as a summer setting and the second is at 48,94% normal to the rays of the winter sun. The panels are mounted on the flat concrete roof at 1500mm c/c to allow sufficient space for manoeuvring and maintenance of the panels. This arrangement allows for approximately 70 panels. According to Lori Ryker, author of the book *Off the Grid Homes*, 18 solar panels are sufficient to supply for the electricity demands of a medium size house and a 100 panels are equivalent to the electricity demand of 5,5 medium sized houses.

With this dual system, two options for the storage of solar energy are available:

1. battery bank
2. the municipal grid

The use of a battery bank was considered for the project, but due to its limited lifespan and high maintenance costs it was decided to rather use the municipal grid as storage device. Energy converted by the solar panels will thus be placed back into the grid and the energy required for the functioning of the building will only be provided in the conventional way by the grid (Ryker, 2007:55).
The energy generated by the photovoltaic system will be applied to drive the pump system of the storm water storage tank as well as for the central plant air-conditioning system of the building.

fig. 7.22 : Diagram of Dual Axis Photovoltaic Grid Intertie.

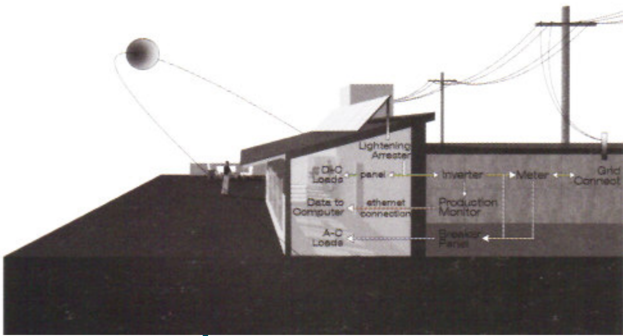
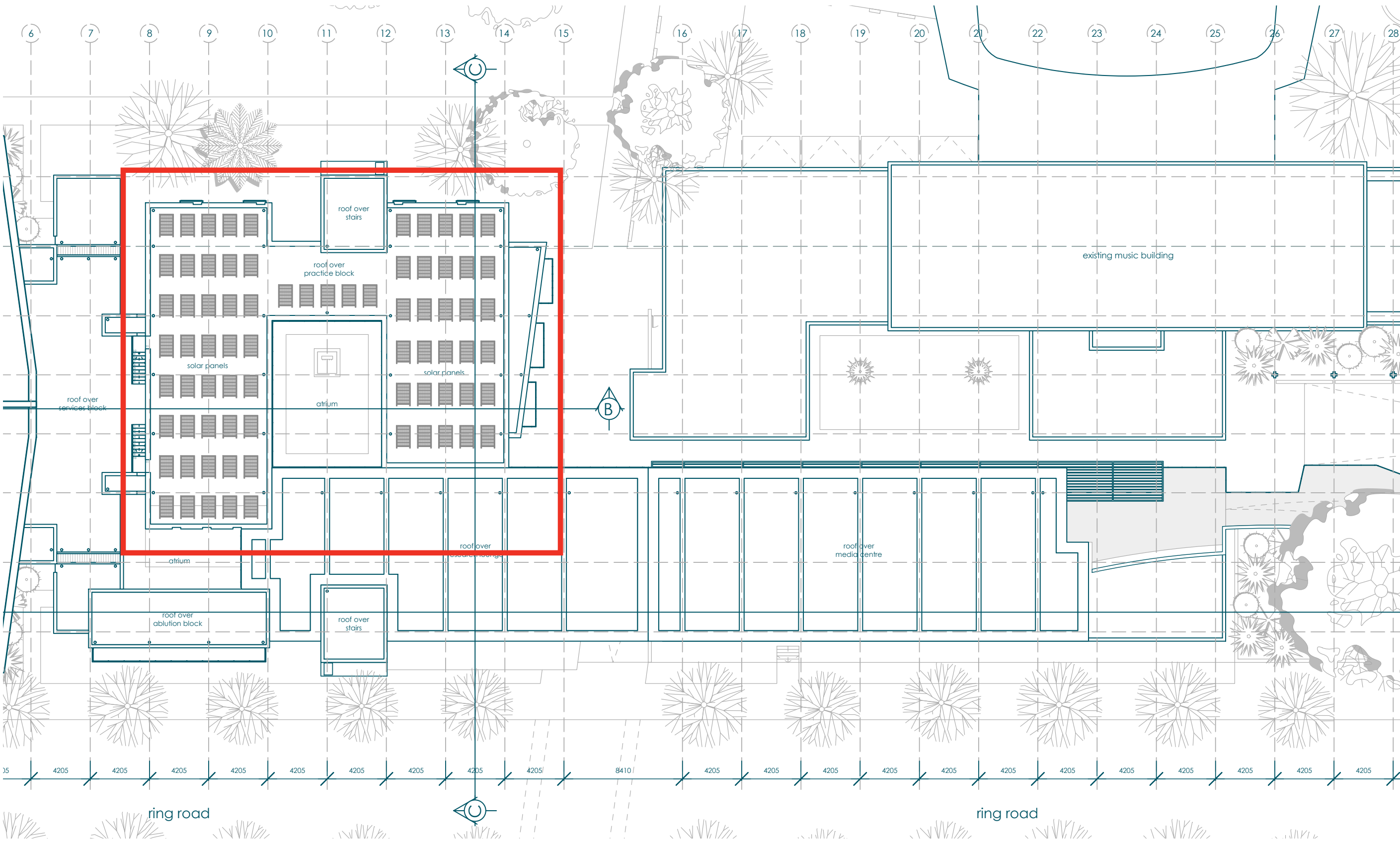


fig. 7.23 : Roof plan indicating the position of the 70 solar panels on the roof of the practice block.



7.3.3.2 hybrid systems
air-conditioning

A central plant air-conditioning system is incorporated in the building to maintain temperature, ventilation and humidity requirements in the internal, public spaces like the lecture halls, media centre and research lounge. The central plant system consists of three main components:

1. The refrigeration cycle or chiller
Due to the size and weight of the chiller, it is located at ground floor level on the south side of the services block. Concrete plinths are provided to spread the weight of the equipment and a floor trap is also included to drain any access water that might be generated by the equipment. The plant room has a sufficient height of 4, 385m and direct access is available to the vertical duct on the north wall of the plant room. Two vertical grids are provided along the total height of the three-story services block to supply sufficient ventilation for the optimum operation of the plant.

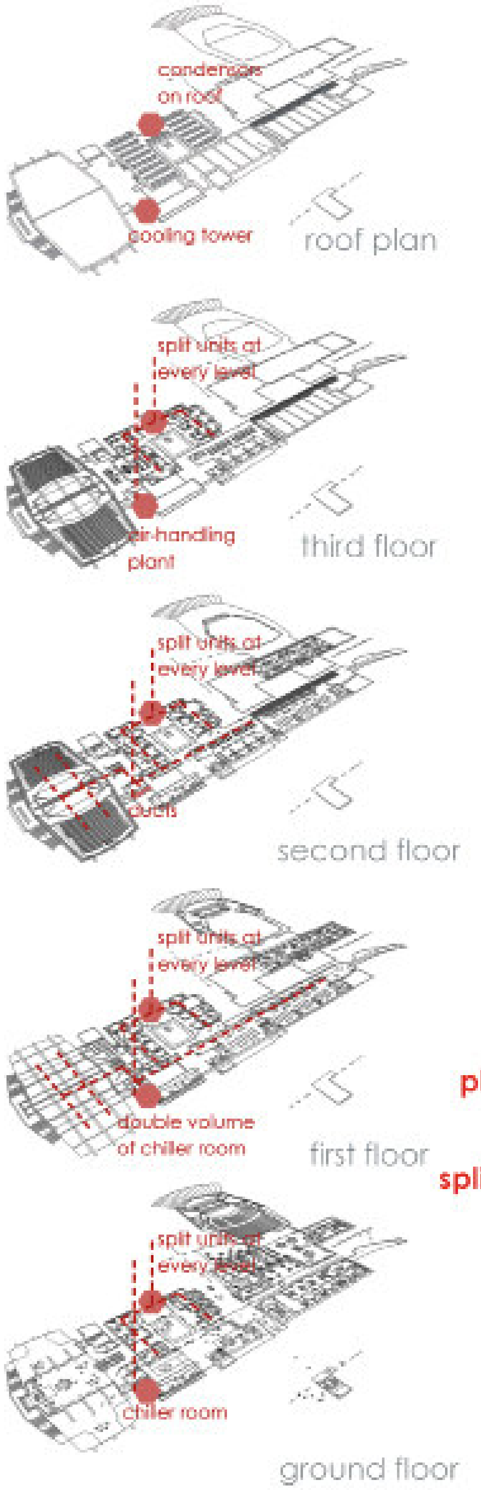
2. The air-handling plant
This component is situated directly above the chiller plant room and the area has similar access and ventilation properties as the chiller plant room.

3. The cooling tower
This component is situated on the roof of the services block, in the south-west corner above the plant rooms. Here, unrestricted flow of air can easily cool down the warm water in the cooling tower. The parapet on the perimeter of the services block has been increased to 1,5m to hide the cooling tower and other service related components from the appearance of the building.

The central plant system serves the two lecture halls via ducts that surface beneath each theatre chair as well as along the ceiling's perimeter. The system is only in use when the lecture halls are occupied. In the research lounge and media centre the air handling ducts run along the soffit of the slab above the suspended ceiling and penetrate the ceiling in strategic areas to ensure an even distribution of air throughout the spaces. Both the research lounge and media centre are provided with openable windows on both the north and south facades to allow for natural cross-ventilation. The air-conditioning system is thus a last resort for temperature and ventilation control in extreme weather conditions.

The practise block's studios are also provided with air-conditioning but in this case a split type air conditioning system is used. The reason for this is that the practise block consists of numerous separate studios, each with individual users. With a split system, the user of each studio can regulate the temperature of that space according to the individual's needs.

The condensers and compressors of the split units are located on the roof of the practise block and the space at the back of the lift shaft is used as vertical duct to connect the split components of the air-conditioning units.



central plant system

auditoria
media centre
research lounge

refrigeration cycle / chiller
ground floor plant room

air-handling plant
second & third floors

cooling tower
roof level behind parapet

plant location vertically aligned

split-type air-conditioning system

practise rooms
studios

individual control

condensors & compressors
roof level of practise block

*fig. 7.24 :
Diagram indicating the location
of the air-conditioning plant.*

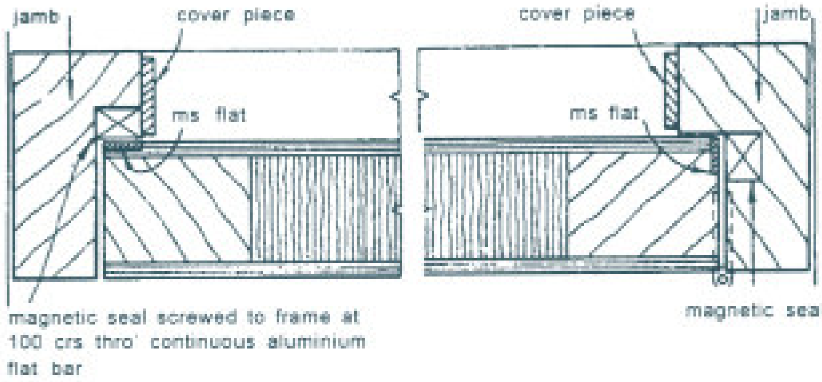
7.4. acoustic requirements
studio design

It is pertinent that the studios of the practise block have the desired acoustic properties for practise and the recording of an optimum quality product. Intrusive external noise, the spread of noise between studios and structure-borne sound transmissions should therefore be kept to a minimum. This can best be achieved by creating a solid structure around the studios.

The wall construction of the studios consists of a 330mm brick cavity wall with a 100mm mineral wool sound insulation cavity. This prevents the majority of external noise entering the spaces and vice versa. Fixed to the internal face of the cavity walls are 50mm mineral wool blankets with black fabric covering; 125x50x25x2,5 cold-formed top hat sections are fixed to the cavity wall but isolated from the structure with neoprene seals to prevent the occurrence of structural noise. 8x2500x2000 perforated commercial plywood panels are fixed to the top hat sections with a gap of 75mm between the plywood and the mineral wool blankets. The perforated panels allow sound to enter the panels and dissipate between the plywood and the mineral wool blankets, giving the studios the desired sound absorption qualities. The glass facades to the performance and group studios on the east side of the practice block consist of a double glazing system angled at 97° to prevent the occurrence of standing waves. Double glazing is a good insulator against external noise. The cavity between the glass panes is filled with copper sulphite in order to absorb any moisture within the cavity.

All the practise studios are provided with acoustic ceilings consisting of 8mm thick, egg-grate profiled plywood panels at 97° to prevent the occurrence of standing waves. These ceiling panels are fixed to a steel grid and suspended from the concrete floor slab above. 100mm mineral wool sound absorption blankets are placed on top of the panels.

Acoustic doors are fitted to the studios and are sealed with 25mm neoprene seals between the door and doorjamb.



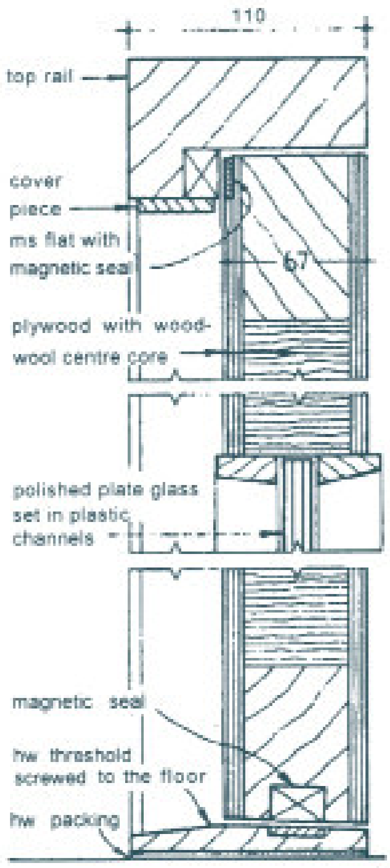


fig. 7.25 :
Plan and section details of an acoustic door.