Royal & Derngate: Decarbonisation Plan

Cultural & Heritage Sector Decarbonisation Pilot Study

January 2026



HaworthTompkins

SKELLY & COUCH

ARTS COUNCIL ENGLAND

Working together with Historic England

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Executive Summary

The following report presents a Decarbonisation Plan for the Royal & Derngate, a theatre and entertainment complex within the heart of Northampton's cultural quarter.

Royal & Derngate is at the heart of the region's cultural life, providing cultural experiences and connecting Northamptonshire's communities through entertainment, arts & learning. By producing, presenting & touring exceptional theatre, the Royal and Derngate also plays a key role in the wider theatre ecology, engaging significant audience numbers through its programme and range of creative and participatory activities.

This report has been commissioned by Historic England and Arts Council England, as part of a pilot study focussing on the decarbonisation of listed and existing buildings within the cultural & heritage sector

The report has been prepared collaboratively by architects Haworth Tompkins and MEP engineers Skelly & Couch, with input from cost consultants Gardiner & Theobald.

The proposals have been developed in consultation with senior staff at Royal & Derngate, based on information collected through:

- Initial briefing workshops carried out with staff at Royal & Derngate.
- A building visit attended by Haworth Tompkins and Skelly & Couch.
- A visual services inspection and thermal imaging survey carried out during the site visit.
- Online information records including the planning portal, and Historic England Listing register.

Building information was also provided directly by Royal & Derngate including:

- Existing building layouts and a plant asset log provided by the site management team.
- O&M manuals for the foyer extension works provided by the site management team.
- Metered data on gas and electricity usage obtained from the energy supplier.
- A Conservation Plan for the Royal, dated 2004
- An Asbestos management survey
- An Environment Action Plan
- A Fire Risk Assessment

The Decarbonisation Plan is underpinned by Historic England's 'Whole Building Approach', and includes recommendations for targeted improvements to building fabric, services, and operations, as well as the development of a costed and prioritised roadmap to decarbonisation.

The development of the Plan has followed a six-step process, which corresponds to Stages 1 and 2 of the Historic England Whole Building Approach.

1 **DEFINE** the goals of the project

2 **GATHER** existing data and documentation

3 **SURVEY & ASSESS** the building and services systems

4 **APPRAISE** options for potential improvement strategies

5 **DEVELOP** a prioritised list of improvements

6 **FORWARD PLAN** the implementation of the decarbonisation pathway

Decarbonisation Plan



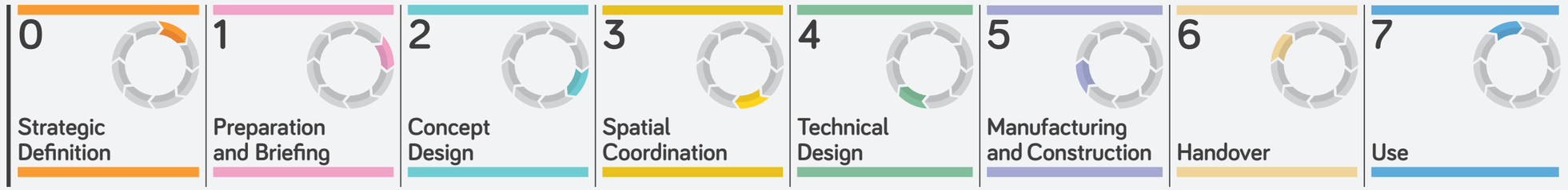
Historic England

Whole Building Approach

WBA Stage 1 Gather Data & Surveys	WBA Stage 2 Assess & Plan	WBA Stage 3: Design & Specify	WBA Stage 4: Procure & Install	WBA Stage 5: Use, Evaluate & Maintain
• Define brief and objectives • Collect information and data • Establish performance baseline • Identify inefficiencies	• Appraise opportunities for improvements • Shortlist preferred options • Create implementation plan • Set pathway to Net Zero			

Decarbonisation Plan

RIBA
Plan of Work
2020



PROJECT DEFINITION

1.1 Introduction

Decarbonisation Context

UK Government carbon targets

The built environment accounts for around 25% of the UK's total carbon footprint. [1]

Decarbonisation of the built environment is therefore a key factor in achieving overall UK carbon reduction targets, such as the UK Government's target to achieve net zero carbon emissions in the UK by 2050.

New buildings and planned refurbishments

Statutory measures exist that require new buildings to achieve high levels of energy efficiency and carbon performance, and energy efficiency to be introduced when work is carried out on existing buildings. This includes Part L of the Building Regulations, which was updated in 2021 with higher efficiency standards. There are also measures set through the planning system.

These statutory measures are relatively demanding and mean that many new and refurbished buildings should meet high levels of energy and carbon performance. Furthermore, industry guidance such as that developed by the UK Green Building Council (UK-GBC), the London Energy Transformation Initiative (LETI), and the UK Net Zero Carbon Building Standard (UK NZCBS) recommends that all new buildings (domestic and non-domestic) should be planned to be Net Zero by 2030 to meet broader climate change targets. Such targets, along with similar targets set by the Royal Institute for British Architects (RIBA) in their 2030 Climate Challenge, are being voluntarily adopted by clients as an enhancement to statutory requirements.

Existing buildings

It is projected that 80% of existing buildings are expected to remain in use until at least 2050,[2] meaning that statutory or voluntary measures for new buildings alone will not sufficiently reduce carbon emissions from the built environment in line with overall targets. There are however currently no direct statutory requirements to make energy and carbon performance improvements to existing buildings where no work is planned, or indeed where only minor works are carried out (e.g. decorative) or where such improvements would affect the nature of historic and listed buildings.

There are some indirect statutory measures that would promote higher carbon efficiency, and grant schemes to promote new systems such as heat pumps.

To meet national carbon reduction targets, voluntary measures to decarbonise existing buildings will therefore be required. It is hoped that the findings and proposals in this report will allow the Royal & Derngate to set objectives for a decarbonisation pathway accordingly.

By upgrading energy and carbon performance, other benefits for the Theatre could include:

- Reduced energy costs
- Enhanced occupant comfort
- Higher resilience in services where loads are reduced
- Potential promotional benefits

Net Zero Carbon

The concept of net zero carbon, where buildings are fully decarbonised in terms of Scope 1 and 2 carbon emissions[3], is gaining increasing attention as a means to bring buildings in line with the wider UK and international targets for decarbonisation.

Interim targets for lower degrees of carbon reductions may also be appropriate, particularly for existing buildings where steep reductions in carbon emissions are technically and economically challenging. Regardless of the target set, it is important that key principles of net zero are applied to ensure consistency.

The UK Net Zero Carbon Building Standard Pilot Version was published in 2024 and creates a unified definition for 'Net Zero Carbon Aligned Buildings' in the UK, underpinned by an evidence-based reporting methodology. The guidance provides set energy use intensity targets, which are compatible with the availability of renewable energy sources expected to be available in 2040, the deadline which the standard sets.

As part of the development of the UKNZCB standard, a working group was convened to look at the specific challenge of applying a Net Zero Carbon Building Standard to historic buildings or those with heritage significance. After extensive consultation and analysis, heritage buildings do not currently form part of the Standard.

There is consequently a need for specific guidance to support the progressive decarbonisation of listed and historic buildings, which offers a more practical and proportionate pathway than achieving absolute net zero carbon. These buildings face unique constraints including heritage significance, structural limitations, and construction typologies that make full decarbonisation technically challenging or inappropriate.

A progressive approach prioritises measurable, incremental emissions reductions through targeted efficiency improvements, system upgrades, and low/zero carbon technology integration, while respecting conservation requirements. This enables steady performance gains aligned with technological progress, funding cycles, and grid decarbonisation.

Crucially, it supports a balance between climate action and heritage preservation, recognising that historic buildings can lead by example in sustainable management and adaptive reuse.

1 Source: UK Green Building Council (UKGBC), Net Zero Whole Life Carbon Roadmap Technical Report (November 2021) p 10. Note: This figure includes buildings and infrastructure and relates to consumption emissions (i.e. the figure includes emissions from imported materials)

2 Source: https://post.parliament.uk/net-zero-and-the-uk-historic-building-stock/

3 Scope 1 emissions are those from on-site fuel use; Scope 2 emissions are indirect emissions from purchased electricity use. Refer to Appendix "Net Zero Carbon Glossary"

1.1 Introduction

The term "net zero" is often used incorrectly. To better define the concept and parameters, a group of construction organisations including LETI and CIBSE produced the following definitions.

NET ZERO WHOLE LIFE CARBON	A 'Net Zero (whole life) Carbon' Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A0-A5, B1-B8, C1-C4) are minimized, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero[1].
NET ZERO EMBODIED CARBON / LIFE CYCLE EMBODIED CARBON	A 'Net Zero Embodied Carbon' asset is one where the sum total of GHG emissions and removals over an asset's life cycle (Modules A0-A5, B1-B5 and C1-C4) are minimized, which meets local carbon targets or limits (e.g kgCO2e/m2), and with additional 'offsets', equals zero.
NET ZERO UPFRONT CARBON	A 'Net Zero Upfront Carbon' asset is one where the sum total of GHG emissions, excluding 'biogenic carbon', from Modules A0-A5 is minimized, which meets local carbon targets or limits (e.g kgCO2e/m2), and with additional 'offsets', equals zero.
NET ZERO CAPITAL CARBON - INFRASTRUCTURE	A 'Net Zero Capital Carbon' infrastructure asset is one where the sum total of GHG emissions, as aligned with the scope of Capital Expenditure (or Capex) as determined by the asset owner's preference but always including Module A and C, is minimized, meets local carbon targets or limits (e.g. kgCO2e/m2), and with additional 'offsets', equals zero.
NET ZERO OPERATIONAL CARBON – ENERGY	A 'Net Zero Operational Carbon – Energy' asset is one where no fossil fuels are used, all energy use (Module B6) has been minimized, meets the local energy use target or limit (e.g. kWh/m2/a) and all energy use is generated on- or off- site using renewables that demonstrate additionality. Direct emissions from renewables and any upstream emissions are 'offset'[2].
NET ZERO OPERATIONAL CARBON - INFRASTRUCTURE	A 'Net Zero Operational Carbon' infrastructure asset is one where the sum total of GHG emissions, as aligned with the scope of Operational Expenditure (or Opex) as determined by the asset owner's preference, has been minimised and meets local carbon, energy and water targets or limits, and where no fossil fuels have been used for operational energy use (Module B6), and which, with additional 'offsets', equals zero.

1 To meet the requirements of 'Net Zero (whole life) Carbon' the definitions for 'Net Zero Upfront Carbon', Net Zero Embodied Carbon', 'Net Zero Capital Carbon', Net Zero Operational Carbon – Energy', 'Net Zero Operational Carbon – Infrastructure', 'Net Zero In-Use Carbon Asset' and 'Net Zero Operational Carbon – Water' must also be individually met as applicable.

2 Note: Direct emissions must include CH4 and N2O emissions from the combustion of biomass and biodiesel fuels. Upstream emissions include: direct and indirect emissions from energy generation and distribution, WTT emissions for energy consumed in the building and from energy generation and distribution.

1.2 Project Context

Development of the Theatre

Royal & Derngate is a complex of buildings comprised of the Theatre Royal, the Derngate Theatre and the Northampton Filmhouse.

The Grade II listed Royal Theatre (1884) was designed by renowned theatre architect CJ Phipps as a 580-seat theatre and opera house (now seating 450), with associated production facilities such as a purpose-built paint frame, still in use. It was listed at Grade II in 1976. The Derngate, designed by RHWL and opened in 1983, is a 1500 capacity multi-purpose space that can be configured in a variety of formats including touring theatre and opera, live music, dance, fashion and sports.
The complex now also includes two independent cinema screens, built in 2013 and 2017 to the south-east of the Derngate.

The two theatres operated independently until 1999, when a formal merger created the Northampton Theatres Trust, which continues to operate the site today. In 2005, a £14.5m redevelopment project was undertaken to link the two theatres into a single complex. Funding for the project, included £1.6m from the Heritage Lottery Fund, £2.6m from the East Midlands Development Agency and Northampton Partnership, and almost £1m from partnership funding by the theatres' development team.

The works included the creation of a new shared entrance and foyer, and the creation of a rehearsal space in an adjacent former warehouse building. The two theatres were also comprehensively refurbished, including new seating and air conditioning systems, upgrade of other building systems, and general fabric repair and removal of asbestos. A creativity centre for education and community work was also added, together with better changing rooms for actors.
The complex reopened as the Royal & Derngate in October 2006.

Royal and Derngate Today

Royal & Derngate is the main venue for arts and entertainment in Northamptonshire, with three auditoria and two cinema screens in a complex of connected buildings in the heart of the town's cultural quarter.

The Royal auditorium presents work predominantly created within the on-site workshop and wardrobe spaces, earning a reputation as one of the major regional producing theatres in the country. Within the Derngate theatre, a diverse range of visiting productions are staged, regularly welcoming more than 250,000 people per year.

In addition, a nationally recognised Creative Engagement programme engages with schools, families, and communities in Northamptonshire and beyond, while the artistic development programme regularly supports hundreds of regional artists each year.

In 2025, Royal & Derngate welcomed 280,123 audience members in Northampton and a further 42,642 to touring 'Made In Northampton' productions across the country. It was also named the UK's Most Welcoming Theatre at the UK Theatre Awards 2025.

The R&D's recent annual report demonstrated strong progress against key strategic priorities, including increased in economic impact to the town and significant achievements against Theatre Green book sustainability standards, as well as tangible impacts on diversity and inclusion.

Despite these successes, Royal & Derngate faces ongoing challenges with regards to its buildings and infrastructure.

The Theatre has a long list of outstanding external repair works, which present continual challenges in keeping out the elements and maintaining a comfortable internal temperature.

Repair works in recent years have included:

- Additional structural support to an area of RAAC roof (2023)
- Repair to the Royal fire curtain safety hoist (2024)
- Repair to the Royal plaster ceiling (2024)

West Northamptonshire Council is responsible for repair of the building's external fabric and structure, which can lead to delays to repair works being carried out. Several areas of roof are difficult to maintain due to access issues, which means defects are difficult to address.

The Royal & Derngate also experience issues with accessibility and internal wayfinding.

Future Plans

The Board recently commissioned a comprehensive strategic review to examine the financial resilience and long-term sustainability of the organisation:

'Over the next five years, we will take decisive steps to ensure our theatre is fit for the future—both structurally and culturally. Success will be defined by a revitalised space, a stronger connection to our community, a renewed confidence in our work, and a sustainable model that ensures our continued impact and growth.

We will transform our theatre into a modern, inspiring, and welcoming space. We will invest significantly in our building, making it not just structurally sound but environmentally and financially sustainable. Contemporary, state-of-the-art facilities will celebrate our history of theatre-making while allowing us to compete with the best theatres around.'

Royal & Derngate have commenced initial consultations on physical organisation and usage improvements, focussing on enhancing audience welcome and foyer experience.

1.2 Project Context

1.2.3 Decarbonisation Aims and Objectives

The Decarbonisation Plan provides an opportunity to establish principles and priority areas for decarbonisation measures that could be included within the brief for any future redevelopment project.

Royal & Derngate have taken steps to improve the sustainability of theatre productions and touring in line with Julie's Bicycle and Theatre Green Book recommendations, however the sustainability of building infrastructure and operations is lagging behind. Their aim is to improve the building's efficiency to both reduce its carbon impact and to reduce running costs.

The key aims of this Decarbonisation study are as follows:

1. To establish the Royal & Derngate's baseline operational energy and carbon performance.
2. To compare this performance against industry benchmarks and standards.
3. To propose suitable targets for enhanced performance, taking into account local planning and listed building requirements.
4. To appraise options available in order to achieve these targets including energy use reductions and low/zero carbon technologies (LZCs).
5. Make recommendations to address historic underinvestment in infrastructure and building fabric.
6. To assist in generating appetite for support, demonstrating where investment will be best positioned from a Decarbonisation perspective.
7. To agree a coherent strategic plan for implementation, both within and beyond the capital project.

The scope of the Decarbonisation Plan has however been limited by:

- the available funds from the commissioning bodies (Historic England and Arts Council)
- the complexity of the building(s), which have developed over several phases and include a variety of construction techniques, fabric performance and services systems
- the availability of metered energy data, and lack of clarity about what parts of the building it relates to.

In response, the team has considered the building complex as a whole where possible, while focussing on the listed elements of the Royal auditorium within the site survey work.

The overall site appraisal undertaken by Haworth Tompkins provides an overview of the history and development of the site as well as its current use and arrangement.

The significance appraisal focusses on the Grade II listed element of the Royal, and is informed by the 2004 Conservation Plan.

The services condition survey focusses on the Royal, while providing an overview of the shared elements of services infrastructure.

The Options appraisal includes a high-level review of site-wide opportunities.

The design development section is focussed on low and net-zero carbon technologies and their applicability to the site as a whole.

Year of construction	1884, 1887, 1983, 2006, 2013, 2017
Architect	CJ Phipps, RHWL,
Listing status	II (Royal Theatre)
Year of listing	1976
Primary function	Theatre and entertainment complex
Other uses	3 Auditoria 2 Cinemas Workshops, Paintframe, Props Rehearsal space Dressing rooms Cafe/Bar/ Restaurant Foyer
Location	Northampton
GIA	
Significant later construction works / alterations	1884 - Construction of Theatre Royal 1887 - Reconstruction of stage house 1983 - Construction of Derngate Theatre 2006 - New linking foyer added to join the two theatres, and refurbishment of Royal Theatre spaces. Construction of backstage facilities (workshop, get in) 2013 - Construction of cinema 1 2017 - Construction of cinema 2 2023 - Remedial works to RAAC roof 2024 - Repair to the Royal fire curtain safety hoist and Royal plaster ceiling
Neighbouring buildings	Whole complex occupies a corner plot Hotel building (under development) adjacent to northeast side Staff car park to rear adjacent to pub

BACKGROUND INFORMATION

2.1 The Building & Site

2.1.1 Site Location

Location, exposure & vulnerability

The Royal & Derngate complex is located within the city centre of Northampton, and forms a key part of the City's Cultural Quarter, which encompasses the Northampton Museum, a historic house (78 Derngate), an art gallery (NN Contemporary Art) and a cinema, (Errol Flynn Film house).

The complex occupies a corner plot bounded by roads to three sides and by low rise buildings housing a pub and a disused boutique hotel, to the North.

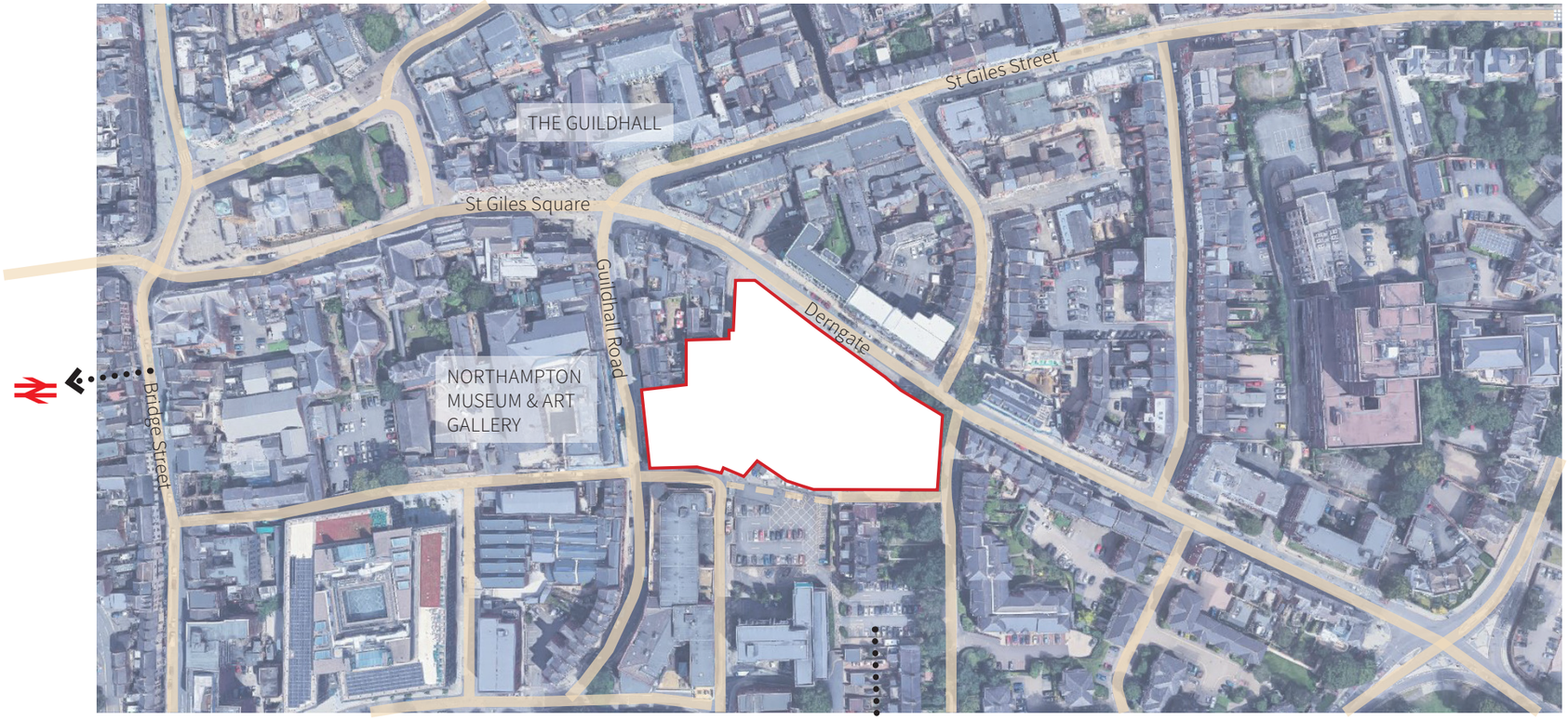


Image source: Google Earth

2.1 The Building & Site

2.1.2 Site Conditions & Constraints

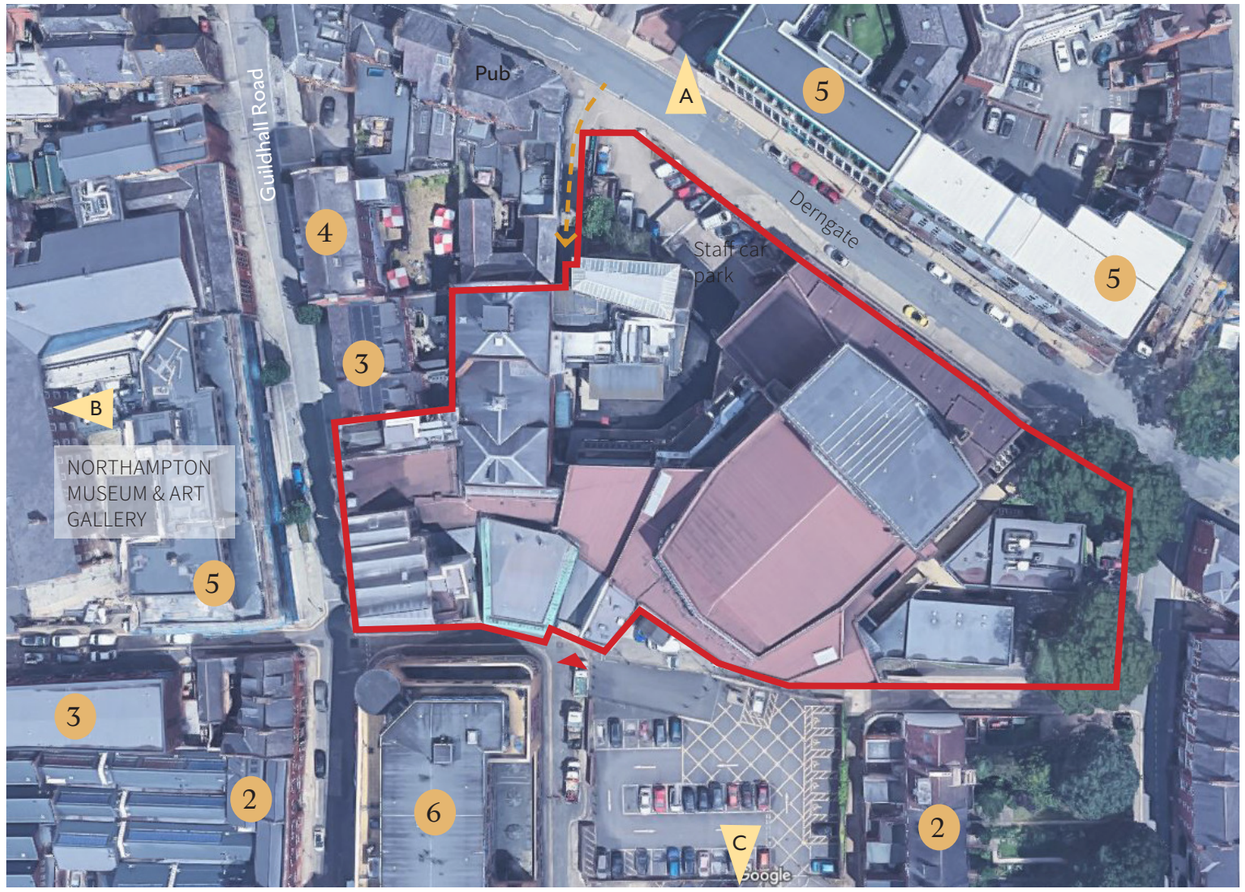


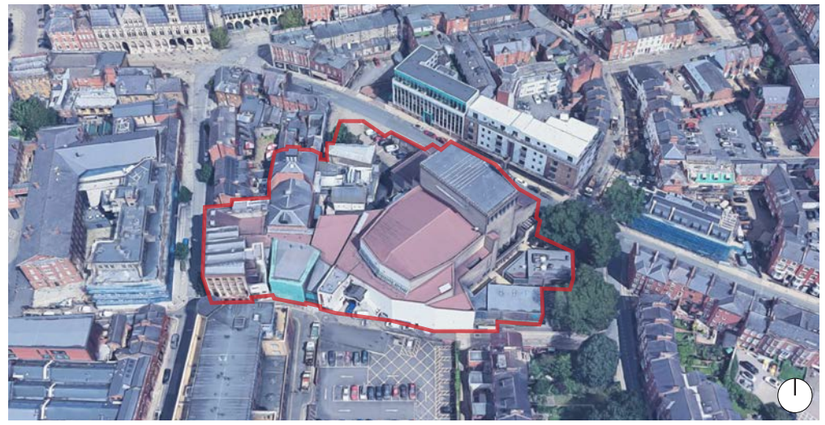
Image source: Google Earth



A



B



C

KEY

- Site boundary
- Entrances
- 3d View
- Number of storeys

2.1 The Building & Site

2.1.3 The Building

The Royal and Derngate is a complex of connected buildings of varying age, scale and character. The site can be divided into six distinct zones:

1. The Royal Theatre (1884)
- Auditorium
- Stagehouse (rebuilt 1887)
- Foyer and ‘Green Room’ event space
- Paint-shop

2. Production facilities:
- Workshop
- Dressing room block (Hector’s House)

3. Admin and Rehearsal building:
- Administrative offices
- Triple-height rehearsal space
- Lola’s restaurant

4. The Derngate Theatre:
- Auditorium
- Underground’ Studio Theatre
- Dressing rooms
- Main plant rooms

5. Main foyers:
- Main entrance
- Shared foyer spaces
- Bars
- Public WCs

6. Filmhouse
- 2 x cinema screens

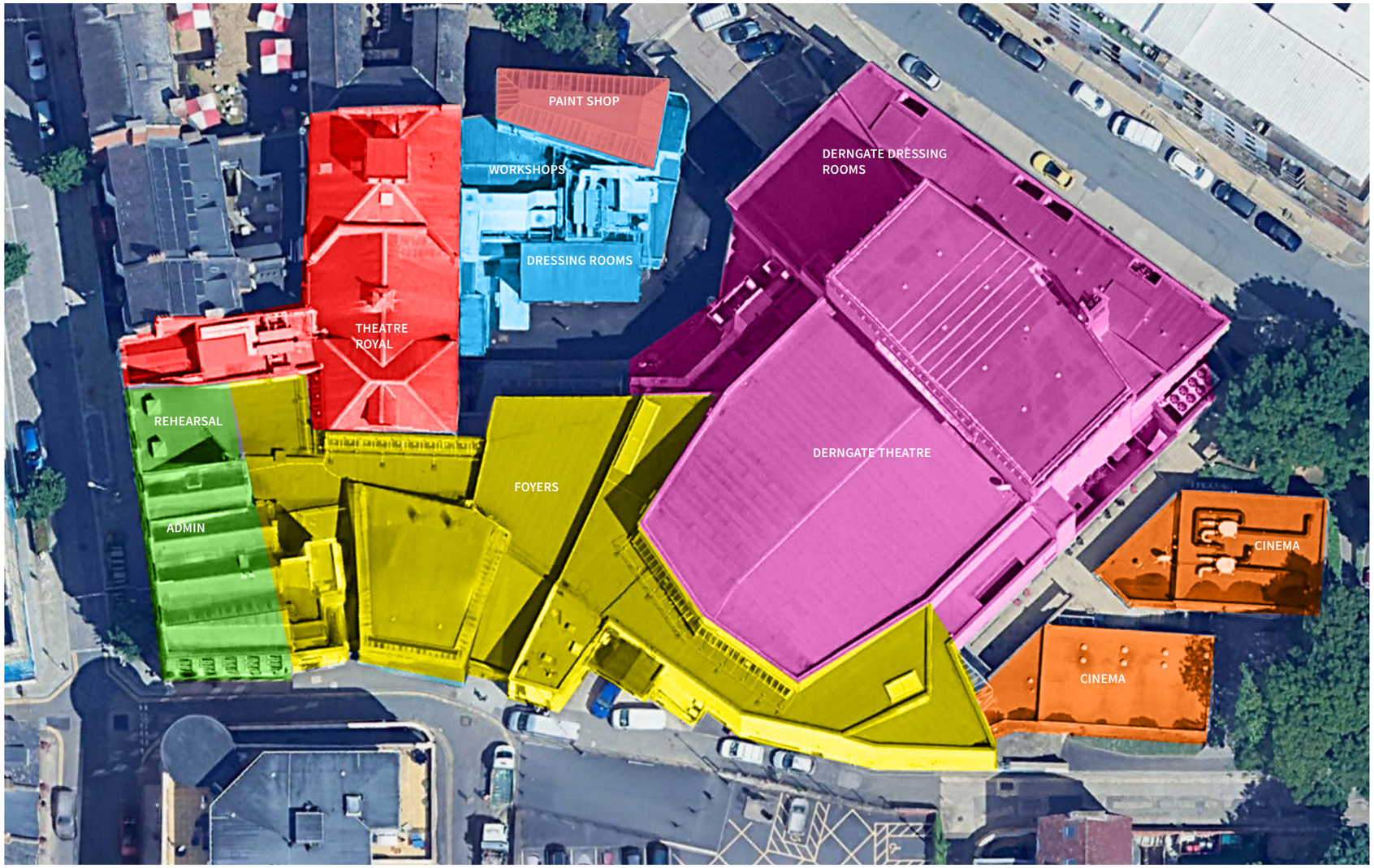


Image source: Google Earth

Building Zones - KEY:

- Theatre Royal and Paint-shop
- Production facilities
- Admin and rehearsal building
- Derngate Auditorium and dressing rooms
- Main foyers
- Cinemas

2.1 The Building & Site

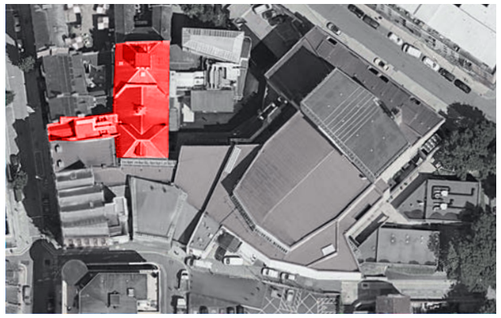
2.1.4 The Royal Theatre

The Royal Theatre was the first building of what now exists as the Royal & Derngate complex. The Royal, then called the Theatre Royal and Opera House, was built for John Franklin by Henry Martin and designed by prolific Victorian theatre architect Charles J. Phipps with mural artist Henry Bird. Since 1976, The Royal has been designated a Grade II listed building.

In 1887, a significant fire gutted the stagehouse and destroyed the backstage facilities. The auditorium survived with only minor damage, and remains substantially with its late nineteenth century form and detailing. The Conservation Plan, prepared in 2004 prior to the 2006 refurbishment, notes that:

> 'The auditorium, with its two horseshoe shaped balcony fronts supported on two main cast iron columns creates a volume of striking intimacy. The dress circle tier is terminated at each end by a public box, set between fluted Corinthian columns. The entablature immediately above supports a deep elliptical arch, which is highly reminiscent of an eighteenth century playhouse with forestage.'

The primary elevation on Guildhall Road is built in Ancaster limestone, in contrast to the exposed brick of the stagehouse. The Guildhall Road elevation features three recessed doorways at ground level defined by pilasters, with three rectangular windows at first floor and a pedimented attic with lunette window above. This facade and the foyer spaces within have lost their primary function since the relocation of the entrance into the new shared foyer spaces created in 2006.





The original frontage to the Royal on Guildhall Street, 2024





The Royal Auditorium
Image source: Photographs by Mike O'Dwyer courtesy of Lit & Phil

2.1 The Building & Site

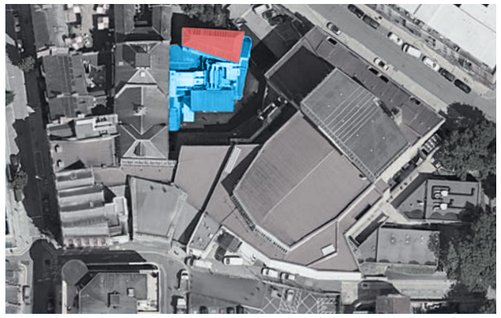
2.1.5 Production Facilities

The Royal is supported by production facilities including workshops, prop facilities and a paintframe. The paint-shop is a rare and important example of its kind, and is thought to date from the reconstruction of the stagehouse in 1887, although an earlier paint shop is understood to have existed on site.

The paint-shop occupies a wedge-shaped plot of land to the north-east of the stagehouse, and is connected to the theatre by corridors at basement and ground levels. The upper volume is a double-height space with exposed brick walls, now cement rendered externally, and a single-glazed roof over a timber structure. The space is uninsulated and difficult to maintain at a comfortable temperature.

The paint-shop abuts a modern workshop building and dressing room block known as Hector's House. Between Hector's House and the stagehouse is a single-storey volume containing the main get-in area, with a small dock door that compromises scenic access whilst also causing significant heat loss during load in.

The roof areas of these buildings now include large areas of ductwork and plant serving the Royal, with connections back to the Derngate services infrastructure.





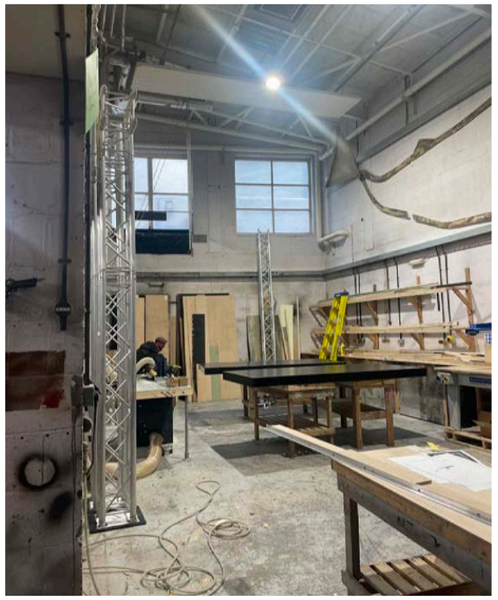
The paint-shop



Dressing room block



Get-in to rear of stagehouse



Workshop

2.1 The Building & Site

2.1.6 Admin and Rehearsal Building

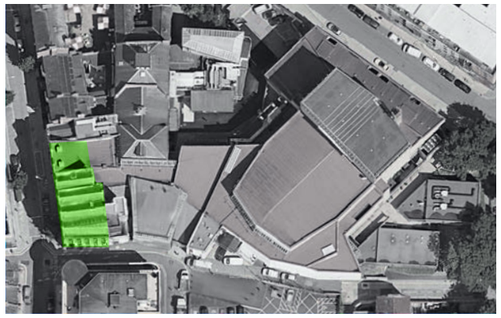
The oldest element of the site, known as the ‘Admin Block’, dates from 1876, and was subsequently extended in 1902. It is adjacent to the original Theatre Royal entrance and occupies a corner plot on Guildhall Road and Angel Road.

Originally built as warehouses, the 5-storey brick buildings are thought to be steel-framed, with solid masonry external walls. The 1876 building features pitched slate roof, while the later extension housing the rehearsal room features a flat roof, coverings unknown. Both areas feature a gabled parapet profile and arched lintels with consistent brick detailing in red and gault brick, giving the façades a unified appearance.

The building now accommodates a triple height rehearsal room created in 2006; administrative offices for the Theatre; and a successful restaurant (Lola’s) at ground floor.

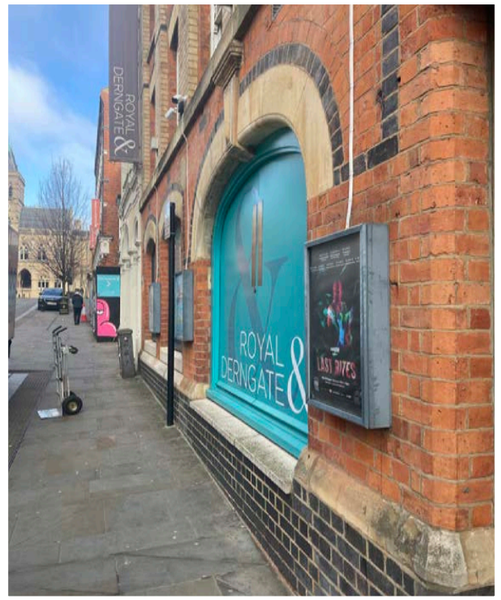
The restaurant is accessed from Guildhall Road, and has a split-level arrangement due to the topography of the streetscape. It can also be accessed from within the foyers.

The Royal & Derngate is currently considering opportunities to create a new entrance to the Theatre on Guildhall Street to help re-activate this important part of the cultural quarter.

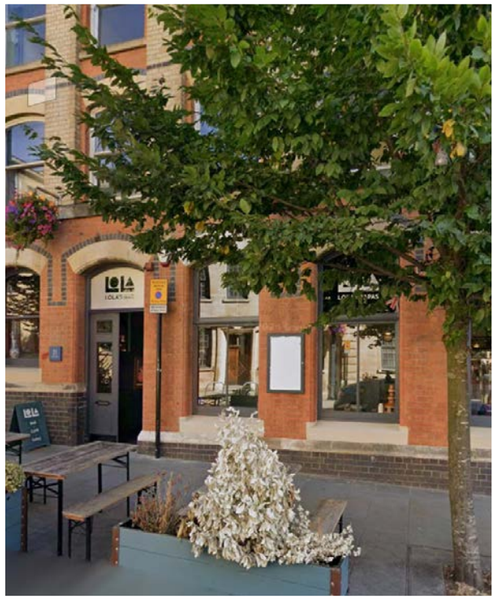




View to the admin and rehearsal building



Location of potential new entrance



Lola’s restaurant, Guildhall Street frontage



Lola’s restaurant, Angel Street frontage

2.1 The Building & Site

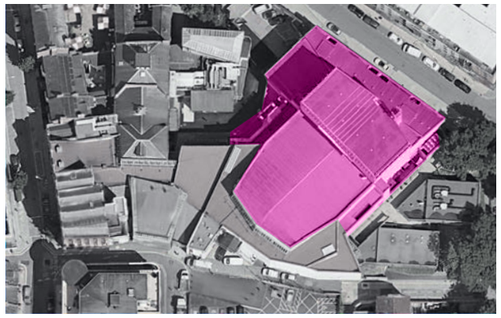
2.1.7 Derngate Theatre

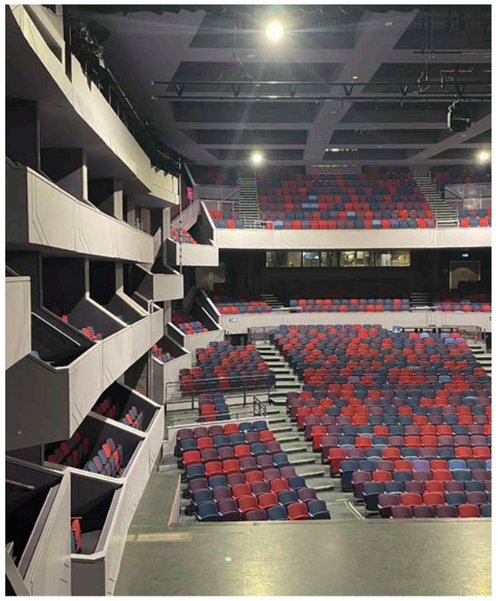
The Derngate was opened in 1983. Initiated by Northampton Borough Council, the venue was designed by RHWL as a highly adaptable receiving house for multi-purpose use. It is regularly re-configured to stage a range of touring performances and events including classical concerts, musicals, opera, dance and ‘in the round’ events such as snooker tournaments.

The auditorium employs an innovative system of air castors, which are used to lift and move large sections of staging and seating blocks, enabling rapid turnaround between formats. The stagehouse also features a double-height substage area with a large stage lift.

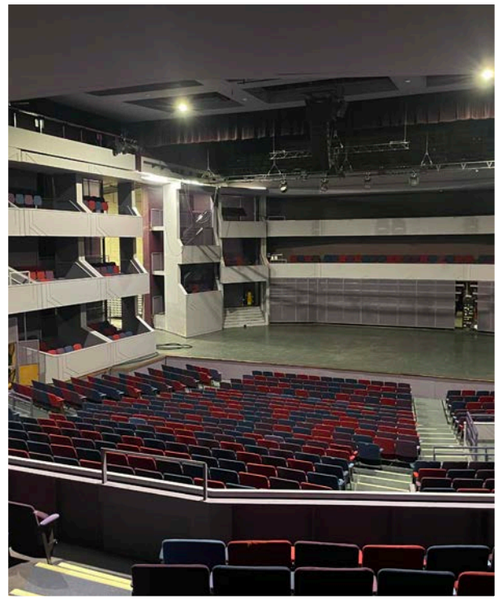
The compressed air system used within the Derngate is also used to drive the Royal Theatre smoke vents. However this offers a poor level of user control and the vents are slow to close and leaky, causing significant heat loss and thermal discomfort in winter.

To the rear of the auditorium facing Derngate (road) are a series of rehearsal rooms and other back of house service and support spaces. This three-storey brick elevation features a deep band of solid brickwork above a staggered facade featuring projecting dressing room windows at first floor facing north and east.

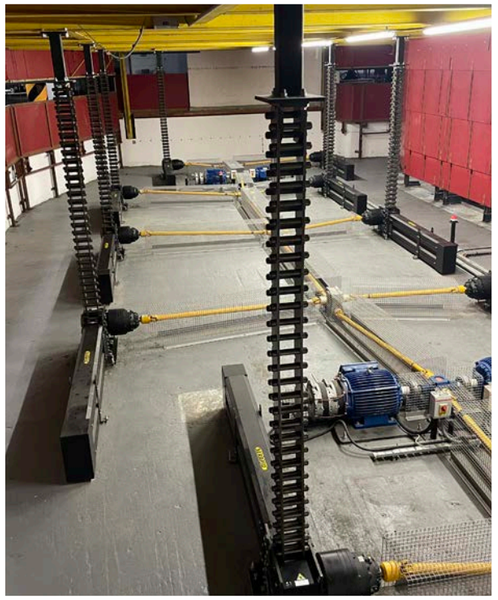




Derngate auditorium



Derngate auditorium towards stage



Derngate sub-stage



Derngate facade / view to dressing rooms

2.1 The Building & Site

2.1.8 Foyers

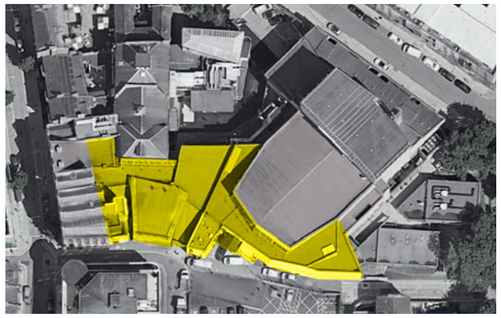
In 2006, a £14.5m refurbishment project was undertaken to create a new enlarged foyer space to serve and link the Royal and Derngate Theatres. The works retained the roof structure and columns of the original 1984 Derngate foyers, with new additions to the south and east, including a new copper-clad facade and glazed entrance on Angel Street.

The triple-height foyers, in which the original brick facade of the Royal Theatre is revealed, feature a series of overlapping walkways connecting the various levels of the two theatres. The original 1980s roof structure is now re-inforced with exposed painted timber beams, recently introduced to support the RAAC structural planks.

The foyers also provide access to a studio theatre, known as 'Underground', recently refurbished and expanded.

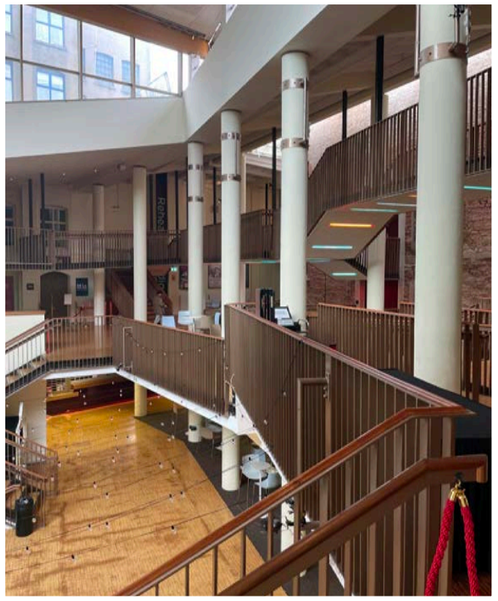
The external envelope of the foyers is generally poorly insulated, and the curtain walling is leaky with significant heat loss and condensation issues.

The foyers are not currently open to visitors outside of performance times, although the box office is operational and the space is heated an lit throughout the day. There are opportunities to intensify the use of the space as an all-day public foyer in order to improve efficiencies of use and income generation.

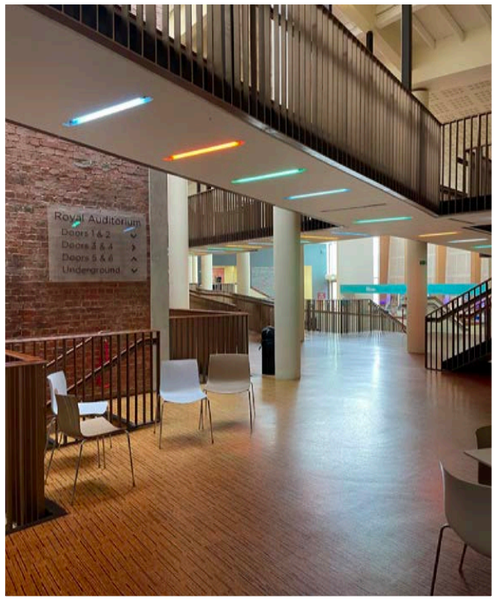




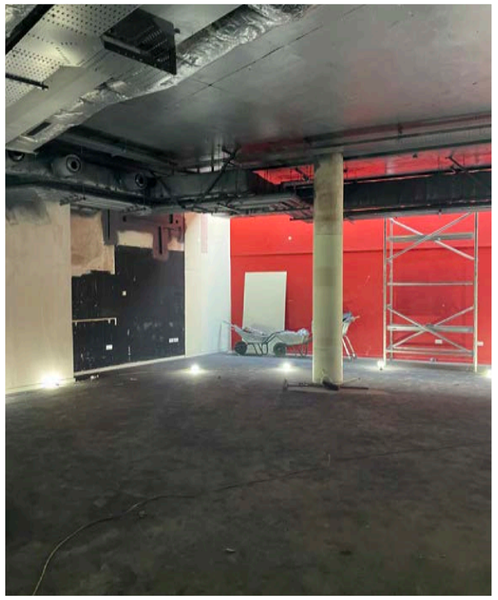
Derngate Foyer demise prior to 2006 works



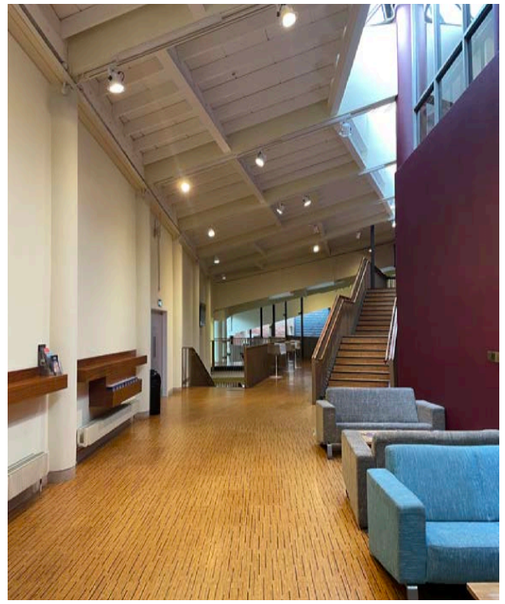
Royal & Derngate Foyers



Royal & Derngate Foyers



Underground studio (under refurbishment)



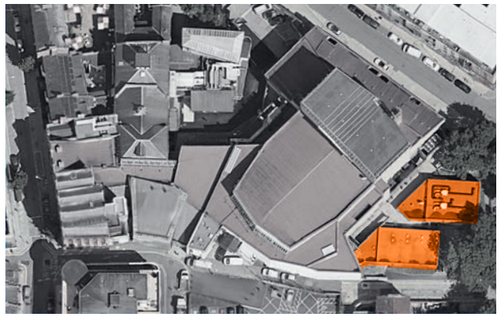
RAAC concrete roof, with secondary timber support in foyer area

2.1 The Building & Site

2.1.9 Northampton Filmhouse

The Royal & Derngate complex now includes two independent cinema screens, delivered in two phases in 2013 and 2017. The first building is a 88-seat cinema, built using off-site construction techniques with a steel frame and western red cedar cladding.

The second building is a 83-seat cinema of similar construction, set within a new raised terrace with outdoor seating. Both screens are accessed from outside the Theatre, but have limited facilities (WCs etc.) of their own.





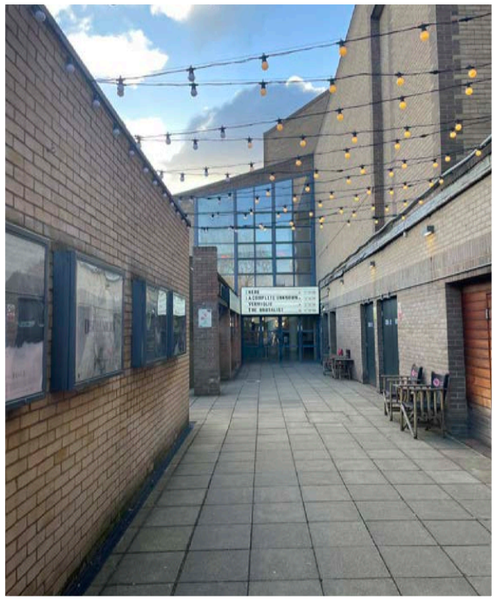




Image source: Errol Flynn Filmhouse

2.2 Heritage Significance

2.2.1 Heritage Designations

The Royal and Derngate is situated within the Derngate Conservation Area, which forms part of the historic core of Northampton town centre. The 9.5 ha Conservation Area includes a diverse range of uses including retail, professional, leisure and residential; as well as the town's cultural quarter.

While the Royal and Derngate theatres are now physically and functionally linked, only the Royal appears to be designated as a Grade II listed building.

Official list entry:

- Heritage Category: Listed Building
- Grade: II
- List Entry Number: 1039681
- Date first listed: 22-Jan-1976
- List Entry Name: Theatre Royal
- Statutory Address: Theatre Royal, Guildhall Road

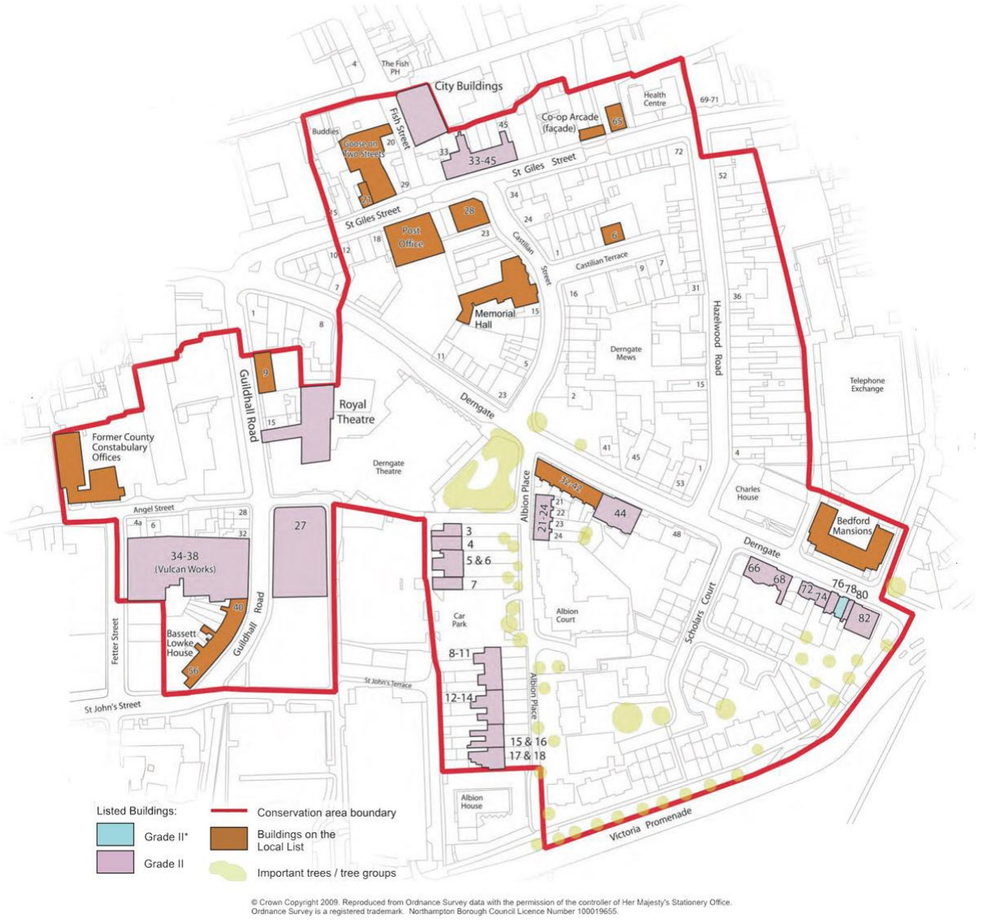
Location:

- Statutory Address: Theatre Royal, Guildhall Road
- District: West Northamptonshire (Unitary Authority)
- Parish: Northampton
- National Grid Reference: SP 75632 60377
- Details: 1. GUILDHALL ROAD 5327 Theatre Royal SP 7560 SE 4/100 II 2.

List description:

1884 by C J Phipps. Known until 1927 as the Opera House. Stucco front. Listed mainly for interior which has original decoration to the auditorium. Applied ornament round proscenium arch. Tall fluted columns to boxes. Scroll acanthus leaf motif on front panels of dress circle parapet. Raised decoration on bombe upper circle parapet. Large shallow decorated ceiling dome with pierced centre. VCH, III, p 40.

Listing NGR: SP7563260377



Derngate Conservation Area Map

2.2 Heritage Significance

2.2.2 Building Significance - Theatre Royal

As a collective term for the sum of all the heritage values attached to a place, Significance can be understood through a series of inter-related themes. For further information on the assessment of heritage values, please refer to the following Historic England document 'Conservation Principles, Policies and Guidance', 2008.

The following section provides a summary of the overall Significance of the Theatre Royal Northampton. The Theatre Royal, Northampton, is a landmark of exceptional cultural, architectural, and historical importance. As one of the country's most celebrated performance venues, it embodies a rich heritage spanning centuries and continues to serve as a focal point for artistic excellence. Its significance can be assessed through the following values:

Evidential Value

The potential of a place to yield evidence about past human activity, or the potential for new knowledge about the fabric or history of the asset.

The Royal Theatre & Opera House stands as a physical record of the evolution of theatre architecture and construction. The current building, completed in 1858 after its predecessors were lost to fire, reflects the advancements of Victorian engineering and design. The use of iron girders in the structure and the early application of Desachy's patent fibrous plaster system were pioneering developments of their time. The theatre's neoclassical façade, with its Corinthian portico and intricate sculptural details, offers insight into mid-19th-century architectural craftsmanship. Extensive renovations in the late 20th and early 21st centuries have further added layers of evidential value, showcasing how historic buildings can be sensitively adapted for modern use while retaining their heritage integrity.

Historical Value

The ways in which past people, events and aspects of life can be connected through a place to the present; or the way in which a place supports a narrative of the past. This tends to be illustrative or associative.

Since its opening in 1884, the Theatre Royal, Northampton, has played a pivotal role in the cultural life of the region. Designed by renowned architect C.J. Phipps, it is part of a legacy of theatres that shaped the Victorian era's entertainment industry. Over the decades, it has hosted performances by some of the most influential playwrights, actors, and directors, contributing to its reputation as a cornerstone of British theatre. Its historical significance is further reinforced by its role in the evolution of regional theatre, adapting to changing artistic trends and audience expectations while maintaining its original purpose as a venue for live performance.

Aesthetic Value

The ways in which people draw sensory and intellectual stimulation from a place, and how they engage with it emotionally.

The Theatre Royal, Northampton, is widely admired for its architectural beauty and artistic embellishments. The auditorium, with its elegant proportions, decorative tier fronts, and richly detailed ceiling, is a fine example of Victorian theatre design. The ornate plasterwork, grand proscenium arch, and traditional red-and-gold colour scheme contribute to the sense of opulence that defines the theatre experience. Sensitive restorations have preserved these historic features while introducing subtle modern improvements that enhance functionality without compromising the building's aesthetic integrity. These elements together create an environment that is not only visually striking but also enhances the immersive experience of performance.

Communal Value

The meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory, as well as how the place brings people together as a community.

Beyond its architectural and artistic achievements, the Theatre Royal, Northampton, holds profound communal value. It is a cultural institution that connects audiences with world-class theatre, attracting visitors from across the region and beyond. The theatre serves as a gathering place for artistic appreciation, fostering a sense of shared cultural heritage. Through educational initiatives, outreach programs, and community engagement efforts, it provides access to the performing arts for a diverse audience, ensuring its continued relevance in contemporary society. Its role in nurturing local talent and supporting touring productions has made it a vital part of the UK's theatre ecosystem.

As a place of memory, inspiration, and artistic expression, the Theatre Royal, Northampton, remains an essential part of the national cultural landscape. Its enduring significance is found not only in its historical and architectural grandeur but also in its continued role as a beacon for creativity, education, and community engagement.

Summary

The Theatre Royal, Northampton, is a significant cultural landmark valued for its historic architectural innovations, long-standing role in British theatre, striking Victorian design, and enduring importance as a vibrant community gathering place for performance and creative engagement.

It now forms part of a complex of buildings offering a range of cultural and educational activities.

2.2 Heritage Significance

2.1.3 Hierarchy of Significance

Key

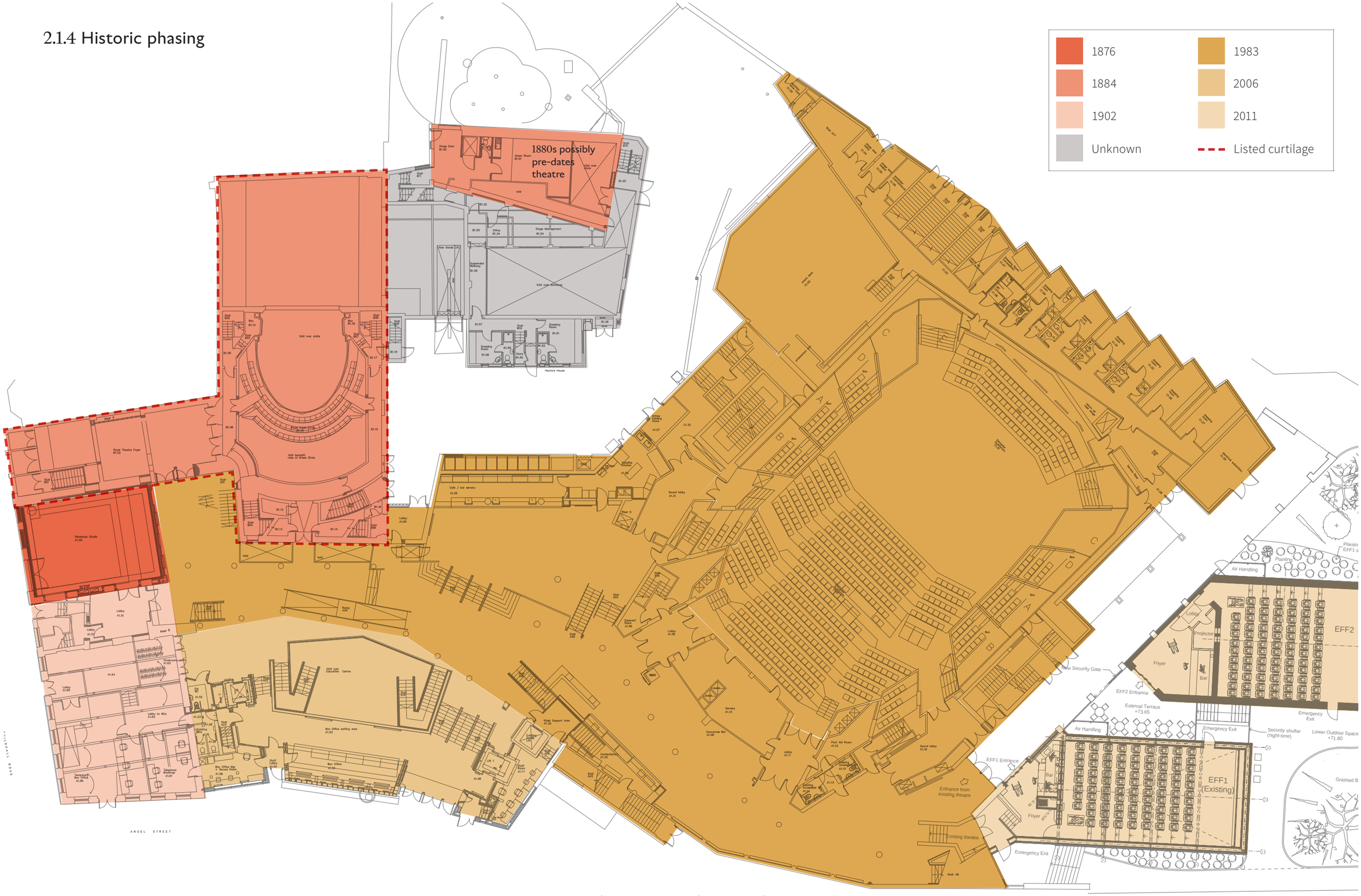
- Exceptionally Significant
- Highly Significant
- Significant
- Neutral
- Detrimental



Ground Floor Plan

2.2 Heritage Significance

2.1.4 Historic phasing



2.4 Occupancy & Management

2.4.1 Use, Occupancy & Management

The Royal & Derngate is one of the major producing venues in the country and is managed and run by a large team of staff, overseen by a Board of Trustees.

Key personnel include:
- Chief Executive
- Deputy CEO
- Artistic Director
- Operations & Commercial Director
- Stage Tech
- Technical & Maintenance Manager
- Maintenance Technician

The Royal Theatre typically hosts small-scale comedy, live music, and community-focused events. Whilst it has a nominal capacity of 583 seats, its practical capacity is 460 given the nature of the seating on the gallery benches. It is a 'producing' house, staging at least six 'in-house' productions each year, and is supported by workshop and wardrobe department, located across the road.

In contrast, The Derngate has a maximum capacity of 1,500 for classical concerts, with 1200 seats for 'lyric' performances and has been run as a touring theatre, regularly welcoming some of the biggest names and shows on the circuit. It was designed for multi-purpose use and can be configured to stage a variety of events including classical concerts, musicals, opera, dance, 'in the round' events such as snooker tournaments as well as gala dinners and product launches.

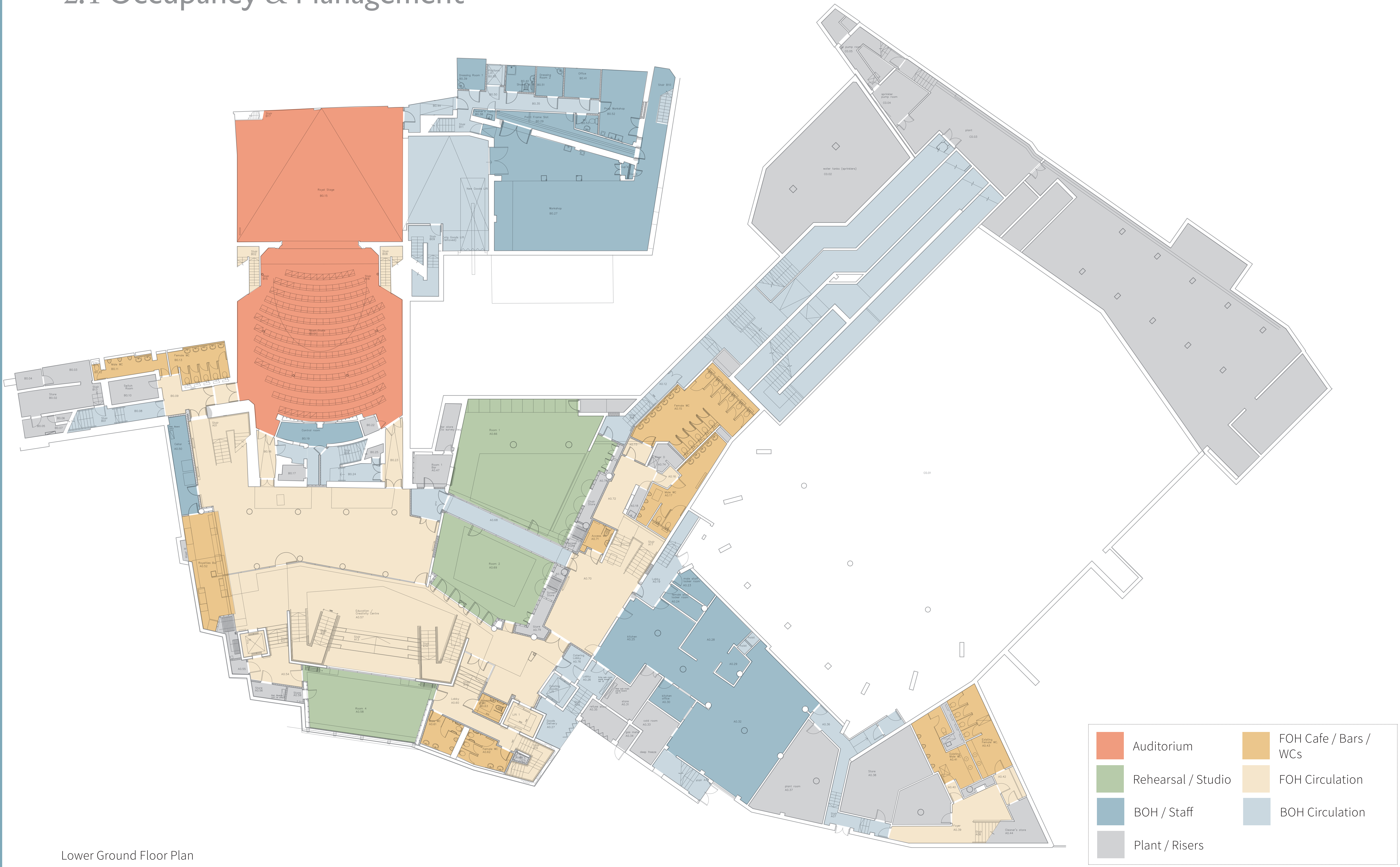
With the merger of the two organisations and the development of new production and artistic strategies, a whole new range of opportunities emerged to encourage cross-site work.



The Derngate in a range of formats.
Image source: Royal & Derngate

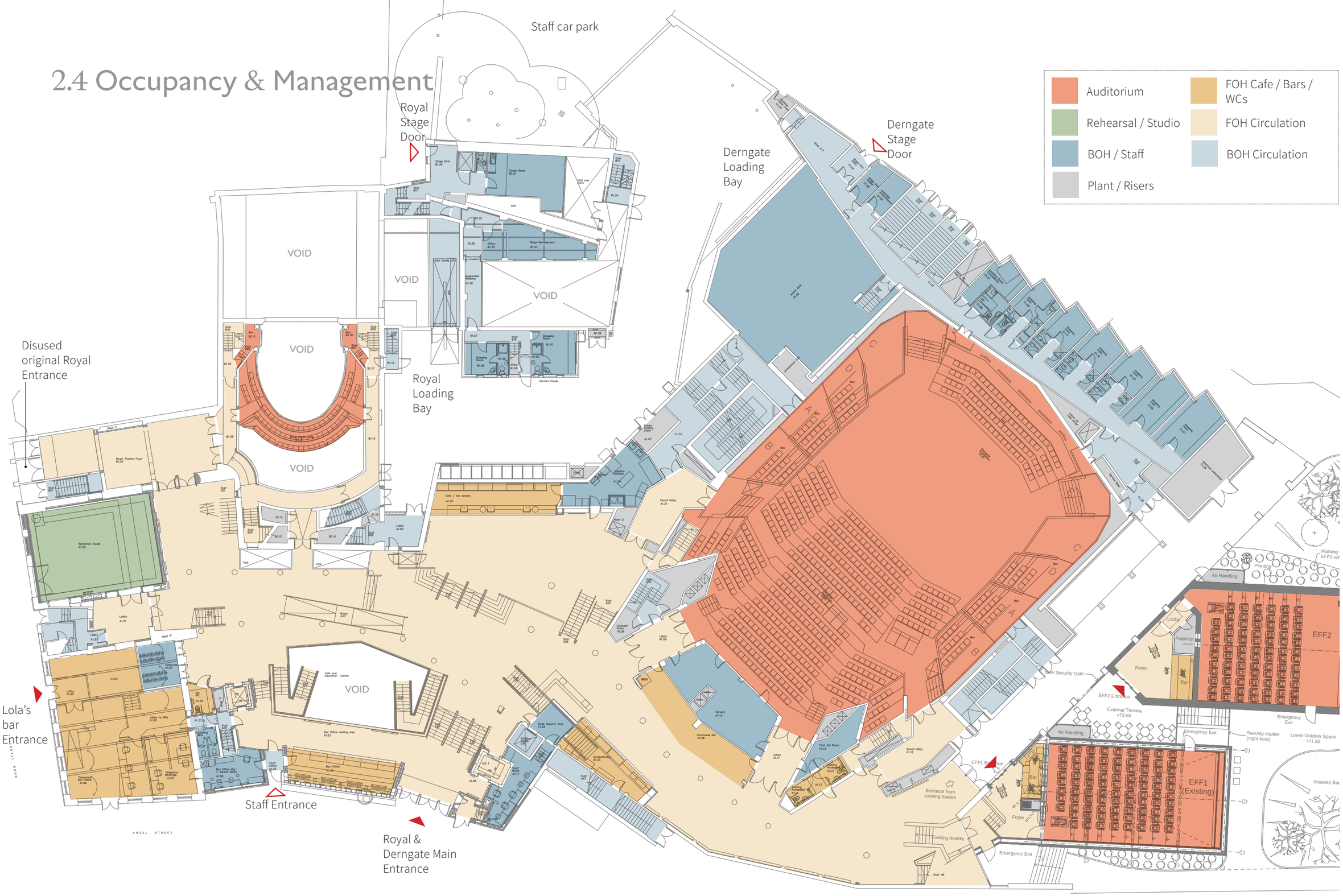
Building Ownership	Leased from West Northamptonshire Council
Management	Charitable company Overseen by Board of Trustees Large team of staff including dedicated technical and maintenance staff
Days of opening	Monday - Sunday
Typical hours of operation	Typical opening: Monday-Friday 8am-6pm Box Office opening: Tuesday–Friday 12pm-6pm / Saturday 10am-5pm
Out of hours use	Late opening to 1am during shows Twice-weekly matinee shows and week-long performances
Occupancy	Royal auditorium capacity – 450 Derngate auditorium capacity – 1500 Basement level studio – 70 Cinema - 90
Users	Diverse audiences - all ages, users generally local to Northamptonshire
Uses	Theatre and comedy productions FOH uses - bars & Lola's cafe Rehearsals Set design & production

2.4 Occupancy & Management



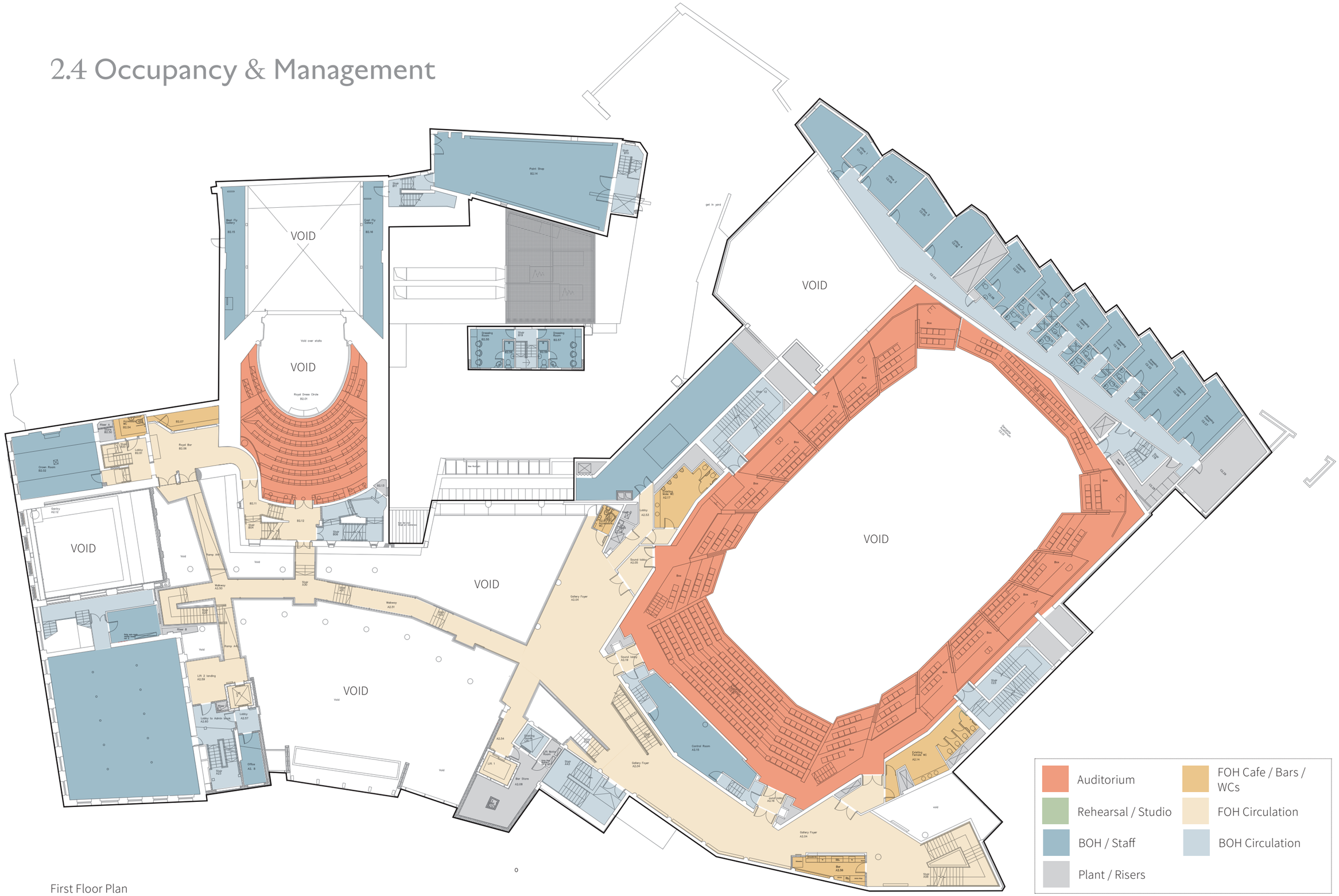
Lower Ground Floor Plan

2.4 Occupancy & Management



Ground Floor Plan

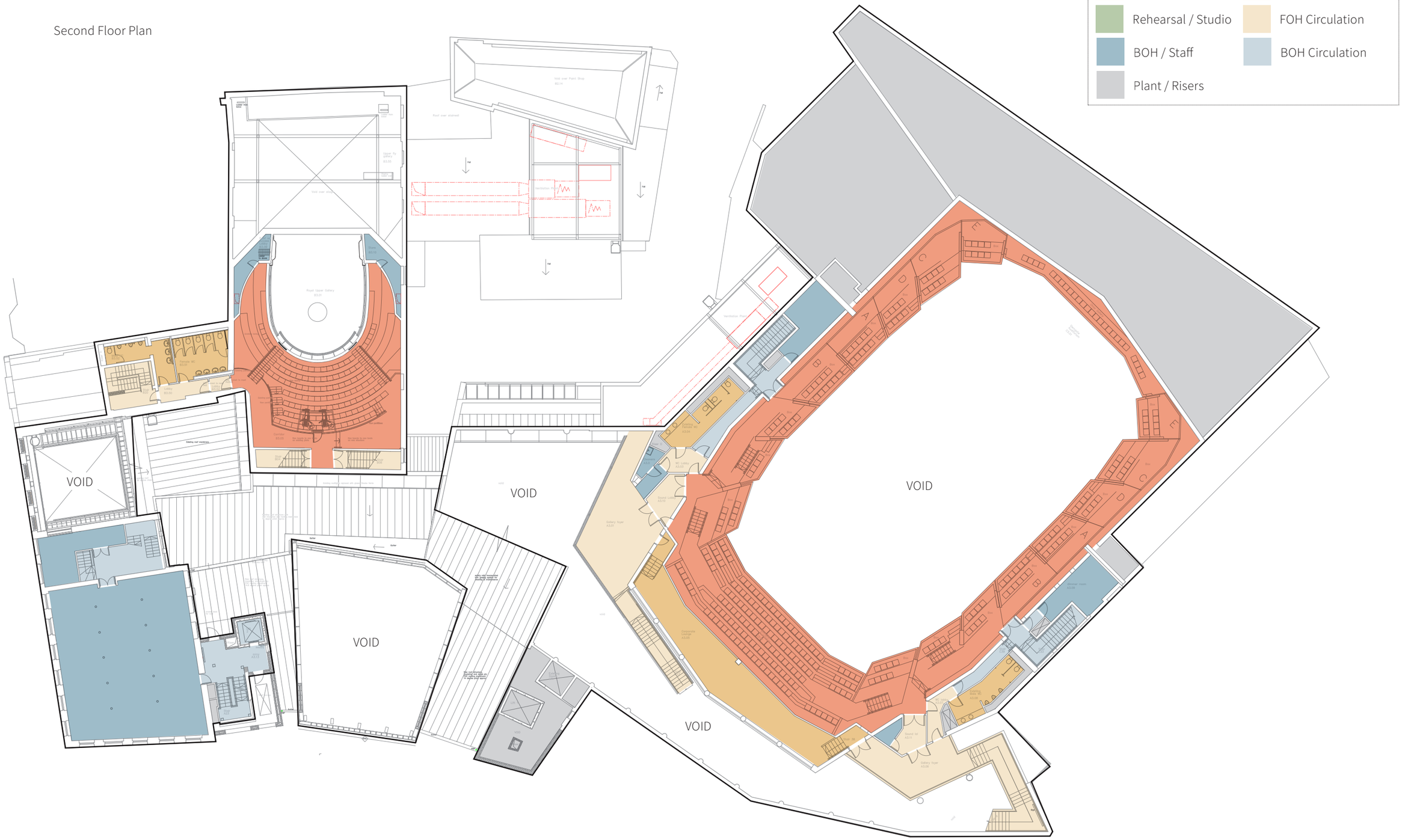
2.4 Occupancy & Management



First Floor Plan

2.4 Occupancy & Management

Second Floor Plan



2.3 Building & Services

2.3.1. Building Condition

As landlord of the theatre, under the lease the Council has responsibility for maintaining the structural integrity of the buildings. The Council also has obligations under Section 4(2) of the Health and Safety at Work etc. Act 1974 as a body with a degree of control over the premises, to ensure that the premises are safe and without risks to health.

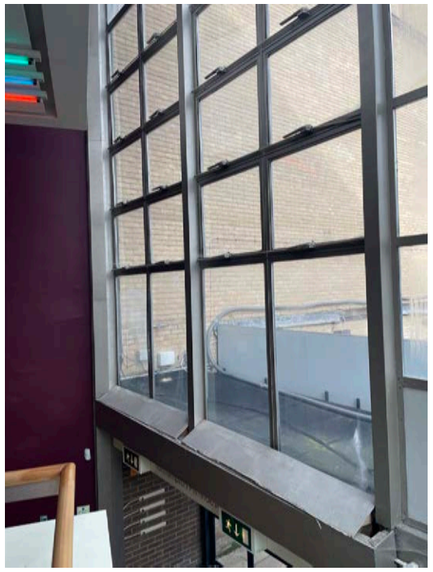
There is a long list of outstanding repair works, presenting continual challenges with keeping warm/cold/dry, and historically, there has been limited investment in upgrading backstage and technical spaces.

Recent major repair works include:

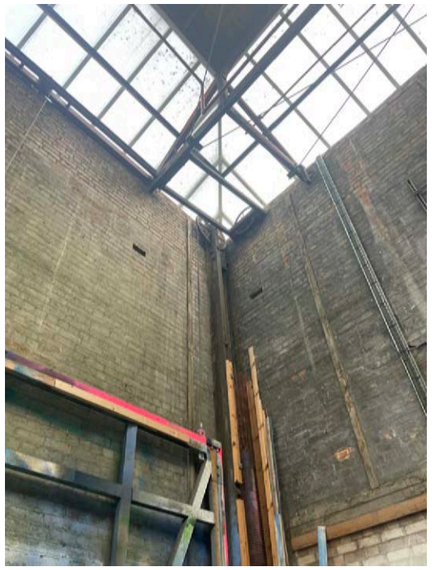
- Safety curtain hoist repair - completed 2023
- Royal plaster ceiling repair - completed 2024.
- RAAC roof reinforcement - completed 2024
- Fire door snagging and repairs - ongoing.

Key issues with the building fabric noted on site include:

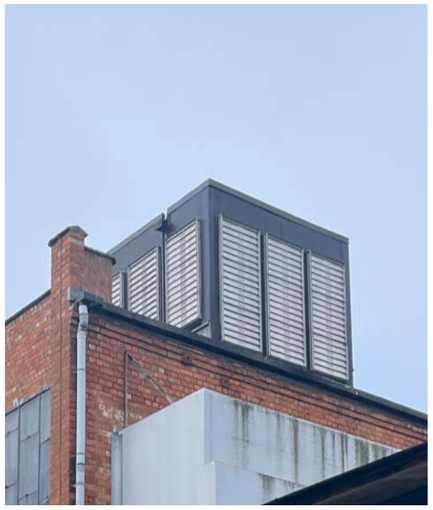
- Significant heat loss through Theatre Royal Auditorium due to draughty infrastructure - smoke vents in wing, draughts through rig area.
- Theatre Royal stage is subterranean. Perishing brickwork external walls were noted.
- Large areas of single glazed curtain walling and glazed entrance doors around main foyer are particularly draughty and letting in rainwater in certain areas.
- The paint-shop workshop areas are heated by temporary heaters, have large areas of single glazing and degraded external fabric.



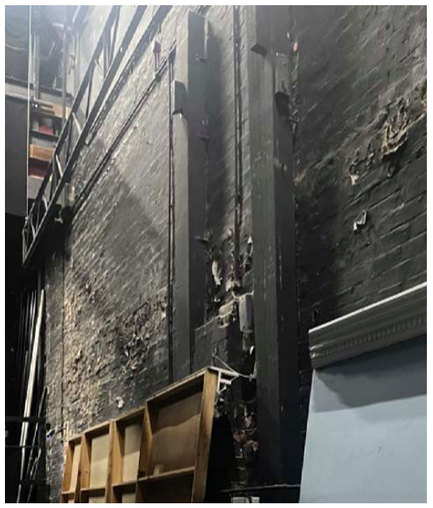
Leaky single glazed curtain walling around foyer area



Uninsulated brick walls and single glazed roof in Paintframe workshop



Royal smoke vent



Royal stage subterranean brickwork

2.3 Building & Services

2.3.2 Building Services

The Royal & Derngate complex have broadly distinct services systems, though there is some centralised control.

There are separate meters for each venue, though scope of what areas are served under each remains unclear.

The building is controlled via a BMS, however this is a bespoke system based on Windows XP. It is not capable of extension modification, which causes difficulties for plant replacement and maintenance.

The two filmhouses have standalone supply and service systems, though water and power are connected to main complex.

Heating

The original Royal boilers were first replaced in the 1990s. Additional boiler capacity was then added in the 2005 works. The Derngate boilers were replaced in 2013.

There are distinct heating systems for the two theatres but with centralised control from the Derngate Theatre plant room.

The Royal primary heating plant is located in a roof top plant room above the workshop (installed in the 2005 works). The primary LTHW heating circuit from the Derngate interfaces with the Royal heating system via a plate heat exchanger in the plant room.

The Derngate boiler room appears to have 3no. primary LTHW heating circuits which zone the heating distribution as follows:

- Zone A – Foyers and FOH (up to cinemas, and admin block)
- Zone B – Royal (FoH and BoH)
- Zone C – Derngate Theatre and basement

Ventilation & Cooling

The Royal ventilation system was replaced in 2006, while the Derngate ventilation system dates from 1982.

The Royal auditorium is mechanically ventilated with supply and extract ventilation. Separate supply and extract air handling units are located in the roof plant area on top of the BOH spaces. A run-around coil is connected between the two units for heating and cooling recovery. The supply air handling unit has a reversible heating/cooling coil.

A “Blue box” chiller is located in the roof plant area in the Royal BOH area. This appears to be reversible and provides LTHW heating as well.

Lighting

Stage light fittings appear to be mainly modern LED-type fittings, although older tungsten-type fittings are still present. Much of the stage lighting isn’t owned directly by the Theatre and can vary to suit touring productions.

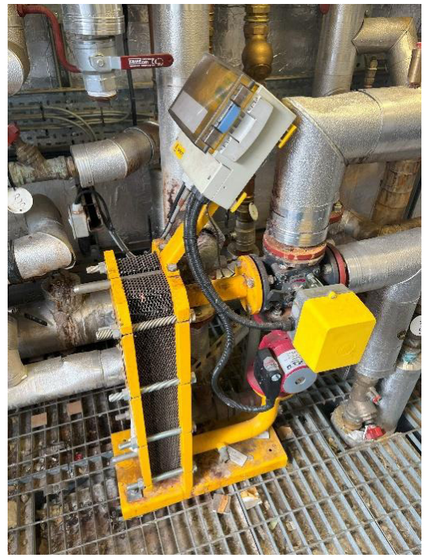
The Royal auditorium appears to use older tungsten-type house lighting with dimming, however a programme of replacement with LED fitting is underway.

Hot Water

Hot water is provided by the boilers in the wintertime and electric immersion in the summertime.



Derngate gas boilers



Royal plate heat exchanger



Royal AHU



Royal supply/extract ductwork

SURVEYS & ASSESSMENTS

3.1 Surveys & Assessments

3.1.1 Scope of Surveys

Due to the size of the Royal & Derngate site it was not possible for all surveys to cover the whole complex as part of this study, due to financial constraints.

The services condition survey focussed on the Royal auditorium and foyer areas which sit within the listed curtilage, though the report also makes reference to shared services and other related areas within the development.

The thermal imaging survey covered key areas across the external fabric of both the Royal & Derngate, but was not a fully comprehensive survey of both buildings.

A building fabric conditions survey of the complex was not carried out due to the scale of work involved, however the overall building fabric condition is well understood by the facilities and maintenance team and information on known issues was gathered through discussions.

3.1.2 Building Services Condition Survey

Skelly & Couch undertook a site survey on 6th February 2025. The report is based on visual inspections made on during this visit.

The building was open and occupied primarily by staff throughout the survey, as the building was not open to public at the time.

The purpose of the report was to identify M&E equipment energy use that could be addressed with a decarbonisation strategy and the capacity of the existing infrastructure to establish a base point for energy reduction measures and the introduction of decarbonised plant.

The report also describes the principle of the non-energy using M&E services identified incidentally as part of the inspection.

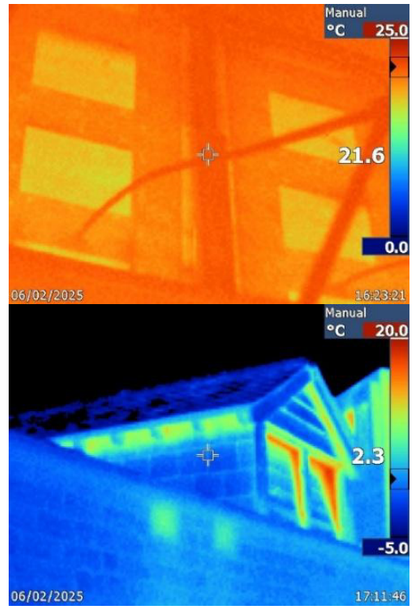
Recommendations for further analysis:

1. Temperature monitoring in peak season to assess performance of control
2. CO2 monitoring in the auditorium to assess performance of control
3. Air pressure tests
    - To quantify how the existing building performs
    - To more closely establish peak heat of the building
    - To identify current air movement that may be mitigating over heating measures

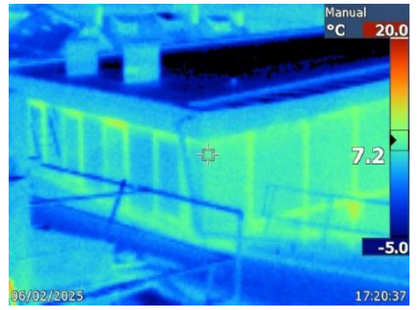
3.1.3 Thermal Imaging Survey

The key findings from the Thermal Imaging Survey were as follows:

1. Direct heat loss from the Royal auditorium area appears to be relatively low. This is mitigated by the surrounding lobbies, apparent insulation to the roof void and general limited glazing/vents. High heat loss is evident through the vent to the rear of the gallery and its associated housing.
2. The surrounding lobbies to the Royal benefit from connections to the new and existing foyers themselves, although heat loss to outside is apparent though the single glazed elements and uninsulated brick walls.
3. The Royal stagehouse appears generally warm internally, although some heat loss is apparent through the roofs and external stagehouse walls from internal imaging.
4. High heat loss (conduction and air leakage) is evident from the existing Royal foyer doors. The effect of this is mitigated by the space being unheated, but this will likely contribute to higher heating demands in connected spaces.
5. Relatively high heat loss was noted through the existing fabric – roof, walls and glazing – of the Royal back of house workshop areas and ancillary spaces.
6. Areas of high heat loss were not noted in the newer Royal back of house areas such as the dressing room block and stage door.



Heat loss through rear vents to auditorium



Heat loss through foyer single glazed curtain walling

3.2 Fabric Performance

Little information is available on the building's original construction as no intrusive inspection into the building fabric has been carried out.

U-values have been based on observations of construction made during the site visit and via the sectional drawings provided. Typical building practices of the time, and any applicable building regulations of the time of construction have also been considered.

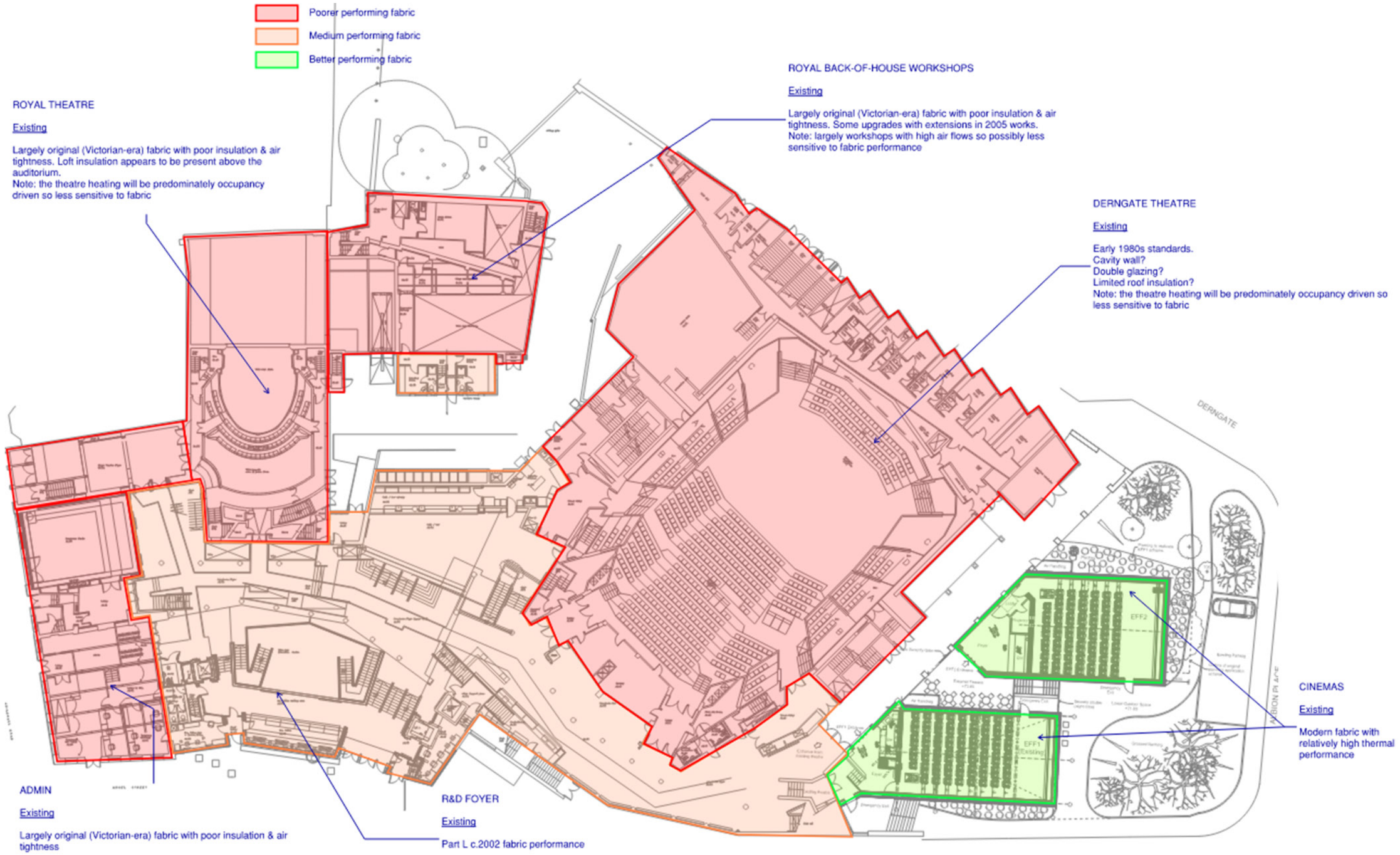
U-values have been either calculated using the wall build ups detailed below (as well as the calculations and material thermal conductivities as described in CIBSE Guide A) or estimated using tabulated CIBSE guidance, and historical Part L U-value limits.

Current knowledge or assumptions of the building fabric have been detailed in table adjacent. The satellite view on the following page details the main spaces of the building, as well as external element types.

	Fabric Element	Construction	Fabric Condition	U-Value (W/m^2K)	Notes / Assumptions
EXTERNAL WALLS	1884 Walls	400mm brick assuming 20mm dense plaster internally	Walls reported as "deteriorating" in stage 1 report.	1.46	Uninsulated Assumed the full thickness as brickwork with internal plaster finish.
	1983 Walls	100mm brick 300mm concrete block 20mm dense plaster internally		1.35	Uninsulated Assumed the full thickness as concrete block and brick with internal plaster finish.
	2006 Walls	Not specified, referred to the Part L requirements only		0.35	
	2011 Walls	Not specified, referred to the Part L requirements only		0.26	
FLOORS	1884 Floor	300mm Hardcore Fill 125mm Concrete slab 20mm Lime mortar bed 25mm floor tiles		0.4	Estimated using CIBSE Guide A table 3.15 detailing uninsulated solid ground floors based on the perimeter/area ratio
	1983 Floor	300mm Hardcore Fill 125mm Concrete slab 3mm DPM 50mm Insulation (EPS or PIR) 50mm Sand/Screed 10mm Carpet		0.54	
	2006 Floor	Not specified, referred to the Part L requirements only		0.25	
	2011 Floor	Not specified, referred to the Part L requirements only		0.22	
ROOF	External pitched roof	5mm Slate 150mm timber		0.82	Uninsulated
	Pitched roof w/50mm insulation	5mm Slate 150mm timber 50mm insulation		0.41	Same as above, but with 50mm insulation
	2006 Roof	Not specified, referred to the Part L requirements only		0.25	
	2011 Roof	Not specified, referred to the Part L requirements only		0.18	
GLAZING	Single Glazed	Wooden framed sash type Single-glazed		5.75	Estimated using CIBSE Guide A table 3.23
	Double glazed	Double-glazed PVC framing		2.73	As above
	Roof Glazing	Double glazed horizontal roof glazing, assuming a 12mm gap.		3.41	Estimated using CIBSE Guide A table 3.24
	2006	Not specified, referred to the Part L requirements only		2.2	
	2011	Not specified, referred to the Part L requirements only		2.2	

Summary of assumed building fabric performance by type

3.2 Fabric Performance



3.3 Building Services

3.3.1 Utilities

Power

The wider R&D development is served by a common utility supply derived from a Western Power substation integrated into the Derngate building on the Derngate Street side. The substation serves both the R&D and separate street supplies. The primary supply enters an ACB in a cubicle switch panel in the Derngate basement switch room.

The electrical schematic show the ACB rating as 1600A TPN but a note on the ACB says that is has been set at 800A TPN, which is understood to then be the limit of the total supply to the R&D development.

Water & Fire Fighting

The Royal has a direct water mains supply to its back-of-house area. A separate mains water supply is provided to the Derngate originating in the sprinkler tank room.

The presence of fire hydrants around the building was not established, but owing to the city centre location they are likely to be in the vicinity.

Gas

There are understood to be 3no. mains gas supplies to the R&D development:

1. Serving the Derngate heating plant
2. Serving the admin block
3. Serving the main kitchen

The gas meter serving the Derngate heating plant is opposite the cinemas off the entrance pathway from Derngate St. It is G250 DN 100 size meter with MPRN: 8880777909.

Telecoms

These were not identified on site but present and may be a combination of BT copper lines and new fibre lines.

3.3.2 Primary source heating, pumps & controls

Derngate

The heating and hot water (except in the paint frame room and during the summer) for the Royal are derived a gas boiler installation in the Derngate boiler plant room. This includes 2no. Remeha Gas 610 Eco Pro Gas boilers. These would have total output between 1,308 and 2,024 kW depending on the models used.

Flues from the two boiler sections join together into a common flue for each boiler set. 2no. flues then appear to rise through the building and terminate at the top of a chimney above the Derngate stagehouse. The flues appear to be natural convection but with a mechanical make-up air system (twin fan).

The boiler room includes primary gas pipework, expansion vessels, dosing pot (Boss) and a pressurisation set (Durapump). Pipework appears be medium gauge steel. The Derngate boiler room appears to have 3no. primary LTHW heating circuits with one circuit dedicate to the Royal.

Royal heating

The Royal primary heating plant is located in a roof top plant room above the workshop (installed in the 2005 works). The primary LTHW heating circuit from the Derngate interfaces with the Royal heating system via a plate heat exchanger in the plant room.

The Royal LTHW system comprises a twin primary LTHW pump set and 3no. LTHW heating circuits pumps as follows (each twin):

- VT heating
- Radiant heating panels
- HWS primary heating

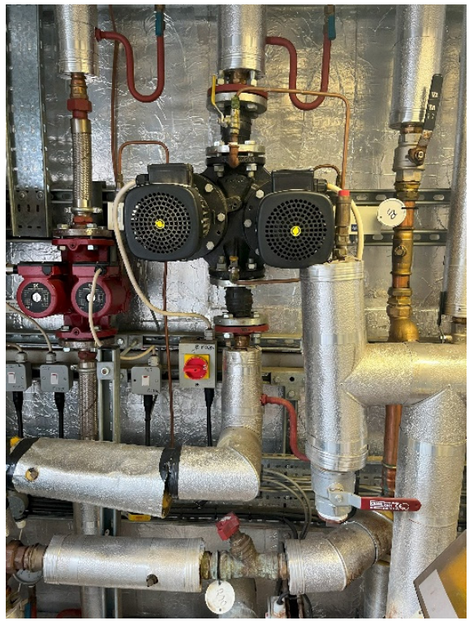
The pump sets are all Grundfos and they appear to date to the original installation works around 2005.



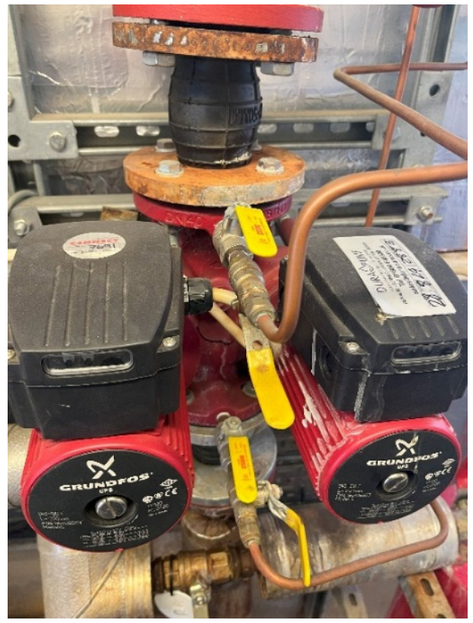
Derngate gas boilers



Royal plate heat exchanger



Pipework



Royal LTHW pumpsets

3.3 Building Services

Pipework

Heating pipework appears to be medium gauge steel. The pipework is generally insulated although it is missing on valves and on some sections of pipework.

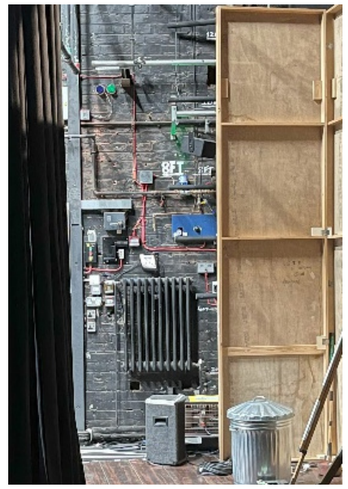
Heat Emitters

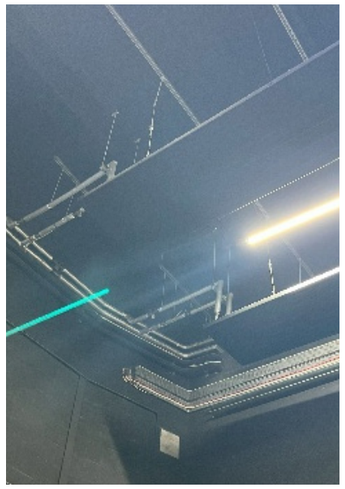
- Royal stagehouse: Column radiators in stagehouse and radiant panels above wings
- Royal BOH workshop: Radiant panels (LTHW)
- Royal BOH paint frame: LTHW fan coil unit (not portable electric heater below which appears to be supplementary)
- Royal BOH 2005 extension: Flat panel type radiators
- Royal original foyer and Crown Room: Over door heaters above foyer doors and column radiators (NB. this area is understood to be generally not heated owing to low use).



Radiant panels in the Royal BOH workshop







Royal stagehouse - column radiators and radiant panels



Fan coil units in the paint shop







Royal foyer and Crown Room - Overdoor heaters and column radiators

3.3 Building Services

3.3.3 Ventilation - Royal Theatre

The Royal auditorium is mechanically ventilated with supply and extract ventilation. Separate supply and extract air handling units are located in the roof plant area on top of the BOH spaces. These are referenced as AHU1
A run-around coil is connected between the two units for heating and cooling recovery.
The supply air handling unit has a reversible heating/cooling coil.

Supply and extract ductwork runs externally from the roof unit to the auditorium and connects into the loft space. Supply air appears to be delivered to the auditorium via supply diffusers at gallery level and above the stage.

Air appears to be extracted via extract grilles at the rear of the gallery. A natural exhaust vent is also located at high level at the rear of the gallery, which would appear to be available for summertime direct purging.

It is understood that the stagehouse does not have direct mechanical ventilation although an under-stage extract system is present. A smoke exhaust vent is located on top of the stagehouse. It is understood that this can be opened during the summertime, but it is not opened during performances.

The back of house area is served by a general supply and extract ventilation system with extract and supply AHUs (AHU6) on the roof. These are linked by a run-around coil
The back of house WC has an extract fan

The front of house areas are served by a general supply and extract ventilation system with extract and supply AHUs (AHU7). These are linked by a run-around coil





Auditorium supply/extract ductwork



AHU with runaround coil

3.3.4 Cooling - Royal Theatre

A “Blue box” chiller is located in the roof plant area in the Royal BOH area. This appears to be reversible and provides LTHW heating as well.

This was installed in the 2005 works and is understood to be dedicated to the Royal auditorium air handling unit. A common CHW/LTHW circuit is connected from the unit to a heating/cooling coil in the supply air handling unit. All pipework appears to run externally between the two units.





‘Blue box’ chiller

3.3 Building Services

3.3.5 Domestic Hot Water

A dedicated hot water cylinder is provided to serve the Royal back of house area. This is located in a cupboard off the green room. The cylinder is a 300 litre Megaflo.

The cylinder is served by the primary LTHW heating system and is understood to be switched over to electric immersion only in the summer. A local DHW circulation pump with circulation loop is present.

The Royal back-of-house paint frame room sink is provided with an electric source-storage hot water heater

Hot water distribution pipework generally appears to be copper.

Separate horizontal hot water calorifiers are provided in the Derngate plant room to serve the Derngate

3.3.6 Cold Water

Cold water is distributed around the Royal from a dedicated main in the back-of-house area.

Water booster sets and storage tanks do not appear to be present in this area and it appears that the system is direct mains-fed. This include supplies to sinks in the workshops, green room kitchenette sinks, WCs, wash hand basins, dressing rooms and plant room pressurisation units.

The pipework appears to be copper.

3.3.7 Sprinklers

A sprinkler system is provided covering the Royal back-of-house area and stage areas. This is derived from a sprinkler tank room in the Derngate, which also serves the Derngate.

It is understood that the Derngate sprinkler tank is 125m3 volume and in total there are 526no. heads across whole R&D sprinkler system. The sprinkler tank is mains water fed and diesel-source pumps are provided.

The Royal stage is also provided with a drencher system.

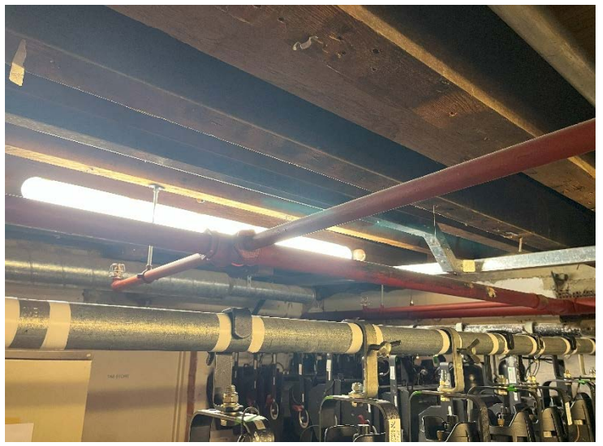
3.3.8 Drainage

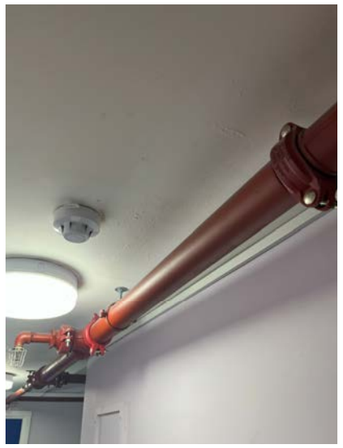
Rainwater drainage

The original drainage strategy for the Royal generally appears to be parapet gutters along the edge of pitched roofs connecting to external downpipes. Original downpipes appear to be cast iron.
Various downpipes appear to have been modified since, likely to suit changes to adjacent roof arrangements. New downpipes appear to be PVC.

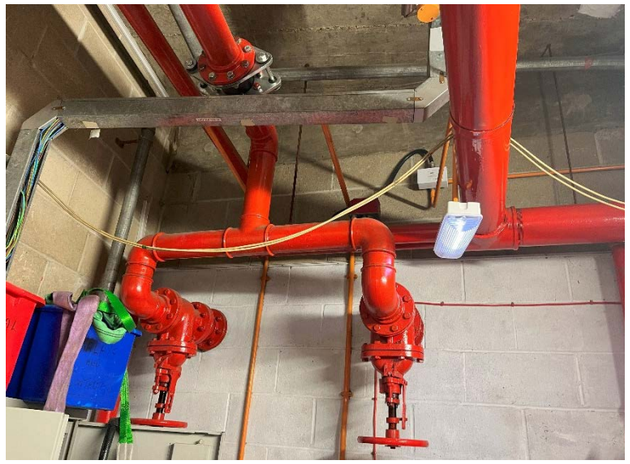
Foul Drainage

This was not inspected closely but it is likely that original above and below ground drainage routes exist with newer drainage systems to suit subsequent extension works.









Royal & Derngate sprinkler system

3.3 Building Services

3.3.9 Electrical

Derngate main LV switch room

The whole Royal & Derngate development is served by a common main LV intake. The main LV switch panel is in the basement of the Derngate.

The main LV switch panel is a cubicle-form switch panel. The original panel appears to date to the Derngate construction in the 1980s but it is understood that the panel was extended to add outgoing ways in the 2005 foyer works.

The main LV intake to the panel is an electronic ACB which is understood to be set at 800A TPN (please see Incoming Services above). Outgoing ways are mostly switch-fuse-type, except for some new ways that appear to be MCCB type.

The switch panel has about 34no. outgoing ways (mostly TPN with some SPN) which serve the Derngate, the foyer, the cinemas and include a common 400A TPN feed to the Royal as “Submain Board B”. Separate feeds to the Royal chiller (200A TPN) and ventilation plant (100A TPN) and control room distribution boards (60A SPN & 60A TPN) are also provided from the switch panel.
The ways do not appear to be generally fitted with sub meters.

Sub mains cabling appears to be multicore armoured on tray, although MICC wiring is also present. Cabling observed was PVC-insulated (BS 5467). It is noted that, owing to the different periods of installation, different cabling colours are present to suit the standards at the time.

Sub main board B

Sub main board B is located in the Derngate building adjacent to the form. It is a cubicle-form switch panel with outgoing switch-fuse ways.

It is understood that most ways are no longer active and its primary function is to extend the LV power supplies to the Royal from the main LV intake in the Derngate (likely replacing a direct LV supply to the Royal prior to the Derngate and foyer constructions).

LV supplies from here to the Royal are understood to be as follows:

- Royal MCCB panel “Sub main Board E” - 200A TPN
- Royal control room projector – 100A TPN
- Royal front of house lower ground floor MCCB board, which includes a supply to the emergency lighting inverter

General LV distribution

General LV distribution board observed were MCB-type, likely fitted in the 2005 works. Use of RCD protection was not observed, which may be consistent with installation prior to the introduction of the 17th Edition of the Wiring Regulations in 2008.



Royal & Derngate sub mains

3.3 Building Services

3.3.10 Lighting - Royal Theatre

Stage lighting

Stage lighting dimmers in the Royal are located on the stagehouse technical galleries with stage lighting boxes nearby.

Stage light fittings appear to be mainly modern LED-type fittings, although older tungsten-type fittings may be present. This may also vary to suit touring productions. Bar-mounted LED-type fittings appear to be used for general work lighting purposes

General lighting

The Royal auditorium appears to use older tungsten-type house lighting with dimming

In the Royal stagehouse high-level linear lighting is used in the stagehouse, which appears to be LED source.

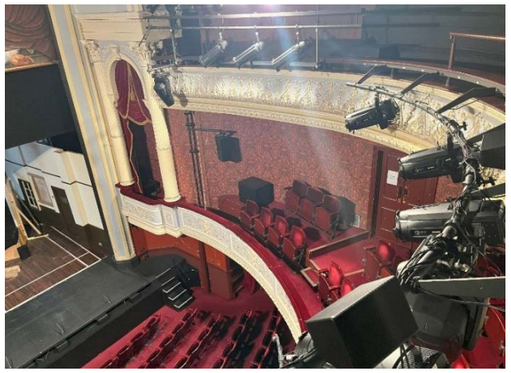
Royal back-of-house workshop areas have high bay lighting, which appears be LED.

Royal dressing room areas have bulkhead lighting (which appears to be compact fluorescent) generally. Dressing mirror lights are included, which appear to be traditional GLS form bulbs with LED sources.

The old foyer and Crown Room have downlights which appear to be LED. The Crown Room also has a chandelier, with replaceable bulbs (which may also be LED).

Emergency lighting

Emergency lighting to the Royal is provided by a central battery system. This is understood to be 230V for front-of-house and 50V for back-of-house. Illuminated emergency exit signs are included throughout, which are assumed to also be served by the central battery (although to be confirmed).







4.1 Energy & Carbon Assessment

The following section investigates the existing energy and carbon performance of the Royal & Derngate theatres. An estimated heating demand has been calculated in order to set a carbon baseline, based on the available building information and reasonable assumptions.

Industry benchmarks and standards are used for a comparison as well as metered data for the observed use of the building.

4.1.2 Collection of Data

The Royal & Derngate buildings were subject to a building services survey and a qualitative thermal imaging survey performed by Skelly & Couch on 6 February 2025. During this, information on the building was witnessed and discussed with management.

The following applies:

- The building was open and occupied to staff and public throughout the surveys.
- Record information including surveys and utility bills was collected.
- Heating provision identified by observation of plant equipment, zones, thermostatic controls and heat emitters throughout building. Verbal feedback on general comfort acquired.
- Ventilation availability noted from existing openings and use of windows during the time of survey.
- Photographs taken to guide building fabric estimations.
- No invasive surveys were carried out.

Due to the scope of the project, the surveys focus primarily on the Royal Theatre and do not cover the whole complex.

Energy data

Utility electricity and gas meter readings have been provided by the theatre's management for a circa one and a half year period; September 2023 to March 2025.

The site's space heating system is fed by gas boilers and the domestic hot water uses local electric heaters. The gas meter readings therefore relate to the heating consumption of the building over the provided period.

The metered data represents most of the complex; excluding the cinemas, because the various areas within the building are not separately metered

Building information

Building floor, external walls, roof and glazing areas have been determined from existing building layouts provided by Royal & Derngate. These include basement, ground floor, first floor and second floor plans.

Little information is available on the building's original construction. Fabric for u-calculations have beenm. The calculated u-values and assumptions used are listed in section 3.

Carbon conversion factors

The annual carbon emissions have been calculated based on The National Calculation Methodology modelling guide – 2021 Edition.

Values used in carbon conversions for different fuel types are detailed in the adjacent table.

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Electricity emissions (kgCO2/kWh)	0.163	0.160	0.153	0.143	0.132	0.120	0.111	0.112	0.122	0.136	0.151	0.163
Gas emissions (kgCO2/kWh)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Gas and electricity CO2 emission and primary energy factors for buildings other than dwellings.
Extracted from the National Calculation Methodology 2021

4.2 Heat Energy Usage Estimate

4.2.1 Design temperature assumptions

The yearly heat energy usage of the existing buildings on the Royal & Derngate site has been calculated as an estimate to provide a comparison with metered data for the site's operational energy and carbon performance before interventions are investigated.

The baseline is for space heating energy usage, which allows comparison to metered gas data and apportionment of the heating energy use to different aspects of the building.

A number of methodologies are available to estimate the expected heating energy requirement in a building, as detailed within the accompanying fact sheets.

In this case, due to the limited building information available, a simple heating degree days calculation was carried out.

This method allows a peak load to be converted into a yearly heating consumption rate, accounting for the local climate.

A brief overview of the assumptions made within this methodology are included below:

- Luton Airport (not the nearest of the available data sets, but the most robust data of the available data sets for the area) heating degree days with a base temperature of 17.5°C.
- An internal design temperature of 21°C for the buildings on the site has been assumed throughout, with the exception of the Foyer and Paint-shop, which have been modelled on 18°C internal room air temperature.
- Peak load calculation using external temperature of -5°C based on the CIBSE tabulated extreme temperature for Birmingham (which is the closest of the available data sets provided by CIBSE).
- Only exposed walls and fabric elements were assessed, where it is assumed that there is no heat loss between adjacent spaces.

4.2.2 Infiltration assumptions

An air permeability test was carried out on the Royal building, finding an air leakage rate of 19.04 m3h-1m-2 @ 50 Pa.

This has been converted into an average annual air infiltration rate of 0.62 ACH using empirical data in CIBSE guide A, figure 4.15, based on the Royal theatre building volume.

Air infiltration rates have been assumed for the remaining buildings using figures from CIBSE guide A table 4.16, with estimated adjustments made for the relative fabric conditions and building performances as identified during site inspections.

Where improvements are made to building openings in the interventions section, an estimated improvement to this infiltration value is made to account for reduced heat losses via infiltration.

For the estimated values, the accuracy of this method is unknown, however with some confidence it can be assumed that the infiltration is significant in certain buildings on the site. Alternative methods of calculation are significantly more involved.

BUILDING	AIR CHANGE RATE (ACH)
Derngate	0.30
Foyer	0.40
Offices	0.30
Rehearsal	0.30
Royal	0.62
Paint shop	0.60
Hector's House	0.20
Workshop	0.60

Assumed air change rates for each area of the building

4.2.3 Ventilation assumptions

	SPACE	ASSUMED FLOW RATE	ASSUMPTIONS
NATURAL	Foyer	120 l/s (based on an occupancy of 15 people)	Building infiltration rate would ventilate the space sufficiently so natural ventilation was not considered to be used here (assuming occupants will not open windows etc. when there are cold draughts entering the space already via the fabric) – Heat losses in this room would consequently be calculated using the infiltration heat losses.
NATURAL	Offices	360 l/s (based on an occupancy of 44 people)	As above
NATURAL	Paint shop	80l/s (based on an occupancy of 15 people)	This area is likely to have mechanical extract ventilation to remove fumes and pollutants, where air from adjacent spaces will infiltrate the space to displace the extracted air. As such we have modelled this as a natural ventilation system for the heat loss projections. As per the previous spaces, due to the infiltration ventilation being larger than the natural ventilation provisions, the infiltration losses take precedence in the heat loss calculations.
MECHANICAL	Derngate Theatre	12,240 l/s	Based on an assumed occupancy of 1530 (max 1500 customers and 30 staff members). No heat recovery accounted for.
MECHANICAL	Rehearsal	320 l/s	Based on an assumed occupancy of 40 people, using an assumed heat reclaim of 50% on the AHU.
MECHANICAL	Royal	3,600 l/s	Based on an occupancy of 450 people, using an assumed heat reclaim of 40% on the AHU due to the use of a run around coil heat recovery system.
MECHANICAL	Hector's House	42 L/s	Based on an occupancy of 10 people, using an assumed heat reclaim of 40% on the AHU due to the use of a run around coil heat recovery system.

4.2 Heat Energy Usage Estimate

4.2.3 Baseline results

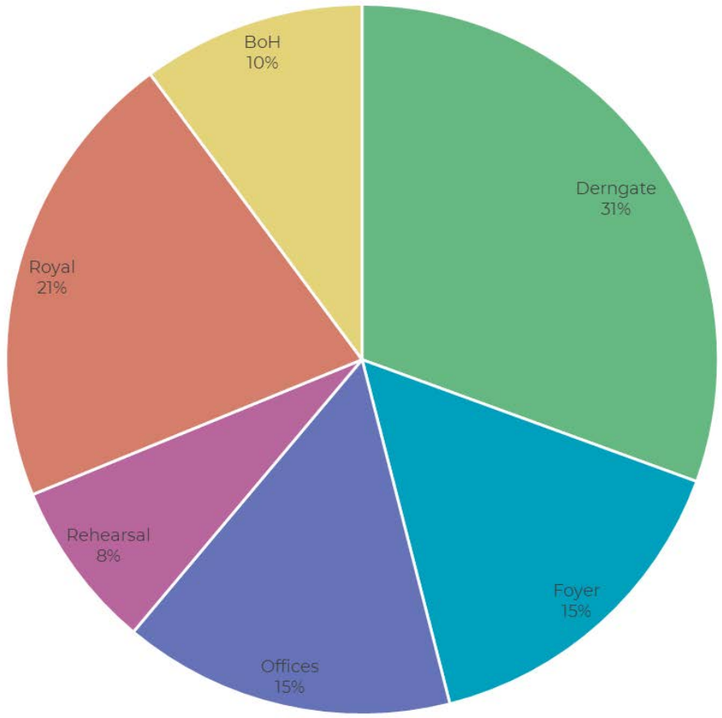
Based on these stated assumptions, the steady state heat losses for the various buildings across the Derngate & Royal Theatre site could be estimated for a peak load scenario. The pie chart adjacent illustrates these for each building as a proportion of the site's overall heat load.

It should be noted that, due to the absence of accurate building fabric information of the various buildings, that these estimated heat loads are to be used primarily to highlight the larger energy users on the site and provide some indication as to where the major heat losses are likely to be and will require further investigation.

We would expect any subsequent investigations of any proposed measures to undertake further more detailed site surveys and the compiling of more information for that study.

Key observations are as follows:

- All areas of the buildings have significant heat loss
- Derngate is by some margin the most significant and should be an initial focus



Estimated steady state heat losses from the existing buildings expressed as a proportion of the total sitewide heat loss. Back of house areas include Hector's House and the Paint-shop.

4.3 Metered Data

4.3.1 Metered annual energy use & carbon emissions

The diagrams adjacent show the total metered carbon emissions, and energy use. and utility cost respectively for the site by fuel type for September 2023 to March 2025. Key observation are as follows:

Energy

- The site used a total of 2,372MWh of energy in 2024.
- Of the total energy use, approximately 39% related to electrical energy and 61% to gas energy.

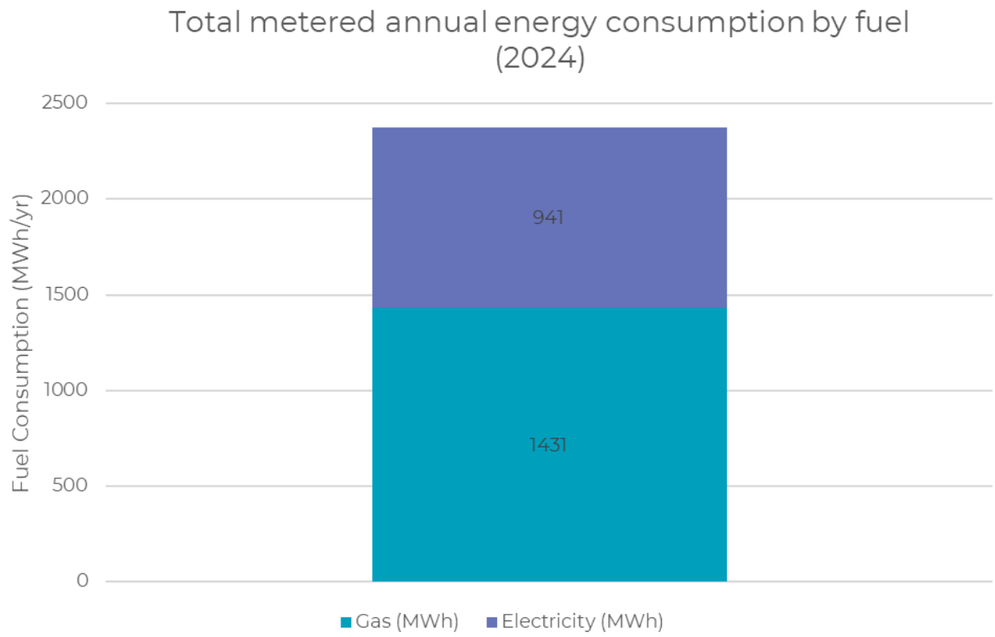
Carbon

- The total carbon emissions of the site was 431 tCO2 in 2024.
- Of the total carbon emissions, approximately 30% related to electrical energy and 70% to gas energy.

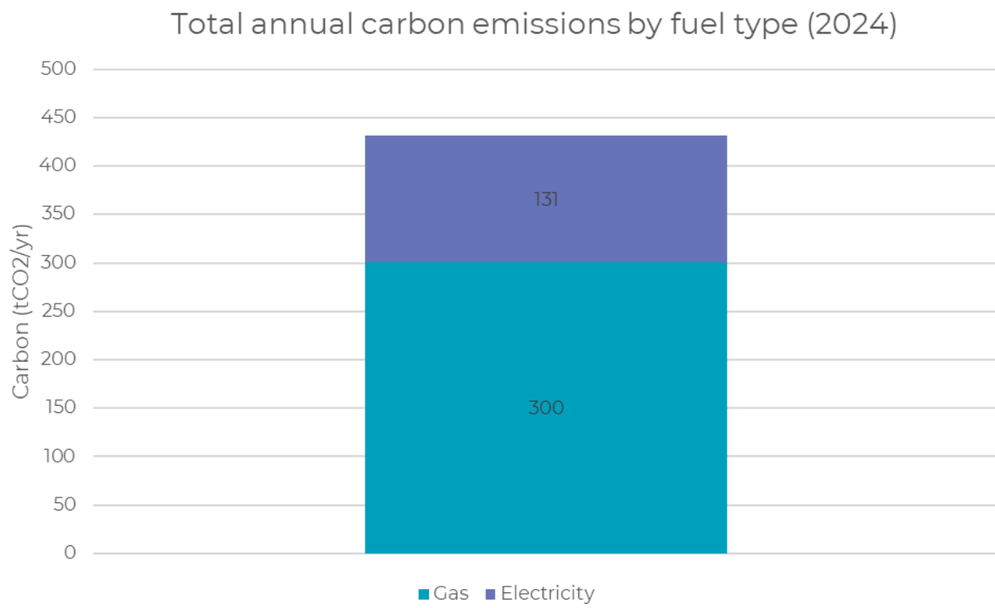
Cost

Based on typical commercial energy costs:

- Electricity £0.30/kWh = £280,000
- Gas £0.07/kWh = £100,000



Total annual energy consumption by fuel in MWh based on meter readings from 2023 - 2024



Total annual carbon emissions by fuel in tCO2 based on meter readings from 2023-2024

4.3 Metered Data

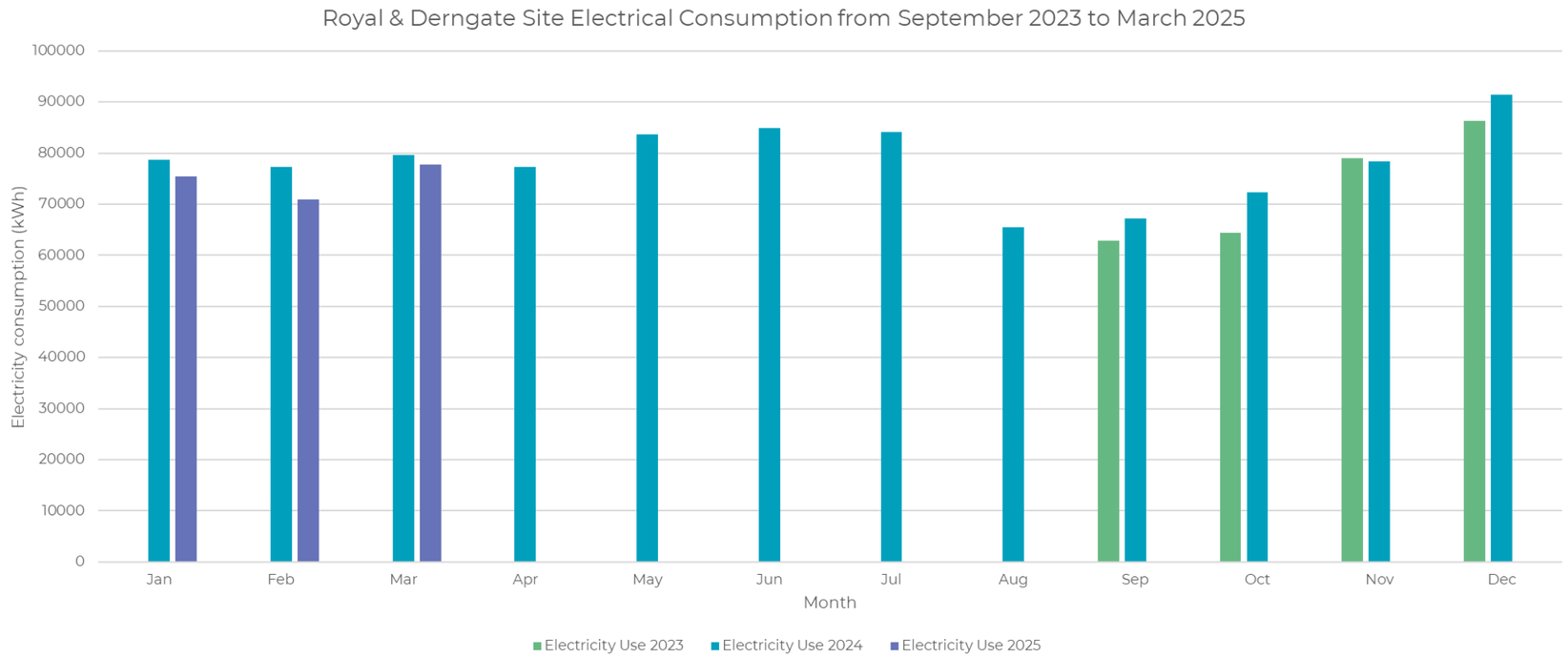
4.3.2 Metered monthly energy use

Electricity

The adjacent graph shows the building's metered electricity consumption by month for the same period.

Key observations across the figure are as follows:

- Electricity consumption has stayed relatively consistent throughout the period; the lowest monthly consumption in September 2023 is seen to be 8% lower than the highest consumption in December 2024.
- The highest consumption was in December both in 2023 and 2024, likely due to high lighting use during these winter months.
- Electricity consumption in September 2023 and 2024 was relatively low compared to other months possibly indicating lower building usage or more temperate climate requiring less conditioning of the internal room air temperatures.
- There is generally a low electricity usage in 2023 compared to 2024. 2025 indicates a slight reduction to 2024 also.



Royal & Derngate Theatre metered electricity use per month (kWh) in the period Sept 2023-March 2025

4.3 Metered Data

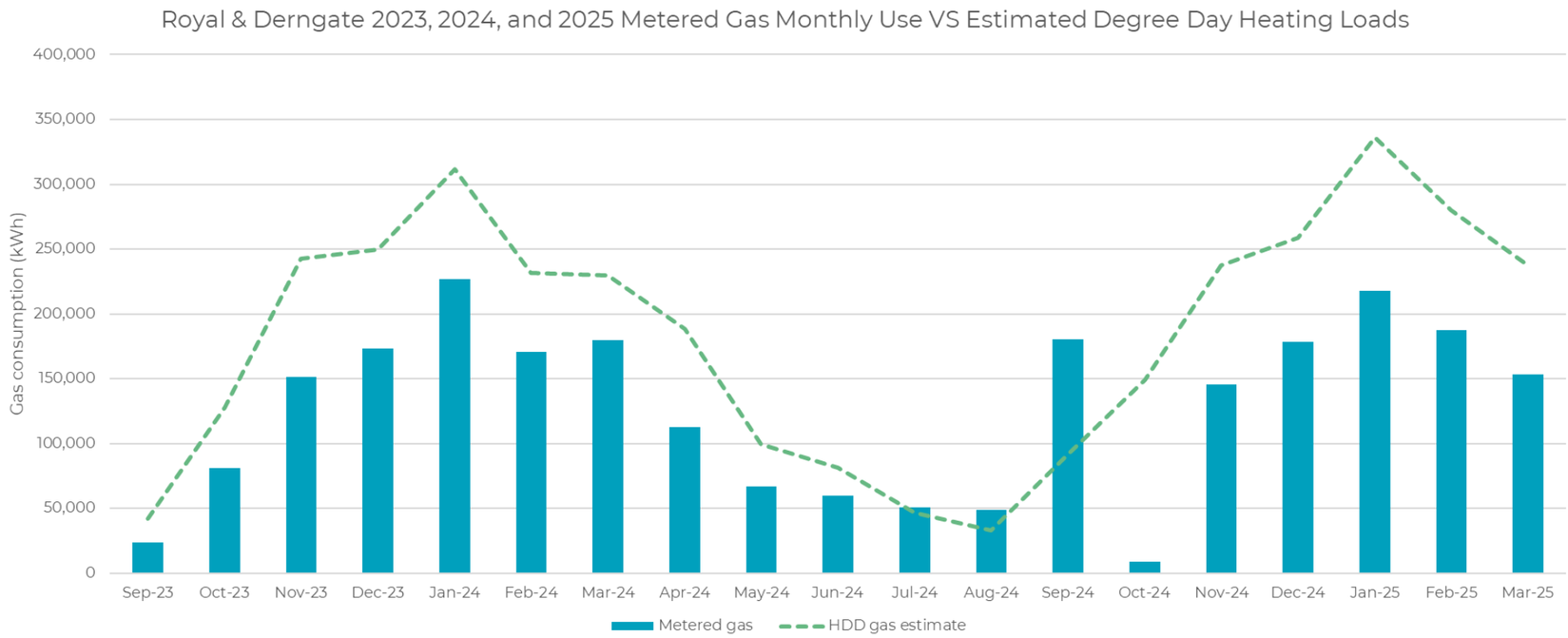
Gas (Space Heating)

The adjacent graph shows the metered gas consumption for the site across the same period (September 2023 to March 2025).

For comparison, the estimated heating loads calculated with Heating Degree Days for Luton Airport (base temperature 17.5°C) have been included as monthly totals (kWh).

Key observations are as follows:

- The monthly gas consumption mostly appears to follow a seasonal profile tracking the heating degree days estimates.
- The highest metered consumption in the period was found to be January 2024.
- The gas consumption reduces over the summer months to a steady usage as the heating is expected to be off during this period. The hot water mostly switches to electric immersion in the summer, however, the gas consumption still present is likely to be from kitchen usage generally including local hot water heating.
- The metered usage in September 2024 was particularly high and the metered usage in October 2024 particularly low relative to their estimates. This is likely due to estimated readings.
- The metered gas energy usage is generally lower than the estimated loads derived from Heating Degree Days. This is likely due to uncertainties in the estimated calculations, like real fabric performance and heating controls.



Royal & Derngate Theatre metered gas use per month (kWh) in the period Sept 2023-March 2025.
Plotted against the estimated monthly heating loads based on Heating Degree Days for Luton Airport with a base temperature of 17.5°C.

4.4 Building Benchmarking

The site's metered energy usage and estimated gas energy usage has been plotted on the graph shown adjacent alongside typical practice and good practice benchmarks for theatre buildings.

The difference between the metered gas consumption and the estimated heating energy usage (operational heating baseline) suggests that the estimated gas usage calculations contain some inaccuracies.

These inaccuracies are likely to include the infiltration assumptions, fabric build ups, and excluding inherent insulators like furnishings, and the degree day constant heating application (which neglects the fact that there's usually no heating operating during unoccupied hours).

However, the estimated heating consumption is still a useful measure as it includes fabric breakdowns and infiltration and ventilation flow rates, which then allows for the impact of specific building interventions to be individually assessed. For this reason, the operational baseline of the heating use has been based on the estimated calculations.

The application of heating degree days only applies to the space heating gas consumption, and so for the site's electrical use the metered value has been assumed for the operational baseline of the electrical energy.

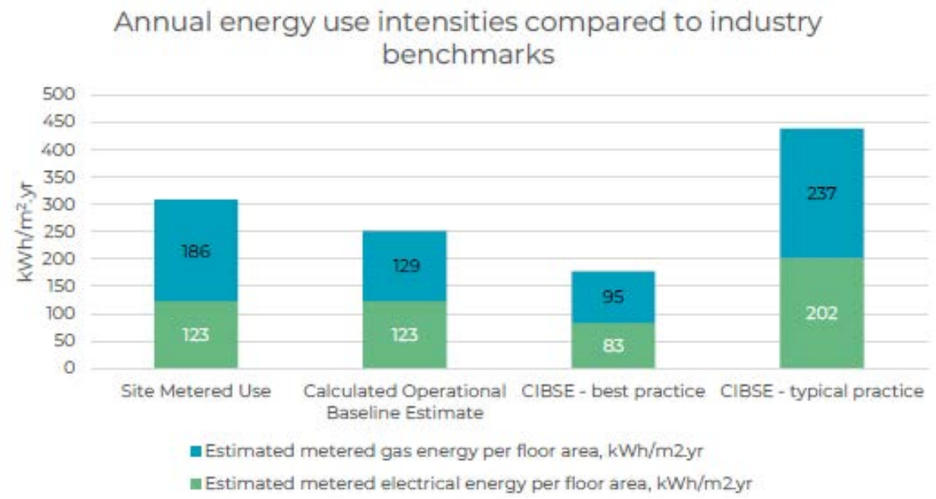
Industry benchmarks are based on the comfortable temperatures and typical operational energy usage of the relevant building type. The benchmarks used in this study are from the CIBSE Energy Benchmarking Tool, which utilises the most up to date data sets for energy consumptions of different building types.

These have been included in the graph for comparison, covering the below:

- CIBSE benchmarking tool best practice – For entertainment buildings, theatres. Stated source DEC. Aligns with good practice buildings.
- CIBSE benchmarking tool typical practice – For entertainment buildings, theatres. Stated source DEC. Aligns with typical practice buildings.

Key observations are as follows:

- The metered electricity usage, and thus the electricity baseline, was less than all the industry benchmarks. This may be due to the fact that the lighting is undergoing a replacement scheme from fluorescent fittings to LED. Due to the age of most of the benchmarks LED lighting will not be included in these values. It may also reflect lower computer use compared with similar buildings. It should also be noted that ventilation does not currently meet building regulations, and in complying with this through the provision of mechanical ventilation, electricity use is likely to increase.
- The current heating use is similar to typical practice benchmarks, so similar to how other buildings of its type are performing.



Annual energy use intensities (kWh/m2yr) comparison between the Royal & Derngate Theatre metered usage 2023-24, and the CIBSE building benchmarks best and typical practices.

OPTIONS APPRAISAL

5.1 Objectives

The purpose of the Options Appraisal is to assess the range of potential measures that could be implemented to reduce the energy use and carbon intensity of Royal & Derngate.

As part of the Whole Building Approach, Historic England recommends that interventions should be implemented according to the 'Energy Efficiency Hierarchy'.

This order of priority reflects the relative benefits, costs, and technical risks of interventions as well as the 'three pillars of energy transition' - sufficiency, efficiency, and generation:

- Firstly, reduce energy consumption in real terms (sufficiency)
- Secondly, minimise unavoidable energy use (efficiency)
- Lastly, generate energy from 'renewables', also known as low and zero carbon technologies, where possible (generation)

There are a number of benefits to reducing the buildings energy consumption:

1. Reduced CO_2 emissions to align with net zero aims.
2. Reduced strain on utility infrastructure e.g. electricity grid.
3. Reduced running costs.
4. Improved occupant comfort
5. Reduced capital cost for new plant e.g. reduction in heat pump size.

A strategic approach to decarbonisation ensures that the most effective and beneficial measures are implemented first, providing a clear roadmap for energy-efficient retrofitting.

Royal & Derngate's established aims and objectives for the decarbonisation strategy include:

1. To establish the Royal & Derngate's baseline operational energy and carbon performance.
2. To compare this performance against industry benchmarks and standards.
3. To propose suitable targets for enhanced performance, taking into account local planning and listed building requirements.
4. To appraise options available in order to achieve these targets including energy use reductions and low/zero carbon technologies (LZCs).
5. Make recommendations to align, where possible, with addressing historic underinvestment in infrastructure and building fabric.
6. To assist in generating appetite for support, demonstrating where investment will be best positioned from a Decarbonisation perspective.
7. To agree a coherent strategic plan for implementation, both within and beyond the capital project.

5.2 Energy Use Intensity Targets

The UK Net Zero Carbon Building Standard (UKNZCBS) Pilot Version was published in 2024 with the aim of providing a clear framework for achieving net zero carbon in the built environment. The guidance provides set energy use intensity targets as part of the Net Zero Operational Carbon definition.

These targets measure the total energy use (excluding on-site renewables) to achieve an energy use intensity compatible with the expected availability of renewables in 2040, the deadline which the standard sets.

The standard gives guidance for a “stepped” and “one-go” retrofit. In the stepped retrofit, guidance is given for the progressive reduction of energy use intensity year-on-year.

The “one-go” retrofit assumes all the improvement works will be carried out in one go, and no improvements will be made following this. The targets are more lenient for earlier starting dates, under the assumption that technology and knowledge will improve which will make carbon reduction easier.

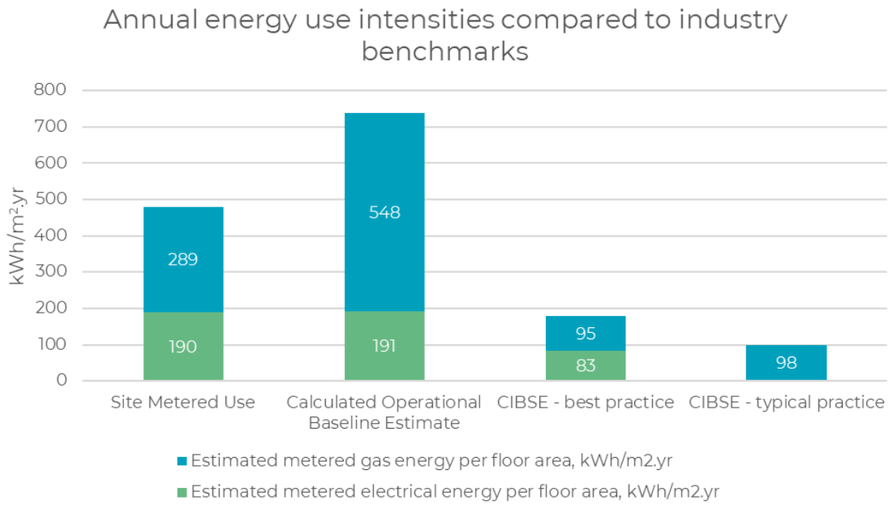
For the purposes of this exercise, the “one-go” EUI target has been applied.

Based on a 2026 start, the energy use intensity for a “Cultural & Heritage – Collection” building is: 98 kWh/m2yr.

If demand can be reduced sufficiently to meet these emissions and the remaining energy for operations is supplied by on or off-site renewable, zero carbon sources, the building can be considered Net Zero Operational Carbon according to these definitions.

Key observations for Royal & Derngate are as follows:

- Current electricity use is similar to that of the UKNZCB target, which would include the heating energy. A significant reduction in electricity use would be required to meet the target.



Annual energy use intensities compared to UK Net Zero Carbon targets.

5.3 Reducing Energy Consumption

A range of opportunities to reduce energy consumption have been explored, including building fabric improvements, services upgrades, system efficiencies, metering and controls.

5.3.1 Building fabric

Wall Insulation

There are a number of opportunities for internal or external insulation to the building fabric within the Royal & Derngate complex. The areas that have the highest potential for insulation in terms of capital cost, ease of implementation and listed building constraints include:

- internal insulation to the Royal Theatre BoH dressing room block (Hector's House)
- internal insulation to the Royal Theatre Workshop
- external insulation to solid wall areas in the R&D Foyer.
- external insulation as part of new vapour-permeable finishes to the Royal Theatre paint-shop, noting that removal of existing cement render finishes carries risk of damage to the existing brickwork

Generally speaking, insulation of these areas provides low benefit in terms of relative energy and carbon reduction, with the exception of the paint-shop which would be more beneficial than the other options.

Areas that appear more challenging to insulate include:

- internal insulation to the Royal Theatre
- internal and/or external insulation to the Derngate Theatre
- internal insulation to the Admin and Rehearsal buildings

The insulation of these areas generally has a higher capital cost due to the complexity of construction within existing constraints, however these areas also appear to show the most significant benefit in terms of carbon reduction.

On balance the two areas that appear most cost effective and beneficial to insulate, in terms of energy savings, are:

- external insulation to Royal Theatre paint-shop
- internal insulation to the Admin and Rehearsal buildings

External insulation to the paint-shop will require planning consent, though as the area does not appear to form part of the listed curtilage it may not need Listed Building consent. This should be confirmed through discussion with Heritage Officers.

The addition of both internal and external insulation will require careful design to avoid risks of cold bridging and condensation. This should be considered as part of the next steps if these measures are taken forward.

Roof Insulation

There is a significant area of roofing across the Royal & Derngate complex with the potential to accommodate additional insulation, however much of this will be quite complex to install, requiring reconfiguration of existing services internally or renewal of roof coverings externally.

On balance, the most cost effective and beneficial roof areas to insulate include:

- internal insulation to the Royal Theatre slate roof
- internal insulation Royal Theatre paint-shop roof (flat central area)
- internal insulation to the Admin and Rehearsal buildings slate roofs

Glazing

The majority of areas in the building, including the Royal Theatre, the Derngate Theatre and the Royal Theatre BoH; paint-shop, workshop and Hector's House, have limited areas of glazing, meaning that upgrading the existing glazing will bring mid level benefit in terms of carbon reduction and cost effectiveness.

Nevertheless, opportunities should be sought to improve the performance of windows to the Royal foyer windows at upper levels; and to the Royal dressing rooms. Options for window replacement; window re-glazing; or secondary glazing should be informed by an assessment of the condition, age and significance of each window type.

The roof of the paint shop contains a large number of pitched, single-glazed rooflights. Upgrading these would deliver moderate energy savings while also improving thermal comfort within the space. Although the works may be more complex to implement, potentially requiring internal scaffolding, they could be undertaken alongside other planned improvements to the paint shop, such as insulation of the flat roof area and external wall insulation. Delivering these measures together would help maximise the overall energy savings while mitigating some of the logistical challenges associated with the installation.

The most significant areas of glazing are within the Foyer, which has a fairly high proportion of rooflights and single-glazed curtain walling, which is associated with reported issues of draughts and water ingress.

Upgrading the curtain walling, including improved weather seals and air tightness in the short term or full replacement in the long term, would bring the most benefit relative to other glazing upgrade options.

The projecting windows to the Derngate dressing rooms also provide opportunities for upgrade or replacement to both glazing and spandrel panels/ structural framing.

Doors & Vents

There are a few known areas of more significant heat loss within the Royal & Derngate:

- The Royal Theatre smoke vent
- The Royal Theatre loading bay
- Derngate Theatre loading bay

Addressing each of these areas may be relatively simple and cost effective to implement and bring about significant benefits, both in terms of energy/carbon reduction and also thermal comfort.

Limiting heat losses from the two loading bays, requires a repositioning of the 'get-in' thermal line within the building. This would include upgrading or resealing lobby doors or adding insulation to internal partitions where the thermal line is affected.

5.3 Reducing Energy Consumption

5.3.2 System efficiencies

Lighting

There is a fairly significant amount of tungsten lighting throughout the buildings, which will use around 10 times more electricity than modern LEDs. In addition, due to the inefficiencies of these fittings converting electricity to light, a significant heat load can be added to spaces. This is of particular concern in auditoria e.g. stage lighting where this heat is removed through the use of mechanical cooling.

Ventilation

Whilst the energy use by fans may be relatively small when compared with some other loads in a theatre, the operation of the ventilation will have a significant effect on the energy use. Over or under-ventilation will lead to increased heating and cooling loads depending on the time of year.

Converting ventilation systems, particularly within auditoria, to displacement ventilation systems (supply air at low level making use of warm airs natural buoyancy to distribute) rather than mixing systems reduces the required air volumes to provide suitable air quality, reducing heating, cooling and ventilation energy use and reducing viral transmission risk. This can be difficult due to spatial constraints within existing buildings.

Existing AHUs generally make use of run-around coils. These are relatively low efficiency and require powered pumps to run, however there will be a balance between specific fan power and heating/cooling energy savings with the introduction of more efficient forms of heat exchange, and these should be tested before work is carried out.

Fans are generally inverter-driven AC, there will be some efficiency saving through the use of EC fans, which will reduce the electricity use of the fans themselves.

Services distribution

Ensuring services are adequately insulated throughout will help to avoid unwanted heat loss and reduce overheating risk.

5.3.3 Metering

Metering is an effective method to reduce consumption and is often relatively low cost to implement. There are very limited, if any, submeters currently within the buildings. The provision of metering on electrical and heating systems will help to understand exactly where the energy is going, and allow focussed attention on where the largest savings are to be had, and allows continual monitoring and improvements.

There are a number of organisations which provide a contract based monitoring services whereby sensors are distributed throughout buildings and building services and are fed into a monitoring system which they then review on a regular basis. This is useful for larger buildings with complex BMS systems, and may be worth pursuing at the R&D.

5.3.4 Controls

There are a number of opportunities to improve building system control and reduce energy consumption. Use of local controls can reduce the unwanted use of energy in unoccupied rooms and smarter controls such as PIRs and temperature sensors can further improve this.

Areas where improved controls can be of benefit:

- Reducing overheating/over-cooling
- Reducing energy use out of hours or when spaces are unoccupied
- Reducing pump and fan power
- Improving air quality
- Reducing lighting energy
- Improving occupant comfort through better control and interfaces.

Technologies such as smart radiator valves can be retrofitted to existing systems to allow for more zonal controls of the heating, reducing usage within unoccupied rooms and comfort to spaces as they can be programmed to heat rooms to comforting temperature in advance of occupancy.

5.4 Low/Zero Carbon Technologies

Along with the building fabric improvements, services upgrades, and energy saving measures discussed in the previous section, the implementation of low/zero carbon (LZC) technologies will play a key role within the carbon reduction strategy.

Key opportunities for implementing LZC technologies on site at Royal & Derngate have been reviewed and analysed below.

The following LZCs have been reviewed for their suitability at Royal & Derngate:

- Photovoltaics
- Solar thermal
- Heat Pumps
- Biofuels
- Variable refrigerant flow

5.4.1 Photovoltaics

Photovoltaic (PV) panels use photons in sunlight to create an electrical current. They are typically placed in an exposed location where they have access to bright, unshaded sunlight. Based on current developments in this technology, the maximum efficiency of panels is around 25%. In the UK, the optimal position for a panel is south facing and pitched between 20-35 degrees to the horizontal. Panels should be arranged to avoid shading from adjacent buildings, trees etc.

The availability of large flat roof areas, away from the listed building curtilage, makes the incorporation of PV's highly feasible. This is further illustrated and developed in Section 6.4.1.

5.4.2 Solar thermal

The Royal & Derngate Theatres do not house a centralised DHW system as the hot water provisions are currently provided by calorifiers local to each building, or local point of use electric hot water heaters. In order to effectively utilise solar thermal technology, a new DHW system would likely need to be implemented throughout the various buildings on the site.

It is also important to note that the buildings on the site will not have a particularly high hot water requirement, where the major hot water demand arises from WCs, small kitchenettes, and perhaps a bar area, making solar thermal technology a less attractive option in this case.

Based on these factors, we will assume that it will be more beneficial for the site to try to maximise its photovoltaic installations, as they will be more useful for the various buildings on the site, hence available roof space for PV should be prioritised over any roof space for solar thermal.

5.4.3 Air-source heat pumps (ASHP)

Air Source Heat Pumps (ASHPs) are low-carbon heating systems that extract heat from the outside air—even at low temperatures—and use it for internal heating. They operate using electricity only. ASHPs typically have efficiencies of 2.5 to 4, meaning they can produce 2.5 to 4 units of heat for every unit of electricity used. This high efficiency, combined with the ability to pair ASHPs with renewable electricity (e.g. from solar panels or green tariffs), makes them a key technology in the push to decarbonise buildings and meet climate targets.

New air-source heat pumps could be installed externally on the flat roof areas across the complex. These could be screened for acoustic and visual comfort if required.

Between 3-6 high capacity ASHPs would allow the site to be entirely heated with air-source heating, which could provide a long-term low carbon solution particularly as imported electricity carbon factors reduce with grid decarbonisation.

Decentralised ASHP

Decentralising the heating system such that smaller ASHPs can be used to meet the heating demands of the individual buildings may be more feasible given the likely space constraints. This is illustrated further in Section 6.4.2.

Exhaust ASHP

Exhaust air heat pumps utilise the warm air being extracted from a heat pump (when the HP is in cooling mode) to heat up domestic hot water. The hot water requirements for the Royal & Derngate site do not appear to be too onerous, and as such this measure would not be particularly beneficial for decarbonising the buildings on the site.

5.4.4 Ground Source Heat Pumps

Open or closed loop Ground source heat pumps require a large open space for boreholes in order to be a feasible option. The Royal & Derngate site has two separate car park areas, which could potentially facilitate this technology. This is further illustrated and developed in Section 6.4.3.

5.4.5 Surface water-source heat pump

The Royal & Derngate Theatre is positioned circa 500m from the River Nene, with a highly obstructed route via a public park, major roads and business developments. Surface water-source heat pumps have therefore been assumed as a not feasible technology due to this proximity.

5.4.6 Biofuels

The term "Biofuels" covers a variety of different fuels and technologies, such as biomass fuel, hydrogen and methane gas, and biodiesel fuel. Each has their benefits and suitability to certain situations, usually in more rural settings, however non are deemed to be beneficial for installation on this site. Biomass fuel is the burning of wooden pellets in a wood pellet boiler.

As such it requires large amounts of wooden pellets to be stored locally to the boiler, as well as regular deliveries of pellets to the site. Due to the particulate nature of the emissions from wooden boilers, these systems tend not to be favourable for the requisite air quality assessments.

More favourable in terms of emissions is the use of hydrogen gas as a fuel source. Again this would require a new boiler installation to operate on the new fuel source (or at the very least modifications to the existing natural gas boilers), and again there is likely to be a requirement to store the fuel on site, as hydrogen is not distributed via a centralised network like natural gas, and so the gas would arrive to site in bottles and be stored on site ready for use. Despite its more favourable emissions to wooden pellet boilers, hydrogen gas would also not

be suitable for this site, due to the storage and delivery requirements, as well as being potentially explosive.

Biodiesel would also require new boilers to be installed, deliveries to site and storage of the potentially explosive fuel on site. Similar to the wooden pellet boilers, the emissions off oil/biodiesel boilers are generally seen as being disadvantageous from an air quality assessment perspective.

5.4.7 Variable refrigerant flow (VRF)

Variable refrigerant flow (VRF) systems operate similarly to air source heat pumps, where heat is extracted from the air by externally mounted condenser units, and upgraded and converted into useful heat to heat up the internal space in the building.

The main difference between VRFs and heat pumps is that VRF systems circulate refrigerant gases around the building rather than low temperature hot water or chilled water. Internal units (fan coil units) would have heat exchangers that then convert the heating (or cooling) energy into temperate air that is blown in to the occupied space.

This intervention would require a considerable change to the existing heating network around the site and as the existing district heating pipework and heat emitters (radiators) would become redundant, and would need to be replaced by a series of internal and external units throughout the various buildings on the site.

5.4.8 Wind Power

The use of wind turbines are typically difficult to implement within city centres, largely due to limited space and height restrictions, planning restrictions as they can often be regarded as an eyesore (which will be further hindered by the fact that this is a heritage property and will likely be in a conservation area), lower wind speeds in city centres, and environmental concerns (with bats and birds). As such wind power has been discounted from this study.

5.5 Option Evaluation

Evaluation methodology

The potential measures to reduce energy consumption and carbon emissions have been assessed against a range of criteria and considerations including:

1. Implementation
2. Heritage sensitivity
3. Indicative capital cost
4. Estimated energy /carbon reduction
5. Cost per tonne CO_2 saved ('energy cost effectiveness')

Implementation

This considers the challenges of implementing the proposed measure within the context of the specific building or site. These will vary from building to building but may include:

- Logistical challenges such as impact on occupation or decant requirements.
- Interfaces with adjacent fabric, both internally and externally.
- Impact on existing retained building services and systems.

Heritage sensitivity

Informed by the hierarchy of significance, this assesses the relative sensitivity of the proposed measure with respect to heritage values, including visual / aesthetic, evidential and historic.

It does not include a full impact assessment as required for planning and listed building consent, nor identify the potential public benefits. It is intended to provide a preliminary consideration of heritage sensitivity in order to guide further investigation at the next design stage.

Indicative capital cost

The cost assessment represents indicative estimates of the likely costs to implement the carbon reduction improvements as described in this study, as a starting point for decision making. It is important to recognise the assessments are based on the limited information currently available. As with all construction works it is advised that further cost checks are carried out at each design stage. The current costs should be viewed as at RIBA stage 0/1.

The allowances currently assume each item is carried out via a direct contract with the supplier, rather than delivered through a Main Contractor. Appointing a main contractor to undertake a work item will lead to additional costs through management and profit layering. Conversely if the works are linked to a wider scope and form part of a larger scope economies of scale may arise.

Note that all costs are current day, 3rd quarter 2025. An adjustment for inflation will be needed once a delivery programme is established. Contingencies should also be considered; design, construction and client contingencies are recommended.

Estimated energy / carbon reduction

This provides an estimate of the potential energy savings and carbon reduction associated with the proposed measure, compared to the baseline developed during the survey and assessment process.

It provides a high-level guide as to the relative scale of reductions achievable with each measure under consideration.

Energy-Cost effectiveness

This provides an indication of the scale of carbon reduction relative to the capital investment required to implement each measure.

It provides a more consistent method of evaluating the relative cost effectiveness of different measures than payback periods, which are influenced by changing energy prices and tariff types.

The costs identified in the table represent indicative estimates of the likely costs to implement the carbon reduction improvements as described in this study.

The costs form a starting point for decision making. It is important to recognise the assessments are based on the limited information currently available. As with all construction works it is advised that further cost checks are carried out at each design stage. The current costs should be viewed as at RIBA stage 0/1.

The allowances currently assume each item is carried out via a direct contract with the supplier, rather than delivered through a Main Contractor. Appointing a main contractor to undertake a work item will lead to additional costs through management and profit layering. Conversely if the works are linked to a wider scope and form part of a larger scope economies of scale may arise.

Please note all costs are current day, 3rd quarter 2025. An adjustment for inflation will be needed once a delivery programme is established. Contingencies should also be considered; design, construction and client contingencies are recommended.

General exclusions

- Removal and reinstatement of furniture and fittings to enable works to be completed
- Structural enhancements to the existing building to accommodate decarbonisation proposal
- Professional Fees
- Contingencies: design, construction, client
- Inflation
- Finance Charges
- VAT
- Client direct costs including loss of earnings, operating costs etc.

5.5 Option Evaluation

NOTE: Cost scale values are high-level estimates and should only be taken as indicative for comparison purposes. Specific figures should be confirmed with a Quantity Surveyor before implementation.

Low: < £100k
Medium: £100k - £1m
High: > £1m

Estimated energy/carbon reduction (relative to the whole site):
Low < 0.5% saving/yr
High > 1.5% saving/yr

Estimated cost effectiveness (cost per ton of carbon saved):
High cost effectiveness < £30,000/tCO2/yr
Low cost effectiveness > £100,000/tCO2/yr

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	• Other considerations
ROOFS									
The Royal Theatre: • Pitched slate roofs • Suspected not currently insulated	Retrofit insulation to the roofs	High Adding insulation internally may require internal scaffolding and would need to be carried out around live services in the roof voids. Adding insulation externally would require external scaffolding and works to remove and reinstate external finishes	Medium/high Reinstatement works would be required to internal and external ceiling finishes and ceiling/roof levels may be altered.	700m2 (roof)	£224,000	High	High	Medium The slate roofs are reportedly in fairly poor condition. Insulation could be carried out externally alongside renewal of waterproofing and rainwater goods, or internally locally between rafters. Remedial works to the internal of the roof have already been undertaken, making it more complex to retrofit internal insulation. External insulation would therefore be recommended	• Internal/External insulation would require Planning and Listed Building consent.
Royal Theatre BoH - Paint shop: • Paint shop - pitched, largely glazed roof, metal roof, with flat solid central area	Retrofit insulation to the roof internally or externally	Medium Roofs appear to be generally accessible internally to add insulation. Internal scaffolding would be required.	Low / Medium Internal or external insulation will not significantly alter the appearance of the roof.	112m2 (roof)	£26,000	Medium	High	Medium	• Replacement of glazed roof area and Royal AHU ventilation plant should be considered in conjunction to roof insulation works. • Internal insulation would require less onerous Planning and Listed Building consent.
Royal Theatre BoH - Workshop: • Workshop, stage management offices and get in area - flat asphalt/bitumen roof	Retrofit insulation to the roof internally or externally	Medium/High Adding insulation externally to flat roof areas may be challenging due to location of rooftop services. Would therefore require internal insulation to the roofs.	Low / Medium Reinstatement works would be required to internal ceiling finishes and ceiling/roof levels would be altered	230m2 (roof)	£161,000	Low	Low	Medium	

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
Royal Theatre BoH - Hector's House: • Dressing room block - corrugated pitched roof	Install additional insulation to the wall either internally	Low / Medium External insulation would cause less disruption to the internal spaces. Low rise building would not require much work to insulate.	Low	43m2 (roof)	£48,000	Low	Low	Low	
Derngate Theatre • Metal roof (red/orange area)	Retrofit insulation to the roof externally	High Insulation to be added externally and would therefore include renewal of roof coverings	Low	1840m2 (roof)	£603,000	High	Medium	Low	• RAAC roof has recently undergone structural reinforcement works, internally, possibly making this area more complex to retrofit. • External insulation would require Planning and Listed Building consent.
Foyer: • Flat asphalt roof to Copper clad external walls • Concrete structure with timber beams to support the roof. • Insulation expected given 2006 construction	Additional insulation to the roof externally	High Insulation to be added externally and would therefore include renewal of roof coverings	Low	270m2 (roof)	£181,000	Low	Low	Low	• External insulation would require Planning and Listed Building consent.
Admin and Rehearsal buildings: • Pitched slate roofs.	Retrofit insulation to the roof voids internally	Medium Ease of access into roof voids unconfirmed	Low	1350m2 (roof)	£154,000	Medium	High	Low	
EXTERNAL WALLS									
The Royal Theatre: • External brick walls of solid construction.	Retrofit insulation to the walls internally	Medium / High Will require remedial works done to the perishing external walls prior to installing internal insulation.	High Will need to work around or avoid the ornate plaster walls	530m2 (external walls)	£328,000	High	Medium	Medium Subterranean walls to BOH/stage area noted as "perishing" and therefore high priority for repair.	• The exposed wall area of the Royal is relatively low so whilst upgrades would be beneficial, the overall energy reduction is likely to be low. • Internal and External insulation would require Planning and Listed Building consent. • External insulation is unlikely to be feasible within the listing constraints.

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
Royal Theatre BoH - Paint shop: • External brick walls of solid construction, exposed brick internally and render finish externally	Retrofit insulation to the walls externally	Low / Medium	Low / Medium Within listed curtilage, however the walls are already rendered externally and in poor condition	488m2 (external walls)	£169,000	Medium	High	Medium Rendered exterior walls noted as being "degraded"	• External insulation would require Planning and Listed Building consent.
Royal Theatre BoH - Workshop: • Rendered external brick walls of solid construction.	Retrofit insulation to the walls internally	Low / Medium Will cause disruption to the internal spaces, and likely to require removal and re-installation of heavy equipment.	Low / Medium Within listed curtilage, however the appearance of the internal walls are assumed to be of less importance from a heritage perspective.	110m2 (external walls)	£49,000	Low	Low		
Royal Theatre BoH - Hector's House: • Dressing room block - rendered cavity brick walls, assumed to have insulation due to the age of the building.	Retrofit additional insulation to the walls internally	Low	Low	125m2 (external walls)	£48,000	Low	Low		
Derngate Theatre: • Concrete block walls (estimated)	Retrofit insulation to the walls internally	High Insulation to be added internally. Would affect internal spatial arrangements and linings	Low	5500m2 (external walls)		High	Low	Low	• Internal insulation may require Planning and Listed Building consent.
	Retrofit insulation to the walls externally	Medium/High Insulation to be added externally, requiring extensive scaffolding and removal and reinstatement of the copper cladding system.	Medium Technically within the curtilage of the listed building, but possibly less significant as a later addition.	5500m2 (external walls)		High	Low	Low	• External insulation may require Planning and Listed Building consent.
Foyer: • Combination of curtain walling and copper cladding. • Insulation expected given 2006 construction	Retrofit insulation to the walls externally	Medium Insulation to be added externally, requiring extensive scaffolding, although this may not affect internal planning or use of the theatre	Low	315m2 (external walls)	£213,000	Medium	Medium	Low	
Admin and Rehearsal buildings: • External brick walls of solid construction.	Retrofit insulation to the walls internally	High Will be difficult to implement without adversely affecting the business operations of the existing tenants.	Medium / High Will alter interior appearance of (listed) building.	480m2 (external walls)	£170,000	High	High	Medium Internal walls generally in fair condition.	• The installation works will be very intrusive to the daily operations of the existing tenants. • These works are likely to detract from the heritage aesthetics of the existing walls and will require Planning consent.

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
GLAZING									
The Royal Theatre: • External facades have a very low proportion of glazed areas. • Windows are single glazed throughout	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Low / Medium	Low / Medium	30m2 (windows)	£49,000	Low	Medium	Low	• Secondary/Replacement glazing will require Planning and Listed Building consent.
Royal Theatre BoH - Paint shop: • Pitched single glazed roof • Single glazed windows to paint shop walls	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Medium / High Glazing upgrades to the roof may require additional structural works, and will require ventilation provisions to avoid condensation, adding to the complexity of the works.	Low	100m2 (windows)	£163,000	Medium	Medium	Medium	• Replacement glazing will require Planning consent. • Glazing upgrades should be considered in conjunction with other roof level works eg. insulation of the flat roof area.
Royal Theatre BoH - Workshop: • Single glazed windows	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Low Small number of windows to replace/rectify.	Low Building assumed not to have as great cultural heritage importance	4m2 (windows)	£7,000	Low	Medium		• Replacement glazing will require Planning consent.
Royal Theatre BoH - Hector's House: • Reported a single glazed windows	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Low Small number of windows to replace/rectify.	Low Building assumed not to have as great cultural heritage importance	4m2 (windows)	£7,000	Low	Medium		• Replacement glazing will require Planning consent.
Derngate Theatre: • Very small proportion of the external façade has windows.	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Low	Low	100m2 (windows)	£163,000	Low	Medium	Low	• Glazed areas in the Derngate are relatively low, so potential energy savings are likely to be low. • Secondary/Replacement glazing will require Planning consent.
Foyer: • Single glazed curtain walling system, reported to be leaking air and water. • Pitched glazed section of roof. - move to 'Foyer' • Fully glazed (appears to be single glazing) section of the facade at the main entrance. - move to 'Foyer'	Replace curtain walling	Medium / High May require additional structural works, and will require ventilation provisions to avoid condensation build up in the void space - adding to the complexity of the works.	Low	170m2 (windows)	£522,000	Medium	Medium	High	• Replacement glazing will require Planning consent.

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
	Fix leaks within the curtain walling system	Low	Low	270m2 (external walls)	£56,000	Medium	High	High	• Existing curtain walling system reported to have various leaks (air and water ingress) throughout.
Admin and Rehearsal buildings: • Single glazed timber framed sash windows.	Upgrade existing glazing (eg. secondary glazing/ reglazing/ replacement glazing)	Medium	Medium	360m2 (windows)	£586,000	High	Medium	Low	• Replacement glazing will require Planning consent.
EXTERNAL DOORS AND VENTS									
The Royal Theatre: • smoke vent	Rectify draughts to the existing smoke ventilation system.	Low	Low	Approximately 4m3/s AHU	£46,000	Medium	High	High	• This is seen as a large heat loss source for the space. There may be significant thermal comfort benefits, even if overall energy reduction is low. • There may also be fire safety concerns involved with this item of equipment, hence should be a priority intervention.
Royal Theatre BoH: • loading bay	Reposition the 'get-in' thermal line within the building, limiting heat losses through loading bay doors. Includes resealing of lobby doors where the thermal line is affected.	Low / Medium May require some re purposing of internal spaces, and a new management plan for taking deliveries.	Low	TBC	£199,000	Low	Medium	N/A	• Will likely require further investigations as to how the thermal line can be brought further in to the building without affecting the operations of the theatre.
Derngate Theatre & Foyer • loading bay	Reposition the 'get-in' thermal line within the building, limiting heat losses through loading bay doors. Includes resealing of lobby doors where the thermal line is affected.	Low / Medium May require some re purposing of internal spaces, and a new management plan for taking deliveries.	Low	TBC	£199,000	High	High	N/A	• Will likely require further investigations as to how the thermal line can be brought further in to the building without affecting the operations of the theatre.
LIGHTING									
The Royal Theatre: • Stage lighting is outdated and energy intensive, though some LED • Foyer lighting is now almost fully LED	Replace existing stage lighting with modern low energy LED lighting	Low Will require scaffolding/ access platforms to high level areas.	Low	TBC - whole building area	£332,000	Medium	Low	Medium	• Note: a roll out of LED fittings is already in progress generally. • Coordination with emergency lighting requirements and existing battery systems will need to be considered • • Replacement Stage lighting could have big impact on efficiency?
Royal Theatre BoH: • Mostly fluorescent lighting	Replace existing fluorescent and halogen lighting with LED lighting	Low Will require scaffolding/ access platforms to high level areas.	Low	TBC - whole building area	£124,000	Low	Medium	Low	• Note: a roll out of LED fittings is already in progress generally. • Coordination with emergency lighting requirements and existing battery systems will need to be considered

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
Derngate Theatre: • Stage lighting is outdated and energy intensive • Other lighting mostly fluorescent or halogen lighting	Replace existing stage lighting, and fluorescent and halogen lighting throughout with LED lighting	Low Will require scaffolding/ access platforms to high level areas.	Low	TBC - whole building area	£803,000	High	Medium	High	• Note: a roll out of LED fittings is already in progress generally. • Coordination with emergency lighting requirements and existing battery systems will need to be considered
Foyer: • Foyer lighting is now almost fully LED	Complete the existing transition to LED lighting throughout the building. Consider also controls to dim or turn off lighting when areas are well daylit.	Low Will require scaffolding/ access platforms to high level areas.	Low	TBC - whole building area	£33,000	Low	Low	Low	• Note: a roll out of LED fittings is already in progress generally. • Coordination with emergency lighting requirements and existing battery systems will need to be considered
Admin and Rehearsal buildings: • Mostly LED lighting	No specific opportunities identified	N/A	N/A	N/A	Included in item 29	Low	N/A	N/A	• N/A
VENTILATION									
The Royal Theatre: • AHU from 2006, with run around coil HR • Natural smoke ventilation system is in a state of disrepair and a source of heat loss	Upgrade with new AHU with plate heat exchangers (or newer runaround coil) and EC fans	Medium Will be subject to space/ access constraints on site	Low	Approximately 4m3/s AHU	£180,000	Medium	Medium	High	• Some downtime would be required to the auditorium ventilation, which would need to be scheduled in.
Royal Theatre BoH: • AHU from 2006, with run around coil HR	Upgrade with new AHU with plate heat exchangers (or newer runaround coil) and EC fans	Medium Will be subject to space/ access constraints on site	Low	Approximately 1m3/s AHU	£88,000	Medium	High	High	• According to the O&M manuals from 2006 works, there is an AHU serving the Royal BoH areas.
Derngate Theatre: • Assumed AHU from 1982, with no HR	Replace existing AHU fans with new EC fans	Medium Will be subject to space/ access constraints on site	Low Replace existing plant equipment with new. Will be subject to site space constraints.	Approximately 10-20m3/s AHU	£15,000	High	High	Medium / High	• The steady state heat loss calculations show the ventilation to be the main heat load for the Derngate theatre. • Some downtime would be required to the auditorium ventilation, which would need to be scheduled in
	Install a new run around coil heat recovery unit in the existing AHU.	Medium Will be subject to space/ access constraints on site	Low	Approximately 10-20m3/s AHU	£46,000	Medium	High	Medium / High	
Foyer: • Natural ventilation turrets	Full service and optimisation of the automated natural ventilation system	Low Will require scaffolding/ access platforms to high level areas.	Low	TBC	£13,000	Medium	High	Medium / Low The urgency of this will depend on the condition and operation of the existing system.	• Natural ventilation strategy to be considered in conjunction with fabric improvements / replacement of openable windows

5.5 Option Evaluation

Elements	Energy saving opportunities	Difficulty of implementation	Heritage sensitivity	Approx. Area / Quantities	Cost Scale	Estimated energy/carbon reduction	Estimated cost effectiveness	Condition influence	Other considerations
Offices and Rehearsal: • Assumed to be naturally ventilated	Install mechanical heat recovery ventilation	Medium Space to be identified on roof for the AHU and within the floorplates for the ductwork	Medium / High Will alter interior appearance of historic building and require careful coordination.	Approximately 2m3/s AHU	£164,000	High	High	Low	• This intervention may become required if secondary or double glazing were installed (depending on provision of background ventilation). • • Although the electrical demand for the building will increase, this should be offset by the reduced heating demand for the building, via the improved thermal performance of the glazing and the introduction of heat recovery for the space.
HEATING									
Site-wide: • BMS system installed in 2006 • Noted as being problematic to run	Rectify / optimise controls	Medium / High Will be subject to access constraints on site	Low	TBC - whole R&D site	£824,000	High	High	High	• It is difficult to assess the potential impact of this solution • Although the electrical demand for the building will increase, this should be offset by the reduced heating demand for the building, via the secondary glazing (improved air permeability) and the introduction of heat recovery for the space.

5.5 Option Evaluation

LZCT Opportunities	Difficulty of implementation	Heritage sensitivity	Indicative capital cost	Operational cost	Total energy output (relative to total site demand)	Estimated energy/ carbon reduction	Estimated cost per ton of carbon saved	Other considerations	
Photovoltaics	Low Can be integrated onto existing roofs, although there will be visual considerations	Medium To be checked in terms of listed building context, but heritage roofs typically avoided	£441,000	Very Low Periodic maintenance only	Low Limited by available space for panels	Low	High	Medium Subject to seasonal variation	• Planning consent will be required • Structural reinforcement to roof may be required.
Air Source Heat Pump System	Medium Requires external plant space	Medium To be checked in terms of listed building context, but heritage roofs typically avoided	£2,819,000	Medium/High Subject to electricity tariffs	High Could potentially meet the site's heating loads	High	High	Medium/High Subject to adequate electricity supply	• Planning consent will be required. • Structural reinforcements may be required. • Requires new plant enclosure location. • May structural reinforcement if located on roofs. • May also require LV supply upgrade. • Heating systems will need to be upgraded for lower grade heating • Some existing infrastructure may be used. May require structural enabling works and extensive sound attenuation
Ground Source Heat Pump - Closed Loop	Medium Requires land area for boreholes	Low Impact on archaeology to be checked	£3,188,000	Medium Subject to electricity tariffs	Low/ Medium Limited by clear ground availability for boreholes	Medium	Medium	Medium/High Subject to adequate electricity supply	• Some existing infrastructure may be used. May require structural enabling works • Borehole drilling
Ground Source Heat Pump - Open Loop	Medium Requires land area for boreholes, interconnecting pipework, and space on site for water treatment plant equipment.	Low Impact on archaeology to be checked	£2,989,000	Medium Subject to electricity tariffs, and likely to require abstraction and discharge fees.	Low/ Medium Limited by groundwater availability	Medium	Medium	Medium Subject to adequate electricity supply, and regular good maintenance of the open loop system.	• Planning consent will be required. • Borehole drilling • EA licensing would be required. • Structural reinforcements may be required. • Requires new plant enclosure location. • May also require LV supply upgrade. • Heating systems will need to be upgraded for lower grade heating

DESIGN DEVELOPMENT

6.1 Summary of potential improvements

Building Fabric & Maintenance & Repair

In the absence of a comprehensive condition survey of the external envelope, it is not possible to provide fully informed recommendations for fabric upgrades.

However, observations from the site visit and briefing workshops identified several areas of the building fabric that are known to contribute to heat loss and poor thermal comfort.

In accordance with Historic England's energy efficiency hierarchy, these issues should be prioritised to minimise unnecessary energy use and reduce wastage.

Key issues identified include:

- Significant heat loss within the Theatre Royal auditorium, primarily due to draughts from smoke vents in the wings and air leakage through the rigging area.
- The Theatre Royal stage, being partially subterranean, shows signs of deteriorating external brickwork.
- Extensive areas of single-glazed curtain walling and glazed entrance doors around the main foyer are highly draught-prone, with evidence of rainwater ingress in some locations.
- The paint shop and workshop areas rely on temporary heating, and are characterised by large areas of single glazing and degraded external fabric.

Service Systems

As with the building fabric, a full survey of service systems across the complex has not been undertaken, limiting the ability to provide definitive recommendations.

Nonetheless, observations indicate that stage lighting and ventilation systems within the auditoria are likely to represent a significant proportion of the building's overall energy consumption. Improving the efficiency of these systems should therefore be investigated as a priority.

Additional measures to reduce energy wastage include the installation of improved metering and heating controls, as well as ensuring continuous insulation of all pipework.

Low/Zero Carbon Technologies

A range of low and zero carbon technologies (LZCTs) were considered during the options appraisal. However, only Air Source Heat Pumps and Photovoltaic (PV) panels were deemed suitable for this building complex.

These technologies have been developed in further detail in the following sections

6.1 Low & Zero Carbon Technologies

Following the initial Options Appraisal, the team undertook further preliminary assessments of the viability of photovoltaics and heat pumps as part of a transition towards low and zero carbon technologies.

6.1.1 Photovoltaics

The Design Team looked at the available roof space on the site, and the likelihood of housing a new PV array (factoring the influences of access; orientation; and shading from adjacent buildings), in order to assess the potential to generate electrical energy on site using photovoltaics.

These areas are shown in the adjacent layout and their potential of each roof area of housing a PV array is depicted using a colour coded RAG rating.

- Arrays shown in green are what are believed to be more achievable with fewer constraints to their installation on site.
- Arrays shown in orange are to indicate that they are potentially problematic areas to locate PVs due to existing plant equipment, access issues, or potential shading from adjacent buildings. This will require modelling (e.g. IES Suncast) to better understand the potential of solar tracking year round, and the shading from adjacent buildings.

For all of these options, further detailed analysis will be needed to better understand their feasibility on site, with particular concerns of access and structural stability of the roofs in their existing state.

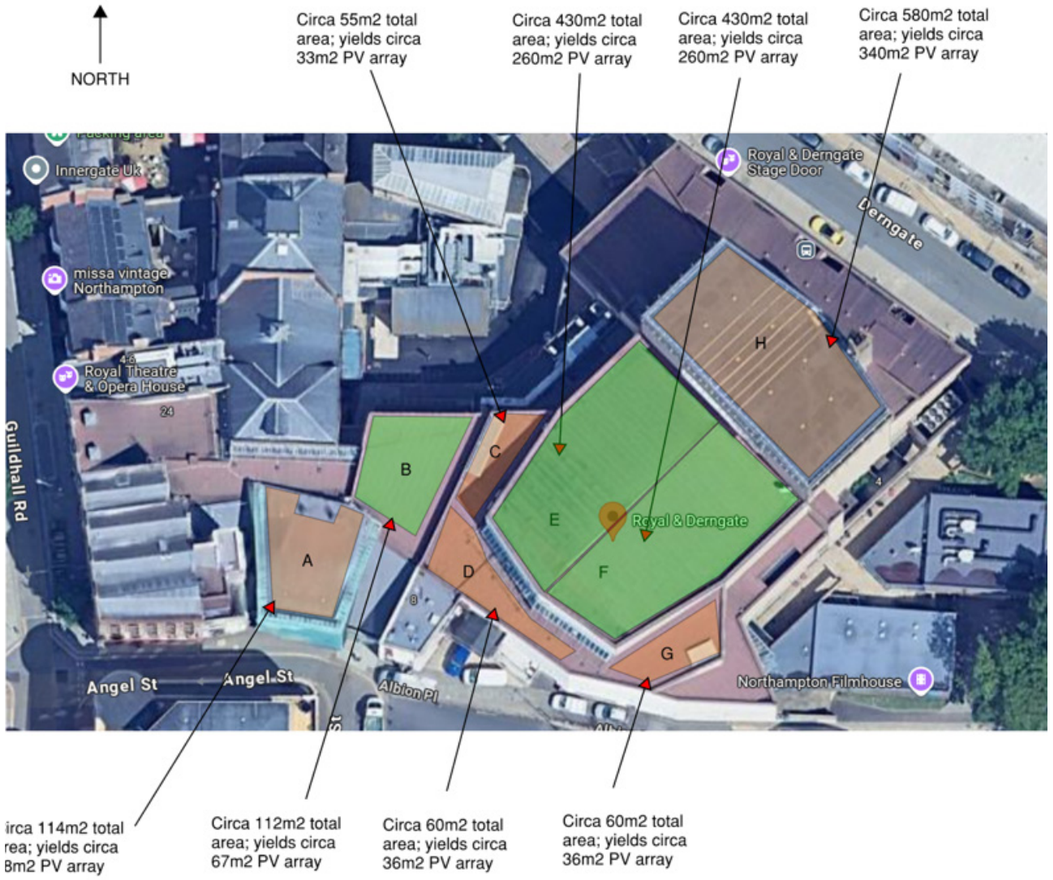
Using the Photovoltaic Geographical Information System (PV GIS) tool from the European Commission's Joint Research Centre, we have estimated the electrical generation for each array to try to understand how much electricity could be generated at the Royal & Derngate Theatre site.

All estimations assume a 30° incline from horizontal (which is widely considered to be the optimal angle for fixed PV panels to be generating electricity year round), and 20% efficient PV panels, with 14% system losses:

From the above table we can see that if all of the roof areas shown were to be utilised for PVs then the site could generate up to circa 21% of the site's electricity requirements for the year.

Of all of the 8no. proposed roof spaces, the most beneficial locations for sighting the PV panels will be areas E, F, and H, which are all on the higher roofs of the Derngate Theatre.

Together these areas comprise circa 81% of the total generated electricity, and would provide for circa 17% of the site's overall annual electricity usage.



ARRAY	AREA OF PANELS (M^2)	ESTIMATED YEARLY ENERGY PRODUCTION (KWH)	PERCENTAGE OF EXISTING ELECTRICITY CONSUMPTION
Array A	54.4	11,002	1.2%
Array B	53.6	10,710	1.1%
Array C	26.4	5,218	0.6%
Array D	28.8	5,748	0.6%
Array E	430	42,598	4.5%
Array F	430	67,512	7.2%
Array G	28.8	5,339	0.6%
Array H	272	52,616	5.6%
TOTAL	***1324***	***200,743***	***21.3%***

6.1 Low & Zero Carbon Technologies

6.1.2 Air Source Heat Pumps

The site heating load is estimated to be in the region of 1,100kW, which aligns with the existing heating provision by the gas fired boilers.

Using the Clade Maple ASHPs as an example, the table below lists the number of units that would be required for each size option.

Of the potentially available locations to house the ASHPs, the location marked as “E” would be the only feasible option to house all the ASHPs in one location, where they will meet the site’s entire heating load requirements.

This location is potentially problematic due to its proximity to the residential flats across Derngate Road, and so will likely require considerable noise attenuation in order to comply with planning requirements.

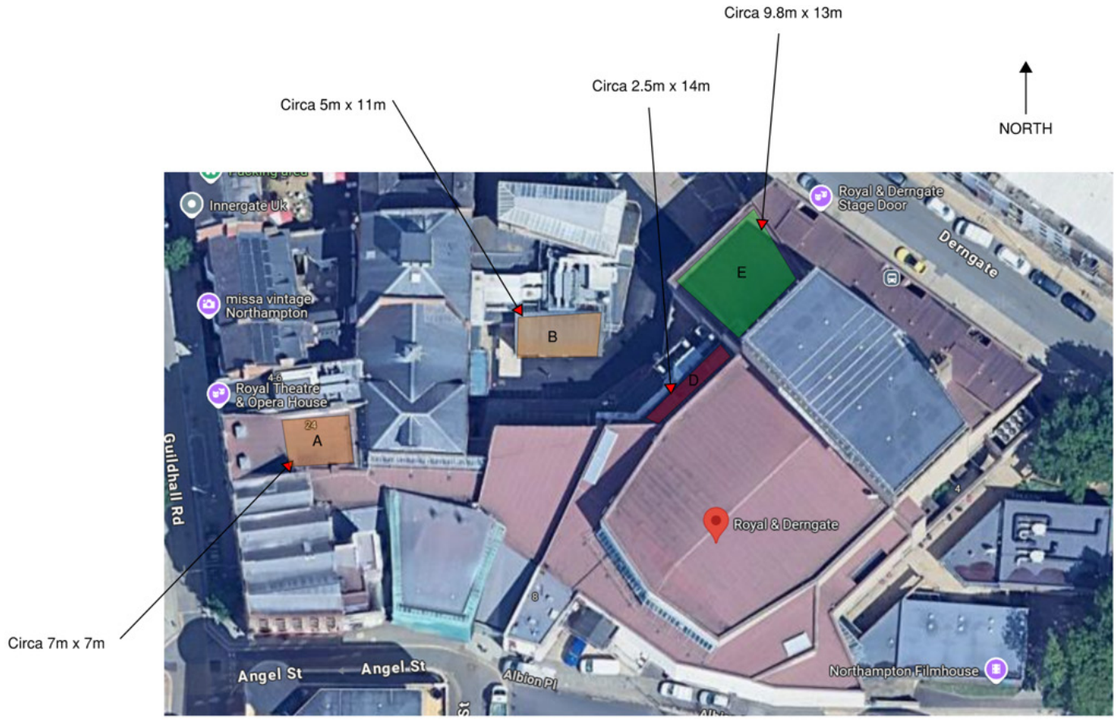
Therefore decentralising the heating system such that we can use smaller ASHPs to meet the heating demands of the individual buildings would be more feasible given the likely space constraints.

Other options that may be explored in terms of locating the ASHPs would be to site them internally in a space currently not being utilised, such as at high level in the Paint-shop on a newly installed mezzanine floor.

For all the heat pump options being proposed within this report, it is important to note that modifications may be required to the existing heat emitters throughout the site, due to heat pumps operating at optimal efficiencies when producing heating water in the region of 40-50°C.

As the existing heating infrastructure is designed to operate at much higher heating flow temperatures of circa 80°C, then the emitters would need to be replaced with larger emitters to provide similar heat outputs whilst using lower temperatures in the heating system.

This requirement (of upgrading the heat emitters) may be mitigated against if we undertake energy reduction interventions, such as upgrading/insulating the building fabric, windows, etc.



OPTION	CAPACITY PER UNIT	DIMENSIONS (L X W X H)	NO. OF UNITS REQUIRED
1	200kW	3.3m x 2.4m x 2.4m	6
2	300kW	4.7m x 2.4m x 2.4m	4
3	400kW	6.1m x 2.4m x 2.4m	3

6.1 Low & Zero Carbon Technologies

6.1.3 Ground Source Heat Pump (closed loop)

The areas shown on the adjacent image are all potential locations for a ground array, and are highlighted in either green or amber, indicating that they are either likely to be feasible or possibly feasible (due to known and/or unknown challenges) options for installing a ground array.

These areas were chosen based on guidance provided in CIBSE TM51 with regards to locating vertical boreholes for closed loop GSHPs, where boreholes must be more than 5m away from the nearest footings of a building, and must be spaced a minimum of 5m apart.

Area A is in the car park south of Albion Place, and is highlighted as amber as it is believed to be owned by others, hence an agreement must be sought from the landowner of this car park to assess the feasibility of using this section of land. As this area is currently being used as a car park, it is unlikely that the landowner would be willing to allow for any downtime of use of this car park.

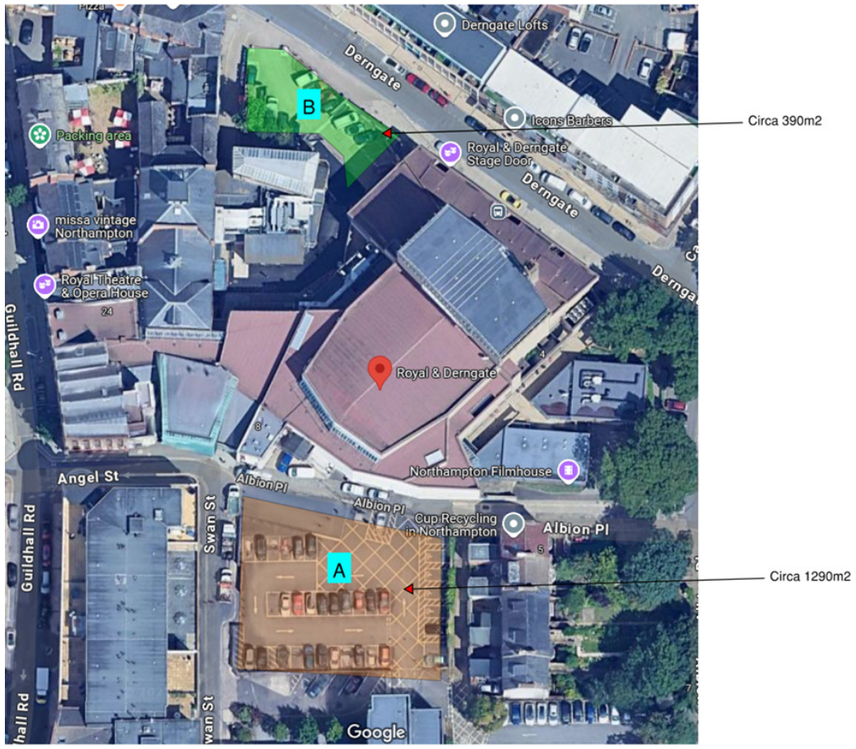
Area B is to the north of the Derngate Theatre and south of the Derngate road. This location seem to be the more viable of the two presented options but is not ideal as it will be sheltered from the southern sun by the various buildings in the theatre complex, and so the ground is unlikely to recharge its heat energy from the sun.

Based on the above areas and guidance provided in TM51 of typically obtaining between 20 and 70 W/m of linear length of the boreholes, and assuming 100m depth boreholes, providing circa 2kW to 7kW per borehole (depending on the pipe diameters and arrangements being used), we have assessed the potential heat energy to be gained from the ground to the site's heating network in the table below:

From the above table we can see that if we could utilise the car park space to the south of the Derngate Theatre, then we could potentially meet up to the region of 25% of the site's heating loads using a GSHP closed loop system. If we were to do this in conjunction with the area to the north of the Derngate theatre, then we would potentially yield up to half of the site's heating energy requirements.

Another point to note about GSHPs is that they perform better year-round for heating and cooling, when compared to ASHPs, as the ground temperatures are more stable year-round. It is also more favourable to use the ground arrays for cooling so as to recharge the ground temperature, which could benefit the site by reducing the load on the existing chiller, hence improving the payback of installing this technology.

Much of this option is subject to the land available for the ground arrays, as well as the geological conditions of that land.



AREA REFERENCE	AREA, M2	NO. OF BOREHOLES	HEAT ENERGY, kW
A	1,290	54	108 - 378
B	390	26	52 - 182

6.1 Low & Zero Carbon Technologies

6.1.4 Ground Source Heat Pump (open loop)

The open loop ground source heat pump option requires fewer boreholes, as this system consist of the extracting water from and discharging water back to a below ground aquifer, and abstracting the heat from the below ground water in the process.

As such this system would only require 2no. boreholes to be drilled, and would likely be in the two regions shown on the previous diagram, both to the north and south of the site. It is usually advisable to have circa 100m between the abstraction and discharge boreholes to avoid any thermal interference between the two boreholes and the effects that this may have on the aquifer.

Although more favourable than the closed loop system in terms of space requirements for boreholes, this would present a further complication in that a pipework system would need to be routed around the site from both boreholes on either side of the site, making installation complex.

It can be difficult to asses the available heat within an aquifer for an open loop system at such a high level, without undertaking further analysis of the ground and below ground conditions, however as a rule of thumb we would estimate circa 5l/s of water being abstracted at a temperature difference of 5^{o}C, then we could extract circa 105kW from the ground, which may be uplifted to circa 140kW by the heat pump. This would provide circa 10% of the site's heating requirements.

Other things to consider for this system would be the more onerous maintenance requirements to ensure that systems are in place so that any pollutants and toxins are removed from the abstracted aquifer water before being re-injected into the aquifer, as well as to ensure that the water is re-injected at the correct temperature, so as not to cause any thermal drain on the aquifer over time.

There are also licences to be obtained from the Environment Agency for the abstraction and re-injection of water into/out of the aquifers, which would present as additional costs to consider.

FORWARD PLAN

7.1 Forward Plan

Due to the size and complexity of the site, it is difficult to make recommendations for the prioritisation of decarbonisation measures without full consideration of the logistical implications, funding opportunities and spatial impacts of each measure.

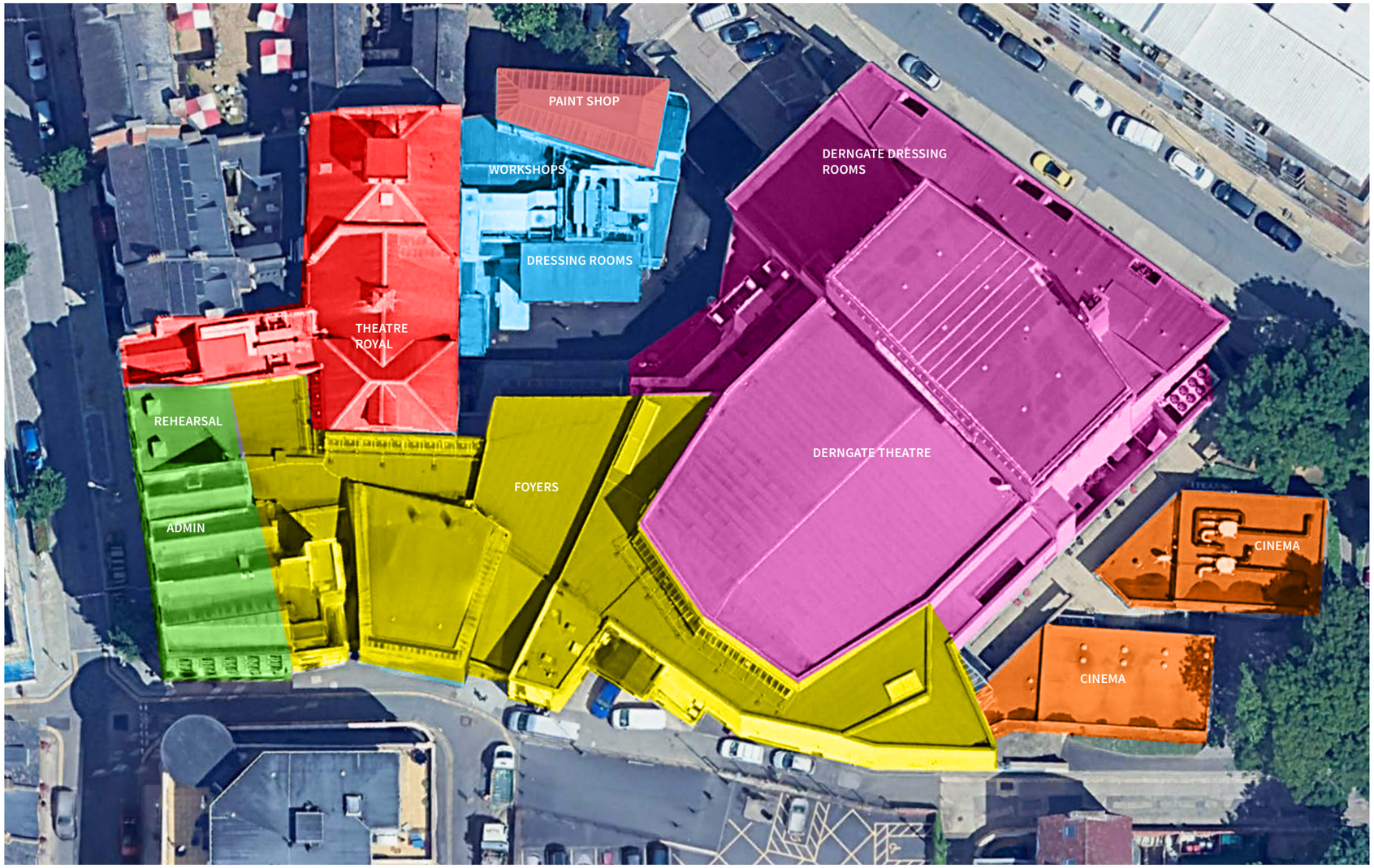
The Future Plan that Royal & Derngate is currently developing will help to define the key strategic priorities for the site as a whole, and may result in a series of phased projects to improve the accessibility, welcome, and creative potential of the building.

As these plans develop, the preliminary findings of the Decarbonisation Plan can help to integrate energy efficiency measures into both capital proposals and ongoing maintenance for each area of the building.

For example:

- A project to install solar PVs to the roof of the Derngate could be combined with upgrades to the thermal performance of the roof.
- A capital project to improve public accessibility and welcome may provide an opportunity to address the performance of the foyer façades.
- Replacement of the smoke vent to the Theatre Royal to improve fire safety may provide air tightness improvements as well as an opportunity for controlled natural ventilation for in warmer months to reduce reliance on mechanical ventilation and active cooling.

Further discussion is needed with Royal & Derngate's leadership team and appointed architects to establish priorities for implementation.



Building Zones - KEY:

- Theatre Royal and Paint Frame
- Production facilities
- Admin and rehearsal building
- Derngate Auditorium and dressing rooms
- Main foyers
- Cinemas

7.2 Next Steps

The scope of this Decarbonisation Plan was refined during the course of the project as a result of a more detailed understanding of the site's complexity. At project inception, it was anticipated that the historic Theatre Royal building could be assessed as a largely independent asset. However, as investigations progressed, it became clear that the building's services and operational systems are highly interconnected with those across the wider site. This level of interdependency required the complex to be considered as a whole rather than as discrete buildings, which significantly expanded the technical scope of assessment.

As a result, the team were not able to undertake the full scope of site surveys and energy modelling that would enable a more accurate understanding of building condition and performance. Instead, the available project budget was directed towards gathering and analysing the most critical information across the wider complex.

To carry out detailed assessments such as quantitative heat loss surveys and air tightness assessments across all areas of the building will require significant up-front investment, and it may be more appropriate to undertake these within specific areas of the building in which capital works are proposed.

As a minimum, we would recommend the following is carried out to inform the key strategic priorities:

1. An up to date condition survey of the external envelope of the whole complex be carried out, in collaboration with the building owners who are responsible for its maintenance.
2. Installation of sub meters to enable relative energy use across different parts of the site to be understood and monitored on a daily and yearly basis.
3. Installation of temperature and CO2 sensors in highly serviced spaces across the building to provide data on thermal comfort and air quality/ ventilation.
4. Continued use of the Theatre Green Book survey tool and resources.

Front cover image: Photograph by Mike O’Dwyer, courtesy of Royal & Derngate

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