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The Hall School

Structural and Civil Engineering Planning Report
&
Basement Impact Assessment

engineering a better society

		Remarks:	**Issued for Planning approval**				
Revision:	P1	Prepared by:	Suzanna Cooper	Checked by:	Agata Downey	Approved by:	James Souter
Date:	01/03/2019	Signature:	Engineer	Signature:	Senior Engineer	Signature:	Associate

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Amendments in Revision P3

Section	**Amendment**
9.10	Changes shown in red

Contents

Appendices

Our practice

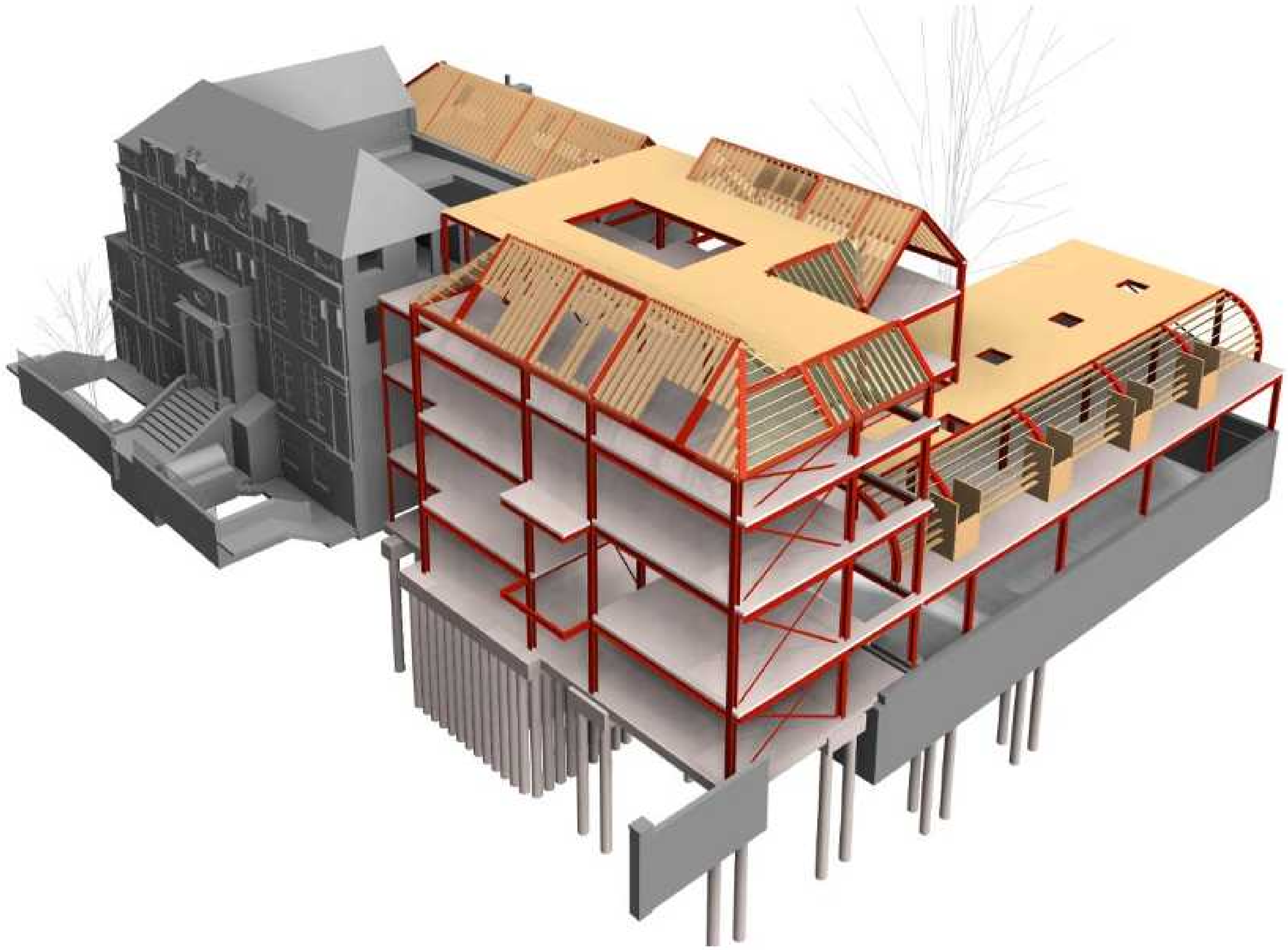
Elliott Wood work with likeminded people to engineer a better society

Our portfolio is extraordinarily diverse, and we particularly enjoy those projects which provide the opportunity to engineer for the common good – from making dramatic improvements to the life of a town or city, through to nurturing a new generation of exceptional engineers in our own in-house academy.

Despite more than twenty years in practice, we continue to be curious and find ways to pass on the benefit of our collective experience. We foster enquiring minds and share ideas because we know that this knowledge can make a real difference to our clients.

Engineering is often about the unseen: much of what we do is hidden when a building is complete. But engineering is not a necessary evil – it's much cleverer than that. Our role is to demystify the invisible workings of a structure, to reveal unexpected opportunities and to make the existing engineering work harder.

We value both technical and creative thinking and are activists for a new kind of engineering profession in which our craft is pivotal to the design process. We are no ordinary engineers.



Reveal / Materialise / Impact

Engineers make a difference

We like to be involved at the start of our clients' creative and commissioning journey, because we are concerned that not enough people are realising the full potential of their buildings. They are only working with what they can see.

Our process challenges usual perceptions of the engineer's role, because we help clients to see the unseen and achieve results beyond the aspirations of the brief – and which have a positive legacy for their wider communities.

Reveal

We ask questions. With innovative thinking, we reveal the unexpected opportunities in an already ambitious brief.

Materialise

We give ideas life. Using expertise and imagination, we materialise new assets for our clients.

Impact

We make a difference. Our work not only benefits our clients, it has a positive impact on society as a whole.

One

Introduction

1.1

This report is for the sole use of the Hall School for whom the report is undertaken and cannot be relied upon by third parties for any use whatsoever without the express authority of Elliott Wood.

1.2

Elliott Wood Partnership Ltd has been appointed by the school to provide structural and civil engineering input for the design of the proposed redevelopment of the Hall School site. The following report has been prepared to ensure that the neighbouring properties are safeguarded during the works. It includes information on the site, the proposed works, and how the works will be constructed. In addition, a Basement Impact Assessment has been undertaken by persons holding the required qualifications relevant to each of the stages. This follows the guidance given in the Camden Planning Guidance on Basements and Lightwells CPG4 and has been prepared in accordance with DP23 and DP27. The report follows Camden Council's updated Local Plan, in particular Policy A5 regarding the risk of damage to neighbouring properties.

1.3

This report has been prepared in collaboration with NORR Consultants Ltd, who are the lead consultant for the project.

1.4

The project involves the redevelopment of the school site, retaining the early school buildings but demolishing and replacing subsequent additions. The front elevation to the new extension will be sympathetic in size and treatment to the retained fabric, with additional studio and classroom space provided on top of the existing hall at the rear of the site. The superstructure of the new extension will be a steel frame with concrete on metal deck floor, below ground the extent of the existing basement will be increased in plan by addition of a new single storey basement between the Old School and the Wathen Hall created with contiguous pile wall.

1.5

A desk study has been undertaken to understand the history of the site and the general ground and site conditions. The study has been used to inform the details of the existing site, buildings and ground conditions presented in Sections 2.0 to 4.0. Geotechnical investigations have been carried out by Geotechnical and Environmental Associates and their report has been included within Appendix C in full.

1.6

The desk study includes information retrieved from or viewed at the following archive sources; London Metropolitan Archives, Camden Local Studies and Archives Centre and Camden Building Control.

Record information has been reviewed from archives held by the school. The archive information is available from Elliott Wood upon request.

Two

BIA Check List

- This report has been prepared by Elliott Wood LLP for the proposed works at Hall School, 23 Crossfield Road. It contains a description of the structural proposals for a new basement, an assumed construction sequence including temporary works and a Basement Impact Assessment carried out by GEA Ltd.

- The report has been written and reviewed by persons carrying the required Qualifications as set out in CPG4.

- The BIA process has been carried out in accordance with CPG4 and considers the effects of the proposals on Land Stability, Surface Flow and Flooding and Subterranean (Groundwater) Flow.

- The BIA screening procedure highlighted potential issues with the site being located on London Clay and the differential founding depths. The report demonstrates how these risks are mitigated by the proposed structural design and construction methodology. Refer to section 9.0.

- A Site Investigation was carried out by GEA Ltd. in July 2016 as part of the scoping stage of the BIA, including soil properties and contamination testing and groundwater monitoring. Refer to section 5.0 in Appendix C. The Report and Ground Movement Assessment in the report has been fully updated in February 2019. The GEA shows that damage to the neighbouring buildings will be negligible (Category 0).

- The proposals will have no significant adverse effect on surface flow and flooding. Refer to section 3.0 in Appendix C.

- The basements will have no significant adverse effect on the local hydrogeology. Refer to section 3.0 in Appendix C.

- The basements will be designed to ensure the ground is capable of supporting the loads and construction techniques to be imposed. Refer to section 8.0 in Appendix 3.

- The basements construction sequence and temporary works will be carried out as described in order to prevent land instability or structural instability to neighbouring structures and highways. Refer to sections 10.0 in Appendix 3.

- A need for monitoring the existing adjacent structures and highways has been identified and proposals have been included in the construction methodology.
  Refer to section 12.0 in Appendix 3.

- A suitably qualified contractor will be able to safely construct the proposed development in such a way as to not impact on the structural integrity and natural ability for movement of existing and surrounding structures, utilities and infrastructure.

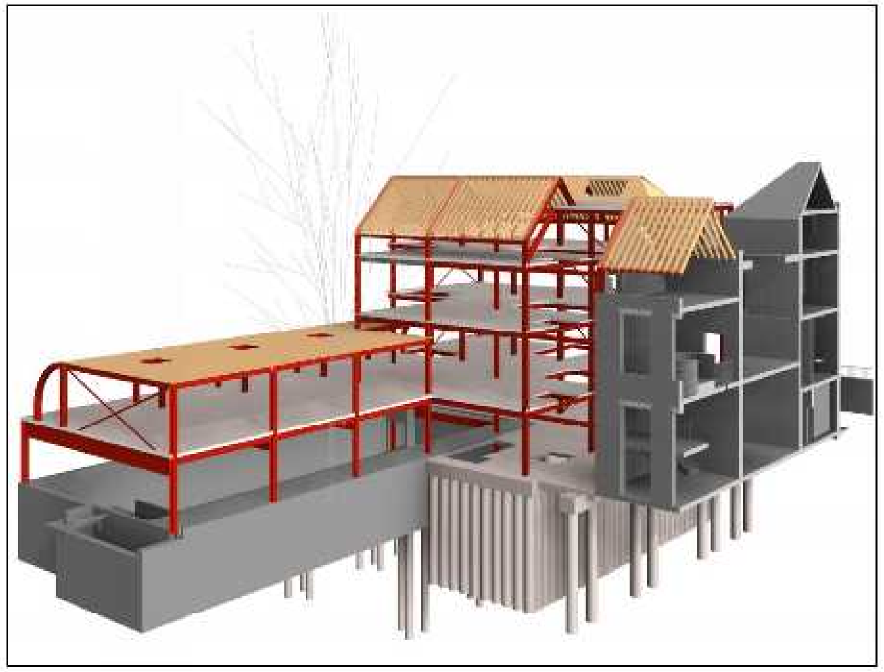


Figure 1: Proposed Project Development (as seen from the play area)

Three

Description of Site

3.1

The school is distributed across three sites in the Belsize Park Conservation Area, northeast of Swiss Cottage London Underground Station. The proposed development is to the Senior School site.

3.2

The Senior School site is located approximately 400m northeast of Swiss Cottage London Underground Station, and fronts onto Crossfield Road to the west. The site is bounded on the remaining sides by residential properties.

3.3

The overall Senior School site is broadly square in shape and measures approximately 50m by 50m on plan. External playing space occupies around a third of the site in the northeast corner.

3.4

A line of trees extends along the east site boundary and there is a large London plane tree in the centre of the site. The London plane is subject to a Tree Preservation Order (TPO), and is to be retained as part of the proposed scheme.

Figure 2: Site location

3.5

The school will remain at the site during the construction phase of the project. Precautions will be put in place to protect the children and staff at all times of the built. Temporary accommodation will be constructed to enhance on site facilities within the rear playground.

3.6

Records for the historic lost rivers known in London indicate that the site is approximately 100m away from the routes shown for two tributaries to the River Tyburn.

3.7

London bomb damage maps indicate that the site and the immediate surroundings did not experience bomb damage during the Second World War. Based on data provided by Zetica, Hampstead is within an area of medium-to-low risk for unexploded ordnance.

3.8

Record information suggests that there are no known underground tunnels or structures near to the site. The Swiss Cottage London Underground Station is located approximately 400m from the site, but the routes of the Jubilee and Metropolitan lines do not pass near to the site.

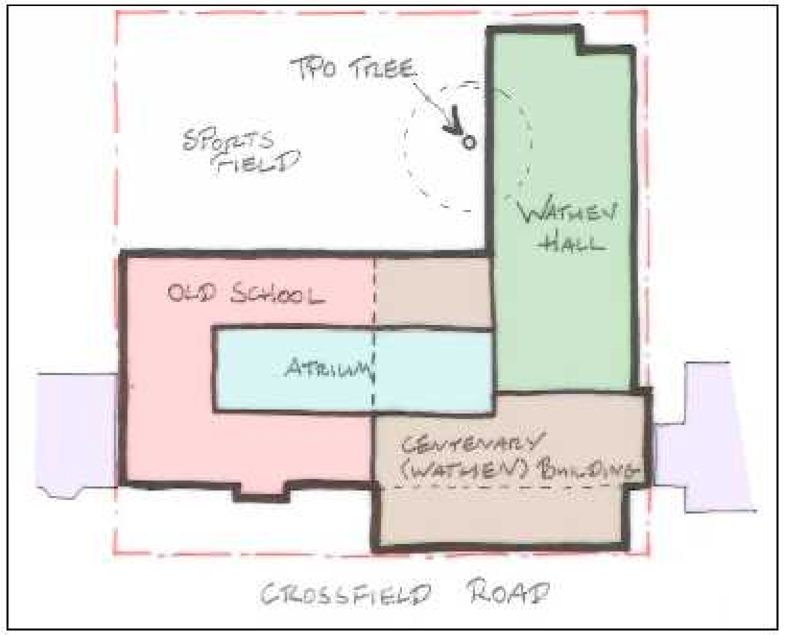


Figure 3: Existing buildings

Four

Site History and Summary of Existing Buildings

4.1

The original Victorian school was constructed c.1900 and occupied the northwest corner of the site. This broadly consisted of a four-storey front elevation, a two-storey central main hall, and a three-storey rear elevation. The original school is understood to be the first construction on the site.

4.2

The Senior School site is located approximately 400m northeast of Swiss Cottage London Underground Station, and fronts onto Crossfield Road to the west. The site is bounded on the remaining sides by residential buildings. The original school was extended to the south with additional single and double-storey accommodation, including new classrooms. Record drawings for these works date to the 1920s and 1930s.

4.3

The rear gable was extended in 1977, providing an additional staircase and further classrooms. The height of the new extension was to match the original building.

4.4

In 1984, the original main hall has damaged by fire. The damaged hall was replaced in 1986 with flat-roofed accommodation.

4.5

A significant extension to the site was carried out in 1989 with the construction of the Centenary (Wathen) Building and Wathen Hall across the south of the site. This included the construction of a new basement, with the hall partially below ground. The three-storey Centenary (Wathen) Building extended the original front elevation, with some existing single storey fabric retained within the envelope of the new structure.

4.6

In 2001, the area of the old hall was infilled with a new Main Atrium structure. The floors are generally across split levels to tie in with the floor levels of the original school building. The curved roof of the atrium extends over to the roof of Wathen Hall, housing additional accommodation.

Old School

4.7

The original school and the 1977 extension are both formed from load-bearing masonry with concrete strip footings, founded on the London Clay stratum present at the site at a shallow depth.

4.8

The suspended floor construction is to be confirmed, but it is assumed to consist of steel beams spanning between the masonry, supporting timber joists.

4.9

The pitched roof is understood to be formed from a series of timber trusses.

Wathen Hall

4.10

The sunken double-height space is created by an insitu reinforced concrete box with castellated steel beams spanning the clear width of the space to form the roof. The retaining walls continue above ground level to support the roof beams, which are grouted into preformed pockets within the concrete walls.

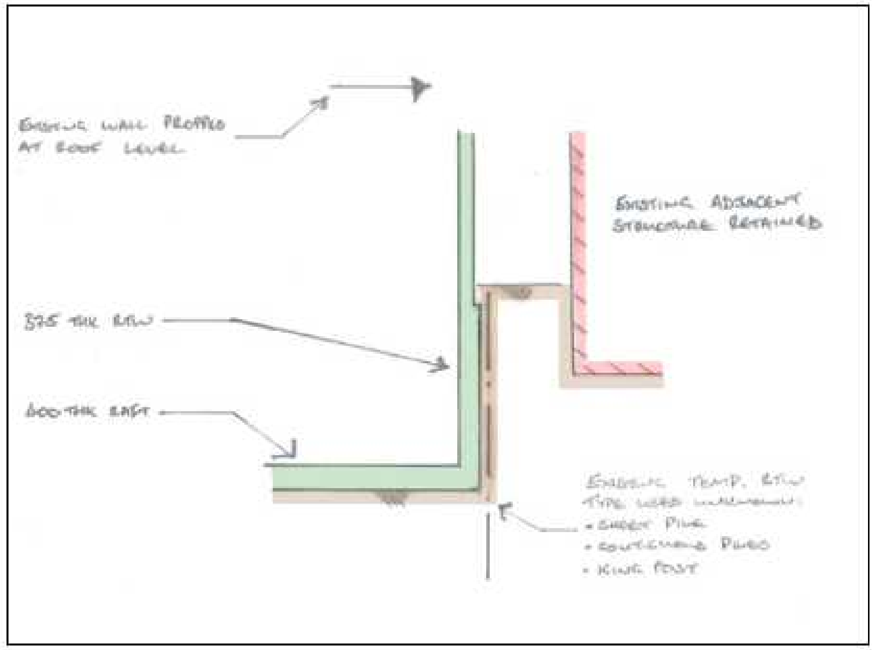


Figure 4: Existing basement wall construction

4.11

It is unclear from the record drawings available what forms of temporary works were used to construct the basement.

4.12

An internal cantilever walkway extends along one elevation of the building, projecting from the reinforced concrete wall.

4.13

Half of the roof is designated as a roof terrace, designed with reinforced concrete on profile metal decking spanning between the castellated steelwork to accommodate the higher load case. The remainder of the roof is covered with lightweight metal sheeting designed for nominal access over.

4.14

The redevelopment of the atrium that followed the construction of the Wathen Hall includes the creation of an occupied space over part of the area designed for the roof terrace. It is assumed that the construction is lightweight and that additional loads were justified within the available capacity of the terrace.

Centenary (Wathen) Building

4.15

The Centenary (Wathen) Building is constructed using two types of structural forms. As viewed from Crossfield Road, the left of the building is a steel frame and the right is constructed from load-bearing masonry.

4.16

This mixed form of construction is assumed as a response to the site constraints. The steel frame is located over an area of existing structure, where part of the older structure was retained. The masonry structure was constructed on previously undeveloped ground where the choice of structure was not constrained by previous works.

4.17

The masonry structure utilises brick and block cavity wall construction, and precast concrete floor planks bearing onto the internal blockwork leaf at each level. In locations of narrow structure, such as between doors and windows, reinforced concrete piers are used instead of blockwork, laterally tied into the floor planks.

4.18

The structure is generally founded on concrete strip footings on the London Clay, with one elevation bearing onto the retaining wall of the sunken Wathen Hall.

4.19

The natural ground locally was ramped in the temporary case to enable excavation and construction access for the adjoining sunken area. The depth of the footings is to bear onto undisturbed ground, and stepped to provide level bearing. The ramp was backfilled with consolidated fill, and the lower ground floor slab over is suspended.

4.20

The steel framed structure is located abutting the area of the building that was the Old Hall. The steelwork structure is framed off four steel columns, founded off a pair of reinforced concrete strip footings.

4.21

The columns penetrate the existing ground floor level without supporting it. The ground floor is instead retained between existing and new masonry walls. Precast floor planks are used at the new floor levels, with the existing timber joists retained between the existing steel beams at ground floor.

4.22

The record information for the Centenary (Wathen) Building makes reference to existing steel posts in the area of the building that was the Old Hall. It is assumed that these formed part of the accommodation provided following the fire damage to the hall.

Main Atrium

4.23

The Main Atrium appears to comprise of a steel frame infill in the centre of the site, interacting with all other phases of construction. A number of steel columns are installed in discrete locations to support the stepped floor slabs and the curved roof over. The roof is partially supported on the roof of Wathen Hall roof.

4.24

The three-storey atrium introduced an additional storey to the centre of the building that was previously provided by the Old Hall. It is therefore assumed that the existing masonry walls did not have the capacity to accommodate the additional vertical loads and new independent vertical structure was required.

4.25

The foundations to the atrium infill are not known. Given that part of the infill is supported from the Wathen Hall roof, it is assumed that the infill structure is founded on the same stratum as the hall, although there may be a movement joint between the two structural forms.

Five

Site Geology

5.1

A detailed Ground Investigation and Basement Impact Assessment were undertaken for the site by Geotechnical & Environmental Associates (GEA).

5.2

The report issued by GEA can be found in Appendix C and the ground conditions for the site are summarised below:

- Below a generally moderate but locally significant thickness of made ground, the London Clay Formation was encountered.
- Made ground extended to depths of between 1.00 m and 3.80 m, although only extended to beyond 1.35 m in one Borehole.
- Seepage of groundwater was encountered in the made ground at depths of 2.40 m and 1.20 m in boreholes and subsequent groundwater monitoring recorded variable water levels within the standpipes, which do not represent a continuous groundwater table, but rather perched water trapped within the standpipes.
- The results of the contamination testing have revealed elevated concentrations of arsenic, lead and total PAH including benzo(a)pyrene in the made ground.

5.3

The recommendations and advice included in the report that have significance to the structural design matters are summarised below:

- The following parameters are suggested for the design of the permanent basement retaining walls.

  In Made Ground; Bulk Density = 1700 kg/m³, Effective Cohesion = Zero (c' – kN/m²), Effective Friction Angel = 27 (Φ' – degrees).

  In London Clay; Bulk Density = 2000 kg/m³, Effective Cohesion = Zero (c' – kN/m²), Effective Friction Angel = 24 (Φ' – degrees).
- Heave, net unloading of around 70 kN/m² which will lead to heave of the underlying London Clay. This will comprise immediate elastic movement, which will account for approximately 40% of the total movement and may be expected to be complete during the construction period, and long term movements, which will theoretically take many years to complete.
- Net allowable bearing pressure for spread foundations excavated from basement level of 150kN/m2, which incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.
- Piled foundations, for the ground conditions at this site some form of bored pile is likely to be the most appropriate type. A conventional rotary augured pile may be appropriate, with temporary casing installed to maintain stability and prevent groundwater inflows, or alternatively the use of bored piles installed using continuous flight auger (cfa) techniques, which would not require the provision of casing, would also be an appropriate choice of pile. A table of ultimate coefficients is provided for the preliminary design of bored piles, based on the SPT & Cohesion / level graph. Refer to Appendix 3 for further information.

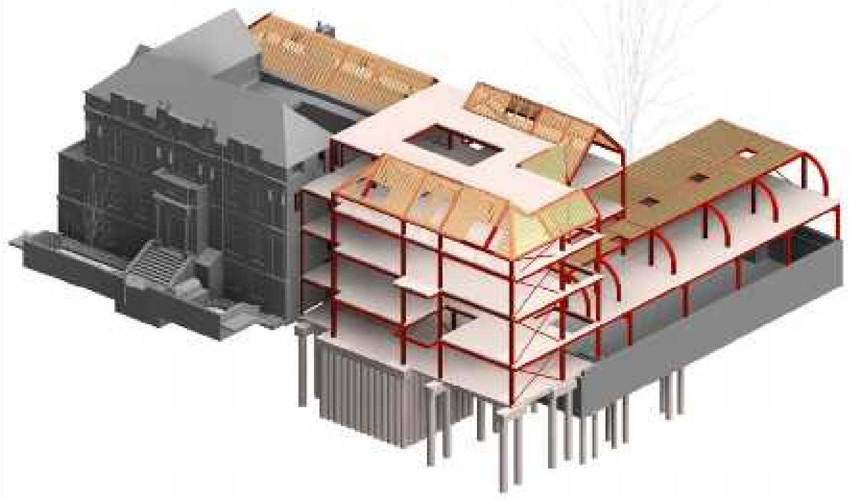


Figure 5: Proposed alterations

Six

Proposed alterations

6.1

The original proposal has been revised since the last Planning Application, the main revisions being as follows:

- Retention of the existing single-storey basement under the Wathen Hall, instead of deepening it to a double-storey basement
- Reduction of an overall plan area of the single-storey basement addition
- Reducing the number of floors above the sports hall to a single level of classrooms under a green roof

6.2

The proposed development of the site can be broadly divided into three elements:

- demolition of the Wathen Hall superstructure to be replaced with new studio and classroom space over the existing single-storey substructure
- demolition of the Centenary (Wathen) Building, to be replaced with a new four-storey school building supported partially over the existing Wathen Hall basement, partially on a new single-storey basement next to the Old School, and partially on new piled foundations from ground level
- refurbishment of the Old School building, including the reconstruction of the roof to the rear elevation at a higher level, and low-key alterations to the internal structure to accommodate the interface with the new school building.

6.3

It is anticipated that the proposed extent of demolition will enable the construction works to proceed by providing necessary site access to the rear of the site. Appropriate measures will be required to provide protection to the retained fabric and to the protected London plane tree and its extensive roots.

Proposed alterations - Substructure Proposal

6.4

It is proposed to retain the existing single-storey basement under the Wathen Hall and to create a new single-storey basement under the part of the footprint of the new building between the Old School building and the Wathen Hall.

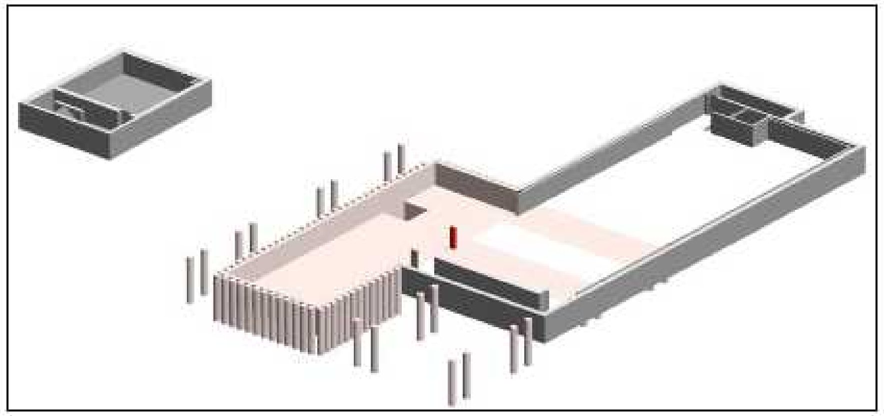


Figure 6: Basement structure: existing and proposed

6.5

The basement under the new school building is proposed using a contiguous piled retaining wall. The piles are anticipated to be 450mm diameter bored piles, designed to be propped in the permanent case by the slab at the lower ground floor level. The internal face of the piled retaining wall will be lined with an insitu waterproof concrete lining wall.

6.6

To mitigate the impact of the new basement on the foundations to the retained Old School building, the piled retaining wall will be set approximately 3m from the face of the existing masonry wall. This offset means that excavations required to form the capping beam to the piled wall will be at an adequate distance to avoid undermining the existing foundation.

6.7

Cantilever ground beams are proposed to support the new vertical structure set tight against the existing masonry wall of the Old School building. Each ground beam will run continuously over a pair of piles centred around 1.2m from the face of the wall; this offset is driven by the constraints of the piling equipment. The depth of the ground beams will be sized to avoid undermining the existing foundations.

6.8

The lower ground and basement slabs under the school building will be typically formed from a suspended flat slab construction. The internal columns will be founded on piled foundations.

6.9

It is proposed to retain the existing basement walls of the Wathen Hall as part of the new permanent structure. In the temporary case, horizontal propping across the basement volume will resist the lateral earth pressure. The retaining walls will act as cantilevers in the permanent case.

6.10

The new columns of the single-storey extension above the Walthen Hall basement will be inset from the basement wall and be founded on pile caps at basement level.

6.11

To provide a column-free space, the ground floor structure will span the clear width of the hall. This long span structure will be sensitive to vibration, particularly as the floor will be used for group activities. The structure is therefore proposed using deep, fabricated steelwork sections acting compositely with the reinforced concrete floor slab. Similar but heavier steelwork sections will act as transfer beams where the hall extends under the new school building.

Proposed alterations - Superstructure Proposal

6.12

The superstructure to the new building is proposed as a steel frame. This is primarily in response to the long spans required over the hall. Steelwork is typically more suitable for long span structures, and this is complemented by the lightweight nature of steel frames when compared to equivalent reinforced concrete frames.

6.13

The floor slabs are generally proposed as reinforced concrete cast on profile metal decking, acting compositely with the steelwork.

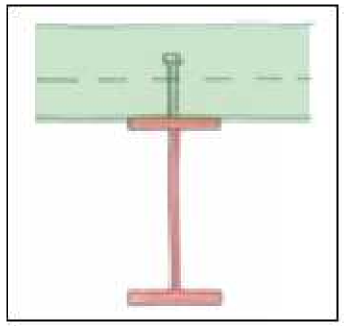


Figure 7: Deep long-span structure

6.14

The superstructure over the hall consists of one storey, with a column-free space at the lower ground floor level. Deep steelwork sections are proposed to achieve this space, supporting the classrooms spaces under a green roof. The roof follows a curved profile, formed using curved steelwork.

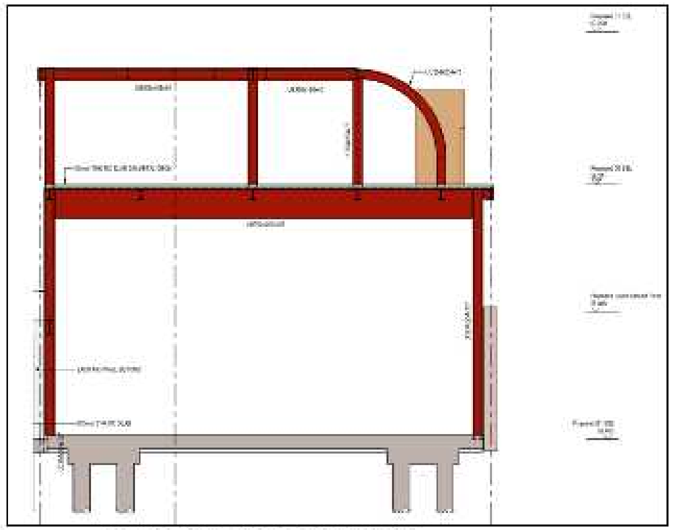


Figure 8: Sports hall structure.

6.15

The superstructure to the new school building is a four-storey steel frame. The internal room layouts allow for a regular column grid to extend up the full height of the building. The columns will typically be formed from steel "H" sections, although narrow rectangular hollow sections are proposed where new structure is proposed tight against the existing walls of the Old School building, to mitigate the extent to which these columns protrude into the new circulation space adjacent.

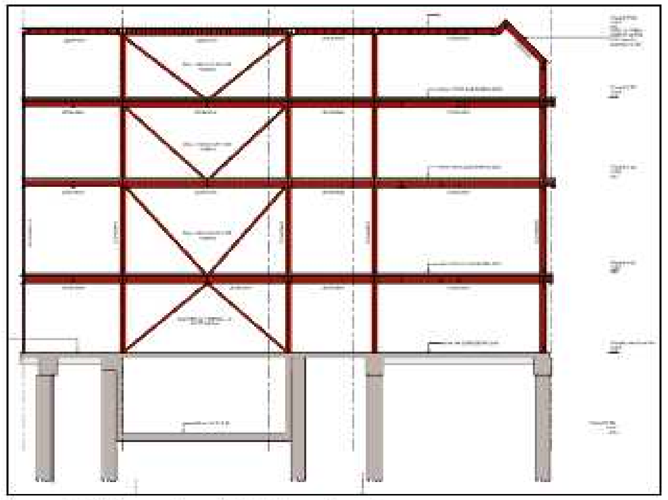


Figure 9: New school building structure.

6.16

A flat roof is discretely positioned behind the pitched roof around the top of the new school building. To achieve this profile, the top of the steel frame is designed with cranked steelwork sections that follow the pitched profile. These beams are typically shallower column sections rather than traditional beam sections, as these achieve a shallower structural depth.

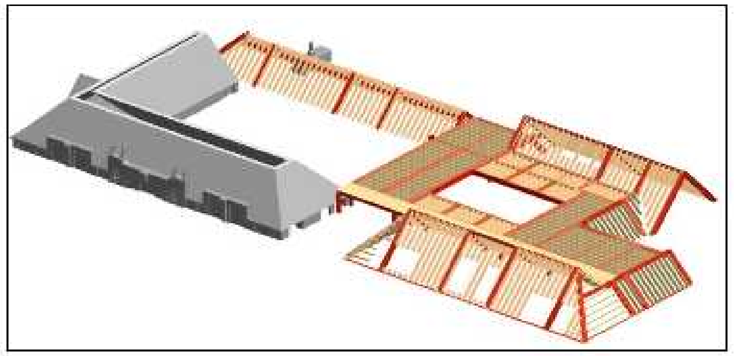


Figure 10: Roof structure.

6.17

The floor levels of the existing Old School building differ between the front and rear elevations, and this continues through to the new school building and the hall; the levels of the new school building typically match those of the front elevation, whilst the classroom over the hall follow the levels of the rear elevation. The half landings of the main stair have been set at these intermediate levels, which can also be accessed from the lift. Local areas of floor slab will be integrated into the structural frame, supported off stub columns or hangers as appropriate.

6.18

The mansard roof to the rear elevation to the Old School building is to be reconstructed to accommodate the new window arrangement proposed. This reconstruction will be formed from load-bearing masonry in keeping with the existing fabric, with new timber roof trusses and steelwork to provide the new roof form.

6.19

The two proposed stairs that enter the basement are reinforced concrete and supported on the local reinforced concrete beams and walls. Above ground staircases are to be lightweight steel built off steel beams at floor level and half landing levels.

Structural Stability

6.20

The lateral loads exerted on the new building, including wind loads and notional horizontal loads, will be transferred by diaphragm action through the reinforced concrete slabs at each level to structural bracing located around the building's floor plate. These are typically located within partitions and behind panels of masonry cladding, positioned to avoid clashes with door and window positions. Where those clashes could not be avoided, steel moment frames will be used to provide stability.

6.21

The stability strategy for the retained Old School building will be maintained as existing, relying upon the cellular nature of the masonry structure to transfer lateral loads to the foundations.

6.22

A movement joint is proposed between the new building and the Old School building. The two buildings will be structurally independent.

Facade

6.23

The external façade construction will be a cavity construction infill to the steel superstructure. This is likely to consist of an outer leaf of single skin of brickwork supported on shelf angles and an inner leaf construction of blockwork or SFS built off perimeter beams. The two leafs of the wall will be laterally tied together and to the steel frame. Movement joints will be allowed for as part of the design process. Elliott Wood have advised Norr and set out the parameters for movement joints and vertical load detailing.

6.24

A full glazed façade will be provided in the area next to the retained Old School, this provides a visual break between the two different areas of construction, on both front and rear elevations. Typical steel to glass connections will be implemented.

Robustness and Progressive Collapse

6.25

The new building contains four superstructure storeys of educational space. It is therefore considered to be a Class 2b building under the requirements of Part A of the Building Regulations.

6.26

The requirements of a Class 2b building is that effective horizontal and vertical ties are provided to all supporting building elements.

6.27

When detailed appropriately, reinforced concrete elements cast insitu are inherently robust. All steelwork and timber elements will be tied together and connected back to the structural frame to maintain robustness.

Basement Waterproofing

6.28

The proposed basement is designed to achieve a Grade 3 standard of internal environment throughout (Habitable to BS 8102).

6.29

The overall waterproofing strategy for the building is the responsibility of the Architect. As part of the overall strategy, it is anticipated that the basement structure will be cast using water-resistant concrete to provide the primary barrier against water ingress. It is anticipated that an internal drained cavity system will be used as a secondary form of protection, with any water seepage collected in a sump and pumped from the basement as part of the wider basement drainage strategy. The final waterproofing detailing and construction will be carried out by a specialist sub-contractor as a contractor design item.

Fire Protection

6.30

The reinforced concrete elements of the new structure will use its inherent fire protection in the design. The cover to the proposed columns, walls and slabs will be selected to provide the appropriate level of protection, to meet the requirements specified by the Architect.

6.31

The steelwork superstructure will require fire protection, and it is anticipated that this will be provided by either an intumescent paint system or by cladding the steelwork with fire-resistant boarding. The required protection and the adopted method will be specified by the Architect, to be compatible with the proposed finishes.

Temporary Works

6.32

The Contractor shall provide adequate temporary support to ensure the stability of the party walls and adjacent structures throughout the works where required.

6.33

An outline of the assumed sequence and associated temporary works for piled walls is given below:

- Install piles
- Install capping beam
- Prop at high level
- Dig down to formation level
- Install basement slab and liner walls
- Remove propping after concrete has cured

Old School Refurbishment

6.34

Refurbishment to the Old School at Lower Ground, Ground and First Floor is minor; single door openings formed in load bearing masonry using multiple precast concrete lintels, timber infill of floor holes where existing stairs are removed, non-load bearing partitions demolished. The final details will be provided during detailed design following site investigations to confirm detail of existing structure. Refer to drawings for works.

6.35

Roof area to the rear elevation to the Old School is to be reconstructed to accommodate a raised roof and new dormer window arrangement. New roof and dormers constructed from timber rafters supported on new steel frames built off the existing load bearing masonry walls.

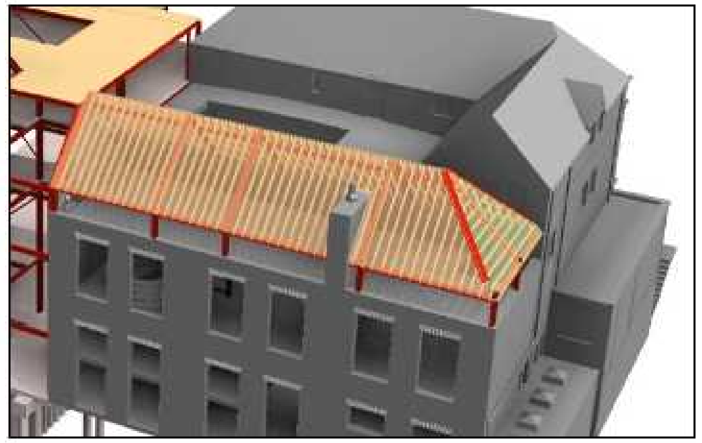


Figure 11: Reconstructed roof at the rear of Old School

Implications of Tree Subject to Tree Preservation Order

6.36

The existing London plane tree is subject to a Tree Preservation Order (TPO) and is located close to the edge of the Wathen Hall. In addition to its influence on the architectural design, the retention of the tree has implications for the design and the construction of the structural works.

6.37

The extent of the existing tree roots is known due to a ground penetrating radar survey which has been undertaken on site. Advice from the arboriculturalist suggests that the major tree roots will have spread away from the basement and that it is highly unlikely that significant roots would be found under the depth of the existing basement.

6.38

Record information indicates that there is a root barrier between the tree and the basement. The root barrier predates the construction of the existing basement and has been found via on site trial pits.

6.39

Protection of the tree during the construction phase will need to be considered. This includes the layout of laydown areas on the site, and how materials are handled both during deliveries and as they are erected, to mitigate potential risks to the tree.

6.40

All construction traffic and material storage should be outside of the tree root protection zone in order to minimise potential damage to the tree.

Seven

Summary of Below Ground Drainage

7.1

The Below Ground Drainage Strategy and Flood Risk Assessment have been produced to support the detailed planning application for the Hall School development.

The reports can be seen in Appendix D.

Eight

Basement Impact Assessment

8.1

As part of the work undertaken by GEA, a Basement Impact Assessment (BIA) has been completed. This includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4 and their Guidance for Subterranean Development 2 prepared by Arup (the "Arup report"). The aim of the work is to provide information on surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development. The assessment is contained within Appendix 3 as part of the ground investigation report and BIA, a summary is presented below.

8.2

The Ground Movement Assessment (GMA) has concluded that the risk of damage to the neighbouring properties is limited to Burland Category 0 (negligible) and Category 1 (very slight).

Qualifications

8.3

For the three sections of the assessment, each stage was carried out by a person holding the required qualifications as set out in CPG4.

- Surface Flow and Flooding – A Hydrologist specialising in flood risk management and surface water drainage, with The "C.WEM" (Chartered Water and Environmental Manager) qualification from the Chartered Institution of Water and Environmental Management:

  Rupert Evans MSc CEnv CWEM MCIWEM AIEMA (Geotechnical & Environmental Associates) (Refer to Appendix 3, Section 1.3.2)

- Subterranean (Groundwater) Flow – A Hydrogeologist with the "CGeol" (Chartered Geologist) qualification from the Geological Society of London:

  John Evans MSc FGS CGeol (Geotechnical & Environmental Associates) (Refer to Appendix 3, Section 1.3.2)

- Land Stability – A Member of the Institution of Civil Engineers and a Geotechnical Specialist as defined by the Site Investigation Steering Group:

  Martin Cooper BSc CEng MICE (Geotechnical & Environmental Associates) (Refer to Appendix 3, Section 1.3.2)

Stage 1 - Screening

8.4

A screening assessment, in the form of responses to the flowcharts within CPG4, was carried out to determine whether a full BIA is required. The screening responses for Subterranean (groundwater) Screening and Stability Screening were carried out by GEA and can be found in Appendix 3 (section 3.1.1 and 3.1.2 respectively). The screening for Surface Flow and Flooding was carried out by GEA (Refer to section 3.1.3 of Appendix 3).

8.5

The assessments for Subterranean (groundwater) Screening and Surface Flow and Flooding Screening identify no potential issues. The assessment for Stability Screening identified several potential issues, requiring the completion of a full BIA. These potential impacts can be seen in section 9.1 of Appendix 3.

8.6

The undertaking of such projects is specialist work and EWP will be involved in the selection of an appropriate Contractor who will need the relevant expertise and experience for this type of project.

Stages 2 & 3 - Scoping and Site investigation

8.7

These stages have been carried out by GEA and details can be found in section 4 of Appendix 3. The site investigation works included 4no. boreholes (1no. boreholes to 25m depth and 3no. borehole to 5m depth) and 5no. trial pits, as well as tests to determine soil properties. 3no. groundwater monitoring standpipes were installed within the boreholes and monitored on two occasions over one-month period.

Stage 4 - Impact Assessment

8.8

Potential impacts with regards to stability were identified in the screening stage of the BIA. These are presented below, along with the proposed mitigation strategy for each impact:

8.9

The site is underlain by the London Clay Formation.

Risk: The investigation has confirmed the presence of the London Clay Formation, which can give rise to a number of potential issues with regard to excavation and construction of a new basement structure. These include slope instability on existing and new slopes greater than 7°, heave of the clay soils associated with the unloading from the basement excavation and shrinking and swelling of the clay soils due to the removal of trees.

Mitigation: No slopes with angles greater than 7° exist or will be created by the development and there are no proposals to fell any trees. In addition, although the depth of the proposed basement will give rise to unloading of the clay and therefore heave movements and pressures, these heave movements are unlikely to be significant as they will, to a certain extent, be restricted by the pressure applied by the loads of the proposed building. Normal design and construction measures will be taken to mitigate any heave movements applying well-established engineering solutions including compressible void formers below the slab and the use of tension piles if necessary.

8.10

The development is located within 5 m of the public highway

Risk: Should the design of retaining walls and foundations not take into account the presence of nearby infrastructure, it may lead to the structural damage of footway, highway and associated buried services.

Mitigation: The design of the retaining walls will take into account any loading from the adjacent highway and the construction work will be carried out in accordance with best practice.

8.11

The site is underlain by the London Clay Formation.

Risk: Having differential founding depths can result in differential settlements, which could arise from seasonal shrink and swell, if underlain by clay soils, or as result of the varied foundations stiffness of the foundations.

Mitigation: The proposed basement does not share any party walls with neighbouring structures and so differential founding depths of neighbouring foundations will not be created. Differential founding depths will exist between the two parts of the building within the school site; the new foundations are to be suitably designed using standard engineering practice, to ensure there is no reason for the proposed basement to cause structural instability of adjacent foundations.

8.12

Combined Effect of Underground Developments – Camden Local Plan.

As part of the planning appraisal the Planning Officer has requested that the BIA is updated to reflect the policy requirements of Camden's updated Local Plan in particular Section A5 paragraph 6.129 extract below:

Basement Impact Assessments must identify all other basements in the neighbouring area, including their extent and ground conditions, and make an assessment of the combined effect of underground development with all nearby basements considered together. The assessment must include existing development and planned development including schemes with planning permission and those to be developed under permitted development or with a Certificate of Lawful Development.

The original GEA report covered the cumulative impact aspect and included a diagram showing surrounding basements and lower ground floors. In order to ensure compliance with the new policy a planning search of the surrounding properties has been carried out, summary of findings:

- No record of basements on the side same side of Crossfield Road as the proposed development.
- Only basement on Crossfield Road is on the opposite side; Hall School - Middle School.
- No record of basements locally on Eaton Avenue to South of Development.
- Basement in closest proximity to development is 28 Adamson Road.

- Record of "Lower Ground Floor Flats" 6, 8, 10 and 12 Strathray Gardens east of proposed development. The floor level of the flats are below Strathray Road but level with their rear gardens.
- 14 Strathray Gardens existing basement has been seen in applications, the levels are understood to be similar to the neighbouring flats.

Refer to Figure 12

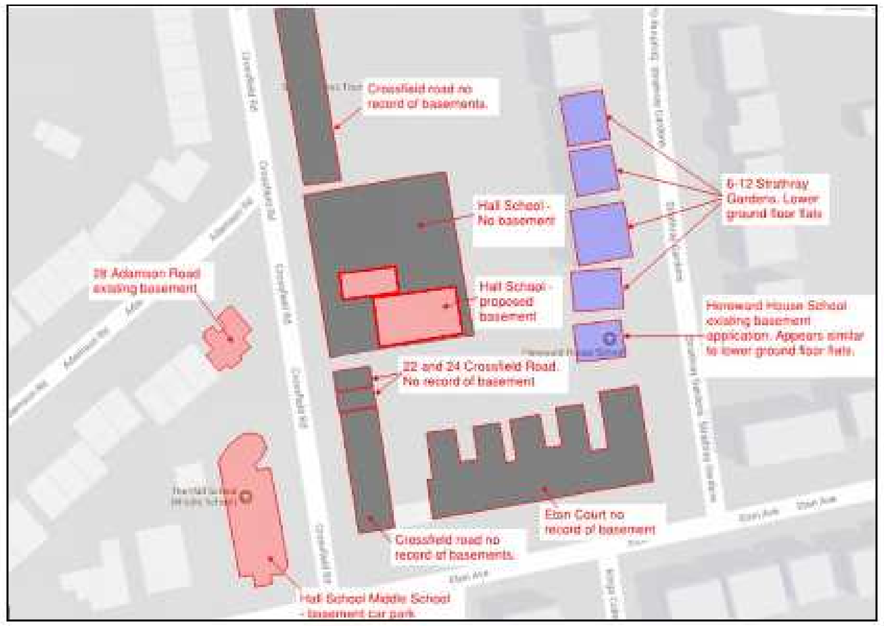


Figure 12: Summary of Planning search of neighbouring basements

The above information has been incorporated into GEA's updated report, refer to section 2.3 on Page 5 for discussion on surrounding structures and section 9.0 and page 24 where cumulative impact is specifically discussed.

8.13

The conclusions drawn from the Basement Impact Assessment is that the proposed development, incorporating the mitigation measures described above, is unlikely to result in any specific land or slope stability issues, groundwater or surface water issues. The ground movement analysis has indicated that the predicted damage to the neighbouring properties will be Category 0 'Negligible' or Category 1 'Very Slight' within acceptable limits of Camden's Local Plan. For further information refer to updated Site Investigation Report in Appendix 3.

Nine

Construction Methodology

Programme

9.1

For an outline Programme of Works refer to separate document by GVA Document.

9.2

Some of the issues that affect the sequence of works on this project are:

- The stability of the existing building during demolition;
- The protection of adjacent buildings;
- Forming sensible access onto the site to minimise disruption to the neighbouring residents;
- Providing a safe working environment;
- Not breaching the tree preservation order.

9.3

The proposed works involve the partial demolition of the existing buildings on the site and the construction of a new steel framed structure varying from one to four storeys over a single-storey basement.

9.4

The undertaking of such projects is specialist work and EWP will be involved in the selection of an appropriate Contractor who will need the relevant expertise and experience for this type of project.

9.5

Once the works commence EWP will have an ongoing role on site to monitor that the works are being carried out generally in accordance with our design and specification. This role will typically involve weekly site visits at the very beginning of the Contract and fortnightly thereafter. A written report of each site visit is to be provided for the Design Team, Contractor and Party Wall Surveyor.

9.6

The Contractor is entirely responsible for maintaining the stability of all existing buildings and structures, within and adjacent to the works, and of all the works from the date for possession of the site until practical completion of the works.

Noise and Vibration

9.7

The Contractor shall undertake the works in such a way as to minimise noise, dust and vibration when working close to adjoining buildings in order to protect the amenities of the nearby occupiers. The breaking out of existing structure shall be carried out by saw cutting where possible to minimise vibration to the adjacent properties and associated construction noise. All demolition and excavation work will be undertaken in a carefully controlled sequence, taking into account the requirement to minimise vibration and noise.

Monitoring

9.8

Monitoring of the ground and adjacent structures will consist of visual and measured monitoring. Prior to commencing works, the Contractor will identify all adjacent assets and buried services, and provide a schedule of condition of all adjacent properties with photographs agreed with relevant Party Wall Surveyors. The locations for monitoring targets and trigger limits will also be agreed. Monitoring will take place on a weekly basis during the main demolition and construction works. For any movements recorded above the agreed limits, all works stop until the cause of the movement can be established and a solution developed and agreed with Elliott Wood Partnership. Before commencement of excavation works, targets will be set up on the piled wall, to ensure that any movement during excavation is within allowable limits. Refer to Elliott Wood 'Movement Monitoring' report for further details.

9.9

An allowance for groundwater monitoring will be made during the construction period, the extent and regularity will be agreed with Camden Council.

9.10

Visual monitoring the adjoining structures and highway will be carried out during the works to monitor any cracking that may occur. For any cracking above Burland damage category 1 (cracks >1mm), all works will stop until the cause of the cracking can be established and a solution developed and agreed with Elliott Wood Partnership.

Stage 1: Site Set-Up

9.11

The services within around the site should be identified and isolated as necessary. Erect a fully enclosed painted site hoarding.

Stage 2: Enabling Works

9.12

The contractor will most likely set up the site accommodation and welfare facilities within the existing sports field at the rear of the site. This is subject to advice from Barrell Tree Consultancy and Tree Protection Officer.

Stage 3: Demolition of the Existing Structure

9.13

The contractor is to demolish the existing Centenary (Wathen Building) and Wathen Hall buildings above ground level and establish a sequence that maintains the stability of the building at all times. The Old School is to be maintained.

9.14

The Contractor shall provide adequate temporary support to ensure the stability of the party walls and adjacent structures throughout the works where required.

9.15

Where possible all below ground obstructions are to be removed from site so that the proposed works can progress without issue. The site is to be cleared of debris and levelled to allow for a CFA piling rig to access site.

Stage 4: Proposed Substructure

9.16

The contractor is to demolish the existing Centenary (Wathen Building) and Wathen Hall buildings above ground level and establish a sequence that maintains the stability of the building at all times. The Old School is to be maintained.

9.17

The Contractor shall provide adequate temporary support to ensure the stability of the party walls and adjacent structures throughout the works where required.

9.18

Where possible all below ground obstructions are to be removed from site so that the proposed works can progress without issue. The site is to be cleared of debris and levelled to allow for a CFA piling rig to access site.

Stage 4: Proposed Substructure

9.19

There are two different methods of basement substructure construction; new contiguous piles with liner wall and CFA piles with pile caps installed at the ground level. This is subject to detailed temporary work design.

1. Carry out required demolition work and construct temporary access platform to allow access for CFA piling rig to install piles.

2. The CFA piling rig is to cast all internal and perimeter piles from high level for new single-storey basement.

3. While installing piles construct new continuous capping beam to top of existing basement wall. Once all piles install complete continuous capping beam.

4. Install lateral props between capping beams. Remove high level props to existing basement.

6. Install all below ground drainage and heave protection. Cast suspended basement slab.

7. Cast reinforced concrete liner walls, columns and core walls to the underside of ground floor. Install ground floor structure.

8. Erect tower cranes. Suitable locations for which could be within the rear sports field and within the proposed building.

Stage 5: Proposed Superstructure

9.20

Construct the lift core, install steel frame with composite concrete on metal deck floor.

Ten

Sustainability

10.1

The structural design has been prepared in line with the principles of "lean design". This approach leads to an efficient structural solution that, where practically possible, uses composite design, direct load paths, and minimises the implementation of transfer structures.

10.2

The steelwork has typically been designed to act compositely with the reinforced concrete floor slabs, except in areas where floor depths are limited by the existing site constraints and the steelwork is proposed within the depth of the slab. Transfer structures are limited to over the sports hall only.

10.3

The flowing table summarises how other sustainable opportunities are being considered for inclusion within the structural specification:

Opportunity	Comments
Over 50% GGBS substitute for cement in concrete mixes	This can be adopted within all insitu concrete structure works. The % substitute is to be confirmed during the detailed design stage.
30% recycled coarse aggregate substitution in concrete mixes	It is possible to substitute a percentage of the coarse aggregate with recycled material that could have a negligible effect on the overall concrete strength. Location of batching plants, availability and cost of replacement aggregates will be reviewed as part of the detailed design of the concrete mix. Well graded recycled concrete aggregate (RCA) may also be used.
Reuse of materials from existing buildings on site	It may be possible to utilise the demolished material from the buildings e.g. for the temporary piling mat.
Power floating of insitu concrete floor slabs	Power float the floor slabs to ensure suitably level floors and avoid the need for additional levelling screed.

Eleven

Structural Design Criteria

11.1

Codes and Standards used for Structural Design

Where appropriate, the following codes and regulations will be applied in the structural design:

Approved Document A - Structure	
Weights of Building Materials	BS 648
Eurocode Basis of Structural Design	BS EN 1990
Eurocode 1 Actions on Structures	BS EN 1991
Eurocode 2 Design of Concrete Structures	BS EN 1992
Eurocode 3 Design of Steel Structures	BS EN 1993
Eurocode 6 Design of Masonry Structures	BS EN 1996
Eurocode 7 Geotechnical Design	BS EN 1997

Documents may be added to the list as and when specific circumstances arise.

11.2

Loadings

The materials used in the project will use the following densities for load calculation.

Reference BS EN 1991 -1

Material	Load (kN/m3)
Concrete (Reinforced)	25.0
Steel	78.5
Brickwork	20.0
Blockwork	16.0
Glass	27.9
Screed	19.0

The following tables give values for the proposed design load allowances for the building.

	Finishes (kN/m2)	Live (kN/m2)	Partitions (kN/m2)
Classrooms	2.5	3.0	1.0
Studio	2.5	5.0	1.0
Corridors, stairways	2.5	4.0	-
Plantroom	2.5	7.5	-
Roof (plant loading)	2.5	5.0	-
Roof (sedum loading)	3.0	1.5	-
Roof (other)	1.5	1.5	1.0

11.3

Wind Loading

Wind loads will be in accordance with BS EN 1991 and should be considered in conjunction with notional loads on the structure and combinations of factored and unfactored dead and imposed loads.

Grid Reference	TQ 269 845
Design annual risk	50 years
Basic Wind Speed, Vb	21.4 m/s
Site altitude	57m
Probability factor, Sp	1.0
Seasonal factor, Ss	1.0
Directionality factor, Sd	1.0
Nearest distance to sea	65 km

11.4

Vertical and Lateral Deflections

Vertical Deflections – The following vertical deflection limits will be used in the design of all new structural members. Where possibly affected, non-structural elements should be designed to accommodate these movements. The steel frame inclusive of any beam is to be designed/fabricated to allow for pre-cambering in order to optimise the overall design of the structural floor and subsequently to satisfy the serviceability check for the predicted deflections.

Element	Deflection Type	Limit
Reinforced Concrete Beams and Slabs	Long term deflection due to dead and imposed loads (including long term creep effects of sustained loading)	L/250
	Incremental deflection due to dead and imposed loads occurring after construction of finishes and partitions (including long term creep effects of sustained loading)	L/500
Steel Beams - General	Elastic deflection due to dead and imposed loads (subtracting camber, if any)	L/250
Steel Beams Supporting Plaster or Brittle Finishes	Elastic deflection due to imposed loads	L/360
Steel Beams Supporting Non-Brittle Finishes	Elastic deflection due to imposed loads	L/300
Steel Beams Supporting Masonry Partitions	Elastic deflection due to imposed loads	L/500
Secondary Framing	Elastic deflection due to wind load	L/360

Note:

L=distance between supports for span considered. For cantilevers, L is equivalent to twice cantilever length.

Lateral Deflections – Analysis and design of the lateral load resisting system is based on the following allowable drift criteria:

Maximum Total Drift: H/500 (under service load conditions)

Maximum Interstorey Drift: h/500 (under service load conditions)

Where H = Total building height

h = Storey height under consideration

Where possibly affected, non-structural elements should be designed to accommodate these movements.

Tolerances

The structure is to be built, as a minimum, to tolerances stated in the National Structural Steelwork Specification and National Structural Concrete Specification. Specified tolerances may differ from the NSSS or NSCS as required to suit any specific building requirements.

11.5

Design Life

The structural frame will be designed in accordance with the relevant Eurocodes which provide a design life of 50 years. Appropriate concrete cover for concrete elements (taking into consideration sulphates, fire, carbonation, chlorides, and freeze/thaw attack) and paint/galvanising systems for steel elements will be specified as required to provide adequate protection. Periodic inspection and maintenance will be required throughout the life of the building to ensure protection measures are performing adequately. External structures will require more frequent inspection and maintenance than internal structures due to more severe exposure conditions.

11.6

Methods of Analysis and Design

The following programmes will be used to assist with the analysis and design of the existing and proposed structures.

Software	Actions
Tekla Structural Designer	Global analysis and design,
Robot	BIM compatible
TEDDS	Global analysis and design,
Excel Spreadsheets (bespoke)	Finite Element analysis and design

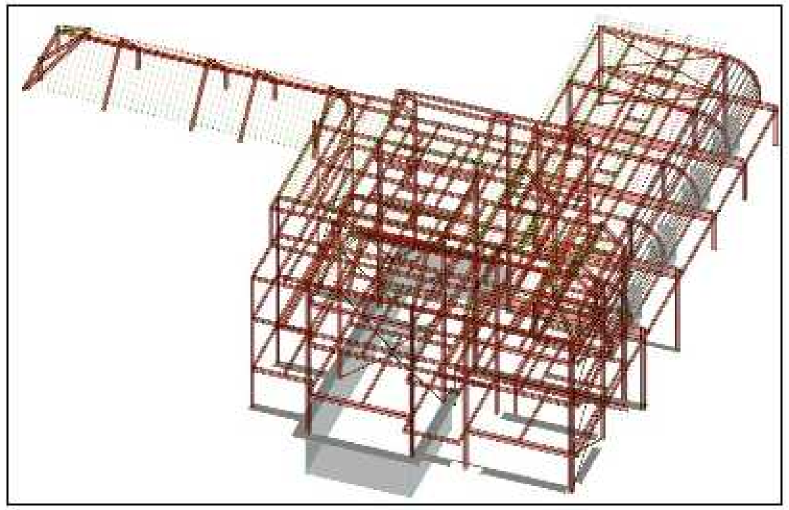


Figure 13: 3D analytical model view

Outline Material Specification:

Material	Specification
Concrete – Superstructure Elements	Minimum 40N/mm2 cube strength. Minimum cement content and maximum w/c ratio to be adjusted to suit exposure conditions taking into consideration carbonation, chlorides, and freeze/thaw attack. Cement Replacement – 50% GGBS, Course Aggregates – 20% Recycled Course Aggregate (RCA)
Reinforcing Bars	fy = 500 N/mm2 (High Yield – Deformed) to BS 4449
Reinforcing Mesh	fy = 500 N/mm2 (Minimum Yield Strength) to BS 4483
Structural Steelwork	Grade S275/S355 as required
Bolts	Grade 8.8 to BS 4190
Welding	To Comply with BS EN 1011

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