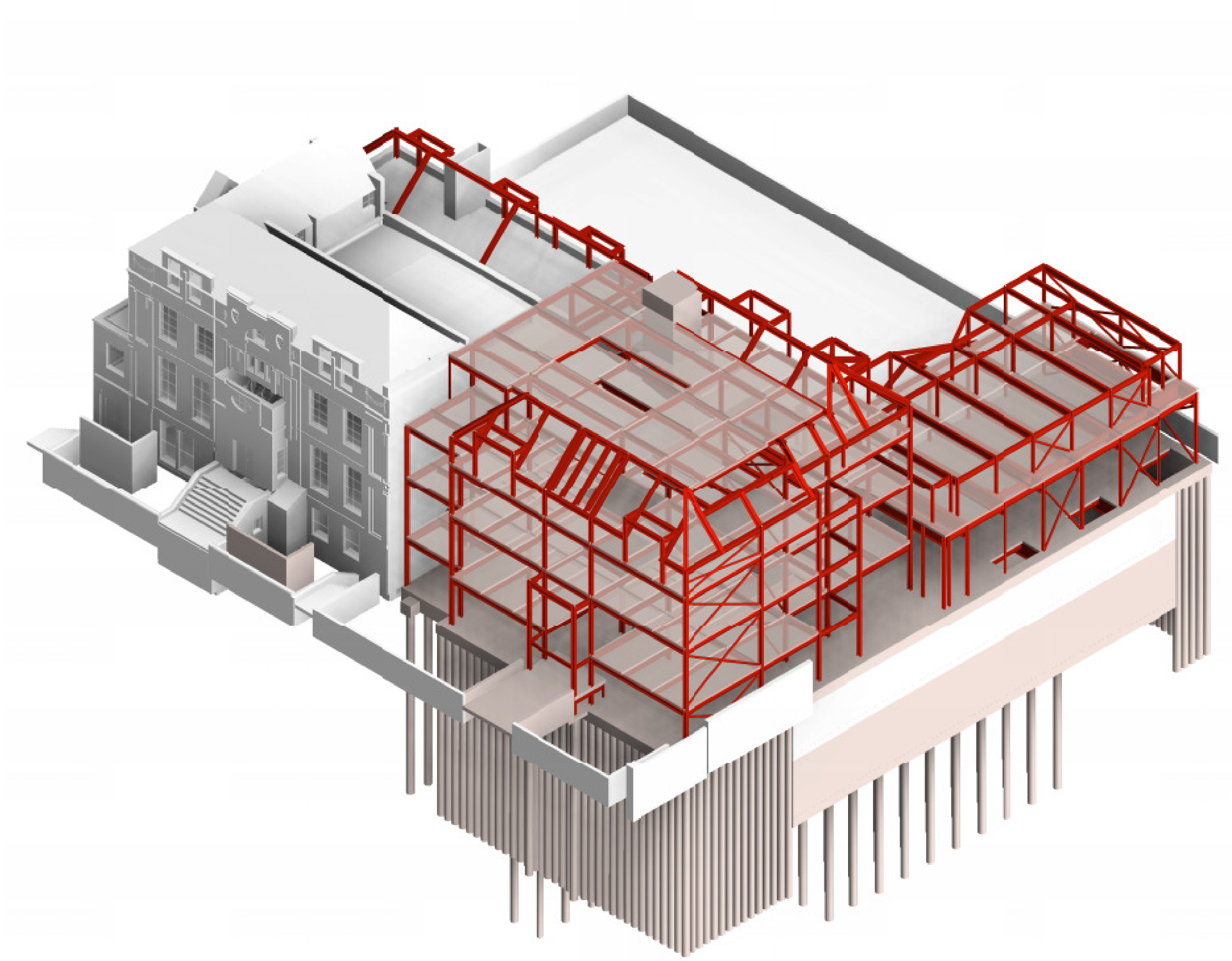
elliottwood



The Hall School
23 Crossfield Road,
Hampstead, NW3 4NU

Structural and Civil Engineering Planning Report and Basement Impact Assessment

Job number:	2150206
Revision:	P5
Status:	Preliminary
Date:	March 2017

Document Control

		remarks:	Incorporating responses to BIA Audit				
revision:	P5	prepared by:	Paul Stuart Davies BEng (Hons), MSc	checked by:	David Dempster MEng (Hons) (Cantab)	approved by:	James Souter MEng CEng MIStructE
date:	03/03/17	signature:		signature:		signature:	

Revision P5:

The report has been updated in response to BIA Audit by Campbell Reith; File Ref; MLml-12466-38-250117-The Hall School-D1.doc, Project Number: 12466-38, Revision: D1.

Summary of revisions (P5):

- Proposed construction methodology and sequence; section 10.7 updated and drawings added to Appendix 5.0.
- Outline retaining wall design; outline structural calculations added to Appendix 6.0 for each construction type.
- Damage Assessment of the Hall School; added to GEA report see Appendix 3.0.
- Damage Assessment; Xdisp and Pdisp added to GEA report see Appendix 3.0.
- Movement Monitoring Proposals; section 10.3 of report updated and Monitoring Movement Report added to Appendix 7.0.
- Works Programme – Reference to an outline programme of works programme by GVA added to 10.1.

All revisions have vertical line in the left hand margin.

Contents

Appendices

1.0 Introduction

1.1 Elliott Wood Partnership Ltd is a firm of consulting structural engineers operating from offices in central and southwest London, and Nottingham. The firm undertakes a broad range of work in both size and type, from minor alterations to major new buildings and refurbishments. Our understanding of the development of London, its geology and unique features together with direct experience on many similar sites puts us in a strong position to advise clients on the structural implications or proposed works and in particular the design and construction of basements.

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.

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 in place 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 and from single storey to double storey, created by underpinning and new piled walls.

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 3.0 to 5.0. Geotechnical investigations have been carried out by Geotechnical and Environmental Associates.

1.6 The desk study has included information retrieved from or viewed at the following archive sources:

- London Metropolitan Archives;
- Camden Local Studies and Archives Centre;
- Camden Building Control.

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

2.0 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 Land Stability and Subterranean (Groundwater) Flow. 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 and appendix 3.
- The proposals will have no significant adverse effect on surface flow and flooding. Refer to Appendix 3.
- The basements will have no significant adverse effect on the local hydrogeology. Refer to section 9.0.
- The basements will be designed to ensure the ground is capable of supporting the loads and construction techniques to be imposed. Refer to section 6.0.
- 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 6.0 and 10.0.
- A need for monitoring the existing adjacent structures and highways has been identified and proposals have been included in the construction methodology. Refer to sections 9.0 and 10.0.
- 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.

3.0 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.

Fig. 3.1: Summary of site constraints

3.5 The broad topography of the local area consists a shallow slope down from northwest to southeast. The external playing space is approximately 1.5m below the level of Crossfield Road outside the school.

3.6 The school have confirmed that they intend to vacate the site of the duration of the construction period.

3.7 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.

3.8 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.

3.9 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.

4.0 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 original school was extended to the south with additional single and double-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 with 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.

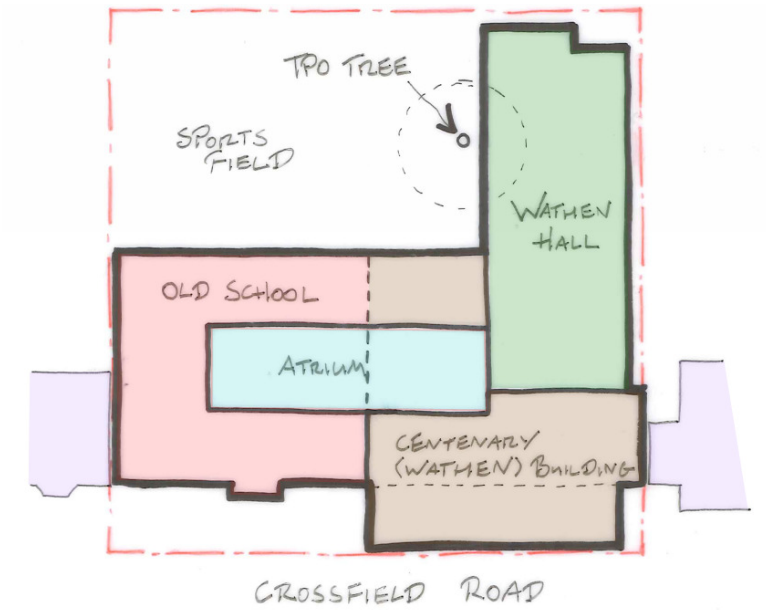


Fig. 4.1: Existing Buildings

<u>Old School</u>

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.

<u>Wathen Hall</u>

4.10 The sunken double-height space is created by an in-situ 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.

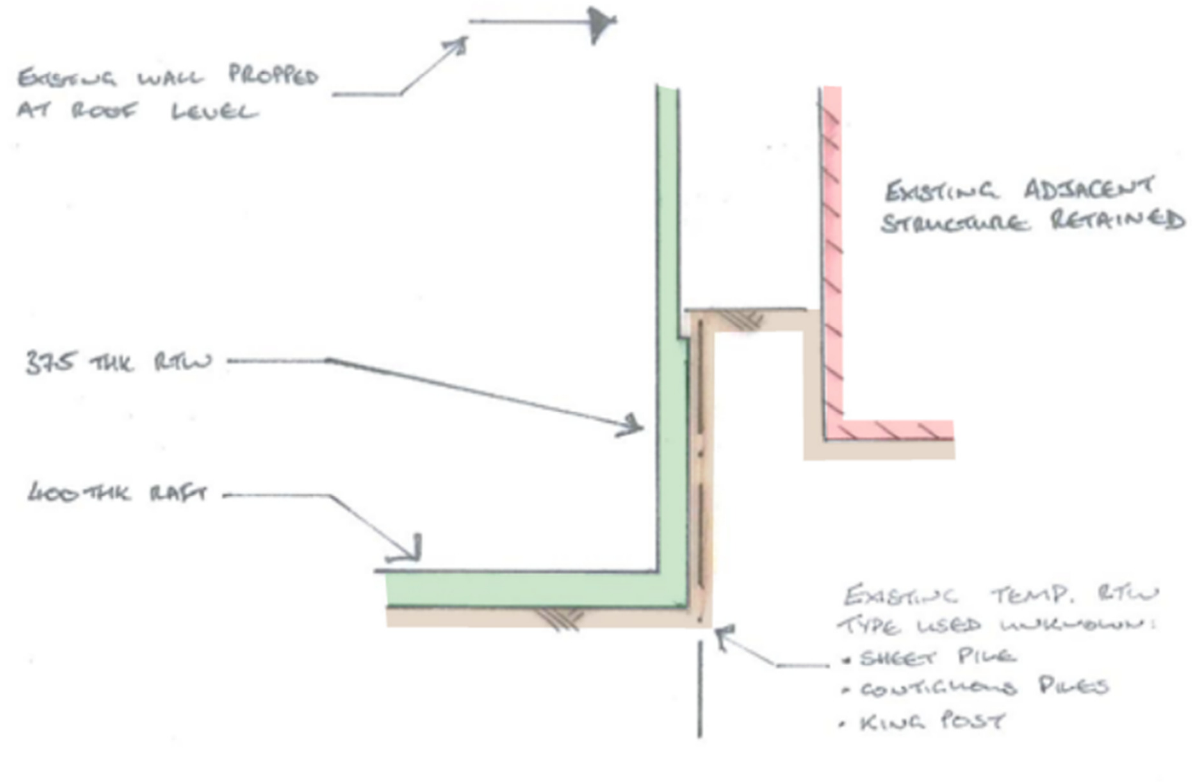


Fig. 4.2: Existing basement wall construction

4.11 It is unclear from the record drawings available what form of temporary works was used to construct the basement.

4.12 A 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, constructed 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 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.

<u>Centenary (Wathen) Building</u>

4.15 The Centenary (Wathen) Building is constructed using two types of structural form. 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 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 cases 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, which 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.

<u>Main Atrium</u>

4.23 The Main Atrium appears to comprise a steel frame infill in the centre of the site, interacting will 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 than was previously provided by the Old Hall. It is therefore assumed that the existing masonry walls did not have the capacity to accommodate the addition 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 joint between the two structural forms.

5.0 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 3 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/m^3, Effective Cohesion = Zero (c' – kN/m^2), Effective Friction Angel = 27 (Φ' – degrees).
  In London Clay; Bulk Density = 2000 kg/m^3, Effective Cohesion = Zero (c' – kN/m^2), Effective Friction Angel = 24 (Φ' – degrees).
- Heave, net unloading of between 80 kN/m^2 and 150 kN/m^2, 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 200kN/m^2.
- 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.

6.0 Proposed Development

6.1 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, and the deepening of the existing basement to form a double-storey hall below ground;
- demolition of the Centenary (Wathen) Building, to be replaced with a new four-storey school building over a new double-storey basement;
- refurbishment of the Old School building, including the reconstruction of the roof to the rear elevation, and low-key alterations to the internal structure to accommodate the interface with the new school building.

6.2 It is anticipated that the proposed extent of demolition will enable the construction works by providing 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.

Substructure Proposals

6.3 It is proposed to construct a double-storey basement under the footprint of the new building. This includes deepening the existing Wathen Hall basement to form a double-storey hall. There are therefore two strategies for the new basement construction.

6.4 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 slabs at the lower ground floor level and at the two basement levels. The internal face of the piled retaining wall will be lined with an insitu concrete lining. The proposals have been subject to a ground movement analysis by GEA which concludes that the expected movements are within the limits set out in CPG4. Refer to Section 9.6 and Appendix 3.

6.5 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.

6.6 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. Refer to figure 6.1.

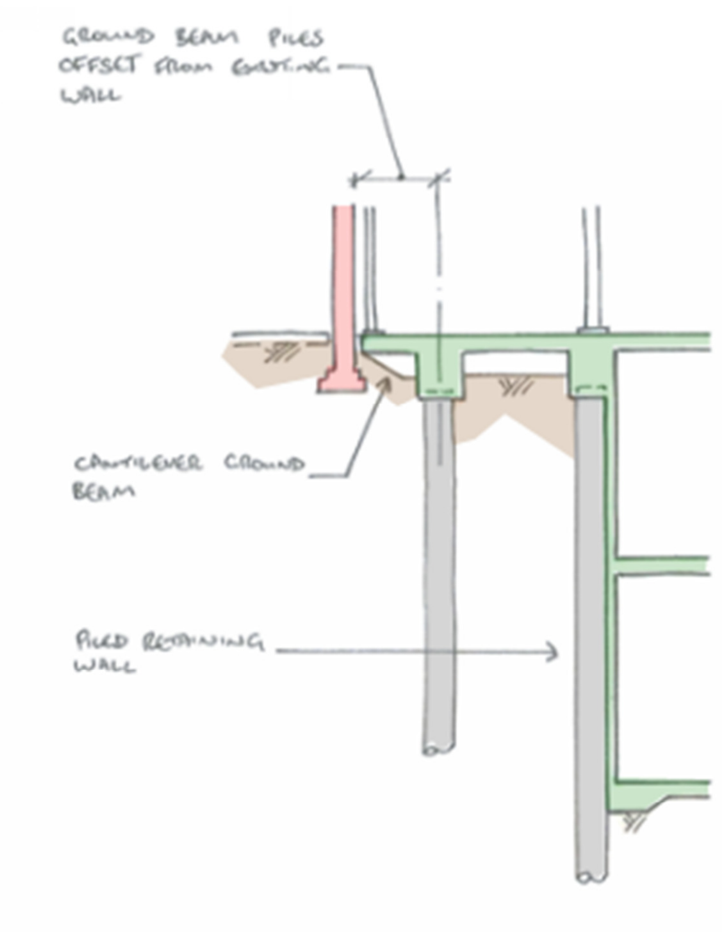


Fig. 6.1: Proposed cantilever ground beam

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

6.8 Piled options have been considered for deepening the existing Wathen Hall basement, but have been dismissed. Piling inboard of the existing basement wall would be too detrimental to the usable space, and piling outboard of the existing wall is not feasible due to the proximity to the site boundary or the protected tree.

6.9 It is instead proposed to retain the existing basement wall as part of the permanent structure, and to underpin them with a new retaining wall. In the temporary case, horizontal propping across the basement volume will resist the lateral earth pressure. The ground and basement slabs will provide propping in the permanent case. The new underpins will be founded on the clay stratum. Refer to figure 6.2.

6.10 At the rear of the site the extent of the basement is to be increased by approximately 500mm in plan, all work is to be carried out in 1m sections in an underpinning sequence. First, remove wall and previously installed "Temporary" works (unknown). Second install new 375mm wall set back in new location to depth to match existing single storey basement. Following installation of full length underpin new wall in similar method as existing side basement walls.

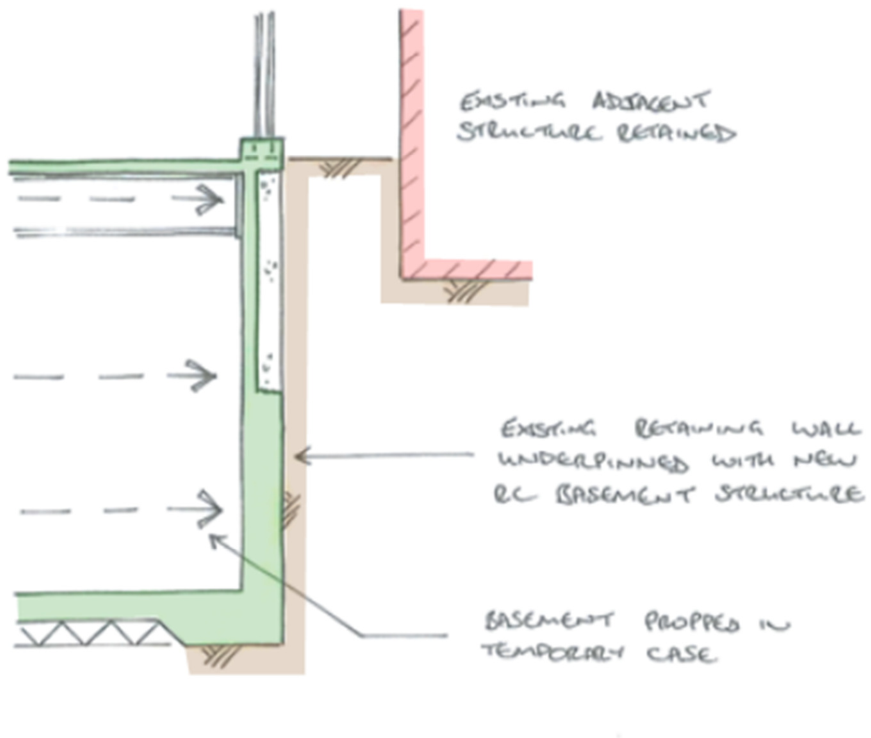


Fig. 6.2: Proposed underpinning construction

6.11 The basement will be designed to accommodate potential loading from clay heave and groundwater buoyancy. Heave protection in the form of a compressible void former will be used beneath the basement slab, and tension piles will be required at approximately 2m centres.

6.12 To provide a column-free space, the ground floor structure will span the clear width of the hall. This long span structure will be vibration sensitive, particularly as the floor will be used for sports and other physical activities. The structure is therefore proposed using deep 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.

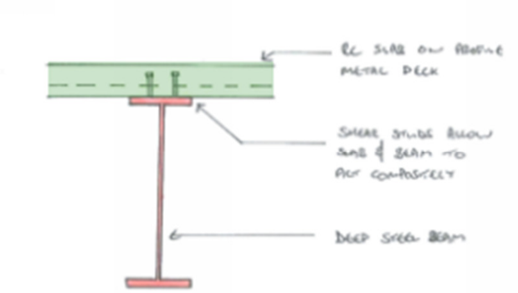


Fig. 6.3: Deep long-span structure

Superstructure Proposals

6.13 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.

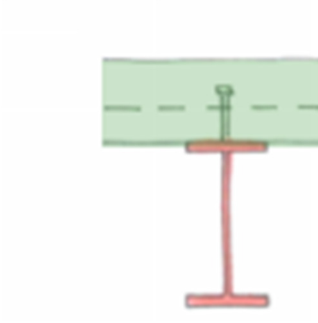


Fig. 6.4: Floor construction; composite floor construction

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

6.15 The superstructure over the hall consists of two storeys, with a column-free space at the lower ground floor level. Deep steelwork sections are proposed to achieve this space, supporting the classrooms spaces.

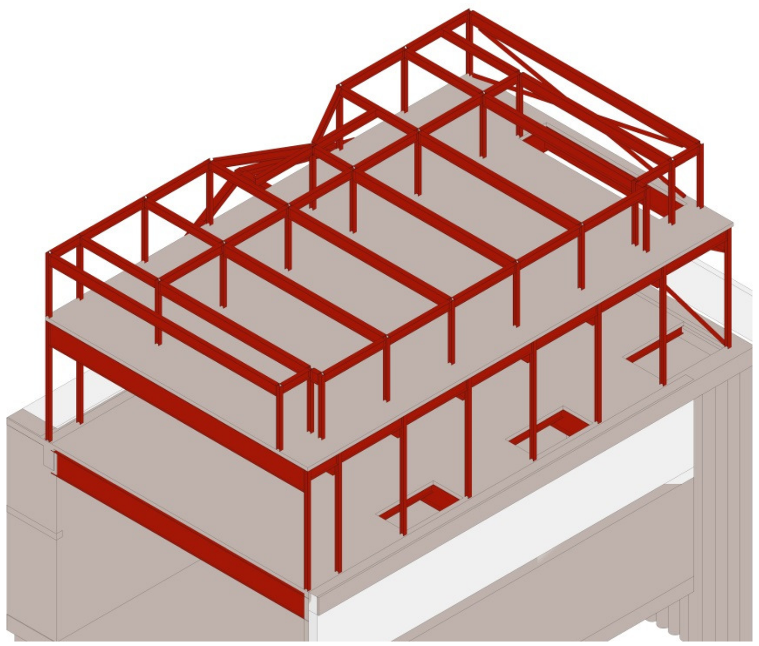


Fig. 6.5: 3D image two storey school building – from Revit Model

6.16 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 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.

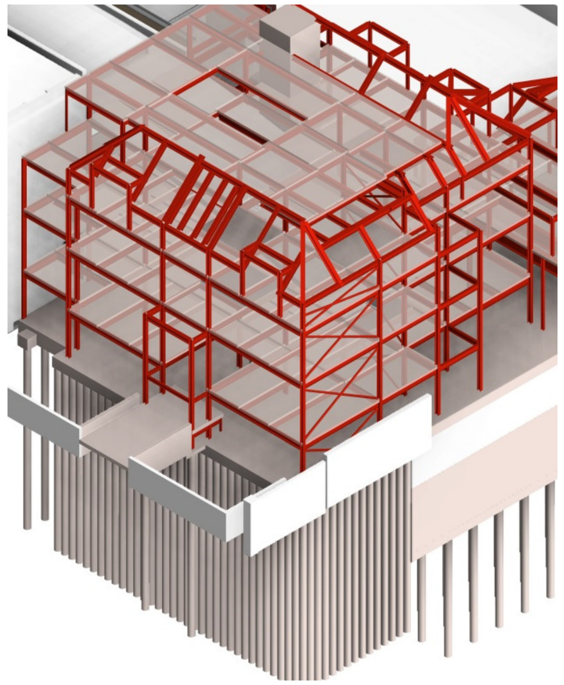


Fig. 6.6: 3D image four storey school building – from Revit Model

6.17 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 use shallow column section rather than traditional beam sections, as these achieve a shallower structural depth.

6.18 The floors 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.

External Feature Stair

6.19 The proposal includes a new external single flight spiral feature stair, it is shaped around the tree that is subject to TPO. At first floor the stair is supported on the new two storey school structure over the Wathen Hall, at Ground Level a new reinforced concrete plinth / ring beam will be constructed supported on screw piles. The screw piles will be located under supervision of a suitably qualified arboriculturalist and will be located so as to ensure they do not hit any of the tree roots. The stair will not apply any load to the tree, a compressible material will be applied between the reinforced concrete plinth and any the ground. Adequate space between the stair and all new structure to allow future growth of the tree. Subject to detailed design.

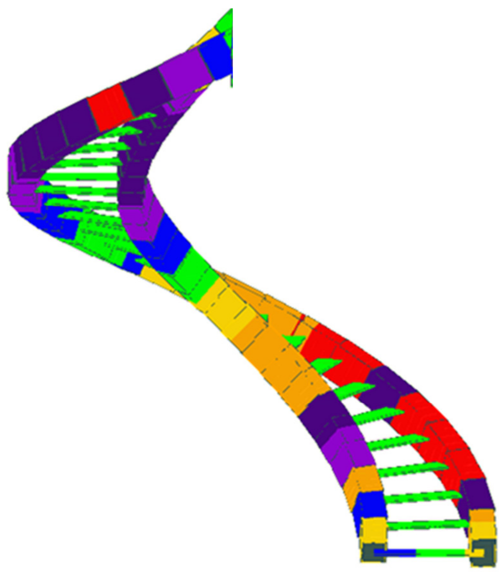


Fig. 6.7: 3D image feature stair – from GSA Structural Design Model

Internal Stair Design Intent

6.20 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.

Smoke Vents

6.21 As part of the M&E scheme multiple holes have been created in the lower ground floor slab to allow smoke vents, reducing the requirement for mechanical ventilation. The removal of slab at the head of the retaining wall removes the lateral restraint in the permanent case. The reinforced concrete capping beam will resist lateral load in the opening locations.

Structural Stability

6.22 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 around the proposed lift shaft, and within partitions and behind panels of masonry cladding, positioned to avoid clashes with door and window positions.

6.23 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.

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

Façade

6.25 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 loads detailing.

6.26 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.

Robustness and Progressive Collapse

6.27 The new building contains two storeys of basement, and 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.

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

6.29 If 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

6.30 It is assumed that the proposed basement is designed to achieve a Grade 3 standard of internal environment throughout (Habitable to BS 8102).

6.31 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

6.32 The cover to the reinforced concrete elements of the proposed structure; columns, walls and slabs will be selected to provide the appropriate level of protection, to meet the requirements specified by the Architect.

6.33 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. Fire resistance of the concrete slab on metal deck will be designed using either the Fire Engineered Method or the Simplified Method.

External Retaining Walls

6.34 At the front entrance of the site there two sunken areas outside the proposed structure, the existing retaining wall constructed in the late 1980s will be maintained and new retaining walls will be created where required.

6.35 Outside the Old School two new retaining walls are required to create areas for a new bike shed and an expanded bin store. Both retaining walls will be reinforced concrete.

Temporary Works

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

6.37 Substructure, there are two distinct construction types; underpinning of existing basement and contiguous piled wall to increase extent of basement. An outline of the assumed sequence and associated temporary works for each is given below.

6.38 Underpinning; Install props at high and mid-level, Dig down to low level, Prop at low-level, Dig down to formations level, Cast all basement slabs and retaining walls from lowest level up.

6.39 Contiguous piled walls, Install piles, Install capping beam, Prop at high level, Dig down to mid-level, Prop at mid-level, Dig down to low level, Prop at low level, Dig down to formation level, Install all basement slabs and liner walls from lowest level up, removing propping after concrete has cured.

Note, at the rear corner of basement; east of site, a contiguous piled section of wall is required, due to the increase in basement size. In the temporary case it is assumed that a platform will be required over the existing basement and tree root protection zone in order to achieve this.
See section 10.0 for further information regarding the construction methodology.

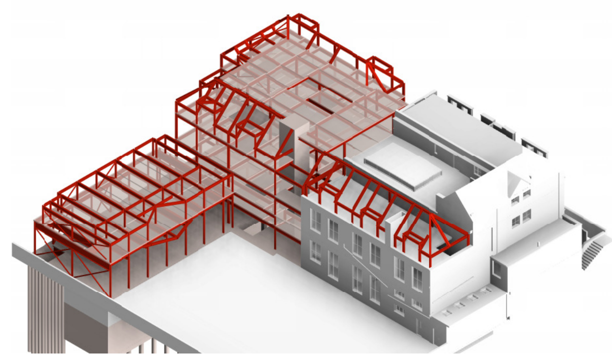


Fig. 6.8: 3D image of Proposal – from Revit Model

Old School Refurbishment

6.40 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.

6.41 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.

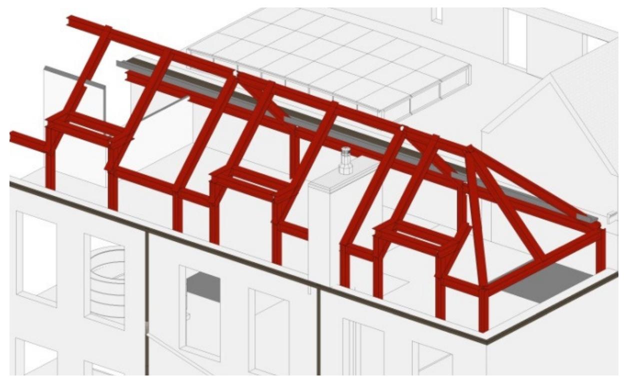


Fig. 6.9: 3D image of Refurbishment– from Revit Model

7.0 Implications of Tree Subject to Tree Preservation Order

7.1 The existing London plane tree subject to the Tree Preservation Order (TPO) 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, the underpinning to the Wathen Hall basement in particular.

7.2 The extent of the existing tree roots has been scanned by Lloyd Bore Landscape architects, ecology & arboriculture consultants. The roots were found to be fairly evenly distributed in the vertical and horizontal profile with no remarkable features in the rooting morphology within the Astroturf area. There are no roots in the footpaths to the east and south of the building, and that the tree does not root under the building, but does root up to the basement wall. 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.

7.3 Barrell Tree Consultancy's has begun consultation with Camden Council's Tree Preservation Team. All works will be carried out in accordance with Barrell's method statements which will be and approved by the Tree Preservation Team.

7.4 Even though it is highly unlikely that significant roots will be found under the existing basement, a strategy will be developed to appropriately address any roots that are encountered during the underpinning works. This includes undertaking the local underpinning excavations by hand or with small-scale plant to identify roots as they are discovered rather than damaging them.

7.5 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.

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

8.0 Summary of Below-Ground Drainage

Summary of Below-Ground Drainage

Existing Below-Ground Drainage

- Public sewer records have been obtained from Thames Water; these are included in Appendix 2. Sewer records show that the offsite sewer network is combined (sewers carry both foul and surface water flows). Records show that a 300mm diameter combined water sewer is located in Crossfield Road.

- Environment Agency Flood Maps indicate that the site is located within Flood Zone 1 (Low Risk), and as the site area is less than 1 Hectare, a Flood Risk Assessment (FRA) in accordance with the National Planning Policy Framework (NPPF) is not normally required. The site is however located within a Critical Drainage Area, as identified in the London Borough of Camden Strategic Flood Risk Assessment (SFRA). On this basis a Flood Risk Assessment will be required; refer to Appendix 4 for the FRA report.

- Sewer flooding history for the surrounding area has been obtained from Thames Water. This has indicated that there have been reported incidents of flooding within the area as a result of surcharging of the public sewers. A non-return valve may be required as part of the below ground drainage proposals.

- The onsite drainage network has been investigated via a CCTV survey. This has identified the locations, sizes, levels and conditions of the existing private drainage network. The site currently drains to the combined water sewer in Crossfield Road, via two existing outfalls located at Lower Ground level.

- The site is shown to be located within a Source Protection Zone, as identified on the Environment Agency's Groundwater Maps. This will not affect proposals however, as surface water will not be drained to ground as part of the proposals (due to ground conditions).

Proposed Below-Ground Drainage

Surface Water

- The surface water drainage system has been designed in accordance with the London Plan Policies, 5.12 (Flood Risk Management) and 5.13 (Sustainable Drainage). The following drainage hierarchy has therefore been considered:

1. Store rainwater for later use;
2. Use infiltration techniques, such as porous surfaces in non-clay areas;

3. Attenuate rainwater in ponds or open water features for gradual release;
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release;
5. Discharge rainwater direct to a watercourse;
6. Discharge rainwater to a surface water sewer/drain;
7. Discharge rainwater to the combined sewer.

- Drainage via infiltration has been considered for the site, however following a review of the ground conditions (i.e. clay soils) soakaways are not deemed feasible for this development.

- There are no nearby accessible water courses and the existing Thames Water sewer network in the vicinity is combined use. Therefore, the foul and surface water generated by the development will aim to re-use the existing gravity connections from the site.

  A full evaluation of SuDS is demonstrated in the table below.

- The London Plan policy 5.13 states that developers should aim for a greenfield runoff rate from their developments. However for brownfield sites, the supplementary planning guidance notes that there may be situations where it is not appropriate to discharge to greenfield runoff rates, a 50 percent reduction of surface water discharge is the minimum attenuation expectation where possible.

- For this development 67% of the site consists of the existing old retained building and newly constructed MUGA which drain via a separate combined water outlet. The remaining 33% is the building which is to be demolished and reconstructed with a double level basement.

- When considering the implementation of restricting surface water discharge rates to less than existing it is not considered possible to separate the existing drainage from the retained parts of the site and flow control due to the extreme complexities, spatial issues and implications on the existing structure. Therefore from these areas the proposed rate of surface water discharge will remain unchanged.

- When considering the new build element again it is not considered viable to implement a restriction on the surface water flow rate to be less than existing. The reasons for this are that there is no suitable location for the inclusion of an attenuation tank, it is not possible to install a tank under the newly constructed MUGA due to the damage it would cause, the implications of the tree with a TPO and it is considered unlikely that the drainage will be able to discharge via gravity hence the need to include a surface water pump (which would increase the flood risk to the building).

- Due to the restrictions noted above it is proposed to maintain existing rates of surface water discharge from this development.

Foul Water

- All drainage at Lower Ground floor level and above should drain to the offsite sewers via gravity, at high level within the Basement (high level in Basement -01).

- Drainage requirements at Basement levels (Basement -01 and Basement -02) will need to be routed to a submersible packaged pumping station, which will then pump discharge up to the suspended gravity network. Only foul drainage from the basement levels should be pumped. All surface water is to drain via gravity at high level. Pumping stations are to include dual vortex pumps (duty and standby) and non-return valves to protect against public sewer surcharge. Pumping stations should also be connected to a BMS system if one is available.

SUDS technique	Y/N	Comment
Green Roofs	N	A green roof will not be incorporated within the scheme.
Rainwater reuse	N	Rainwater reuse is not considered appropriate for this site.
Basins and ponds	N	The site is very limited for space and is located within an urban area; as such there is no feasible location or space for a detention basin or pond.
Filter strips and swales	N	Filter strips and swales are not appropriate due to the spatial restrictions on site and unsuitable ground conditions.
Infiltration devices	N	Spatial restrictions and unsuitable ground conditions preclude the use of soakaways.
Permeable surfaces	N	There are no new external surfaces associated with the new development; therefore the use of permeable surfaces is not applicable.
Filter drains	N	Infiltration is not feasible for this site due to space constraints and the ground conditions
Tanked systems	N	It is not possible to incorporate a tanked attenuation system due to a lack of space. An attenuation tank cannot be installed in the courtyard due to the TPO tree and the inability to be able to get drainage back via gravity to the outfall. It is also considered inappropriate to install an attenuation tank below the Basement -2 level of the building as this will result in the need to pump surface water which leads to an increase in flood risk to the building.

- Existing onsite surface and foul water connections are to be reused where practicable. If connections to public sewer cannot be reused an application for a new direct connection will need to be submitted to Thames Water. Any indirect connections will also require an indirect connection application.

9. Basement Impact Assessment

9.1. 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:

9.2. Qualifications

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)

9.3. Stage 1 - Screening

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).

9.3.1. 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 9.5.

9.4. Stages 2 & 3 - Scoping and Site investigation

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.

9.5. Stage 4 - Impact Assessment

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:

9.5.1. 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 void formers below the slab and the use of tension piles if necessary.

9.5.2. The development will increase the differential founding depth of adjacent foundations

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 increased foundations stiffness of underpinned foundations relative to those that remain unchanged.

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.

9.5.3. 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.

9.6 Basement Impact Assessment Conclusions

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' and Category 2 'Slight' within acceptable limits of CP4 and DP27. Furthermore all elevations shown as Category 2 only just fall inside this damage category and are considered to be Category 1 due to the conservative method of analysis adopted. For further information refer to updated Site Investigation Report in Appendix 3.0.

10. Construction Methodology

10.1 Programme

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

10.1.1. 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; and
- Providing a safe working environment.
- Not breaching the tree preservation order.

10.1.2. 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 two to four storeys over a double height basement.

10.1.3. 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.

10.1.4. 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.

10.1.5. 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.

10.2. Noise and Vibration

10.2.1. 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.

10.3. Monitoring

10.3.1. 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 cracking 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.

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

10.3.3. 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 2 (cracks >5mm), all works will stop until the cause of the cracking can be established and a solution developed and agreed with Elliott Wood Partnership.

10.4. Stage 1: Site Set-Up

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

10.5. Stage 2: Enabling Works

10.5.1. 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.

10.6. Stage 3: Demolition of the Existing Structure

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.

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

10.6.1. 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

10.7. Stage 4: Proposed Substructure

10.7.1 There are two different methods of basement construction substructure; underpinning of existing basement and new double height contiguous piles with liner wall. Refer to Appendix 5.0 for sequence of construction drawings; S-3000, S-3010 and S-3020.This is subject to detailed temporary work design.

1. Prop existing basement at high level.

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

3. The CFA piling rig is to cast all internal and perimeter piles from high level for new double height basement. The design is to allow for the internal piles to be broken down to the required lower basement depth.

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

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

6. Commence first phase of underpinning and complete first level of reduced level dig across entire site and laterally prop, break down the internal piles as progress.

7. Commence second phase of underpinning and complete second level of reduced level dig across entire site and laterally prop, break down the internal piles as progress.

8. Install all below ground drainage and heave protection. Cast suspended basement slab leaving a 150mm kicker where required for columns and walls.

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

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

10.8 Stage 5: Proposed Superstructure

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

11.0 Sustainability

11.1 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.

11.2 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.

11.3 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.

12.0 Structural Design Criteria

12.1 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.

12.2 Loadings

The materials used in the project will use the following densities for load calculation.
Reference BS EN 1991 -1

Material	Load (kN/m^3)
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/m^2)	Live (kN/m^2)	Partitions (kN/m^2)
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	7.5	-
Roof (sedum loading)	3.0	1.5	-
Roof (other)	1.5	1.5	

12.3 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, V_b	21.4 m/s
Site altitude	57m
Probability factor, S_p	1.0
Seasonal factor, Ss	1.0
Directionality factor, Sd	1.0
Nearest distance to sea	65 km

12.4 Vertical and Lateral Deflections

<u>Vertical Deflections</u> – 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 (Wind posts / Cladding Rails etc.)	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.

12.5 Design Life

The structural frame will be designed in accordance with the relevant British Standards 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.

12.6 Methods of Analysis and Design

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

Tekla Structural Designer	Global analysis and design, BIM compatible
Robot	Global analysis and design, Finite Element analysis and design
TEDDS	Individual element analysis and design
Excel Spreadsheets (bespoke)	Various uses

12.7 Outline 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	f_y = 500 N/mm2 (High Yield – Deformed) to BS 4449
Reinforcing Mesh	f_y = 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

Appendix 01: Proposed Structure Drawings

Appendix 02: Public Sewer Records

Appendix 03: Site Investigation and BIA

Appendix 04: Flood Risk Assessment

Appendix 05: Outline Construction Sequence Drawings Basement

Appendix 06: Outline Structural Calculations -Basement

Appendix 07: Movement Monitoring Report

Wimbledon
241 The Broadway
London
SW19 1SD

tel. (020) 8544 0033
fax. (020) 8544 0066

Central London
46-48 Foley Street
London
W1W 7TY

tel. (020) 7499 5888
fax. (020) 7499 5444

Nottingham
1 Sampson's Yard
Halifax Place
Nottingham
NG1 1QN

tel. 0870 460 0061
fax. 0870 460 0062

email: info@elliottwood.co.uk
www.elliottwood.co.uk

elliott wood partnership ltd
structural and civil engineers