UCL New Student Centre – Basement Construction Plan

Project Particulars	
Main Contractors Project Number	32927
Project Development Address	15 to 26 Gordon Street, London, WC1H OAH
Project Start Date	15th July 2016
Project Finish Date	21st December 2018
Local Authority	London Borough of Camden
Owner / Client	University College London
Main Contractor	Mace Ltd

Basement Construction Plan Sign Off			
Design Responsibility	Organisation	Name	Signature
Basement Design Engineer (Permanent State)	Curtins	Suleyman Ekingen	
Support Basement Temporary Works Engineer	Bridges Pound	Stuart Heaton	S M Heaton
Certifying Engineer	Curtins	Neill Duke	

Revisions				
Date	Revision	Page Number	Comments	Initial
02.06.16	First Issue	N/A	N/A	IT
06.06.16	Revision 1	Various	Sam Wood comments added / revised	SM
07.06.16	Revision 2	Page 2	Paragraph 2.1 Detail added to basement raft foundation make level -2, including upper floor level -1 and 00 or clarity.	IT & SH
07.06.16	Revision 3	Page 9	Paragraph 5.3.2 Pile deflection to be undertaken in place of take place	SH
07.06.16	Revision 4	Page 9	Paragraph 5.3.3 Vast majority changed to whole	SH
07.06.16	Revision 5	Various	Ian Thomas - Amendments to the whole of the document to make good grammar and formatting	IT
16.06.16	Revision 6	Page 11	Utilities section added as advised	IT
16.06.16	Revision 7	Page 17	Basement design in temporary and permanent state clarified.	IT
17.06.16	Revision 8	Page 6	Words to proposed monitoring points amended to show reduction in quantity	IT
20.06.16	Revision 9	First Page	Spelling of Certifying Engineer's name corrected from Neil to Neill	IT
20.06.16	Revision 9	Page 2	Reference to a 3000mm thick basement slab at level -2 removed to avoid confusion	IT
20.06.16	Revision 9	Page 2	Detail added to depth of secant piles, Female piles installed to a maximum depth 9.450 meters and Male piles installed to a maximum depth 22.750 meters. All depths taken from pile matt level of 24.200.	IT
20.06.16	Revision	Page 9	Piling, Capping and Excavation durations changed to match up with Table of Proposed Monitoring Frequency Matrix as shown on Page 10.	IT
20.06.16	Revision 9	Page 6	Revised monitoring drawing LO1254 / S-M01 P2 added to Appendix H of Plan, reduction of monitoring proposed to be, Inclinometers 10, Tilt Meters 6 and Settlement Points 6	IT
20.06.16	Revision 9	Page 19	Words added to state that Bridges Pound back up documentation is to include for calculations and design loads for struts which is included within Appendix D.	IT
20.06.16	Revision 9	Page 17	Words added to explain that the Corbles will be designed by Bridges Pound and will be interfaced with the Capping Beam design by Curtins. Design to be carried out at the detailed design stage later in the project.	IT

Contents

1. Introduction

The purpose of the report is to provide a concise plan for the construction of the basement for UCL's New Student Centre. The report defines clear methods of ensuring that the adjacent buildings are not damaged during the construction period by initially carrying out condition surveys to achieve a baseline of current conditions and then provide suitable movement monitoring throughout the construction period.

The Basement Construction Plan will contain

1. Method Statement detailing proposed method of ensuring the safety and stability of neighbouring properties.
2. Method statements to include temporary work drawings.
3. Appropriate Monitoring – Risk Assessment Thresholds and Contingency matters is applicable.
4. Local Factors – Affecting ground conditions, local water environment etc.
5. Any other factors affecting construction.

The report also gives an overview of the construction sequence and proposed temporary works for the construction of the basement. The information enclosed in the document has been written and supplied by the main contractor Mace Ltd, Curtins Consulting Engineers the Structural Engineer responsible for the permanent works (Basement Design Engineer) and Bridges Pound the Consulting Engineers responsible for the temporary works design.

Curtins Consulting Engineers will also fulfil the role of Certifying Engineer for the basement construction plan with the Engineer responsible being devoid from the project scheme.

2. Existing Conditions

2.1 Proposed Development

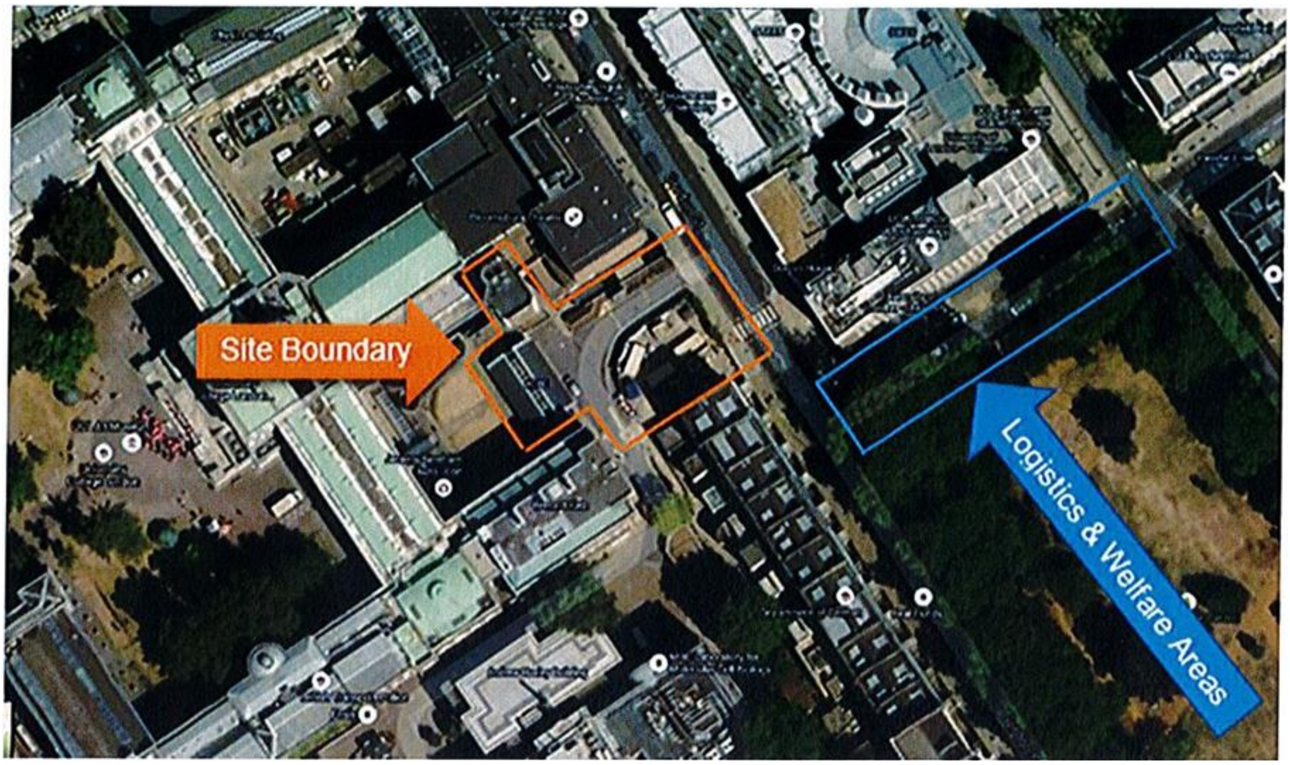
For the past 2 years the site has been occupied by a 4 storey temporary building used as office and welfare units for the owners (UCL) many construction sites, these were removed in February 2016 as part of the enabling works for the development. Access to the site is generally gained off Gordon Street, this leads onto a service road / yard to the rear of the terraces along Gordon Square which also doubles up as a Fire Tender Road. The site is surrounded by single storey basements on three sides and disused coal vaults along Gordon Street, which is similar to the neighbouring terraced houses in the vicinity.

The development will cater for a 5 storey high building that includes for a small raised platform at the rear of the roof which allows access to the air handling units positioned adjacent to the Bloomsbury Theatre. The building will be used as a student centre by UCL and its core will be constructed of reinforced concrete (RC) frame with 300 mm thick flat slabs. The basement raft foundation will be cast at an average depth of 1000mm and will be constructed within a two storey secant piled wall with the female piles being installed to a maximum depth of 9.450 meters and the male piles being installed to a maximum depth of 22.750 meters, depths taken from pile matt level 24.200. The foundations to the columns and walls of the upper superstructure will be supported on the capping beam over the secant pile wall, on the internal piled raft foundation and on the same pile caps and ground beams.

The stair to the back of the Bloomsbury Theatre is to be demolished and the building extended in its footprint with a new tunnel linking the plant room in the new basement with the existing plant room and the network of tunnels at the back of the theatre.

2.2 Site Description

The site is centred on National Grid reference 529650 & 182300, it occupies an area in Bloomsbury within the former London Borough of St. Pancras which now forms part of the London Borough of Camden. It lies near the British Museum (to the west) and Euston Station (to the north). Presently to the south of Bloomsbury Theatre the site forms part of the complex of buildings owned by The University College London (UCL) within the same block and immediately to the west of the original University building on the east side of Gordon Street.



2.3 Site History

Early maps indicate that the site was occupied by All Saints Church and by 1896 the Church had expanded and residential properties had been constructed on the site. By 1945 the site had been generally cleared of all building debris resultant from the second World War and remained this way until the early 1950's when large pre-fabricated units where installed by UCL. All buildings on the site were demolished in the early 1990's and the site remains generally unchanged until the present day.

The surrounding area is comprised of inner city terraced properties with some areas of public open spaces. University College is located adjacent to the site's Western Boundary and Euston, St Pancreas and Kings Cross Stations are located approximately 700 meters to the North.

Over time and specifically post World War 2 much of the residential properties have been demolished either due to bomb damage or through intended redevelopment. By the late 1900's much of the site surrounding area was comprised of commercial and office buildings. UCL has expanded significantly and has a number of buildings located within the sites vicinity.

In 2008 a building was proposed for the site and the design progressed sufficiently to allow installation of a section of the proposed secant pile wall forming the basement however the project was abandoned due to various reasons.

2.4 Surrounding Land Uses and Restrictions

The footprint of the site is positioned within the "live" campus of University College London and neighbours Bloomsbury Theatre to the North. The other surrounding buildings are either laboratories, classrooms or libraries and are highly sensitive to noise, dust and vibration.

2.5 Ground Conditions

Main ground conditions has been reviewed in detail in the Basement Impact Assessment however to summarise a study of the Envirocheck records and British Geological Survey mapping records indicates the following geological succession underlying the site.

1. Lynch Hill Gravel Member (Sand and Gravel)
2. London Clay (Clay, Silt and Sand)

The Envirocheck report confirms that there is a low risk to no hazard from the following ground stability hazards on and around the site.

a) Collapsible ground
b) Compressible ground
c) Landslide
d) Ground dissolution
e) Running Sand
f) Moderate risk of shrinking or swelling clay

The sequence and indicative thickness of the strata found is as shown below

Strata Encountered	Depth Encountered (m) From	Strata Encountered (m) To	Strata Thickness (m)
Made Ground	0.00	1.20 to 1.80	1.20 to 1.80
Firm orange, brown and grey sandy gravelly clay	1.20 to 1.80	2.00 to 2.91	At least 1.11
Orange to yellowish brown gravelly sand	2.91	4.00	Bets Unproven

Made Ground is quite varied across the site, but in general comprised of yellow brown to brown sandy gravelly clay. Gravel is angular to sub-rounded, fine to coarse, with ash, clinker, flint and brick. A black geotextile was encountered in two of the window samples holes at 0.15 m

Lynch Hill gravel member was observed in two of the boreholes and comprises of gravelly sands and clays. The soil mechanics site investigation shows the general succession to comprise of firm mottled light brown and grey slightly gravelly clay overlaying medium dense locally dense brown sand and gravel, overlying firm brown slightly sandy gravelly clay. Flint nodules are present at most horizons within the stratigraphic record.

Although clay was observed in 2 of the 3 bore holes it is considered unlikely that this would be London Clay. The borehole logs from the soil mechanics site investigation indicate that the London Clay is encountered at approximately 6.50 m depth, considerably deeper than the 4.00 m achieved during the most recent site investigation.

The deeper cable percussive boreholes undertaken by Soil Mechanics indicate that below the London Clay is Lambeth Group which comprises of very stiff locally hard dark grey sandy fissured clay. Fissures are extremely closely spaced and randomly orientated. The material appears slightly polished.

2.6 Ground Contamination

The environmental chemistry results have been compared with Tier 1 criteria for soils with respect to human health for the intended end use in a number of locations. Given these levels of contamination it would normally be necessary to break the source / receptor pathway by installing a clean and inert capping layer / concrete or tarmac hard standing, however as the proposed development will comprise of a five storey building comprising a two storey basement and such will require excavation to a depth of approximately 10.00 meters of both made up ground and natural material. It is therefore envisaged that any of the potential contaminated made ground observed across the site will be removed during the reduced level dig.

If the proposed basement does not fully occupy the plan of the development site and any soft landscaping is proposed then these areas should be provided with a 300mm of clean and inert cover. In providing this cover in conjunction with building and hard standing construction any risk presented to site end users will be mitigated.

Construction workers should be protected from contaminants observed using 5 point PPE with welfare and sanitary facilities as set in the construction management plan.

2.7 Ground Obstructions

A site wide safe bomb impact desk top study report has undertaken by Zetica Site Safe on behalf of UCL, the report which researched documentary evidence during the first and second world wars identified that currently there are no records available of explosive ordnance clearance on the proposed site therefore given the density of the WW 2 bombing and indications of damage through record photographs in the area at the time, the overall risk of potential UXB being present on the site has been considered to be moderate to high.

To mitigate the potential risk of unearthing UXO during piling and ground works excavation Mace as the main contractor have employed BACTEC a company with 21 years' experience in over 50 countries in clearance of landmines, unexploded ordnance and the clearing or verifying of UXO contaminated land. BACTEC will deliver a bespoke explosive ordnance risk mitigation strategy from an initial desktop assessment through a complete risk mitigation process deploying the latest technology to provide clearance certification.

In addition to UXO survey works, ground investigation survey's for the main works have identified a 300mm thick concrete slab positioned approximately 2.50 meters lower than the existing ground level running approximately the whole width of the basement excavation, this slab was constructed during the second World War and was used as a water tank facility this will need to be removed prior to the UXO survey work is under taken and piling works commencing. (See photo on page 15).

Although not positioned within the basement excavation, parts of UCL are currently served by HV Cables, Gas Main and Water Mains that run through the development, these are currently being diverted as part of the enabling works package and will have been cut off prior to excavation works commencing.

3. Condition Surveys

External and internal condition surveys have been under taken by G Dolden and Associates Chartered Building Surveyors based at 213 High Street Kelvedon Essex C05 9JD a copy of their reports and associated drawings can be found in Appendix A of this document.

4. UXO Mitigation

As described above to mitigate the risk of potentially unearthing an UXO during construction of the piled foundations and basement construction Mace as the main contractor have employed BACTEC.

BATEC's methodology for mitigation will be to use Intrusive Magnetometer Survey Technique (TFG) which is based around a drilling philosophy where a UXB may have penetrated to a depth beyond the detection capability of non-intrusive survey systems. The TFG system and methodology will be to use an intrusive magnetometer rig prior to piling works, the methodology will include for approximately 101 survey points across the basement area, 49 survey's for the 119 bearing pile locations and 52 survey's for the 90 meter secant pile wall line.

The TFG System has the following features

1. Flexible Application - System can be deployed with a variety of sizes of drilling rigs to suit a variety of ground and working conditions.
2. Rapid and Cost Effective Data Capture - Real time data is captured and reviewed with results provided within 48 hours after a Quality Control Review.
3. Safety - The methodology is deployed in stages to ensure that the survey is conducted safely with a 1 meter look ahead capacity.
4. Detection Radius - Will be up to 2.00 meters for a 50kg bomb or larger.
5. Detection Depth - Will be up to 8.00 meters from ground level.

Upon completion of the survey works a clearance certificate will be issued, if a buried magnetic anomalies' are identified that cannot be discounted as ordnance related BATEC will provide an exclusion zone around the object or target investigate to positively identify the suspect object and organise its safe removal if necessary. Once the survey is completed and any necessary target investigation conducted then a clearance certificate and report will be issued.

5. Movement Monitoring Proposal

As discussed previously the development includes a double height basement which is to be constructed within a secant piled concrete retaining wall. The site is located on and sits between three existing buildings, to the South of the development there are terraced houses built during the Regency Period and constructed of traditional masonry, to the West lies the ACBE plant room and associated laboratories constructed from modern building techniques of framed construction and to the North lies Bloomsbury Theatre a multi-storey framed building.

As part of the planning permission for the development a scheme for monitoring the potential movement of these buildings has been proposed and presented by Curtins Consulting Engineers in their Basement Impact Assessment Report, Document Reference L01254, Revision 3 23/08/2015 Appendix D. (Attached Appendix F of this report)

The main contractor Mace has reviewed the proposed monitoring proposal as set in the Basement Impact Assessment in conjunction with their Temporary Works Engineer Bridges Pound and feel that the scheme is slightly too onerous and feel the actual monitoring points can be reduced as the table below and the revised monitoring proposal drawing L01254/S-M01 Rev P2 which has been included in Appendix H.

Monitoring Activity	BIA Report L01254 /S-MO1 Rev P1	BIA Report L01254 /S-MO1 Rev P2
Inclinometers	13 Points	10 Points
Tilt Meters	9 Points	6 Points
Settlement Monitoring	8 Points	6 Points

In addition to reducing the quantity of monitoring points Mace are also requesting that the amount of surveying visits is reduced for the basement construction period a case for which is set over leaf for consideration.

5.1 Need for Monitoring

Mace have reviewed the monitoring specification and wish an amendment to be considered. Firstly it is important to understand why monitoring is being asked for and installed. The construction of the basement will induce some movement in the ground surrounding the new basement. These movements have been considered in the Basement Impact Assessment Report, as referenced above, which has been prepared by Curtins Consulting Engineers. Any movement of the ground will, via the foundations of the adjacent buildings, be reflected in one way or another in the buildings surrounding the site.

The Basement Impact Assessment has determined that a degree of movement of the existing structures will be acceptable and has limited the allowable degree of movement so as to limit the potential damage to these buildings. The assessment report clearly sets out the degree of anticipated movement induced by the construction of the basement and the effect thereof on the existing buildings.

Monitoring has been specified so that the actual movement of the buildings can be related to the movement predicted in the Basement Impact Assessment Report. This will allow decisions to be taken in regards to the degree of movement, the rate at which movement is occurring and will assist in the prediction of final movement. As such the monitoring provides a tool by which progress on site can be assessed against potential damage to the existing buildings.

Monitoring is not only a record of what has happened but can be used to predict what will happen. At stages in the construction an assessment of ground movement, relating to the basement construction, has been made and this movement can be judged against actual movement to see if the movement pattern is consistent with the modelled behaviour.

The Basement Impact Assessment Report uses a standard procedure for estimating ground movement which, whilst widely adopted, is known in certain cases to produce overly conservative results showing a greater degree of movement than will actually take place. The calculations are based on a limited number of case studies and, quite rightly, takes a conservative assumption on generated movement.

There are four types of movement induced in the ground during basement construction as follows

5.1.1 Movement due to the installation of the piled retaining wall

This movement is caused by the relaxation of the ground during piling. During installation of the piles as ground is excavated the surrounding ground is relieved of the lateral restraint of the removed ground and can "relax" causing horizontal movement of the ground, which translates to vertical movement of the ground at the surface.

The movement of the ground during this phase can be unpredictable and a conservative assessment of this movement is included in the Basement Impact Assessment. The degree of movement is related to a number of factors as follows

(a) Type of pile installation

(b) Type of soil being piled through

(c) Sequencing of the works.

In this case a rotary bored pile is being proposed. This type of pile construction causes the least ground disturbance and results in the least potential ground movement. The soil at high level is granular, which tends to suffer greater ground movement due to piling, but the upper levels will be sleeved to reduce this. At low level the soil is London Clay, which tends to minimise ground movement during pile installation. The sequencing of the works is being undertaken in a manner so as not to create any large lengths of unsupported newly cast bored wall, which might cause local movement in excess of the movement due to installation of an individual pile or small group of piles. The above factors lead us to consider that the movement expected during pile installation shall be considerably less than the figure quoted in the Basement Impact Assessment. Keltbray piling, the piling sub-contractor, are extremely well experienced in piling in this sort of location and have confirmed that they expect to see less than 5mm of movement during pile installation.

5.1.2 Movement of the Piled Wall

The piled wall is subject to lateral loads due to the ground pressures retained behind it. These pressures include the weight of the various soils and the pressure exerted by the foundations of adjacent buildings. Keltbray piling have undertaken the design of the piled wall and assessed the total anticipated deflection of the wall. This deflection tends to over-estimate the actual movement as a number of factors, such as the actual applied foundation loads cannot be accurately assessed and so are generally conservative.

As the basement comprises a box stiffening of the wall at the corners occurs, which will reduce movement considerably, however the effects of corner stiffening have not been taken into account. The maximum calculated deflection of the wall is in the order of 15mm, in line with the Basement Impact Assessment.

5.1.3 Movement of the Pile Restraining System (Propping)

The piled wall is, in the temporary condition, propped to prevent excessive deflection from taking place. In this case the concrete capping beam is being propped to support the heads of the piles. Movement of the propping system is in two parts, deflection of the capping beam and shortening of the props due to the induced axial load. The proposed props are hydraulic props which will be pre-loaded. This pre-loading will reduce or remove the effects of axial shortening of the props and so minimise any movement.

The capping beam is a substantial RC beam typically 1.5x1.5m and maximum the calculated deflection is in the order of 3mm.

5.1.4 Long Term Movements

In the long term the ground "relaxes" as the loads imposed on it dissipate pore water pressures and there is a small degree of change in loading on the wall. However, these long term effects occur over a periods of months, and even years, and so do not have an effect on the overall movement.

Within the timescale for the long term factors to come into play the basement slabs will be have been constructed, propping the wall at intermediate levels hence reducing the deflection of the wall well below the temporary condition.

The overall movement predicted in the wall, and hence transmitted to the ground has been calculated to be around 25mm, which is within the figures utilised in the Basement Impact Assessment Report.

5.2 Current Specification

The current monitoring Specification calls for a number of things including daily monitoring of the movement points during pile installation and basement construction. We consider that a better monitoring regime can be established which will give better information and allow confidence in the results being obtained.

The current specification does not require any pre-construction monitoring. It is well known that all buildings move, to one degree or another, both daily and annually, depending on the weather, ambient temperature and ground conditions. We consider that a period of pre-construction monitoring should be undertaken to establish a background baseline of building movements. This baseline will then be used as a guide against which any future movements during construction can be compared.

It is expected that the pre-construction monitoring will identify that movements in the order of 1-3mm take place in the existing buildings due principally to thermal effects of the sun heating the building fabric and changes in the ambient air temperature.

Even when using accurate surveying techniques any result of +/- 1 to 2mm can be considered to be a reasonable tolerance in reading, so any movement of this order can, in effect, be ignored.

5.3 Proposed Specification

The construction of the basement will take approximately 16 months and over this period a large amount of data will be collected relating to building movement. The process itself is time consuming and each stage takes a period of time to complete. There are 4 basic stages to the works and 5 periods of monitoring suggested.

5.3.1 Pre-Start Background Monitoring

For 3 weeks prior to the commencement of piling taken at twice weekly intervals so giving a total of 6 results for comparison and baseline data. The baseline tolerance will be established, which will be limited to no more than +/-2mm, even if the survey results show a greater value.

5.3.2 Pile Installation

As noted above the piles are being installed by rotary techniques which Keltbray Piling have confirmed will produce much less movement than predicted in the Basement Impact Assessment Report. Movement of less than 5mm is anticipated during pile installation.

Monitoring will commence to monitor 2 times a week, which equates to between once every 2 or 3 days. This period has been chosen as the process for installation takes at between 3 and 4 days, and possibly a longer period as follows;

Day 1 - Install "soft" female pile, these are unreinforced piles of concrete with a limited compressive strength to allow the "hard" piles to be cut through them.

Day 2 & 3 - Allow female piles to gain strength to the optimum so that they are strong enough to be self-supporting but can be "cut" satisfactorily.

Day 4 - Install reinforced male piles between the female piles.

So a 2 to 3 day monitoring regime will pick up at least one if not both days of piling adjacent to any building. Piling is anticipated to take approximately 36 weeks in a phased sequence so at least 72 sets of monitoring will be undertaken at this time.

During pile installation a number of inclinometers will be installed into piles within the basement walls. These inclinometers will allow measurement of the actual pile deflection to be undertaken, which can then be compared to the deflection calculations carried out by Keltbray Piling.

5.3.3 Capping Beam and prop installation

This part of the sequence will generally have minimal impact on adjacent buildings as, for the whole of the basement perimeter, the capping beam is above the foundation level of the existing buildings.

During capping beam installation background monitoring will be maintained at the previous twice a week interval. This will maintain the level of information on the existing building movement.

Capping beam installation is programmed to take approximately 13 weeks and during this period monitoring of the inclinometers on the same twice per week interval will be carried out to provide baseline readings for these devices.

5.3.4 Excavation

This is the most critical phase of the works as the majority of the predicted ground movement will take place during this phase. Excavation is relatively slow, especially when taking place at depth, as the time take to physically extract the ground and remove the spoil dictates the pace of the works.

In this instance space only exists for a single excavator within the basement so no more than around 400 m3 of material can be removed per day. The excavation of the basement is expected to take 12 weeks.

The general reduction in level will therefore not exceed 1m average depth per day.

In these circumstances the change in loading between one day and the next will be gradual and so monitoring on a daily basis is not considered necessary or even beneficial. Monitoring every other day will give clear information as to the movement of the walls during excavation and allow estimation of final movements to be monitored so, if necessary, remedial action can be taken.

The absolute movement of the wall is not necessarily the most important thing to assess, more the rate of change of movement. It is expected that during excavation the movement of the wall will change at an increasing rate until the final depth of excavation has been reached. At this point movement will continue but at a reducing rate until the wall reaches equilibrium.

It is possible with the inclinometer readings to monitor the rate of movement change and to establish that this increase and reduction in movement is taking place in line with predictions.

It is preferable to continually review the movement reports and predict future movements than to rely on a 'Traffic Light" system based upon the building movements. The allowable movements are those predicted in the Basement Impact Assessment Report and so any movement within these figures is, by definition, allowable and does not require any action. What is necessary is to be able to confidently predict if movement is likely to go outside these figures and take action to prevent this from happening. The building movement will always lag behind the movement of the wall so monitoring the wall is critical.

Plotting the actual against predicted pile movement provides a much better analysis tool for predicting the final movement. The pile movement will be directly related to the movement of the adjacent buildings, but monitoring of the buildings only really provides evidence that the movements are being maintained within the agreed limits.

Monitoring will be maintained at three times per week until movement has reduced to within the baseline tolerance between 3 sets of readings. Once this point has been reached monitoring frequency will be reduced by 50% to twice weekly monitoring.

5.3.5 Basement Slab Construction

As noted in the excavation section monitoring will be maintained at 3 times per week day until movement has reduced to within the baseline tolerance between 3 sets of readings. Once this point has been reached monitoring frequency will be reduced by 50% to twice weekly monitoring. This is not likely to happen until after the base slab has been cast.

Twice weekly monitoring will then be maintained until again movement has reduced to 1mm or less between readings. Then reading frequency will then be reduced to weekly until the ground floor slab has been constructed and has gained adequate strength to act as the permanent support to the capping beam to the basement wall.

Monitoring will be continued until such time as results have stabilised at which point after 3 successive surveys with no progressive movement monitoring will cease.

Table - Proposed Monitoring Frequency Matrix

Stage	Sequence	Monitoring Frequency	Programmed Period	Anticipated Number of Survey Results
1	Pre Start	2 Times / week	3 Weeks	6 Sets
2	Piling	2 Times / week	36 Weeks	72 sets
3	Capping Beam	2 Times / week		
4	Excavation	3 Times / week	12 Weeks	36 Sets
5(a)	Basement Construction	3 Times / week	9 Weeks	27 Sets
5(b)	Basement Construction	2 Times / week	13 Weeks	26 Sets

Over the period of construction it is anticipated that 167 monitoring visits will be undertaken, providing well over 1000 individual readings. Hence giving a very good picture of building movements around the site.

5.4 Remedial Actions

The monitoring of the movement of the piled wall will allow predictions to be made of the final overall movement of the wall and hence of the adjunct buildings.

The predictions will be carried out on an ongoing basis using the survey results obtained through the monitoring. If the predictions show that movement in excess of the agreed limits is likely to be induced then remedial action will be taken.

Initially works will be stopped to prevent increasing the risk of inducing further movement. A meeting shall be arranged to review the movement results, the potential estimated final movement based upon the monitoring to date and the possible damage category resulting from this movement.

If allowing for the new predicted movement the damage category does not change works will be allowed to proceed but monitoring will be increased by 50%.

If the predicted movement, based upon the survey findings, increases the damage category then measures will be taken to restrict future movement so as to ensure that the agreed damage category is not exceeded.

There are a number of ways in which measures can be taken to reduce movement.

1. Install additional propping or support to the wall.
2. Re-sequence the works to minimize excavation in critical areas.
3. Phased excavation and propping.

If movement is noted in one wall rather than another then specific action can be taken such as relocating spoil locally to form a temporary berm against the wall of concern. Parts of the basement slab, such as the central portion, could be excavated and cast allowing this to form a thrust block to support additional secondary propping. This would allow a berm of soil to be maintained around the perimeter providing temporary support for the wall until such propping is in place.

If no other alternative exists then a second level of Walers and propping could be installed at above Basement 1 slab level to stiffen the support system which would reduce the deflections to well within the required figures. It is considered that this option is highly unlikely due to the nature of the design and ground, but is available as a final safety-net if entirely unexpected movements occur.

6. Utilities

Within the site's current boundary there are live HV electrical cables, Gas and Water mains that serves the existing UCL Campus. To construct the basement in a safe and productive manner these services require to be diverted from the confines of the site and then re-connected where necessary once the basement has been constructed. To achieve this Mace have been in consultation with UKPN, Thames Water, National Grid, Triio and UCL Maintenance Engineering.

Service diversions works forms part of Maces' early enabling works and are currently underway, as these services are being removed from the construction zone they will be at no risk of any ground movement.

Attached in Appendix G of this document for reference are the services drawings

1. Plowman Craven - Main services drawing
2. Radar Survey (by Lazer Surveys) - Additional survey commissioned by Mace

During the Construction of the Basement there will be one LV cable resident in the footpath running along Gordon Street positioned approximately 8 meters away from the centre line of the capping beam. The maximum horizontal deflection of the wall at ground level will be less than 25mm and will cause no foreseen damage.

7. Piling

The main contractor “Mace” has appointed Keltbray as their intended sub-contractor responsible for the design and installation of the secant and bearing piles for the construction of the basement their full design can be seen in Appendix B of this document. The piles have been design in accordance with Curtins Basement Impact Assessment for ground movement

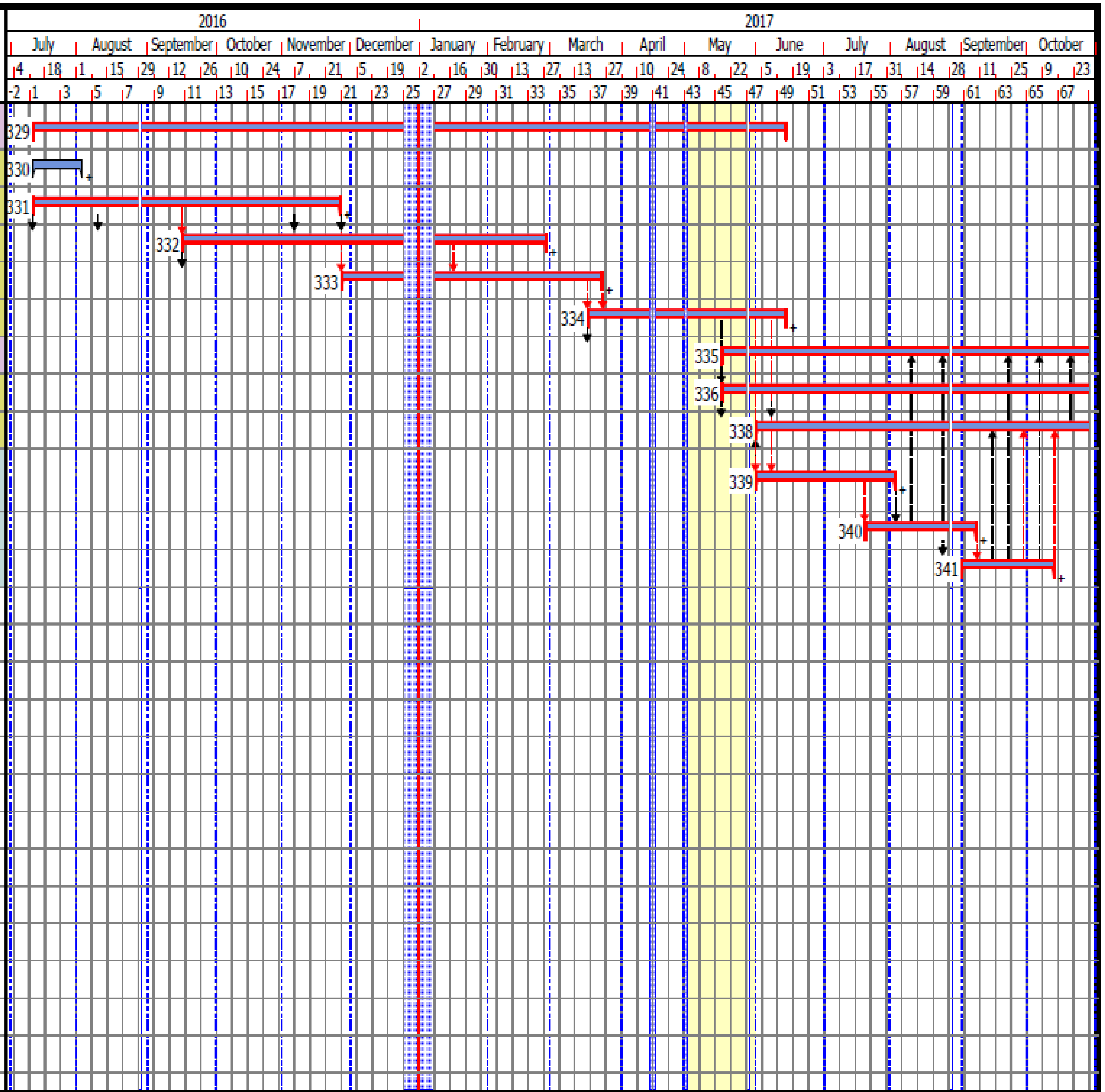
8. Programme

The programme for the construction of the basement is shown overleaf (Programme Reference 82927) this represents just a snap shot from the whole programme of works for UCL New Student Centre. The basement works are planned to commence on Tuesday 12th July with the removal of the Node Basement at the far North West Corner of the site, this section of works will be overlapped with the Site Welfare and Hoarding Set Up and the actual commencement of the Ground Works for the basement as described in Section 8.1. Completion date for the basement excavation will be 14th June 2017 making the total duration of 45 weeks for excavation.

The basement frame construction level -2 is due to be commenced on the 17th May 2017 with the first milestone being the installation of the tower crane which is positioned on level -2 slab within the Atrium of the building. The basement frame construction will be completed when the ground floor slab level 00 is cast which is programmed for the 12th October 2017 making the frame duration up to ground floor level 00 18 weeks.

BASEMENT CONSTRUCTION PLAN – UCL NEW STUDENT CENTRE

Line	Name	Duration Working Weeks	Start	Finish
329	SUB-STRUCTURE WORKS	45w 2d	12 Jul 16	14 Jun 17
330	Node basement demo	3w 1d	12 Jul 16	02 Aug 16
331	Area 1 (Ramp and Waco cabin area)	19w 3d	12 Jul 16	28 Nov 16
332	Area 2 (North half of site)	21w 2d	16 Sep 16	27 Feb 17
333	Area 3 (South half of site)	14w 4d	28 Nov 16	23 Mar 17
334	Basement excavation	12w	17 Mar 17	14 Jun 17
335	SUPER-STRUCTURE WORKS	80w	17 May 17	20 Dec 18
336	TOWER CRANE	63w 2d	17 May 17	24 Aug 18
338	CONCRETE FRAME	41w	01 Jun 17	29 Mar 18
339	Basement level -2 (pile caps incorporated and cast into slab)	9w	01 Jun 17	02 Aug 17
340	Basement slab level -1	7w	20 Jul 17	07 Sep 17
341	Ground floor	6w	01 Sep 17	12 Oct 17



Project title	NEW STUDENT CENTRE	Dated 18/02/2016	Drawn by MR
Programme title	Project programme	Programme No 82927	Revision comment
Client	UNIVERSITY COLLEGE LONDON	Notes	Sub-structure extract
		Sheet 1 of 1	Revision Draft; Revision Date 11/05/2016

mace

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9. Methodology and Sequencing

The following construction sequence / methodology is based on a traditional open excavation using MGF 600 series hydraulic struts / props designed to prop the head of the retaining walls. Mace as the main contractor has employed Bridges Pound Consulting Engineers as a Supporting Temporary Works Engineer Service to design all temporary works related to the construction of the basement.

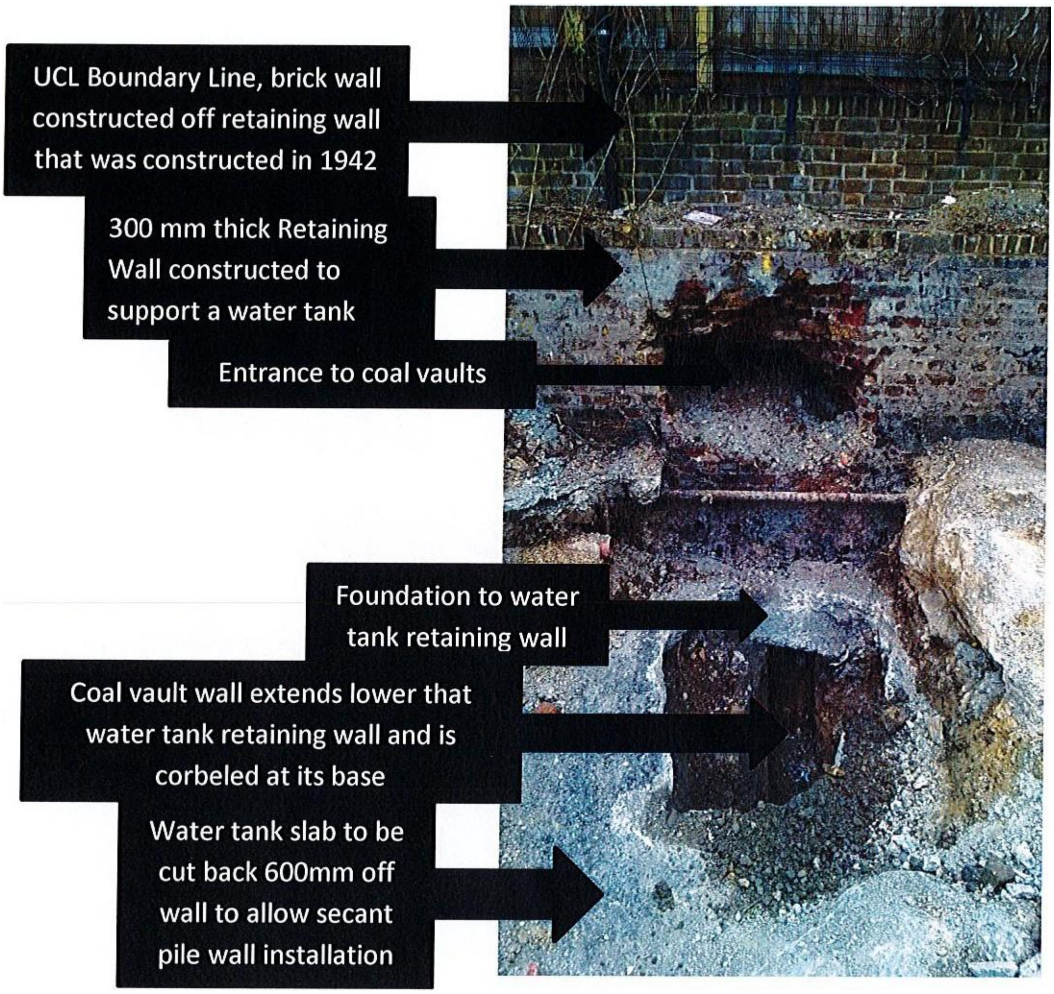
9.1 Site Set Establishment

1. **Undertake Topographic Survey**- To establish benchmarking to allow for movement monitoring stations to be formed for horizontal and vertical control.
2. **Undertake Additional Surveys** - To establish site conditions undertake simplistic survey's to ….
   a) WAC test to confirm ground conditions
   b) Radar Survey to confirm extent of services.
   c) Excavation to confirm obstructions and vault construction.
   d) Intrusive survey of existing secant pile wall for core samples and line and level.
   e) Confirm bearing pile positions of existing pile from old development in 2008.
3. **Termination and diversion of existing services** - Existing HV Cables, Gas and Water Mains are currently being diverted.
4. **Pre Start Background Monitoring** - Background Monitoring Stations to be established 3weeks prior to works commencement to establish comparison readings.
5. **Establish Hoarding Lines**- Obtain appropriate licenses for carriageway closure, erect hoarding lines and pit lane as detailed in CMP to allow safe access to site.
6. **Establish Welfare Facilities** - Erection of Gantry to support Welfare Units at Gordon Square as CMP.
7. **Traffic Controls_**- Entrance gates to be established to be manned with trained traffic marshals / banks men and security all as CMP.
8. **Designed Concrete Hard Standing_**- Construction of the designed temporary hard standing to allow safe usage of mobile cranes, pumps, excavators, muck away Lorries and delivery vehicles. Hard standing positioned in place of existing footpath along Gordon Street above line of vaults.

9.2 Reduced Level Dig to Establish Piling Matt.

As detailed in the AIP the boundary line along Gordon Street houses coal vaults which were constructed during the Regency period, the terraced housing that the vaults served were reduced to rubble during the second world war. From Historical photographs and the surveys undertaken it has been established that a retaining wall and water tank were constructed in 1942, the remains of which can be seen in the photograph overleaf. The wall and concrete slab runs along the whole length of the site boundary along Gordon Street.

The extent of the retaining wall, its foundation and water tank slab level has reduced the requirement for temporary works support for the coal vaults running along Gordon Street. During the basement construction a small element of support will be required to be installed at the south east corner where New UKPN Sub Station has been constructed to support the footpath / carriageway. This is shown on Bridges Pound Drawing's Temporary Restraint to Inner Walls Number 031-51-1000-DR-Y-00006-B1 Rev 1.



Based on this information the sequence for reduced level digging and forming of pile matt level will be as below

1. **Installation of Temporary Works Gordon Street Boundary** - Temporary Works to be installed as Bridges Pound Drawing Number 031-51-1000-DR-Y-00006-B1 Rev 1 between Retaining Wall and UKPN Sub Station Wall.
2. **Reduced Level Dig** – Existing hardcore fill to be excavated and stored on site in zones to avoid carting way from site in preparation for the concrete water tank slab removal.
3. **Water Tank Concrete Slab Removal** – Concrete Slab to be cut back at approximately 600mm off brick retaining wall and removed using drilling and bursting methodology for breaking out the concrete. Works to carried out in zones
4. **Pile Matt Installation** – Pile Matt to be installed to a nominal depth of 1.3 meters up to a reduced level of 24.200, hardcore to be rolled in thickness as indicated on temporary works design.
5. **UXO Survey's –** UXO Survey to be carried out using Intrusive Magnetometer Survey Technique
6. **Pile Matt Remediation –** Pile Matt to be checked and remediated following UXO survey.
7. **Guide Wall Installation to Secant Piles** - Guide wall to be constructed to engineer's details ready for pile commencement.

9.3 Pile Installation

1. **Secant Pile Wall** – On completion of guide wall, secant wall to be installed along Gordon Street, working in phased sequence.2
2. **Bearing Piles –** Bearing piles to be installed in conjunction with secant wall piles, working in phased sequence.
3. **Guide Wall Removal –** Guide wall to be removed upon piling completion
4. **Inclinometers Installation –** Inclinometers to be set up ready for installation.
5. **Piling Complete –** Piling works completed in phased sequence.
6. **Construction of Pile Capping Beam to Secants** – After piles have cured, reduced level dig to commence to an approximate blinding level of 23.500mOD to the underside of the capping beam. Secant piles to be cut down to cut off level and capping beam formed including corbels as designed in conjunction with phased sequence of works.
7. **Inclinometers –** Inclinometers to be read and data recorder for traffic light monitoring in line with movement monitoring proposed scope.

9.4 Excavation of Basement

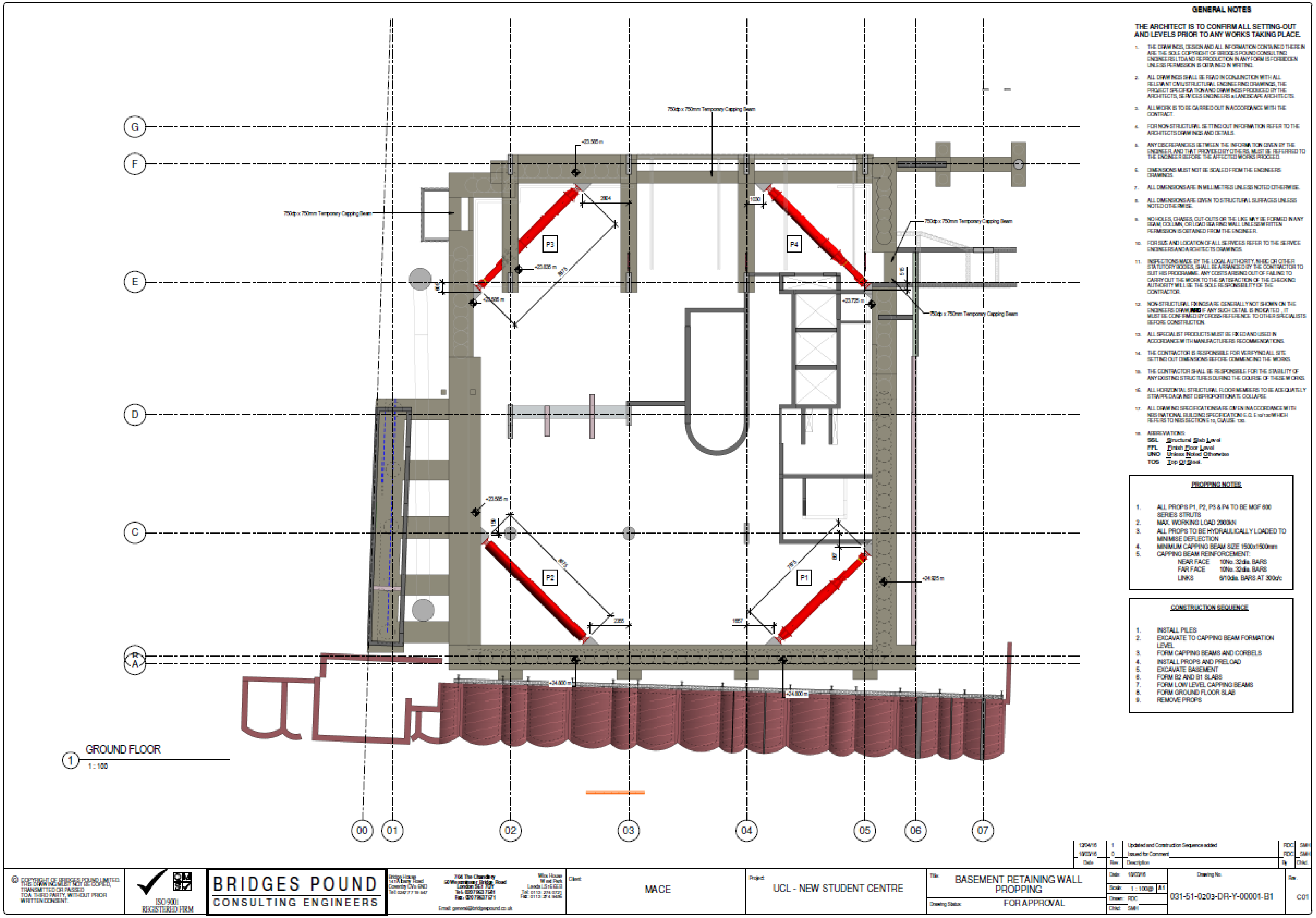
1. **Pile Cap Beam** – Pile cap beam to be struck and pile matt to be reduced level dig down to a nominal dig of 1.00 meters.
2. **MGF 600 Modular Bracing Struts Installation** – Four MGF 600 modular hydraulic struts to be installed at each corner of the basement, mounted on the corbels provided using an 360 degree excavator all as Bridges Pound Drawing 031-51-0203-DR-Y-00001-B1 Rev C01
3. **Pre Load Struts** - MGF 600 struts to be pre-loaded and signed off.
4. **Commence Excavation –** Excavation to be commenced to form basement. Sub-soil removed via 360 degree excavators to lorries all as CMP using the designed temporary hard standing installed within the site compound to a reduced level of 14.750mOD.
5. **Ground Water Control –** It may be required to provide limited de-watering for ground water control at made ground at gravel layers from inclement weather.
6. **Installation of Blinding –** On completion of excavation blinding to raft foundation to be laid to reduced levels to allow center raft foundation to be cast ready for Tower Crane installation.
7. **Tower Crane Installation –** On completion of first pour sequence of raft basement slab level -2 Tower Crane to be installed off Gordon Street to enable construction of basement.
8. **Commencement of Basement Frame Works** – Construction of the Basement Frame is to be carried out in a bottom up sequence as Curtins Consulting Engineers Drawings (Appendix E) for works in the permanent state, following on from the pouring of the raft foundation the perimeter liner walls will be constructed then column and inner wall formwork installed and poured which will be followed by the pouring of the floor slabs on each level up to ground level.
9. **MGF 600 Modular Bracing Strut Removal** – The MGF 600 hydraulic struts require to remain in position until the ground floor slab has been cast and cured which provides the bracing in a permanent state for the pile caps.

10. Temporary Works Design

The basement secant piled wall is designed as a propped cantilever. In the temporary condition it's propped by diagonal struts at each corner and the base cantilevers in the permanent condition by the ground floor slab. As described previously Mace as the main contractor has appointed Bridges Pound as their Temporary Works Consulting Engineer, they have based their temporary works design around using one level of MGF 600 heavy duty modular hydraulic bracing struts positioned at capping beam level with each strut being capable of supporting loads of up to 2500KN (Specification enclosed with Appendix C of this document). The struts are simple to transport, assemble and use, in essence they will prop the capping beam at a 45 degree horizontal angle at each corner of the basement and will be mounted and mechanically fixed to specially designed corbels which will allow for a safe and economical means of constructing the basement. The design of the Corbles will be designed by Bridges Pound and will be interfaced with the Capping Beam Designed by Curtins. The struts are extremely heavy and the system will need to be assembled on site prior to being lifted into position with a large excavator or crane. The Bridges Pound design is illustrates on 12 drawings as listed below enclosed within the Appendix D

Drawing Title	Drawing Number
Basement Retaining Wall Propping	031-51-0203-DR-Y-00001- B1 Rev C01
Basement Prop 1	031-51-0203-DR-Y-00002- B1 Rev C01
Basement Prop 2	031-51-0203-DR-Y-00003- B1 Rev C01
Basement Prop 3	031-51-0203-DR-Y-00004- B1 Rev C01
Basement Prop 4	031-51-0203-DR-Y-00005- B1 Rev C01
Temp Restraint to Inner Walls	031-51-0203-DR-Y-00006- B1 Rev 01
Work Adjacent to 26 Gordon Street	031-51-0203-DR-Y-00007- B1 Rev C00
Works Along ACBE Boundary	031-51-0203-DR-Y-00008-B1 Rev C00
Works to Service Entry on Grids E-01	031-51-0203-DR-Y-00009-B1 Rev C00
Temp Works to Form Tunnel (1 of 2)	031-51-0203-DR-Y-00010-B1 Rev C00
Temp Works to Form Tunnel (1 of 2)	031-51-0203-DR-Y-00011-B1 Rev C00
Works Adjacent to Grid Line 05	031-51-0203-DR-Y-00012-B1 Rev C00

The main retaining wall propping plan is shown over leaf and details the 4 main MGF 6OO hydraulic props mounted on corbels positioned at 45 degrees horizontally at each capping beam corner.



GENERAL NOTES
THE ARCHITECT IS TO CONFIRM ALL SETTING-OUT AND LEVELS PRIOR TO ANY WORKS TAKING PLACE.
ABBREVIATIONS:
SSL Structural Slab Level
FFL Finish Floor Level
UNO Unless Noted Otherwise
TOS Top Of Steel
PROPPING NOTES
1. ALL PROPS P1, P2, P3 & P4 TO BE MGF 600 SERIES STRUTS
2. MAX. WORKING LOAD 2000kN
3. ALL PROPS TO BE HYDRAULICALLY LOADED TO MINIMISE DEFLECTION
4. MINIMUM CAPPING BEAM SIZE 1500x1500mm
5. CAPPING BEAM REINFORCEMENT:
NEAR FACE 10No. 32dia. BARS
FAR FACE 10No. 32dia. BARS
LINKS 8/10dia. BARS AT 300c/c
CONSTRUCTION SEQUENCE
1. INSTALL PILES
2. EXCAVATE TO CAPPING BEAM FORMATION LEVEL
3. FORM CAPPING BEAMS AND CORBELS
4. INSTALL PROPS AND PRELOAD
5. EXCAVATE BASEMENT
6. FORM B2 AND B1 SLABS
7. FORM LOW LEVEL CAPPING BEAMS
8. FORM GROUND FLOOR SLAB
9. REMOVE PROPS
750dp x 750mm Temporary Capping Beam
750dp x 750mm Temporary Capping Beam
750dp x 750mm Temporary Capping Beam
750dp x 750mm Temporary Capping Beam
P1
P2
P3
P4
G
F
E
D
C
B
A
00
01
02
03
04
05
06
07
1 GROUND FLOOR
1 : 100
BRIDGES POUND
CONSULTING ENGINEERS
ISO 9001 REGISTERED FIRM
Client MACE
Project UCL - NEW STUDENT CENTRE
Title BASEMENT RETAINING WALL PROPPING
Drawing Status FOR APPROVAL
Scale 1 : 100@ A1
Drawn RDC
Chkd SMH
Drawing No. 031-51-0203-DR-Y-00001-B1
Rev. C01
1 Updated and Construction Sequence added RDC SMH
0 Issued for Comment RDC SMH
Date Rev. Description By Chkd.

The array of temporary works design to construct the basement is as described below, back up documentation to include calculations and design loads for struts is included with Appendix D.

Basement Retaining Wall Propping - Drawing 031-51-0203-DR-Y-00001- B1 Rev C01 shows a main plan view of the propping arrangement and includes propping notes and construction sequence at capping beam level which is Ground Floor Level 00.

Basement Prop 1 - Drawing 031-51-0203-DR-Y-00002- B1 Rev C01 shows a MGF 600 hydraulic strut positioned at the North East corner of the basement mechanically fixed onto 2 designed corbels incorporated within the capping beam installed at a reduced level of 24.125 to the top of the strut.

Basement Prop 2 – Drawing 031-51-0203-DR-Y-00003- B1 Rev C01as prop 1 shows a MFG 600 hydraulic strut positioned at the South East Corner of the basement mechanically fixed onto to 2 designed corbels incorporated within the capping beam installed at a reduced level of 24.000 to the top of the strut.

Basement Prop 3 – Drawing 031-51-0203-DR-Y-00004- B1 Rev C01 and 031-51-0203-DR-Y-00009-B1 Rev C00 shows MFG 600 hydraulic strut positioned at the South West corner of the basement mechanically fixed onto to 2 designed corbels incorporated within the capping beam installed at a reduced level of 24.000 to the top of the strut. The design also includes a temporary capping beam at the utility service entry point which is designed in to allow the main capping beam to be constructed at a lower level, externally the design includes for Mabey M8 trench sheets with RMD Slimshor Walers to allow for manual access for the removal of the temporary capping beam and the installation of the HV cables and Water Main.

Basement Prop 4 – Drawing 031-51-0203-DR-Y-00005- B1 Rev C01 and 031-51-0203-DR-Y-00008-B1 Rev C00 shows MFG 600 hydraulic strut positioned at the North West corner of the basement mechanically fixed onto to 2 designed corbels within the capping beam installed at a reduced level of 24.125 to the top of the strut. This design also includes for temporary capping beam to allow the permanent capping beam to be installed at a lower level and includes Mabey M6 trench sheets tied in with an RMD Slimshor Walers supported by RMD raking Slimshor props as support during the temporary condition.

Temporary Restraint to Inner Walls - Drawing 031-51-0203-DR-Y-00006- B1 Rev 01 shows the temporary support to the footpath / carriageway at the site boundary parallel with Gordon Street. As described previously the existence on the retaining wall running in front of the coal vaults has negated the requirement for temporary works along the whole elevation at the boundary line, the only temporary works required spans the break in the wall line near to the UKPN sub-station at the South East corner of the site (As seen on the photograph overleaf). Temporary Works for this area involves installing Mabey M8 trench sheets, supported by a RMD Slimshor Walers mechanically fixed with M12 resin anchors.

Work Adjacent to 26 Gordon Street – Drawing 031-51-0203-DR-Y-00007- B1 Rev C00 re-affirms the requirement to check the existing foundation make up at 26 Gordon Street gable end to re-affirm its construction as the initial trial pits, the works will require a watching brief during construction by construction management.

Temporary Works to Tunnel North West Corner – Drawings 031-51-0203-DR-Y-00010-B1 Rev C00; 031-51-0203-DR-Y-00011-B1 Rev C00 and 031-51-0203-DR-Y-00012-B1 Rev C00 shows the temporary works requirement to construct the tunnel arrangement that links the new plant room with existing plant rooms within the current UCL Campus. The Temporary Works allows for a temporary capping beam to allow the lower permanent capping beam to be constructed and Maybe M 6 Trench Sheets supported with Slimshor Walers for the works carried out in a temporary state.

11. Ground Movement Assessment

11.1 Ground Movement Analysis

A comprehensive assessment of both the ground movement and damage assessment has been documented in The Basement Impact Assessment under-taken by Curtins Consulting Engineers in the spring of 2015. A final and updated version of this document was completed on the 21st August 2015 and issued to the London Borough of Camden and is attached with this document in Appendix F. In the report the ground movement has been analysed with regards to taking into account the piled wall installation and wall deflection. Additionally heave and long term ground movement have been also been considered.

As stated previously for the final basement temporary works scheme the main contractors Temporary Works Consultant Bridges Pound has designed an arrangement whereby only one set of props are to be used, positioned at capping beam level, this is in contrast to the scheme proposed by Curtins in their Basement Impact Assessment which proposed three sets of props.

The Bridges Pound temporary works design has been formulated around the piling and capping beam designs and allowable deflection tolerances as set in The Basement Impact Assessment to keep within the outlined ground movement estimate.

The maximum vertical displacement will be at the centre of the excavation which gradually reduces towards the perimeter where the presence of the piled secant wall will contain the heave movement within the site perimeter. The proposed loads on the secant walls are fairly high and will mitigate potential for uplift movement.

The proposed basement construction methodology is a very common form of construction and the structural design is such as to mitigate the effect of ground movements.

11.2 Damage Assessment

As discussed previously full condition surveys have been conducted by G Dolden & Associates a fully qualified Chartered Building and Consultancy Services based in Essex to identify any existing damage that may have occurred to the neighbouring buildings.

The results from the ground movement analysis reported in the ground movement and damage report held within the Basement Impact Assessment (See Appendix F) has been used to assess the potential damage to the surrounding buildings from the construction of the proposed basement. The damage category assessment does not exceed Category 2 at any place around the perimeter of the basement construction works emphasising that there could only be slight damage to the wall of neighbouring buildings.

CIRIA Section 2.5.4 based on the methodology proposed by Burland and Wrath and later supplemented by the work of Boscardin and Cording identifies Category 2 Damage as "slight" easily filled cracks with probable re-decoration required, with several slight fractures showing inside the building. Cracks will be visible externally and some repointing may be required to ensure weather tightness with doors and windows sticking slightly. The advice gained is that this is normal category damage for this type of building construction nestled closely between two or three building lines.

11.3 Conclusion & Mitigation

The analysis from the reports concludes that the damage to the neighbouring properties would be generally slight, this damage would inevitably occur as a result of such a construction process and would fall within the acceptable category limits. As a mitigation process movement monitoring will be heavily scrutinised during construction with a traffic lights warning system being overseen by the main contractor as detailed in the section on monitoring.

The screening process of the Basement Impact Assessment identified subterranean water flow and land stability from the movement of the ground as the two potential issues for the development. Both have been assessed and found to be within the guidelines of acceptable values with slight damage likely to result from the movement of the ground subsequent to the excavation of the basement and only a very small potential change in water level is likely from the damming effect of the secant wall on the ground water. The proposed basement will not result in flooding of the area and will not cause instability of the surrounding ground structures.

12. Appendices

12.1 Appendix A - Condition Survey Documents

12.2 Appendix B – Keltbray piling design secant and bearing piles

12.3 Appendix C – MGF 600 Strut / Prop Specification

12.4 Appendix D - Bridges Pound Temporary Works Drawings and Back Up Calculations for Basement Propping.

12.5 Appendix E – Curtins Consultant Engineer Basement Construction Drawings

12.6 Appendix F – Curtins Consulting Engineer Basement Impact Assessment

12.7 Appendix G – Utilities drawings

12.8 Appendix H – Revised monitoring proposal LO1254/S-M01 Rev P2