Westminster City Council's Residential Basement Report

Prepared for Westminster City Council

July 2013

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Contents

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Contents (continued)

Executive Summary

Westminster City Council (WCC) is reviewing its detailed planning policies in relation to residential basements. This report has been prepared to identify some of the key aspects of basement construction. It is an engineering report to assist WCC prepare their planning policies in relation to residential basements but the report in itself does not form part of the planning policies. It is also aimed at building owners and their advisors and it sets out an approach to basement design and construction issues. The report provides general background information on topography, geology and groundwater aspects in Westminster. It describes the factors which have influenced these aspects including historic "lost" rivers and emphasises the need for site specific desk study and site investigation.

Basements are prone to flooding and the report identifies various causes of flooding which can occur and suggests protection measures. If a basement is proposed in a high flood risk area, a site specific flood risk assessment should be carried out.

The report then describes a variety of techniques for constructing basements. It highlights the importance of selecting a design team who are experienced in basement construction together with a competent contractor and that they can demonstrate a track record of projects which have been completed successfully. The interaction between the design team and contractor is discussed, where temporary works and permanent works may need to be integrated. It identifies some of the considerations in relation to the effect on the surrounding buildings and areas where the risks may be higher. It also emphasises the need to consider attached properties as part of the same overall structure rather than treating a property in isolation. Basements under gardens are also discussed.

One of the common concerns of basement construction is the effect on groundwater. The issues are considered and areas where this could potentially be an issue are identified. It is also essential that cumulative effects of basements are considered.

The excavation for a basement will cause a degree of ground movements. The causes of the movements are discussed. While in general, ground movements will relate to the size and the depth of the basement, the most important factor is likely to be the quality of the design and construction and how well the temporary propping is carried out.

Basements in close proximity to adjacent properties will need a Party Wall Award. This will record the existing condition of the adjacent properties and provides a mechanism for the costs of remedial works or redecoration to be recorded if necessary.

The impact of basements under gardens is also considered in relation to trees and groundwater. Proposed basements should respect tree root protection zones. There is no engineering reason to limit the size of the basement in rear gardens in relation to groundwater issues, although it is desirable to leave a zone so that major trees can be planted.

Finally the report sets out recommendations on the approach to the design and identifies the steps which should be taken in advance of submitting a planning application. It provides details of the supporting documents which should be supplied and emphasises the need for them to be site specific rather than generic documents.

1.0
Introduction

1.1 Westminster City Council is reviewing its detailed planning policies. Applications are currently determined with reference to the Core Strategy (adopted 2011) and 'saved' policies in the Unitary Development Plan. The Council previously consulted on a second development plan document, the City Management Plan (CMP) in November 2011. This contained more detailed development management policies. One of the new policy areas in this document relates to residential basement (subterranean) development. Following publication of the National Planning Policy Framework (NPPF), the CMP is not being taken forward as a separate document but, instead, these detailed policies and any necessary supporting text will be inserted into the Core Strategy to create a single local plan for Westminster. At the same time, the Council is taking the opportunity to review this policy. This report sets out the key issues which need to be considered as part of such subterranean development for residential basements.

1.2 High land values combined with the lack of available sites mean that there are significant pressures to extend existing residential buildings. There are major constraints on adding height, so there is an increasing trend to build basements below gardens or below existing buildings. WCC has seen a year on year increase on the number of applications for residential basements over the last 5 years, a trend which is likely to continue.

1.3 Basement construction involves significant engineering structures, which create a permanent irreversible change in ground conditions. The complexity increases rapidly with the depth. This can have a long term impact on the future planning and development within the City of Westminster.

1.4 Planning policy in the UK has evolved to control above ground construction with policy designed to deal with issues such as visual impact, character, views, density and the open space between buildings, which are usually considered at design stage. In addition, considerations of overlooking and sunlight/daylight are now key issues due to the increasing density of development and the impact on adjoining owners. There is little in the way of policy in relation to subterranean development in residential areas, as until recently, residential basement developments were relatively rare. The increase in basement construction has led to a need to have more comprehensive guidance on the overall effect of basement development on an area and the potential impacts on adjoining buildings and the surrounding area.

1.5 Basement design and construction in dense urban areas is technically challenging particularly when basements are beneath or adjacent to existing buildings. If a problem occurs, it often affects adjoining buildings. The process of constructing a basement can cause significant disturbance to neighbours and the surrounding streets due to the nature and volume of construction materials to be delivered to, or removed from site. The construction programme usually extends for longer periods than for a similarly sized above ground development.

1.6 Adjoining owners and some residents in WCC have raised concern about basement construction. These concerns relate to the risk of damage to their properties caused by adjacent basement construction including the effects of ground movements, the disruptive effects of the construction process and the potential for basements to cause changes to the groundwater regime in an area and consequential flooding. Noise, dust and additional traffic are also concerns. Many of these issues are not considered in Westminster City Council's current planning policies and many are not addressed through planning legislation.

1.7 A recent Parliamentary Bill was proposed to control subterranean development but this has been rejected by government as it was felt that existing Party Wall legislation and common law were sufficient to deal with relationships and disputes between adjoining owners. This legislation and a number of different regulatory regimes, control different aspects of the design and construction process, as set out below.

1.8 The **Party Wall legislation** is specifically aimed at maintaining the party walls between adjoining owners and controlling how development on each side of a party wall is arranged, so as to preserve the status and integrity of the party wall. When the Party Wall legislation was drawn up it did not specifically consider the addition of basements close to or beneath party walls. The Party Wall legislation deals with work to the party wall, including construction beneath it (such as underpinning) and construction in the ground close to the party wall that might affect it. Party wall surveyors therefore have to interpret the Party Wall legislation in situations which were not contemplated when the Act was drawn up. (See Section 8.2).

A limitation of the effectiveness of the Party Wall Award (PWA) is that agreements made under it normally apply for the construction period only and would not normally cover damage occurring later which may still be a consequence of the works.

1.9 The **common law** comes into play only when problems arise and usually first requires there to be a dispute. When and if things reach this stage, the remedies, which may be to seek injunctive relief or damages, are expensive and often unsatisfactory. In addition to the expense, this can be the cause of a great deal of anxiety and concern.

1.10 **Health and Safety legislation** is also a factor in that it imposes duties on designers and contractors to work in ways that do not endanger construction workers or the public. The CDM Regulations which impose duties on the client (building owner or developer) as well as those who design and construct developments do not currently require domestic owner-occupied projects to be notified to the Health and Safety Executive (HSE). This is understandable where most domestic developments in the UK are straightforward, but the full requirements of the regulations should logically apply to all building owners and developers when complex works are to be carried out. The CDM regulations are currently under review and this aspect may be reconsidered as part of that review. However, Health and Safety legislation deals only with people and not with property, so it cannot be relied on to protect adjoining owners' property interests.

1.11 **Building Regulations** control works associated with environmental performance, the engineering design, fire protection, means of escape etc. to check that a design complies with a minimum set of standards. Building Control Officers also make periodic site visits during construction to see that the designs are being constructed in accordance with the approved drawings. However design responsibility remains with the designers and the contractor is responsible for the construction

There are a large number of other regulations in force which control aspects of the design and construction process. A list of the most relevant regulations are set out in Section 14 and these are also referred to throughout the document, where relevant.

1.12 Planning policy is unable to resolve all of the issues but it is able to guide development, when it is of a scale that requires planning permission, and encourage applicants who wish to carry out works to their properties or sites, to do so in ways that mitigate impacts on and difficulties for residents, adjacent owners and the public in general. It is incumbent on the applicant to clearly demonstrate feasibility and provide details of how they intend the work to be done and what the implications of that work will be, when submitting a planning application.

The issues that need to be considered by the applicant and their design team and those issues which should be presented as part of a planning application are described at the end of this report.

1.13 This report uses the words 'basement' and 'subterranean' interchangeably.

2.0
Purpose of Report

2.1 WCC have set out initial draft policies in the Draft City Management Plan (CMP) November 2011 in relation to subterranean residential development which is now under review. As part of the consultation process, concerns were raised about the potential impact of the construction of basements on the structural integrity of adjoining properties and on the hydrology and geology of the area.

The National Planning Policy Framework (2012) states that to prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location.

It states that planning policies should ensure that

- The site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;
- Adequate site investigation information, from a competent person is presented.

It also states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at high risk.

2.2 The main purpose of this report is to address the above and provide guidance to WCC to assist them with their developing planning policies. It is also aimed at building owners and their advisors. It identifies the different construction techniques which can be adopted when constructing residential basements in Westminster and highlights particular risks associated with basement development in different areas of the City and how the design and construction should take account of the ground conditions, the configuration of the basement and the location of the basement in relation to other buildings.

2.3 The report sets out the issues and factors which need to be understood and considered by the building owner, his designers (including Architects) and building contractors when a new basement is proposed and prior to submission of a planning application. It also provides information as to what the possible implications of constructing a basement might be on adjoining occupiers as well as some other key issues which might be addressed in planning policy.

2.4 The report provides background information on hydrology (groundwater), geology and flooding issues in the City of Westminster. It highlights the importance of appointing suitably experienced designers and contractors and the need for detailed investigations of the ground and adjacent structures at an early stage in the process of configuring and procuring a basement project. It provides a number of recommendations in relation to those issues which need to be considered by a chartered civil and/or structural engineer, and information which should be submitted by applicants, as part of the development management process.

2.5 This is essentially an engineering report intended to provide input to the City Council's evidence base in preparing its policies and help address some of the issues which have been raised in consultation on draft policies. The detailed civil and structural engineering advice given is in the main intended to assist homeowners considering undertaking basement works. Although this report will also inform the emerging planning policy, there is no expectation that it can or should be incorporated into planning policy. The detailed design of basements will, for the main part, be regulated under the relevant codes.

2.6 This report is primarily related to basement design and construction close to or under existing residential properties, although most of the content also applies to basements for new residential buildings. Proposals for commercial basements adjacent to residential properties should also consider these principles.

3.0
Site Constraints

3.1 Topography

3.1.1 The general topography of Westminster was primarily influenced by the River Thames. The area north and west of the Thames up to Knightsbridge and Piccadilly is low lying and relatively flat. The land generally rises from here up towards Regents Park. See Figure 2.

3.1.2 There are two main historic water courses within Westminster – the River Tyburn and the Westbourne, both of which had a number of tributaries. See Figure 2.

The River Tyburn flows into Regents Park and south towards the Thames with a delta of outlets into the Thames in the area around the Palace of Westminster. The River Westbourne flowed into the Serpentine and then down to the River Thames at or close to the boundary between WCC and the Royal Borough of Kensington & Chelsea (RBKC).

3.1.3 These rivers have now been culverted and are no longer visible but they have impacted on the superficial geology and influence the groundwater regime in the area. They have eroded valleys through the London Clay and gravels, and there are alluvial deposits along the historic river routes.

3.2 Geology

3.2.1 The surface geology of London and the Thames Basin lies above a deep concave layer of chalk which outcrops to the north as the Chilterns and to the south as the North Downs. The material within the chalk basin comprises Thanet Sands at depth overlain by the Lambeth Beds (formerly known as the Woolwich and Reading Beds) which are generally a mixture of sands and clays. Above this is London Clay which, in Westminster, is generally around 50m deep and which outcrops at the surface to the north of the Borough. See Figures 2, 3 and 4.

3.2.2 Above the London Clay there are deposits of sands and gravels which can be up to 10m thick. These were deposited over the last ice age. At that time, the route of the River Thames assumed its current location. The process of eroding its valley has created a series of sand and gravel terraces. Each of these are named by the area where they are best known. While each of these have slightly different characteristics, which impact on their geotechnical properties, they can all generally be classified as sands and gravels.

3.2.3 In places there are deposits of Langley Silt (sometimes called brickearth) which is a mixture of silts, clays and sands. Typically this overlies the sands and gravels. Because of its use for making bricks, Langley Silt has been excavated in many areas and the resulting pits backfilled generally with poor quality material. Also, in some locations, the sands and gravels have been excavated for use in construction and replaced with fill.

3.2.4 The south of the Borough has extensive areas of alluvial deposits laid down by the River Thames and along the routes of the Tyburn and Westbourne. This area was historically very low lying and marshy until the route of the Thames was defined by river walls. The general groundwater levels in these areas remains relatively high.

3.2.5 On top of the natural deposits, there is often a layer of fill or made ground which results from hundreds of years of human occupation. The area around Covent Garden was first built on during the late Roman era and the depth of made ground is often in excess of 4m. Other areas have only been built on for 100-200 years so there is less fill, typically 1 to 2m.

3.2.6 The geological strata in the Borough are well known although the precise boundaries between the different geological layers at the surface, at any particular site, can vary from those indicated on the published geology maps. At these boundaries, there can be significant variations in ground conditions over short distances. The groundwater levels in these areas can also vary as a result of the geology.

3.3 Groundwater

3.3.1 The London basin contains an aquifer which lies deep below ground within the Thanet Sands and Chalk. It is fed from the chalk outcrops to the north and south of the Thames Valley. This is the Lower Aquifer and does not have any effect on normal residential basement construction. However, because of the impermeable London Clay, which lies beneath the gravel terraces, large areas of WCC contain water arising from precipitation within the gravels. This is known as London's Upper Aquifer which is a perched water table. A significant contributor to the water in the upper aquifer is burst or leaking water mains. The water in this Upper Aquifer tends to flow slowly across the surface of the London Clay towards the River Thames. The flow depends partly on the permeability of the overlying sands and gravels. London's development has altered what were rivers, running in natural open ditches which flowed into tributaries of the River Thames; the River Westbourne and the River Tyburn. The Upper Aquifer water levels do not vary significantly, as water drains away into the Thames basin through the permeable sands, gravels and alluvial layers.

3.3.2 The water flows across the surface of the London Clay have over time eroded shallow channels in the surface of the clay. These tend to be filled with sands and gravels. They can have an influence on local ground water levels and ground water flows. This can be an important factor in the area north of Kensington Road, Knightsbridge and Piccadilly, and other areas where the London Clay outcrops at the surface as fingers, between the different Terrace Gravel areas, as illustrated in Figure 3.

3.3.3 In the areas in the north of the Borough, where the surface geology is London Clay, perhaps overlain by topsoil or a relatively thin layer of made ground, there is not generally a perched water table, although there may be some groundwater on top of the clay following periods of prolonged rainfall. In these areas there is little if any flow of water in the ground at or near the surface, so the construction of a basement is unlikely to have any significant impact on the hydrology of the area.

3.4 Summary

The topography, geology and groundwater within Westminster is well known although the geological boundaries may not be well defined. More care should be taken when considering basements close to geological boundaries. An initial assessment may be made using Figures 2, 3 and 4. This should then be supplemented with a detailed site investigation, particularly where the basement extends through differing geological layers.

4.0 Flooding

4.1 Flooding from the Thames

4.1.1 The River Thames is protected against a 1:1000 year fluvial flood event by a combination of the river wall and the Thames Flood Barrier. The critical situation for flooding from the Thames is a combination of prolonged heavy rain in the Thames Valley in conjunction with a storm surge in the North Sea, leading to extremely high tides. The effects of climate change are increasing the risk of flooding and will need to be addressed further in a future flood defence strategy for London.

4.1.2 Parts of Westminster close to the River Thames are at risk from overtopping of the river walls in a significant flood event if there was a failure of the Thames Barrier. If an exceptionally severe tidal flood occurred, the Thames Barrier itself could overtop and be unable to defend London against tidal flooding. Generally the Thames Barrier is operated to control the river levels which are a result of a combination of tidal and fluvial conditions, so that they do not exceed the height of the river walls in London. The areas of Westminster that are at risk of such flooding are indicated in Figure 5. While statistically this combination of events has a very low probability, the consequences of inundation are extremely serious, so all thresholds to new basements in these areas (i.e. the unprotected access points above the enclosing walls and roof slabs) should where possible be set to prevent water ingress in the event of an overtopping incident, particularly if they are used for bedroom accommodation.

4.1.3 Another event which also needs to be considered is a possible local breach of the river wall i.e. a localised failure of the wall during a high tide. In the event of this occurring, water could flow into the flood plain behind the wall for several hours before the tide drops. The areas which are affected are very similar to the areas at risk of fluvial flooding, noted above. (Figure 5). Again the thresholds of new basements should be set to prevent water ingress, ensuring that both access and egress will be safe where there is a breach incident. Where such levels cannot be achieved, flood management plans can be considered as an alternative approach. These need to deal with safe exit from basements in the event of flooding (amongst other things).

4.2 Surface Water Flooding

4.2.1 During periods of very heavy rain, rainwater is sometimes unable to soak sufficiently into the ground, partly because of the large areas of impermeable paving and roofs and because the ground may already be saturated. When this occurs, the only route for the stormwater to escape is via the drains and sewers. Any area of the country can experience localised flooding as a result of short duration, very intensive rainfall, but the worst case scenarios are when the sewers and drains become ineffective in such storms. Road gullies and drains in hard landscaped areas may have insufficient capacity to drain the area, or drains can become surcharged. In such cases water tends to build up locally and flow along roads. At low points or where there are obstructions, significant local flooding can occur, so basements in such areas may be at risk of flooding. This represents the most likely occurrence of flooding within Westminster.

4.2.2 WCC has commissioned a **Strategic Flood Risk Assessment and Preliminary Flood Risk Assessment report from Halcrow**[1] to identify the areas in the Borough most at risk from surface water flooding. This report also considers the potential effects caused by climate change. These areas are illustrated on Figure 6. Areas outside those

noted in Figure 6 may nevertheless be at risk of surface water flooding. For each site the risk of flooding in the street should be considered, particularly if a new basement is proposed. Climate change is likely to mean that there will be prolonged periods of wetter weather. The intensity of heavy rainfall is also expected to increase. This will increase the risk of surface water flooding.

4.2.3 Applicants who wish to build basements in areas which have a risk of surface water flooding (Fig 6) should consider the issue and take steps to protect their basements against water ingress as a result of this flooding. Measures such as setting all thresholds to the basement to be above the flood level could be adopted or, if this is not feasible the construction could be designed to be flood resilient.

4.3 Flooding from Sewers

4.3.1 London's sewage and stormwater drainage system is, mostly, a combined one, with the same drains being used to carry foul and stormwater. The system was designed and installed in the 19th century with local sewers flowing into main west-to-east interceptor sewers built by Joseph Bazalgette.

4.3.2 The steady state foul water flows are low and the sewers depend on higher flows from rainfall conditions to cleanse them. During periods of prolonged high rainfall or short duration very intense storms, the main sewers are unable to cope with the storm flows.

4.3.3 During these events, the interceptor sewers overflow directly into the Thames but when this happens, they back up and the water levels in them rise. This causes backing up of some local sewers and a loss of drainage capacity. The consequence of this is that during periods of intense rainfall, some roads and paved areas can flood. As parts of Westminster are located at the lower end of the sewer catchment there have been several instances of the sewer system backing up resulting in flooding of properties. Basements and lower ground floors of buildings which are directly connected to such sewers are at risk of being flooded with sewage in these conditions, normally by back-flow through showers, baths, sinks and toilets.

4.3.4 Consideration should be given to the installation of a one way valve in all drainage connections from basements to sewers to prevent the drains flooding the basement if they surcharge. During periods when the drains are surcharged, the drainage system may not work. Basement designers should also consider installing a pumped sewage system with storage to protect against this, particularly in areas where there is an increased sewer flood risk.

4.3.5 WCC has a particularly high concentration of restaurants. Fat, oil and grease from these can contribute to reduction in flow or blockages of the drainage system exacerbating the flood risk associated with sewers.

1. This report is currently being revised and it is envisaged that an updated version will be issued towards the end of 2013. WCC will be publishing a local flood risk management strategy for consultation in due course.

Further more detailed surface water modelling is also being carried out and this will also be available by the end of 2013.

4.4 Groundwater Flooding

4.4.1 As described in 3.3.1 there is often a perched water table within the sands and gravels which overly the London Clay. This is constantly topped up by rain and burst or leaking water mains. Following prolonged periods of heavy rainfall, groundwater levels will rise. This can last for weeks rather than hours or days and can cause flooding of subterranean construction or at the surface. Where this water table meets the surface, groundwater or springs can appear. There are a few isolated records within WCC of where this has occurred. These are shown in the Preliminary Flood Risk Assessment for City of Westminster 2011 Management Plan prepared by Halcrow. Reference should also be made to the Strategic Flood Risk Assessment for the City of Westminster.

4.4.2 Groundwater flooding is likely to impact on basements where the basement floor level is close to the existing groundwater levels.

4.4.3 Flooding of local areas or basements is usually caused by a combination of events (surface water, groundwater and sewers). Basements planned in areas which are at risk of flooding from any single event will need to be designed to take account of these combined flood risks. To do this, those designing and building new basements need a thorough understanding of the flood risks and groundwater conditions. (Refer to Section 6.3).

4.5 Summary

When considering a basement project the site should be assessed for flood risk. The risks could relate to overtopping of the flood defences or a breach in the defences, surface water flooding, flooding as a result of sewers surcharging or groundwater flooding. An initial scoping appraisal should be carried out to assess whether any of the above may occur and if so identify the requirements for a flood risk assessment as referred to in 13.2.1.f. Basements are also prone to flooding as a result of surcharging of drains so consideration should be given to fitting one way drainage valves. In high risk areas a pumped system should normally be recommended.

5.0 Structural Engineering Considerations and Construction Techniques for the Design and Construction of Basements

5.1 General Considerations

5.1.1 The approach that needs to be taken to the engineering design and construction of basement extensions depends on a number of factors. The most significant of these are:

a) Whether the basement is under the existing house, under the garden outside the footprint of the main house or a combination of the two conditions.

b) The depth of the basement.

c) The ground conditions.

d) The ground water conditions.

e) The structure of the existing building and of its neighbours

f) Flooding.

5.1.2 Basement extensions are usually constructed under residential buildings originally built for single occupancy. Typically, these were constructed as loadbearing masonry structures either as individual houses, semi-detached or terraced. When a basement is to be constructed under a semi-detached or terraced property, the effect on the structure of the pair of semi-detached properties or the whole terrace needs to be considered.

5.1.3 Older properties were generally constructed using solid masonry walls built with lime mortar which is relatively weak. This form of construction is able to accommodate minor movements without causing structural cracking. More modern buildings have cavity walls set in cement mortar. The walls are more brittle and any significant movements are likely to cause the mortar or masonry to crack. Such building structures are therefore much more susceptible to ground movement.

5.1.4 For single basements, underpinning is the most common form of engineering construction to extend the foundations of the existing building down to below the level of a proposed new basement floor. Generally foundations have to be lowered by around 3m to 4m. This usually involves two stages of underpinning construction to avoid dangerous, deep excavations.

5.1.5 When a basement is proposed the overall quality of the construction of properties likely to be affected should be assessed as this can be very variable. Previous structural alterations need to be assessed and understood, as these can impact on how a new basement is to be constructed.

5.1.6 Westminster has an exceptionally high concentration of heritage assets. The structural engineering challenge does not change significantly if the building is either a listed building or in a conservation area. However the construction of a basement could lead to the loss of some historic fabric and the significance of this fabric will need to be assessed in consultation with conservation officers. Another factor is that listed buildings may have more fine or delicate finishes which may be difficult to repair if they are damaged as a result of significant ground movements (see section 7, Para 7.4.1-7.4.2). The nature of the structure of the building will be a factor in selecting which construction techniques are most appropriate. The possibility of archaeological deposits being present should also be considered both during planning stages and while work is on site.

5.1.7 The size and accessibility of the site should be carefully considered. Large houses on individual plots with vehicle access to the rear and with good access to main roads are obviously more suitable sites for basement projects. Terrace houses or mews buildings on narrow streets have many more constraints and as such proposed basement construction is likely to have a greater impact on their neighbours.

5.1.8 Unlike most above ground structures, where temporary works tend to be independent of the permanent structure (e.g. access scaffold, formwork, falsework or temporary shoring to boundary walls), parts of the permanent works are often used as temporary works to achieve the new underground volumes. This means that the designer and constructor need to collaborate closely to understand how their work influences and relates to that of the other party. Underpinning and contiguous or secant piled walls are examples of elements of construction which have to perform both permanent and temporary works functions. Often the permanent works can only partly perform the temporary works function and have to be supplemented by temporary propping or strutting.

5.1.9 In most situations the design and construction are technically demanding and should not be underestimated. Problems generally do not arise when the design and construction are thoroughly and fully considered and the interaction between design and construction is properly explored and taken into account. Things tend to go wrong when basement design and/or construction is undertaken by those who do not have the ability or expertise required, or where there is inadequate interaction between design and construction. Building owners are often not in a position to judge the level of competence and ability required for their project. Many procure the design and construction on price alone, without understanding or checking whether those they entrust the design and construction to actually have the ability and expertise to do the work.

5.2 Underpinning

5.2.1 Underpinning through London Clay is relatively straightforward, as there is usually no groundwater present. Most, but not all, excavations in London Clay remain stable in the short term, but shoring will be required in all excavations to provide safe access.

5.2.2 Underpinning through sands and gravels above the perched water table is relatively straightforward. The excavated faces are likely to require temporary shoring and extra attention is needed if the sands and gravels are loose.

5.2.3 Where there is a perched water table in the sand and gravel the underpinning should ideally stop 300mm or more above the water level. If excavation has to continue below this level, then measures must be taken to control the ground water. Water ingress in an excavation can cause the sides of the excavation to collapse. If the material is predominately sandy, the situation is much more challenging, as the sand can easily be washed out by the ground water. Apart from safety issues, this can lead to settlement of the ground in the surrounding area and damage to structures. Options available include local dewatering and permeation chemical grouting. Injection of cement based grout is unreliable in these situations and is not effective in controlling ground water inflows. Local dewatering can be problematic if there are high ground water flows which cause loss of fines.

5.2.4 Underpinning is a challenging construction technique that needs considerable thought. It is often undertaken without sufficient care and planning. It involves the temporary removal of support to the construction above in sequential stages and relies on the construction above each section of underpinning being able to span or bridge over each excavated section, while the underpins are constructed. The configuration of the structure above the foundation level is a very significant consideration which needs to be fully understood if underpinning is being proposed. Large openings at the base of walls, buried services, poor quality construction of existing walls and poor ground conditions can all be problematic and if not considered and understood, these issues can lead to problems or even collapse of structures being underpinned.

5.2.5 The integrity of the construction immediately above each section of underpinning is critical for the safety of the construction workers carrying out the underpinning. In cases where the masonry is not well bonded, contains voids, or has lost its integrity, propping may be needed. In some cases, underpinning may not be possible.

5.2.6 Underpinning of isolated piers or of framed building structures with pad foundations is extremely challenging and may not be technically feasible. Such operations are very specialist in their nature and are outside of the scope of this report.

5.2.7 When underpinning operations go wrong, resulting in movements, cracking of masonry or collapse of the construction above, it is often because the issues mentioned above in 5.2.4 to 5.2.6 have not been studied, understood and taken into account by the designers and constructors of the underpinning.

5.2.8 Traditional underpinning is usually designed to support vertical loads. Lateral earth pressures must also be considered. These can be very significant when one side of an underpinned wall is excavated to form the basement volume. One approach to this, which is sometimes proposed, is to adopt reinforced underpins with enlarged bases that can act as vertical cantilevers or span vertically between the ground floor and basement slabs. If the wall to be underpinned is a Party Wall, these reinforced underpins are denoted as special foundations under the Party Wall Etc Act 1996. They are not ideal, as the foundations to the Party Wall are not equally shared by both sides and there may be long term implications for both of the adjoining ownerships. Special foundations should be avoided where possible.

5.2.9 The formation of double level basements using reinforced underpinning, often extending below the water table is a construction technique which is sometimes proposed. It requires extensive temporary works and a high degree of skill, care and co-ordination between the underpinning, excavation, installation of temporary works and the permanent works. While this method of construction can provide the largest basement area, it is also one of the most high risk construction techniques and is much more likely to result in significant ground movements than other methods such as using a piled wall where potential ground movements are more quantifiable. The consequence of such movements is usually structural damage to the building being underpinned and to the adjoining construction. Because of this, if underpinning is to be used for deeper basements, it should only be considered in locations which are well away from any buildings i.e. in garden areas which are remote from building structures or site boundaries and where there is no groundwater, or if groundwater is present, where it can be controlled without causing settlement of the ground. Constructing basements using underpinning, whether mass concrete or reinforced should in general be restricted to a single basement level.

5.2.10 Generally it is considered to be best practice to construct a reinforced concrete box within the perimeter of the underpinning, which is designed to resist all permanent and long term lateral loads and to provide support for the internal structure. Until this structure is complete, the underpinning has to be propped (as the excavation proceeds) to resist the temporary lateral earth pressures. This approach of building a reinforced concrete box within the underpinned walls also helps with detailing of the basement waterproofing.

5.3 Piled Walls

5.3.1 A contiguous piled wall is one where piles are constructed at close centres, but where there is a small gap between each pile which can easily be bridged by the ground. The construction of such walls to form a basement under a house requires a low headroom piling rig to work within the footprint of an existing building. This solution reduces the basement area available and so is only really suitable for larger residential properties. It is likely that there may still be a requirement for shallow underpinning of the perimeter walls along the line of the piled walls to facilitate the construction of a capping beam that has to be constructed on top of the piled wall.

5.3.2 Once the piles are constructed, the basement is formed by excavating within the perimeter of the piled wall. Most piled walls need to be propped during this stage of construction to resist the lateral earth pressures on them from the retained earth and adjoining construction and to limit movement of the surrounding ground. The stiffness and arrangement of propping is critical and is often not well considered, especially as this propping is a nuisance to the contractor, because it obstructs the site and complicates the construction. Some contractors do not understand the relationship between stiffness of these propped walls and ground movements.

5.3.3 Contiguous piled walls need to be faced up with sprayed or cast concrete walls to fully support the ground on the retained earth side of the basement in the permanent condition.

5.3.4 Where groundwater is present, secant piled walls are normally used. These are similar to contiguous walls but, as their name suggests, they are a continuous line of intersecting piles that provide a barrier to groundwater. They are more specialist than contiguous piles. There are a variety of arrangements but typically, every other pile is constructed as a "soft" pile using a bentonite concrete mix, so that the subsequent hard piles which are reinforced concrete to carry the vertical and horizontal loads, can be drilled through them, intersecting the pair of "soft" piles on each side as each is constructed. Once the piled wall is built, the construction can progress as for a contiguous piled wall, but care is required, as breaches in the wall are possible due to the construction tolerances of the piles. These may allow water ingress locally that will need to be dealt with as soon as it is discovered.

5.4 Basements under terraced or semi-detached houses founded in clay which have a history of ground movement

5.4.1 Some buildings with shallow foundations in London Clay or fill material have and continue to experience ground movements, generally as a result of seasonal or climate-related changes in moisture content of the clay in the immediate vicinity of their foundations. The effects of trees on the moisture content of the clay can also be a cause of this movement.

5.4.2 Most of these buildings were built in the 19th century using bricks set in weak lime mortar and are generally able to cope well with minor movements, because the lime mortar can accommodate them without visible cracking. Internally cracks tend to be minor and distributed. Terraced properties move as a whole and semi-detached properties move together, because they have similar foundations. They are effectively single structures.

5.4.3 With structures such as this, underpinning one building in a terrace, or one of a pair of semi-detached properties, will extend its foundations and those of the party wall down to a depth where the clay is stable and where there is no seasonal variation to cause ground movements. The consequence of this can be to create new problems which are experienced by an adjoining building, because of differential movements between the structure that has not been underpinned and the one that has. These problems will be more significant than those experienced prior to the construction of the underpinning and will be ongoing into the future. They will be significant if there is a history of movement in the buildings and particularly if that movement is current. In cases where terraces or semi-detached properties founded on London Clay do not have a history of movement or exhibit ongoing movements then the problem is less likely to arise but needs to be considered nevertheless.

5.4.4 It is essential when considering the construction of a basement under a terraced or semi-detached property founded on London Clay, that these issues are carefully considered, understood and addressed. Basements can be formed without underpinning and in cases where there are ground movements of adjoining properties founded on clay, other techniques such as piled walls may be more appropriate and preferable.

5.5 Basements under gardens or open space

5.5.1 In densely developed urban areas such as WCC, piled walls are usually used when forming basements in rear gardens or on land without any construction above it. Contiguous or secant piled walls can be used but there are other methods available, particularly where there are no groundwater problems present.

5.5.2 It is beneficial for the existing adjoining buildings if these basements are designed and built so that they are structurally independent of the structures of the adjoining houses.

5.5.3 Sheet piled walls

Sheet piles can either be driven into the ground or jacked in. Driving sheet piles is noisy and causes vibrations, so is not suitable for the construction of basements in residential areas. Jacking can be adopted, but requires relatively large construction equipment. Jacking piles through gravels can be difficult and sometimes impossible if the gravel is dense. Another approach is to excavate a trench and slot the sheet piles in. This approach is not generally possible if close to buildings or site boundaries, as it leaves the face of the trench unsupported in the short term and the ground will have to move to fill the inevitable voids, unless the voids are grouted up. Water jetting can also be used but again this can cause movement of nearby structures, and so is best avoided close to other buildings.

5.5.4 King Post Walls

These are a practical alternative to piled walls for single level basements. They usually require less space than a piled wall but a mini piling rig or a large excavator will be needed to install the king posts. However, they are less suitable for deeper basements

or where excavations extend below the water table. Ground movements are generally greater than for underpinning or contiguous/secant walls and they cannot be readily used close to existing buildings.

5.6 Basements that are both under a house and garden

5.6.1 The principles set out in 5.4 and 5.5 above apply generally, but thought is needed as to how the basement walls are constructed where they cross the line of the rear (or front) wall of the property. It is not possible to construct a continuous secant piled wall across the interface so, if ground water is present, some other method of resisting the ground water inflows at the gap in the wall needs to be found. Permeation grouting is one possibility.

5.6.2 Additional temporary works are likely to be required to deal with groundwater pressures and ground movements at these locations until the permanent works have been completed.

5.6.3 It is preferable, when constructing a basement that extends both under an existing building and the rear (or front) garden, to arrange the design and construction such that there is a structural joint between the sections of basement under the footprint of the house and that below the garden. This will influence the spatial design of the basement. It is very important, when designing such basements, to give full consideration to the proper support of the walls of the house, account for differential movement between the house section and garden basement and consider the effect of the design proposals on the adjoining buildings and boundary walls. It can be difficult to achieve a joint when the basement is below the water table.

6.0 Effects of basement construction on groundwater (the Upper Aquifer)

6.1 Where the surface geology is London Clay, there is generally no Upper Aquifer present and no groundwater flow. Water falling on gardens or parks tends to be retained in the topsoil or upper clay layers until it evaporates or is absorbed by vegetation. Some finds its way into drains connected to the sewers. In areas which are underlain by sands and gravels, any rainwater which is not held in the top soil or absorbed by vegetation will slowly drain down to the Upper Aquifer. A reasonable proportion of a garden should be retained unbasemented to ensure that rainwater can continue to recharge the Upper Aquifer (see section 10 for further advice).

6.2 Excavations and basement construction in sand or gravel, which is wholly above the perched water table of the Upper Aquifer, should not impact on any flow of groundwater. The groundwater flows, if any, can continue to occur in the sands and gravels below the level of the new basement. When the construction extends down close to or below the aquifer it can create a cut off to the flow of water.

6.3 Basements which extend through the gravels below the perched water table into the underlying London Clay or which have their lower levels close to the level of Upper Aquifer (say within 300mm of it) should be considered in more detail. While an individual basement is unlikely to cause any significant change in groundwater levels, the long term cumulative effects need to be considered. In reality potential cumulative impacts will increase as more basements are constructed. Checks should be carried out on the levels and direction of falls at the interface of the London Clay with the overlying materials. This can be done by initially obtaining British Geological Society borehole logs in the area which can then be used to define the levels and slopes at the gravel/clay interface. If a flow is expected, then clearly identified routes should be explored, together with any potential impacts on the surrounding buildings. In some cases it may be necessary to provide drainage paths below or around the proposed basement. Ideally the water levels in the Upper Aquifer should be monitored by the design team before and after construction to establish whether or not the basement construction has impacted on groundwater levels. This should help to confirm that the drainage system, if installed, is working as designed. It would also assist the applicant to confirm whether the construction of the basement has had any material effect on the water levels.

6.4 A long terrace of houses with a significant number of basements through gravel into clay can act as a barrier to the flow of ground water and can change the groundwater regime in an area. If an assessment of the cumulative effect of basements in a terrace shows this to be a possible problem, such changes can be addressed in the design of a basement, by providing drainage or engineered flow arrangements below or around the proposed basement.

6.5 Basements which are close to historic water courses require even more detailed checks. The two principal water courses, The Westbourne and Tyburn are both now culverted and used as sewers. The alignment of the sewers generally follows the original route but not always. Underground water flow is more likely along the historical route. Any proposed basements in these areas need careful checking. Both these water courses had a number of tributaries which may not be culverted. While these have long since been buried, it is likely that they will be routes for groundwater flows.

6.6 In areas where there are existing houses with basements or lower ground floors and where the existing perched water level is close to the lowest occupied area, a new basement in the vicinity needs very careful consideration. The construction of a new basement could slightly raise groundwater levels "upstream" and on either side of the basement, locally raising the level of the perched water. In certain locations this could cause previously dry basements to become damp or wet. Proposals for basements in situations such as this should incorporate extended monitoring of the groundwater levels before and after construction to establish if the construction has impacted on the ground water levels. It should also incorporate drainage measures to provide flow paths around or under the basement. This issue needs to be addressed at the design and construction stage as it is almost impossible to retrofit such drainage.

6.7 There are a number of different names for the gravel beds which relate to the geological process when they were deposited. The area north of Piccadilly and to the south of Hyde Park for example has a series of terraced gravels interspersed with outcrops of London Clay. The perched water in the upper gravel terraces can flow out at the interface with the London Clay causing ground water flooding. Also the surface of the London Clay may not be uniform. There can be channels in the London Clay which are infilled with sands and gravels. These can link the various gravel terraces hydraulically. In areas where this occurs, basement excavation can experience significant groundwater flows. If blocked, groundwater levels may rise upstream.

6.8 Where a basement is to be built which extends below the water table, the designs should be capable of resisting the water pressure. While temporary dewatering during construction may be required, a design solution which requires permanent pumping of groundwater is not sustainable. There is also a likelihood of failure at some time in the future. In any event, Thames Water will not accept any significant long term flows into their sewers from water which is pumped out of the Upper Aquifer.

7.0
Ground Movements Resulting from Basement Construction

7.1 General

7.1.1 The excavation of a basement removes load from the ground. In simple terms, this tends to cause the surrounding soil to try to move towards the excavation, which then exerts forces on the structure of the basement. For single storey basements which are properly designed and constructed the movements are small. They may not be noticeable or result in just minor superficial damage to finishes of the buildings over or adjacent to the basement.

7.1.2 Generally construction techniques have been developed that seek to maintain the equilibrium in the ground when excavations take place. It is not possible to fully maintain the state of equilibrium, but by adopting methods of construction which provide continuous or near continuous support to the ground, with propping (both temporary and permanent) designed to control movements, the effects of subterranean development can be mitigated and controlled. Movements, when major works are carried out, occur both in the short term as well as over a longer period (of a year or more) as the ground adjusts to the new loading.

7.1.3 Things have gone badly wrong in situations where these issues have not been fully considered, understood or implemented, either because proposals have been too ambitious or because incorrect techniques and procedures have been followed. It is important that the various causes of potential movement are understood and considered when planning the construction of a basement beneath or next to an existing building.

7.2 Settlements caused by underpinning and piling

7.2.1 The process of underpinning a wall inevitably leads to a degree of settlement of that wall. The amount of settlement depends on a wide variety of issues, such as ground conditions, the depth of underpinning, presence of ground water, the condition of the wall being underpinned, the extent of shoring provided and the quality of workmanship. Small uniform settlements of a building do not generally cause distress, but when differential settlement occurs, this may result in cracking of the walls above. There is no available data which can provide an estimate of the settlement, but the quality of workmanship is a key factor.

7.2.2 If feasible, the whole structure should be underpinned. When this is not practical, transition pins can be provided to reduce the effect of a sudden change in founding level. However, this may not be feasible where one owner is forming a basement next to an adjoining building with no basement. There will be steps in founding levels between adjacent walls of adjoining buildings. This can be significant for terraced or semi-detached houses founded on fill or in London Clay which exhibit a history of movement (see 5.4).

7.2.3 The process of installing a bored pile wall or a king post wall also causes a degree of settlement of adjacent structures, as the lateral support to the soils is disturbed during the process of their construction. These effects are generally relatively small if the construction is carefully and diligently carried out.

7.3 Ground heave caused by excavation within an under-pinned perimeter

7.3.1 Following the installation of the underpinning either a “top-down” or “bottom up” method of construction is used for the basement excavation.

7.3.2 A top-down construction forms the ground level slab first which provides lateral support to the top of the walls. It is then under-dug to form the basement. A bottom up construction adopts a system of temporary props while excavation is carried out and the new basement constructed in a conventional manner.

7.3.3 Either solution is acceptable and the choice is usually site specific. Most basements built as part of residential buildings are bottom up, unless they are unusually large or deep. Generally the movements resulting from bottom up construction are slightly greater than for top-down.

7.3.4 As the excavation progresses, the loading on the underlying soil reduces and it expands or heaves. Some of this happens immediately. However, in London Clay part of the heave can occur over many years. In sands and gravels there are no long term effects and the short term effects tend to be small. Clay underlying sand and gravel will heave even if it is below the level of the new basement floor as the overall loading on it is reduced.

7.3.5 The overall heave which can occur for a single level basement is generally not a significant issue but for two storey or deeper basements, ground heave needs to be carefully considered by the designers.

7.4 Ground movements associated with ground heave and the excavation of a basement within an underpinned or piled wall

7.4.1 When a basement is excavated the change in stress in the ground, particularly at the bottom of the excavation, results in a general migration of the ground surrounding the excavation, towards it. The inward movement of the retaining structures (walls) even if they are well propped, cannot be completely avoided and this adds to the movements. Overall, if properly designed and built, these effects are usually small, but they need to be considered for the structure above the excavation and for adjoining buildings, whether they are attached as part of a terrace or detached but adjacent structures. Initially the ground at the surface adjacent to the excavation will settle and move horizontally towards the excavation. The movements are greatest near the excavation (though the vertical movements are less immediately at the wall because of restraint). In time heave can be an issue causing small upward ground movements in some cases. It is the differential movements (the difference in movement between different parts of a building) that matter, especially for the adjoining buildings. Most 19th century buildings can cope with small differential vertical and horizontal movement without suffering structural damage although this can sometimes affect delicate finishes.

7.4.2 Each case needs to be considered on its merits and this will be particularly important when considering heritage assets. Houses with fine stone stairs need careful consideration, as cantilevering stone stairs are much less tolerant to movement than walls built in lime mortar. Similar considerations apply when there are tiled or marble floor finishes.

7.4.3 In most cases, well designed and carefully constructed residential basements can be achieved without causing structural damage to adjoining buildings. (For the classification of structural damage see CIRIA Report C580 Embedded Retaining Walls: Guidance for Economical Design – Table 2.5). It is not always possible to avoid minor damage to finishes, which can be dealt with by local making good and redecoration. Most situations involving structural damage associated with residential basement construction have arisen because of a lack of correct configuration or adequate temporary support to retaining structures and excavations during the construction process.

7.4.4 The aim of all clients who embark on basement schemes for their properties should be to procure the works so that they do not cause structural damage to their own property but more importantly to their neighbours properties, and also to services, utilities and any major infrastructure (for example railways and sewers) close to these sites.

8.0
General Factors to be considered for Basement Design and Construction

8.1. Each basement construction project has site specific requirements which means that there cannot be generic solutions. There is always a close relationship and interaction between the design and the construction. Parts of the permanent works are often used as part of the temporary works to achieve the new construction. This means that the designers and the contractors need to collaborate closely to understand how each party's work influences and relates to that of the other.

8.2 If underpinning is used to enable a basement to be excavated close to or immediately adjacent to a structural wall, the lateral pressures from the retained ground on the side opposite the excavation must be carefully considered and generally supported in the temporary construction case using a system of lateral props. The permanent works design ultimately needs to resist these lateral pressures. If piled walls are used, they often have different spans in the temporary and final cases and need to be designed for both scenarios. The temporary works design is a critical part of the process.

8.3 In most situations the design and construction are technically demanding and should not be underestimated. Problems generally do not arise when the design and construction are thoroughly and fully considered and the interaction between design and construction is properly explored and taken into account. Things tend to go wrong when basement design and/or construction is undertaken by those who do not have the ability or expertise required, or where there is inadequate interaction between design and construction. Building owners are generally not in a position to judge the level of competence and ability required for their project. In such cases they should seek advice from firms or individuals who are able to make such judgements. Many procure the design and construction on price alone, without understanding or checking whether those they appoint for the design and construction actually have the ability and expertise to do the work.

8.4 In many cases, the close relationship required between designer and contractor is not maintained throughout the course of the project. This can lead to problems at the construction stage. Consideration should be given to imposing planning conditions which require the Chartered Structural Engineers to make regular site visits and to advise the building owner on the construction risks. Also, the building owner should ideally remain liable for any damage which occurs to the surrounding or adjoining properties. This liability should not be passed to the Contractor.

8. 5 When designing and constructing a basement beneath or close to an existing building, the following engineering issues need to be considered.

a) How to resist earth and water pressures on the new basement walls and floor

b) How to deal with groundwater and potential water ingress

c) How to support existing structure above and adjacent to the new basement construction

d) Drainage

e) Ground movements and how these affect the existing structures above and adjacent to the new basement construction both in the short and long term.

f) Whether or not the proposals are likely to alter groundwater levels or groundwater flows.

g) How the construction will effect landscaping and in particular trees in the short and longer term.

h) Flooding

8.6 Details of how these issues are addressed should be provided as part of the planning application (see Section 13).

9.0
The Party Wall Act

9.1 Following the granting of planning consent, there will usually be a requirement for the building owner to obtain a Party Wall Award for the construction of a basement.

The Party Wall Act etc. 1996 was designed to control development on each side of a party wall, so as to preserve its integrity and function. It also applies to construction in the ground that might affect the property of a neighbour which is close to the party wall. The Act requires that notice is served on certain neighbours who can appoint their own surveyor to consider and advise them on the prosed works. Agreement for the works to proceed is contained in a Party Wall Award.

9.2 The property owners have a joint responsibility to main support and restraint to the party wall. The party wall is a shared structure which both buildings rely on. When one or both properties have multiple leasehold interests the ownership issues are very complex.

9.3 The provisions of the Act apply when an adjoining owner is carrying out work in the ground within 3m of the party wall, or within 6m if it falls below a line drawn at 45o from the bottom edge of the foundation of the wall.

9.4 The party wall legislation recognises that the party wall may be underpinned, using conventional mass concrete techniques. More complex foundations to party walls including reinforced concrete structures are classified as "special foundations" under the Act. In theory it is possible to include reinforcement in the half of any underpinning on the side where a new basement is proposed. This approach can be used where there is a requirement for the underpin to span vertically to support lateral earth pressures. If special foundations are required, the Adjoining Owner must give consent to these – they should seek advice from the Party Wall Surveyor or the structural engineer advising them, if one is appointed.

9.5 Underpinning arrangements which are designed to work as reinforced concrete retaining walls usually result in party wall foundations that rely on support of structure that is not jointly owned by the adjoining owners on each side of the wall. The basic concept of party wall legislation is that the property on either side of a party wall can be demolished and rebuilt without affecting the party wall (with the provision of temporary lateral support) so this approach is undesirable.

9.6 Conventional foundations to party walls of Victorian or earlier buildings consist of corbelled brick foundations. Later buildings may be founded on mass concrete strip foundations. Basements formed by underpinning of party walls usually require the corbels to be removed. The face of the underpinning is aligned with the party wall. The underpinning is then stepped out at its base to at least the same width as the original corbels to provide the same degree of load spread. In some cases it may be desirable to increase the width of spread. The Adjoining Owner has the right to request that the underpinning aligns with the face of their wall, so as not to disadvantage them if they decide to build a basement in the future.

9.7 Where basements are formed with or without underpinning (for example by forming a contiguous piled wall parallel and close to the line of the party wall), the Party Wall Act requires that the works are done in a way which does not cause damage to the party wall.

9.8 Most party wall surveyors interpret the Act as requiring structural damage to be avoided. Damage to masonry buildings as a result of ground movements associated with ground retaining structures is described in CIRIA report C580 (Embedded Retaining Walls: Guidance for economic design). Structural damage is generally

considered to occur if cracking takes place that is in excess of 5mm, classified as Category 2 Cracking (slight) in the CIRIA report, table 2.5. This means that when basements are procured they should be designed and constructed to limit the damage to an adjoining building to Category 1 but certainly no more than Category 2. BRE digest 251 (Assessment of Damage in Low-Rise Buildings) contains the same damage classification describing cracking of category 2 and less as aesthetic, with category 3 and 4 being serviceability damage.

9.9 The Party Wall Act contains provisions for dealing with damage as a result of works at an adjoining property. If the damage is cosmetic and confined to finishes (i.e. non-structural) then repairs and making good are relatively straightforward.

9.10 When an Adjoining Owner receives a notice of work under the Party Wall Act, concerns are immediately raised and the whole process can be stressful and involve a great deal of emotional energy, unless it is well handled by the promoter of the work. This applies equally where works are proposed to buildings where no party wall exists but when the adjoining owners property is likely to be affected.

9.11 The following principles are suggested in relation to party walls and adjacent properties when a building owner proceeds with the procurement of a basement extension.

- Any underpinning to the party wall should be symmetrical. It should be no wider than the wall. The underpin should be widened at its base so that it should be at least the width of the original foundation.
- Any additional vertical loads associated with the construction of the basement should be supported independently of the party wall.
- The new basement structure must provide adequate lateral support for the party wall or for the ground beneath the party wall.
- The works need to be designed and constructed with the aim of not causing structural damage to the party wall or the adjoining building.

9.12 Supporting party walls off reinforced concrete structure on one side of the wall is not recommended as it changes the nature of a party wall from being a structure that has its own independent foundations to one that is reliant on the ongoing existence of a building structure on one side of it.

9.13 Good practice should apply in all cases. Owners planning basements below their houses or gardens should consult with all of their neighbours in advance of submitting a planning application. They should explain what they intend to do and how it may affect them. The Party Wall Act does not address the noise, disruption and traffic aspects of basement construction.

9.14 Under certain conditions the adjoining owner, advised by his party wall surveyor, can request that a sum of money is held in Escrow as security, for example, to be used to complete the works to a party wall or the neighbouring building to cover cases where building work commences but are not completed. It can also be used to pay for the repair of any damage caused as a result of the construction work.

9.15 A building owner who is considering a basement should consult with his neighbours in advance of submitting a Planning Application, although this is not a formal requirement of the planning process. They should engage in consultation with adjoining owners and residents to explain the proposals and identify what the implications might be and what mitigation measures may be appropriate. This may assist to reduce the number of objections to the proposals at planning.

9.16 The Party Wall Award is a legal requirement between the various parties and is not relevant to the planning application.

10.0
Basements under Gardens – Trees and Groundwater

10.1 The ability of gardens to support landscaping and the growth of trees is an important issue in relation to the setting of buildings, the ability of the ground to absorb rainwater (thereby reducing surface water flood risk) and general sustainability and biodiversity issues.

10.2 The extent of a basement below a garden is not limited by structural engineering requirements other than the need to install a form of retaining structure. However WCC propose setting a limit in its emerging policy that a basement should not extend under the whole of or a significant proportion of a garden. There is not a direct correlation between the amount of a garden which should be basemented, and the ability of the ground to absorb rainwater or feed rainfall to the Upper Aquifer. 50% was initially proposed by WCC as an appropriate figure.

10.3 It is generally accepted that a minimum of 1m of soil and adequate soil volume should be provided over a basement regardless of whether or not the garden is currently hard paved. This allows the option of reinstating top soil and soft landscaping in the future which will support the growth of medium sized trees. Greater depth of soil will be needed where larger trees are required. It is also suggested that where there are medium sized gardens a minimum of a 3m strip of a garden is left unbasemented to allow the potential for large trees to be planted.

10.4 In addition to the above proposed limit on length of extensions, basement proposals should take account of the requirements to protect existing trees where these are to be retained. Trees within a neighbours garden but close to a boundary can also be affected. All trees within conservation areas and other trees with Tree Preservation Orders (TPO's) are protected and must be considered when designing a new basement. British Standard 5837, 2012 (Trees in relation to design, demolition and construction) shall be referred to. In general this suggests that basements should not be constructed within a distance of twelve times the diameter of the trunk of the tree.

10.5 Basements which extend under trees or root protection areas are technically demanding. They require the use of complex tunnelling techniques or horizontal thrust boring at close centres. Because of the techniques required, this type of construction is likely to result in greater ground movements. Therefore, this should be avoided particularly in areas where they are close to other buildings.

10.6 Applicants should ensure that tree protection measures are put in place. If required, an arboriculturalist should be consulted. Overhanging branches must be protected from piling rigs, excavators etc and excavations close to tree roots should follow the arboriculturalist's advice. The final ground level around a tree should not be varied significantly from existing levels.

11.0 Sustainability Issues

11.1 Forming a new basement under an existing house can assist with maintaining a use for the building without the need to relocate or redevelop the whole property. Making best use of the existing housing stock helps to reduce the embodied energy requirements for building wholly new buildings. However in relation to the floor area provided, the construction of a basement requires more embodied energy than above ground construction due to the nature of the materials used and the increased transport requirements.

11.2 It is considered that, when constructed, basements tend to perform much better in environmental terms than above ground construction. They tend to maintain lower temperatures in the summer and higher temperatures in the winter due to the high thermal mass of the construction and surrounding soil which acts as insulation. This can result in lower heating and cooling loads, although this does to some extent depend on how the spaces are insulated. Internal insulation which may in theory be needed to comply with Part L of the building regulations will mean that the thermal mass of the structure is ineffective. Lighting requirements will be higher, although low energy lighting systems are reducing the impact of this.

11.3 Most new single storey basements can be naturally ventilated. Deeper basements of more than one storey (~3m) are likely to require full mechanical ventilation and lighting which inevitably requires greater energy use. Usually the energy use is offset by higher insulation and energy efficiency. The decision to build a single or double level basement will relate to the site and the proposed use of the space and not sustainability issues.

11.4 New basements create major underground structures which are difficult to remove. The space created should be flexible and adaptable so it can accommodate changes in use without requiring major alterations to the structure e.g. partition walls can be moved, generous floor to ceiling heights and complying with lifetime homes standards.

11.5 All major construction projects have a significant carbon footprint and generate CO_2 emissions. The primary material for the construction of a basement is usually concrete which has a high embodied carbon content. Modern concretes often incorporate some cement replacements such as GGBS or PFA which help reduce this. In theory, recycled aggregates can be used but this is often impractical on small projects – the benefits may also be limited as they usually require additional transport.

11.6 Another significant construction-related aspect is waste. The construction industry produces around 25% of the waste in the UK each year, 13% of which is unused materials. This represents three times more waste than is produced by the total of all UK households combined. National legislation and planning policies are addressing these issues and they should be considered on basement construction projects. In addition to taking steps to reduce waste, the disposal of waste is equally important.

Much of the waste from construction is potentially hazardous and disposal must be carefully planned to minimise environmental damage. Some waste can be recycled, but is not. It is reasonable to require that all such materials are recycled, even if some additional vehicle movements are generated by this. Other non-recyclable waste should be segregated. All aspects of waste reduction, management and disposal should be set out in a site Waste Management Plan. This is already a requirement of larger construction projects.

11.7 In conclusion, there are pros and cons from a sustainability viewpoint for basement construction. The positive aspects are that it allows the existing building to be retained and that the energy requirements in use are likely to be low. The downside is that the embodied carbon used during the construction is higher than above ground construction.

12.0 Recommendations for the Approach to the Design and Construction of Residential Basements

12.1 General

12.1.1 The design and construction of a residential basement, particularly in close proximity to other buildings is a challenging endeavour. It is of a much higher order of difficulty than normal extensions and alterations to residential properties, yet it is often the same designers and contractors who carry out this work. Building Owners should recognise this and appoint Chartered Structural (MIStructE) or Civil (MICE) Engineers who can demonstrate the relevant skills and a track record of successful basement projects in central London. If a basement is proposed or in an area where the basement may impact on the groundwater regime, the Building Owner should consider appointing a specialist geotechnical engineer and/or a geo-hydrologist. The engineers should be retained during the construction stages and be instructed to review the contractor's method statements, sequence of construction and temporary works proposals having regard to the design and its implementation. They should also be required to visit site during construction to monitor progress and compliance of the construction with the design requirements. The building owner should also appoint a suitably qualified main contractor who has overall responsibility for the construction, methodology, sequencing, temporary works and quality of the construction. The various subcontractors, particularly for the structure of the basement should be suitably experienced.

12.1.2 As good practice and when the design team is employed by the contractor, consideration should be given by the Building Owner to appointing an independent Chartered Engineer to review the construction at appropriate stages and report to the Building Owner, Building Control and the Party Wall Surveyors.

Westminster City Council (WCC) should also consider whether it is possible to secure such review and monitoring through a planning condition.

12.1.3 Every basement project is different and needs a design solution which meets the brief. Generic design solutions as part of a planning application should not be accepted.

12.1.4 All Planning Applications for basements should be accompanied by a Structural Methodology Statement (SMS). This needs to include a site specific structural design solution, worked out to a sufficient stage to show the principal design concepts. The SMS must also show how the basement can be constructed together with the nature and extent of temporary works which will be required. The issues to be dealt with in the SMS are discussed in Section 13..

12.1.5 Basement construction carries risks of causing unacceptable ground movements if not carried out properly, and there is almost always an overlap between the temporary works and the permanent works (refer to 5.1.8). The SMS should include an assessment of the ground movements which may occur and assess the impact on adjacent buildings. If a basement of more than one level is proposed, then the assessment of ground movements should be carried out by a Geotechnical Engineer with relevant experience of basement construction.

12.1.6 Issues such as noise and vibrations, materials delivery and storage, vehicle movements, parking, site access, working hours, site welfare and the overall project programme are not easily addressed through the planning process but are of significant concern to residents and should also be considered at the pre-planning stage. All basement Planning Applications should therefore be accompanied by a Construction Management Statement (CMS), the primary purpose of which is to inform WCC Planning and the adjoining owners of these various issues and how they will be addressed.

12.1.7 Building Owners proposing basements should consult with adjoining owners or their representatives prior to submitting a planning application. They should explain the proposals and what the implications of the works are likely to be, and to take account of the concerns expressed where reasonably possible. Evidence of this consultation should be provided as part of the Planning Application. Some adjoining owners may not wish to engage or request that the works are not carried out. In this event, it should be acceptable to demonstrate that they have provided the details of the proposals and explained the implications to the adjoining owner.

12.2 Specific Recommendations for engineers/ building owners in relation to basement design and construction

12.2.1 Designing and constructing a basement under a traditional residential property is challenging but is likely to be feasible in most locations in Westminster provided an appropriate approach is used such as is described in this report. However applicants should note that, where a basement is proposed under a semi-detached house or one house in a terrace, which is founded on shallow foundations and where there is a history of structural movement, the basement may cause ongoing problems for the adjacent properties. This generally relates to areas where the founding material is fill or soft alluvial deposits, or buildings are founded at very shallow levels in London Clay or Brickearth (refer to 5.4).

12.2.2 Basements formed by underpinning should be limited to one storey or approximately 3m (floor to ceiling). (Refer to 5.2).

12.2.3 Deeper basements may be considered provided they are formed using piled walls. In most cases, these deeper basements are achievable below larger properties, within large gardens or in cases where the majority of the site is being redeveloped. When deeper and larger basements are being considered, there must be good access for construction vehicles which is normally only found in larger detached and semi-detached houses. (Refer to 5.5).

12.2.4 Underpinning that extends into the Upper Aquifer in gravels and sands should be avoided. Alternative techniques for forming basements in these ground conditions should be considered (such as set out in 5.3).

12.2.5 Basements below rear gardens should generally be formed within a piled wall, although a King Post Wall could be used where the basement is not close to buildings. The use of reinforced concrete walls formed sequentially using underpinning techniques should generally not be permitted where they are within 6m of a site boundary or adjacent buildings as they generally result in higher ground movements and are very workmanship dependent. (See section 5.5).

12.2.6 Basements below gardens should have a minimum of 1.0m of topsoil and adequate soil volume above the waterproofing and insulation to allow for planting of medium sized trees and to maintain the surface water and groundwater balance. Consideration should be given to providing locally increased depths of soil for larger tree planting and leaving an area of the garden undeveloped to allow for larger tree planting. There should be no additional surface water drainage run-off as a result of the construction of a basement beneath a garden. (See section 10.0).

12.2.7 Basements close to trees should follow the guidance as set out in BS5857, 2012. Any basement which is close to, or within the Root Protection Area must be accompanied by an aboriculturalist report to justify the proposals. (See section 10.4). Investigation of the extent of tree roots may be needed to support the justification.

12.2.8 All drainage from basements should be fitted with one way valves. Basements within critical drainage areas or areas within local surface water flood risk zones should have a pumped drainage system with storage. The Planning Application should show how flooding of the basement is prevented and how the basement drainage will work when the main sewers are surcharged and unable to function.

12.2.9 Any basement proposal which is to be constructed within the Upper Aquifier must demonstrate that it will not increase the flood risk to adjoining properties and not alter the groundwater regime. Cumulative effects must also be considered. (See sections 6.3 and 6.4).

13.0
Documents to be submitted with a Planning Application for the Construction of a Residential Basement in WCC

13.1 General

The applicant should appoint an appropriately qualified design team including a Chartered Civil or Structural Engineer, to design the basement structure, advise on the appointment of the contractor and monitor the construction on site. Many of the detailed issues set out in the SMS will not be assessed in detail or enforced by planning but are covered by a range of other legislation.

13.2 Structural Methodology Statement (SMS) including self certification of contents from a Chartered Civil or Structural Engineer

The SMS should be submitted in the form of a report and supporting drawings. The SMS should, as a minimum, include the following:

a) A thorough desk study to include the site history, age of the property, site survey, geology, historic river courses, underground infrastructure, including utilities services, drains and tunnels. This should also identify other basement developments in the area, so that cumulative effects can be considered.

b) An appraisal of the existing building including drawings to show the arrangement of the structure. The appraisal should identify previous alterations and any obvious defects. It should also assess the condition and location of the building with respect to adjoining buildings.

This appraisal should include opening up works to investigate the existing structure, which should be summarised on a set of drawings.

c) A site investigation which can be demonstrated to be relevant to the site. This must include boreholes which must be on site or from a very nearby development together with trial pits to show the existing foundations and the material they are founded on, for all walls which may be impacted by the proposals.

If groundwater is present, the levels should be monitored for a period of time.

d) Details of the engineering design which should be advanced to detailed proposals stage (as set out in the Services of ACE Agreement 1: Design, 2009 Edition). Relevant drawings should be provided to show how the designers have addressed the following:

- ground conditions and groundwater
- existing trees and infrastructure
- drainage
- flooding
- vertical and horizontal loading
- structural engineering general arrangement and details; drawing showing underpinning, piled wall etc.

e) An analysis of the Upper Aquifer (when present) and how the basement may impact on any groundwater flow.

f) Consideration of flood risk, surface water flooding, and, if appropriate, critical drainage areas explaining how these are addressed in the design. If the basement is in Flood Zone 3, a full flood risk assessment should be carried out.

g) An assessment of movements expected and how these will affect adjoining or adjacent properties. This needs to include both short term and long term effects. The design and construction should limit damage to all buildings to a maximum of Category 2 as set out in CIRIA Report 580.

h) Details of sequences of construction and temporary propping to demonstrate how the basement can be built to prevent movements exceeding those predicted. It should show how the horizontal and vertical loads are supported and balanced at all stages of construction and consider the interaction between permanent works and temporary works.

13.3 Construction Management Statement (CMS)

13.3.1 A CMS should be provided for all residential basement schemes, and be produced in support of the planning application. It should address the issues set out in 12.1.6 and in particular it should address the issues which are likely to impact on neighbours and those who use the surrounding roads.

13.3.2 Particular attention must be given to how plant and materials are to be transported to site and how excavated material is to be removed. Details of how materials are delivered or removed from site should be provided and routes identified.

13.3.3 Estimates of vehicle movements should be provided together with details of how many parking bays will be suspended. In areas where access is restricted, details of how loading and unloading is to be carried out should be provided together with an assessment of the impact on local residents. This is particularly relevant if the street is to be blocked for periods of time.

13.3.4 An initial construction programme should be provided.

13.3.5 The CMS should also show how the basement can be constructed so that it reflects the design and the requirements or assumptions of the designers in their work, paying particular attention to the temporary works.

13.4 Drawings to be provided with the Planning Application

- Site plan
- Surveys plans, sections and elevations of the existing building and all adjacent buildings
- The location of existing trees and their species on or within 6m of the site and a description of the existing garden and paved areas of the building and adjacent properties
- Drawings of the existing building showing its structure
- Architectural plans, sections and elevations of the proposed works
- Structural engineering plans, sections and details of the proposed works
- Drawings showing the groundwater levels and the relationship of the groundwater to the proposed new basement. The drawings should show the direction of flow for both groundwater and surface water run-off
- Drawings to illustrate how it is envisaged that the project will be built, showing a sequence of works and the envisaged temporary works, particularly propping to limit and control ground movements
- These drawings are to be referenced in the relevant SMS, CMS and other statements provided for planning.

14.0
Reference Documents

- Subterranean Development Bill (HL) February 2012
- Preliminary Flood Risk Assessment for City of Westminster by Halcrow
- Strategic Flood Risk Assessment for the City of Westminster
- CIRIA C580 Embedded Retaining Walls: Guidance for Economic Design
- BRE Digest 250 Assessment of Damage in Low-Rise Buildings
- Party Wall Etc. Act 1996
- BS5837 2012 Trees in Relation to Design, Demolition and Construction
- The Construction Design and Management Regulations 2007 (CDM)
- Building Regulations
- Planning Policy
- The Planning (Listed Buildings and Conservation Areas Act) 1990The Contaminated Land (England) Regulations 2006
- The Health and Safety at Work Act 1974 (HASAWA)
- The Air Quality Standards Regulations 2007
- The Building Act 1984
- The Controlled Waste Regulations 1992
- The Disability Discrimination Act 1995
- The Energy Performance of Buildings Regulations 2007
- Hazardous Waste (England and Wales) Regulations 2005
- The Highways Act 1980
- The London Building Acts (Amendment) Act 1939
- Rights of Light Act 1959
- The Site Waste Management Plan Regulations 2008
- ACE Agreement 1: Design 2009

Appendix A
Brief

WESTMINSTER CITY COUNCIL

CITY PLANNING DELIVERY UNIT

BUILT ENVIRONMENT

TITLE OF STUDY:	**Study to inform the City Management Plan Basements Policy**
DATE ISSUED:	**10 August 2012**
CONTACT OFFICERS:	**Lisa O'Donnell** lodonel1@westminster.gov.uk 020 7641 4240 **Jane Hamilton** Jhamilton@westminster.gov.uk 020 7641 8019

1.0 Background and Purpose of Study

1.1 The City Council is currently developing its detailed spatial planning policies. These are set out in the Consultation Draft City Management Plan (CMP) (November 2011). The intention is to adopt these detailed policies by 2014.

1.2 One of the new policy areas in the document relates to basement (subterranean) development. During public consultation, specific concerns were raised about the potential impacts of such development on the hydrological and geological environment of Westminster and whether there are areas which may be more susceptible to instability and localised flooding. The City Council therefore wishes to obtain further evidence to establish whether the proposed policy approach to basement development is appropriate or if a different approach should be applied. The council's principal concern is with public safety and stability of buildings.

2.0 **Aim of Study:** To consider the potential risks associated with basement development in relation to the differing hydrological and geological characteristics across Westminster and the proposed planning policy response to this.

3.1 **Scope of Study**

3.1 The study will include a desktop analysis of the hydrological and geophysical character of the City. This should review existing data held by Westminster, identify any gaps and obtain missing data, to provide an up-to-date picture of the varied existing geological and hydrological conditions in Westminster including: Topography, Geological conditions (clay, gravel, old river channels etc) and Hydrological and hydro-geological conditions (surface water, shallow and deep aquifers).

3.2 The study will consider whether these differing characteristics across the City will increase risk of flooding and land instability and as such require a differing approach to basement development. It should indicate:

- whether there are specific geographical areas or types/ages of buildings In Westminster where the risks are such that basement development may be inappropriate,
- whether certain forms of basement development may be appropriate in different areas, including any circumstances in which the building of more than one storey of basement many increase risks,
- whether the cumulative impacts of multiple basement developments may increase risk and what these risks are,
- appropriate mitigation and adaption measures, considering in particular whether the criteria set out in the draft policy limiting extent and depth of basements extensions are appropriate and sufficient to minimise risks. These may vary between between areas where differing levels of risk are apparent.

3.3 Finally the study should identify what hydrological, geological and other technical information developers should be required to submit with planning applications assessing whether the information requirements suggested in the draft policy are adequate.

3.4 The Council will provide the following background information and data:

- Statistical information on the incidence and spatial distribution of basement applications in Westminster.
- Baseline data on geology and hydrology from the City Council's Strategic Flood Risk Assessment and Draft Surface Water Management Plan.
- Comments received as a result of consultation on the City Management Plan
- Draft City Management Plan Policy

4.0 Timetable and Format

4.1 The study is required to inform the emerging policy and the final report should be completed by **1 October 2012**. The consultants will be required to attend one inception meeting and a follow up meeting to discuss a draft Report and any amendments required.

4.2 Draft and final reports must meet the City Council's quality expectations. Reports should:

- Comprehensively address the requirements set out in this project brief,
- Be accurate and appropriately reference any source material,
- Be explicit about any methodological assumptions and set out clear justification for these,
- Be set out in a logical manner and well presented and contain an executive summary written in plain English that accurately reflects the main report,
- Be robust enough to withstand scrutiny at independent examination.

4.3 The report will be the copyright of the City Council.

5.0 Costs

5.1 The consultant should provide a total cost for the work on a lump sum basis. They should also provide a breakdown showing the costs/time for each element of the study. An hourly rate should be provided for any additional work that may be required.

5.2 The commission may also include supporting City Council officers at public examination, including appearing if necessary. A separate estimate / rate may be provided for this aspect of the work

Appendix B
Figures

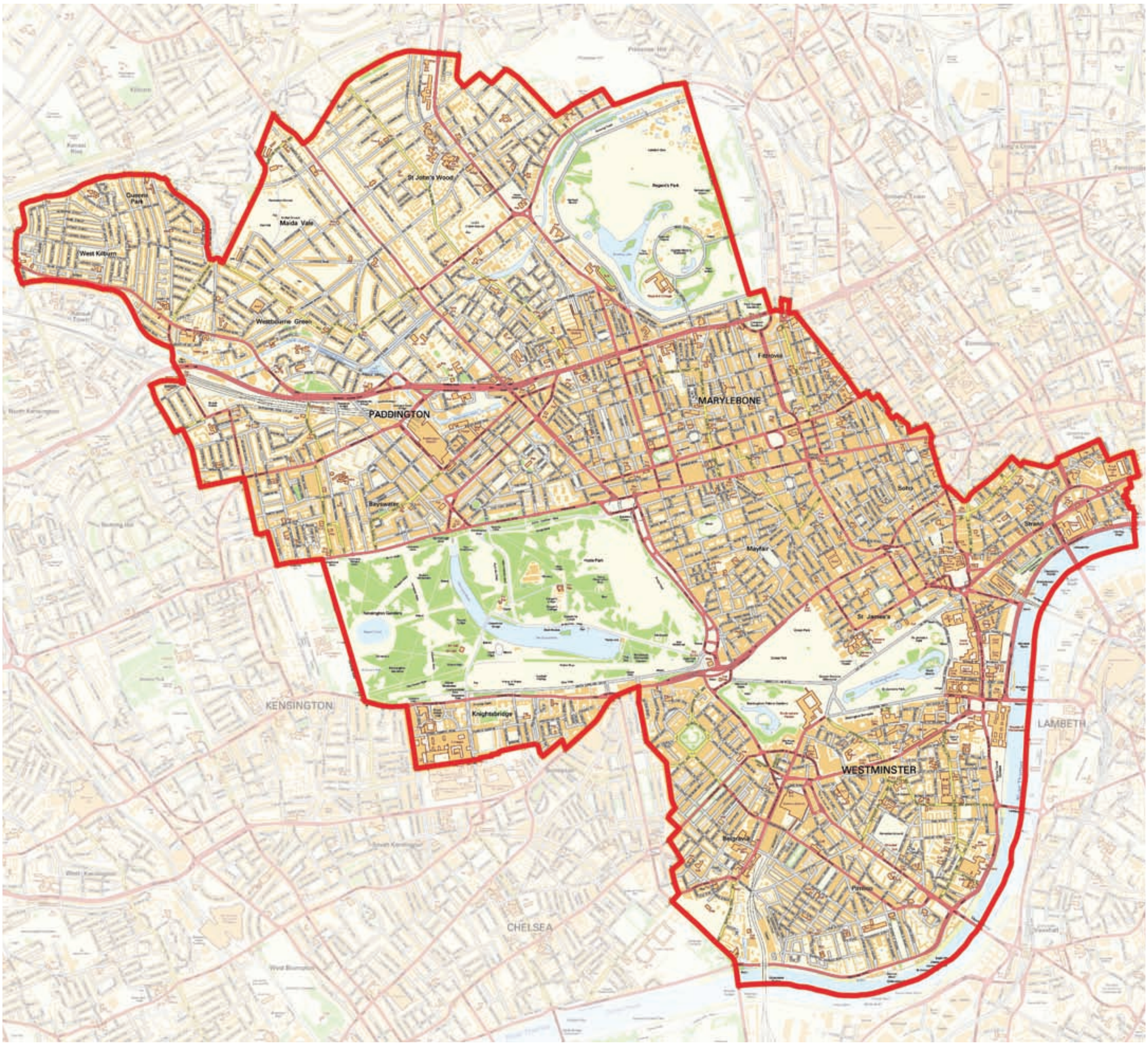

Figure 1
Map of development of Westminster, c. 2010

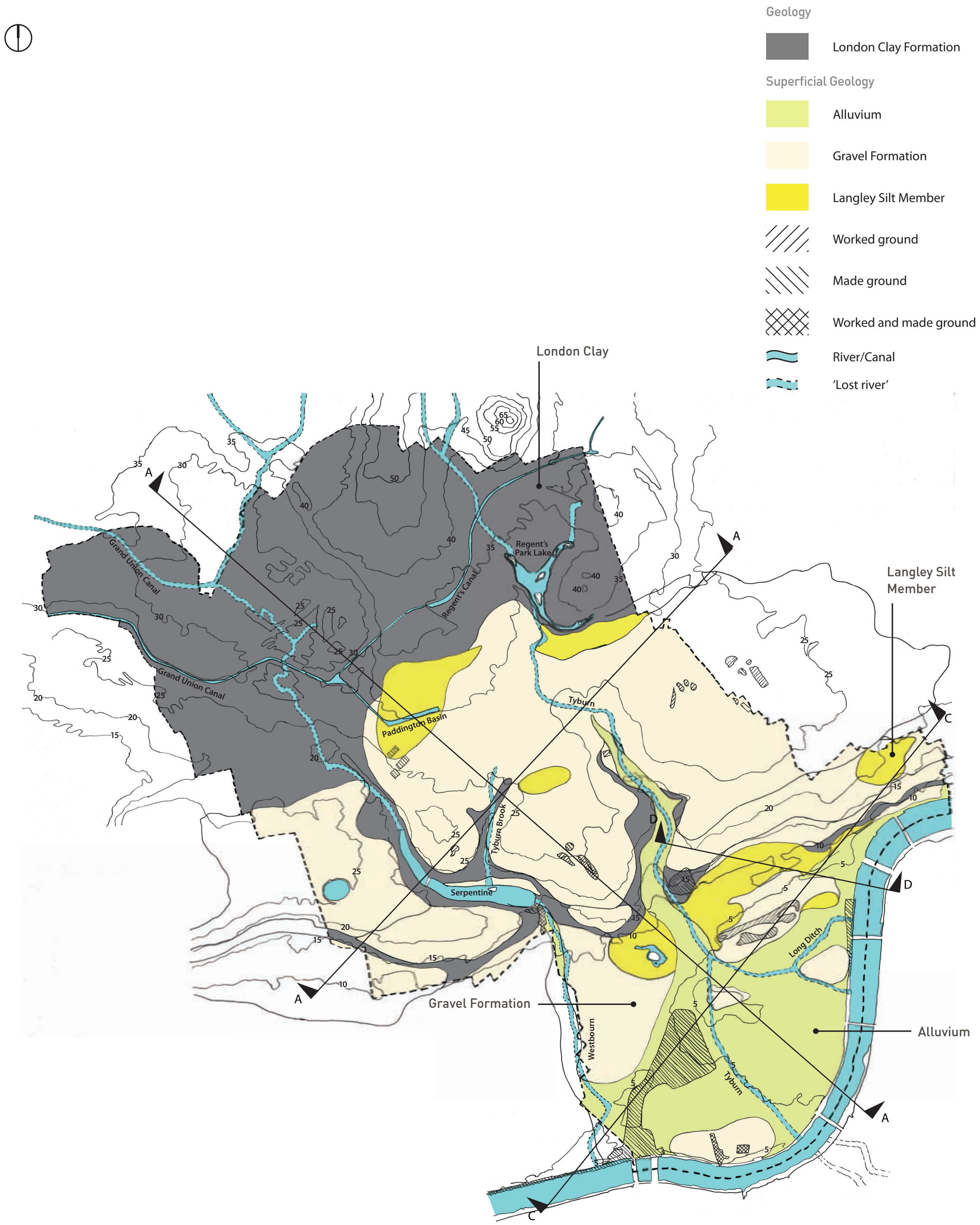

Figure 2
General Topography, Geology and Historic Water Courses

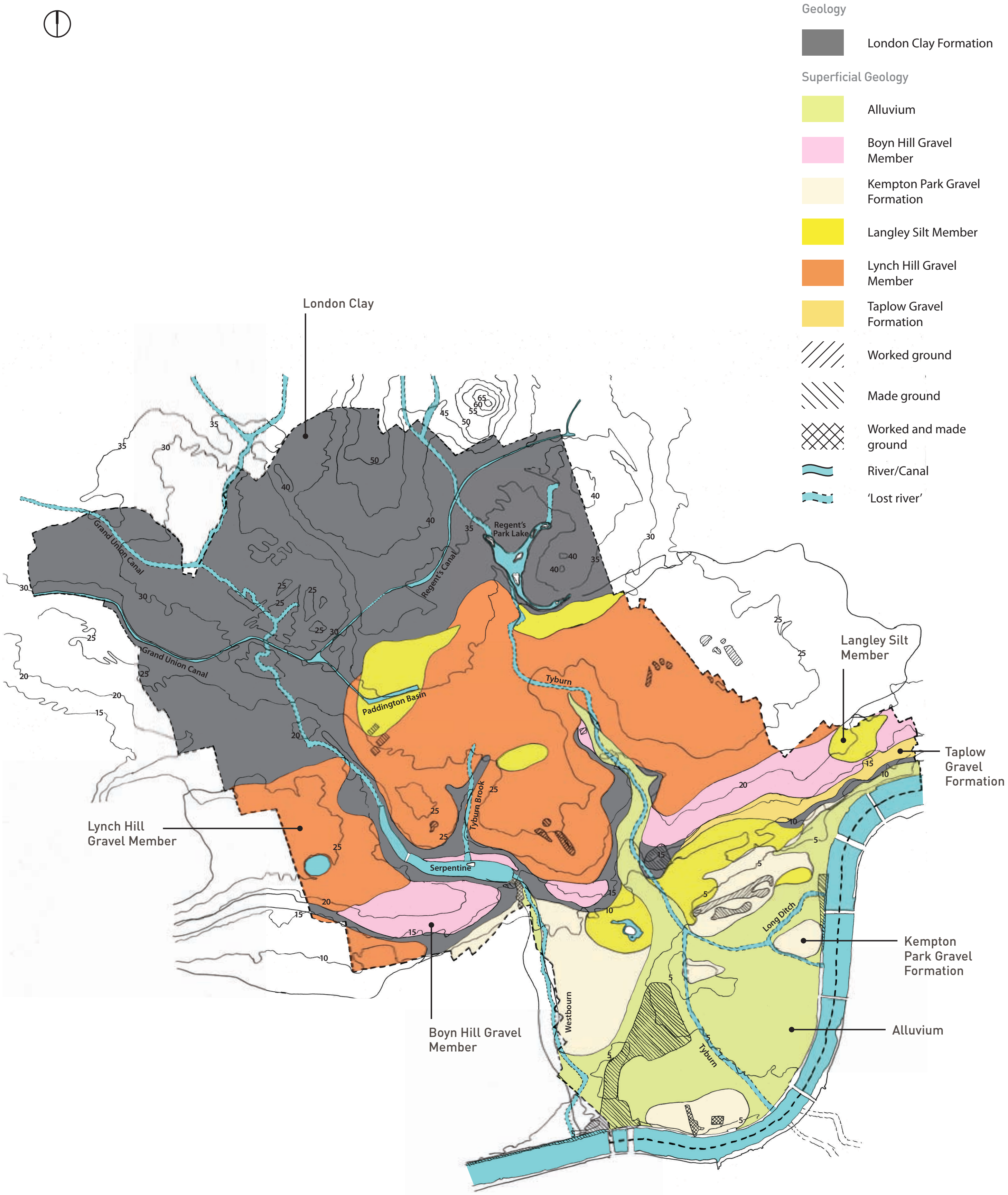

Figure 3
Detailed Topography, Geology and Historic Water Courses

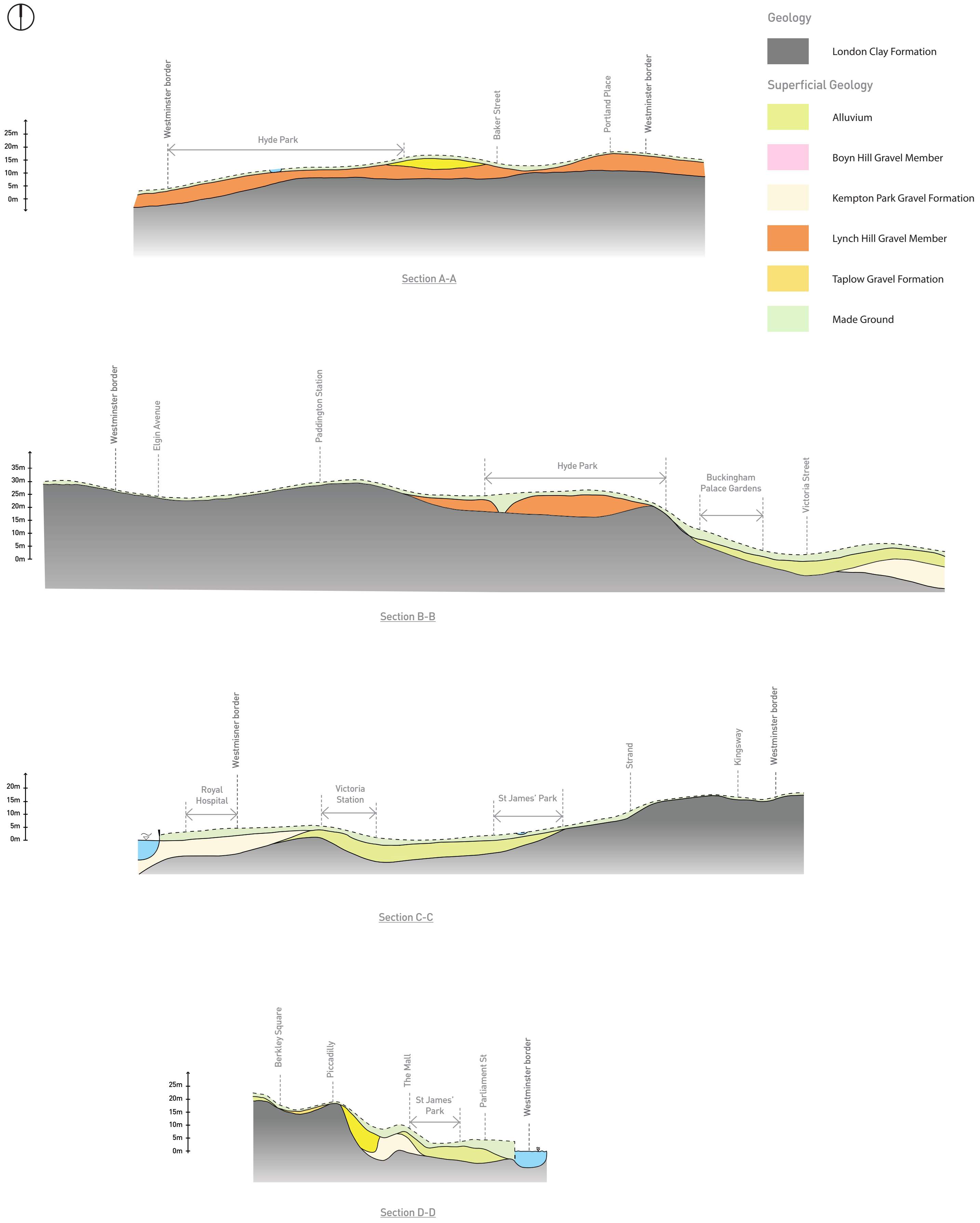

Figure 4
Geological Sections

Note: Indicative only, and for initial guidance purposes

Areas at risk of flooding

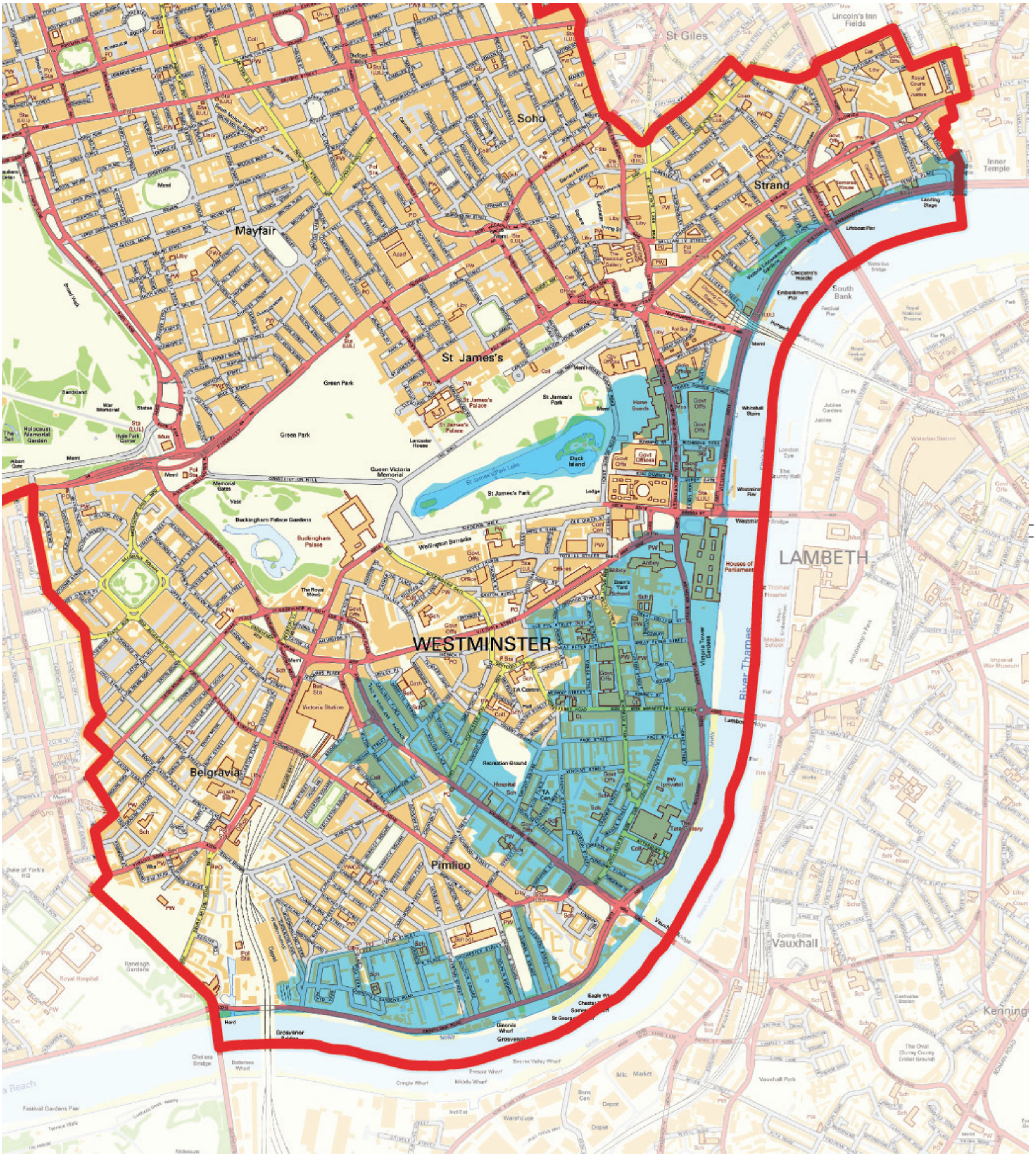

Figure 5
Overtopping Inundation and Breach Inundation

Note: Indicative only, and
for initial guidance purposes

Areas which historically have had increased risk of surface water flooding

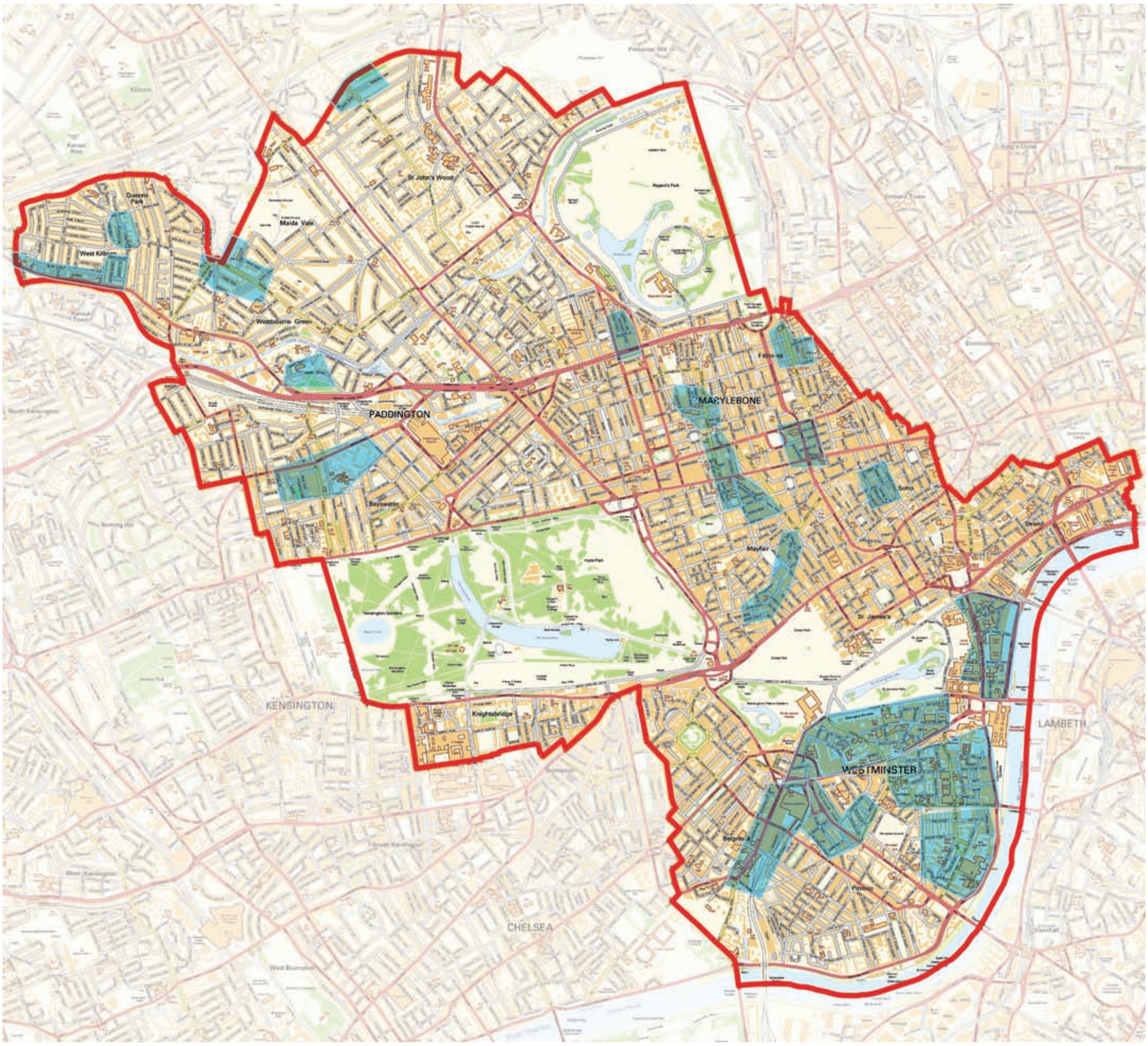

Figure 6
Local Surface water flood risk zones

Note: Indicative only, and for initial guidance purposes

Areas where there is a significant increased risk of the drains being surcharged during periods of heavy rainfall

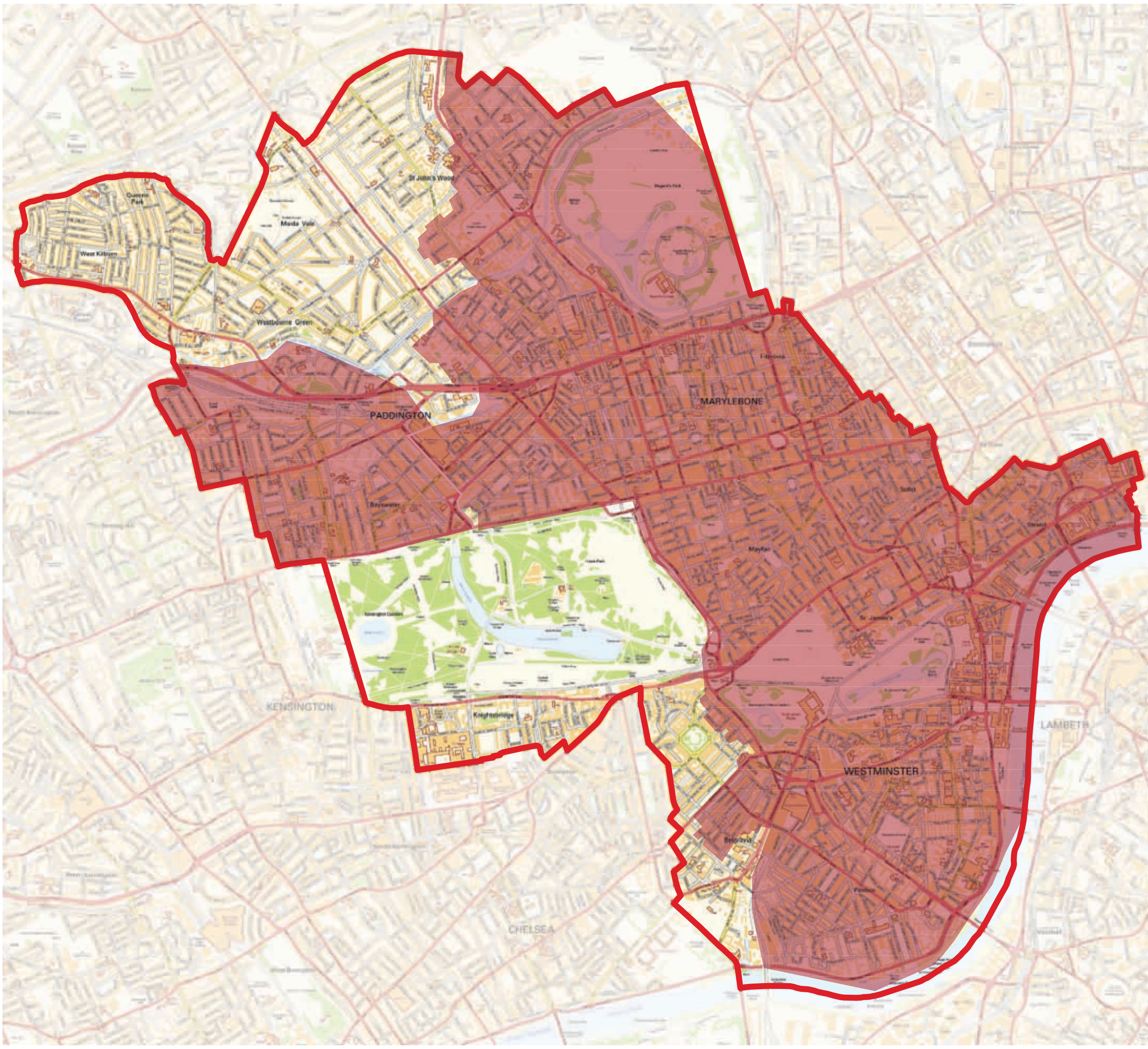

Figure 7
Critical drainage areas

Alan Baxter

Prepared by Jim Gardiner
Reviewed by Michael Coombs
Draft issued July 2013

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