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# GLOSSARY

<table>
<thead>
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<th>Full Form</th>
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<tr>
<td>AOD</td>
<td>Above Ordnance Datum</td>
</tr>
<tr>
<td>CLG</td>
<td>Department for Communities and Local Government</td>
</tr>
<tr>
<td>DEFRA</td>
<td>Department for Environment Food and Rural Affairs</td>
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<tr>
<td>DTM</td>
<td>Digital Terrain Model</td>
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<td>EA</td>
<td>Environment Agency</td>
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<td>FEH</td>
<td>Flood Estimation Handbook</td>
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<td>FRA</td>
<td>Flood Risk Assessment</td>
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<tr>
<td>FSR</td>
<td>Flood Studies Report</td>
</tr>
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<td>FZM’s</td>
<td>Environment Agency Flood Zone Maps</td>
</tr>
<tr>
<td>GI</td>
<td>Ground Investigation</td>
</tr>
<tr>
<td>FZM’s</td>
<td>Environment Agency Flood Zone Maps</td>
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<tr>
<td>LDF</td>
<td>Local Development Framework</td>
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<tr>
<td>LiDAR</td>
<td>Light Detection And Ranging</td>
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<tr>
<td>LPA</td>
<td>Local Planning Authority</td>
</tr>
<tr>
<td>NPPF</td>
<td>National Planning Policy Framework</td>
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<tr>
<td>PPG25</td>
<td>Planning Policy Guidance 25</td>
</tr>
<tr>
<td>PPS25</td>
<td>Planning Policy Statement 25</td>
</tr>
<tr>
<td>ReFH</td>
<td>Revitalised FSR/FEH Rainfall-Runoff method</td>
</tr>
<tr>
<td>SFRA</td>
<td>Strategic Flood Risk Assessment</td>
</tr>
<tr>
<td>SuDS</td>
<td>Sustainable Drainage Systems</td>
</tr>
<tr>
<td>SWMP</td>
<td>Surface Water Management Plan</td>
</tr>
<tr>
<td>UDP</td>
<td>Unitary Development Plan</td>
</tr>
<tr>
<td>WINFAP-FEH</td>
<td>Statistical rainfall and runoff analysis software program</td>
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EXECUTIVE SUMMARY

This report has been prepared to accompany an application to Royal Borough of Kensington and Chelsea (RBKC) to vary/remove planning conditions relating to flood risk mitigation measures.

The original three proposed options have been thoroughly assessed and it has been established that none are feasible. In order to prevent sewage from the West Road sewer backing up into the site in an event of sewer surcharge a non-return valve will be installed in the last manhole before the connection. The Flood Risk Assessment confirms that there would be no harm to flooding in the area. The development therefore conforms to RBKC Local Plan Policy CE2 and the conditions can be removed. For reference, the relevant conditions include:

- S73 amendment application PP/15/05366 – Condition 4
- Conservatory at rear lower ground floor with terrace – PP/14/08045 – Condition 3
- Basement plant area and landscaping – PP/15/01473 – Condition 9
1 INTRODUCTION

General Information

1.1 The site being assessed is Gordon House in Chelsea.

1.2 The site lies within defended Flood Zone 3 of the defended River Thames.

Planning Background

1.3 The change of use of the buildings for residential use and the principle of a new Annex building were secured by the consent granted in January 2012 (ref: PP/11/02556 and LB/11/02557), and a Flood Risk Assessment (FRA) was submitted with the application (Water Environment reference 11053\FP dated 25th July 2011). Condition 5 attached to this permission required a plan for flood protection measures be submitted to and approved in writing by the Local Planning Authority. Planning permission has been granted for minor amendments to this permission, including planning permission PP/14/02509 (and LB/14/02993), which included an updated FRA (Water Environment reference 11053\FP\GL dated 26th March 2014). Permission has also been granted for internal and external revisions to Gordon House, the annex building and basement, and adjustment in basement depth (ref: PP/14/07483 and LB/14/07484), with a Flood Risk Assessment also submitted with this application (Water Environment reference 11053\FP\GL dated 18th September 2014). The latest minor amendments to the main planning permission for Gordon House were approved in October 2015 (ref: PP/15/05366 and LB/15/05370).

1.4 Alongside the main, amended permission, separate applications have been approved for the erection of conservatory at rear lower ground floor with terrace above (ref: PP/14/08045 and LB/14/08047) and a basement plant area and landscaping (ref: PP/15/01473 and LB/15/01474). Conditions attached to these permissions contain references to the approved Flood Risk Assessment (PP/14/08045 refers: Water Environment reference 11053\FP\GL dated 18th September 2014) as well as an addendum Flood Risk Assessment that was prepared for PP/15/01473 (Water Environment reference 11053\FP\GL dated 18th February 2015).

1.5 The relevant condition attached to the various consents states that ‘The development shall incorporate the mitigation measures as set out in the Flood Risk Assessment prepared Water Environment Limited’ referenced with the date of the relevant report.

1.6 Three S73 applications were submitted in June 2016 to vary/remove the conditions relating to flood mitigation attached to permissions PP/14/08045, PP/15/01473, and PP/15/05366. The planning applications were accompanied by a letter report detailing the proposed flood risk mitigation measures for the proposed development. RBKC responded on the 2nd July 2016 requesting further information. The RBKC response was discussed in detail with Patricia Cuervo. Since this conversation further design and reporting work has been undertaken. The latest Environment Agency flood data has also been received.
Scope of Study

1.7 As a Flood Risk Assessment has already been submitted and approved as part of the planning grant, the assessment has not been copied. Full details of the site location, extents and the proposed development are included in the various FRAs as referenced above and these should be consulted for further background information.

1.8 Since the FRA was prepared, a number of surveys have been conducted and a significant amount of work has been undertaken in order to determine the appropriate mitigation measures.

1.9 The main objectives of this study are to investigate the three potential flood mitigation measures included in the FRA to consider and refine the three potential flood risk mitigation options presented in the FRA to:

- Consider the latest Environment Agency tidal modelling data,
- Ensure that the development is safe for future residents and occupants, and
- Does not increase flood risk elsewhere, and where possible, reduce flood risk to neighbouring properties.

1.10 To ensure that this study is as detailed and as robust as possible, the expertise of various specialists within the design team have been used including Applied Landscape Design ltd for landscape design and Alan Baxter Ltd for structural engineering.
2 LATEST ENVIRONMENT AGENCY TIDAL MODELLING DATA

Modelled Flood Water Levels

2.1 The Environment Agency provided the latest present day and predicted future extreme water levels for the closest node to the site, which in this case was identified as node 2.28. These in-channel flood levels are taken from the Thames Estuary 2100 (TE2100) study which was undertaken by HR Wallingford in 2008. Table 1 indicates the “TE2100 climate change levels” and Table 2 below indicates the “TE2100 2008 levels”, both tables reflect levels at node 2.28.

<table>
<thead>
<tr>
<th>Location</th>
<th>Node</th>
<th>1000 yr design water levels</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>2008</td>
</tr>
<tr>
<td>Battersea</td>
<td>2.28</td>
<td>4.87</td>
</tr>
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Table 1 – Thames Estuary 2100 modelled 0.1% AEP climate change levels for Node 2.28

<table>
<thead>
<tr>
<th>Location</th>
<th>Node</th>
<th>Extreme Water level (m)</th>
<th>Current Left defence (m)</th>
<th>Current Right defence (m)</th>
<th>Allow for future defence raising to a level of...</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Left bank (m)</td>
</tr>
<tr>
<td>Battersea</td>
<td>2.28</td>
<td>5.82</td>
<td>5.41</td>
<td>5.41</td>
<td>6.35</td>
</tr>
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Table 2 – Thames Estuary 2100 modelled 0.1% AEP for Node 2.28

2.2 As shown in Table 2 there is the possibility that levels may rise as high as 5.82m AOD by the year 2100, depending on the chosen defence policy in the Thames Estuary. The site is, and will remain, formally defended to a standard in excess of the 1000 year return period and, even assuming the worst case climate change levels show in Table 2 would be protected from tidal flooding (flood defences will be raised to ensure continued protection past 2100 as shown in Table 2)

2.3 The Environment Agency have stated that design flood levels are no longer associated with specific return periods for flood events in the tidal section of the River Thames upstream of the barrier because flood levels are the highest tidal events permitted by the operation rules of the Barrier. If levels and flows are forecast to be any higher, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a lower level. For this reason, the probability of any given water level upstream of the Barrier is controlled and therefore any associated return period becomes irrelevant. The Thames Barrier and associated defence system has a 1 in 1000 year standard which means it ensures that flood risk is managed up to an event that has a 0.1% annual probability. The “Extreme” water level therefore represents the absolute maximum flood that could occur when taking into account the operation of the Barrier, encompassing all
events up to the 1 in 1000 year return period. The Environment Agency has also noted that TE2100 takes into account operation of the Thames Barrier when considering future increases in tidal levels due to predicted future sea level rise.

2.4 The Thames Barrier requires regular maintenance and with an increase in the closure frequency, opportunities for maintenance would be reduced. Consequently, to avoid a high frequency of barrier closures, the forecast tidal level for which the Barrier is closed will need to be increased in the future, resulting in higher tidal events being allowed to progress upstream. For this reason, levels upstream of the barrier will increase and the tidal walls will need to be heightened to match. The TE2100 plan notes that the preferred protection policy up to the year 2070 is therefore to improve the standard of existing defences along the Thames (referred to as “holding the line”). Thus, it may be assumed that, although the severity of floods is predicted to increase in the future the site will continue to be defended against flooding from the Thames to the 1 in 1000 year standard.

**Flood Levels in Relation to the Site**

2.5 The present day design floodwater level for the River Thames is 4.87m AOD. The defences closest to the site location are all raised, man-made and privately owned. It is the riparian owners’ responsibility to ensure they are maintained to a crest level of 5.41m AOD (the current Flood Defence Level in this reach of the Thames). The Environment Agency inspect the defences twice a year to ensure that they remain fit for purpose. The current condition grade for defences in the area is 2 (good), on a scale of 1 (very good) to 5 (very poor). The site is therefore protected from flooding by the Thames Barrier and formal flood defences to a standard in excess of the most extreme present-day predicted flood water level in the river.

**Residual Risk**

2.6 Breach modelling has since been undertaken by the Environment Agency to consider the implications of a failure of the flood defences during a flood event. The Environment Agency data is deemed most reliable and robust.

2.7 The Environment Agency has recently completed a comprehensive study assessing the likely extent of flooding that would arise in the event of a breach in the raised Thames Tidal Defences. The results show that the site would be affected by a breach of the defences.

2.8 The “Product 4” information also includes information with specific modelled flood levels at the site. These have been taken from the Thames Tidal Breach Modelling Study 2015 completed by CH2M HILL in March 2015. The breach location scenario nearest the site is West01 (TQ2789577755). The levels assume that the Thames defences have been breached immediately south of the site near the intersection of Tite Street and Chelsea Embankment. Flood water levels for several 2D node points have been extracted and provided by the Environment Agency as shown in Figure 1. The full set of results at these nodes are shown in the enclosed Product 4, however flooding will only occur at points 1, 3 and 4 with a ‘Max Likely Water Level’ of 5.254m AOD at point 1 and 5.253m AOD at point 3 and 4.
2.9 A 0.1% AEP event, in 2100, would result in a flood level of 5.254m AOD on the site. This is 1m higher than the previous breach model level. The full set of breach floodplain maps can be seen in the Product 4 enclosed. The map showing the max depth in 2100 (considering the lifetime of the development) is shown in Figure 2.

2.10 The extent of flooding in the event of a breach in 2100 covers the southern part of the site. In the wider area flooding is shown in the properties on Embankment Gardens, Chelsea Embankment Swan Walk and Dilke Street between the site and the river, up Tite Street passed the site entrance and extensively across the grounds of the Royal Hospital Chelsea.

2.11 The site is on the edge of the floodplain with the northern part of the site not shown at risk of flooding in the event of a breach.

**Figure 1 - River Thames tidal breach 2D node locations at Gordon House**
In summary, in the highly unlikely event that a breach of the defences occurred simultaneously at the peak of a tidal flood, water levels on the site could be as high as 5.254m AOD.
3 IMPACT ON FLOOD RISK ELSEWHERE

3.1 With reference to flood risk and the potential impact on flooding in the surrounding area (as noted in the Advice report dated 24th August 2015 reference PRE/PLB/15/00749) this is not relevant to the planning conditions which are sought to be varied/removed which state the reason is ‘To protect future occupants from the risk of basement flooding’. Despite this, the Flood Risk Assessment submitted with each relevant planning application includes an assessment of any potential impact on flood risk elsewhere and concludes that the development will not increase flood risk. The FRA was accepted by the Environment Agency and RBKC and this issue has therefore been dealt with.

3.2 The key points are summarised as follows:

- the site is not at risk of fluvial or tidal flooding from the River Thames during operating conditions of the Thames Barrier and the flood defences
- the site is only at potential residual risk of flooding in the event of catastrophic failure of the flood defences coincidental with a 1 in 1000 year event
- the site is not located in a Critical Drainage Area

3.3 Despite this, the impact on flood risk elsewhere has been assessed further following the response from RBKC.

3.4 The response from RBKC stated:

“If it is important to note that the boundary wall could potentially reduce the speed and amount of flood waters entering the site and prevent flood risk elsewhere in the area, making it a valuable flood risk asset. The report concludes that the development will not increase flood risk elsewhere. However, it is not understood how there could be a reduction in risk in the surrounding area by not implementing the mitigation measures as the report claims. This statement clearly does not take into proper consideration the importance of the wall.”

3.5 A structural survey and analysis has been undertaken of the boundary. It has been determined that the existing boundary wall would not withstand the hydrostatic pressures of a tidal breach. The full report has been included in the Appendix¹.

3.6 It is possible that the wall could potentially reduce the speed of flood waters entering the site however the Environment Agency breach modelling shows that the site would flood from the main entrance off Tite Street as well as from the Royal Hospital Chelsea grounds. Therefore any impact of the boundary wall in delaying the onset of flooding before failure of the wall would be offset by the fact that flood water can enter the site from other sides.

3.7 Importantly, the boundary wall would make no difference to flood risk elsewhere. The site is at the edge of the floodplain and other properties at risk of flooding from a breach area between the site and the river i.e. these sites would flood before Gordon House.

The boundary wall does not offer any protection to other properties and it is not a valuable flood risk asset.

3.8 The structural survey shows that the wall would fail based on a breach flood water level of 4.3m AOD. It follows that the wall would also fail if the breach flood water level reaches 5.254m AOD. Therefore, if the site were not developed, the site would flood in the event of a breach in the defences.

3.9 If the site is not defended locally post-development, the status quo would be maintained and the site would flood in the same way that it would at present. There would therefore be no impact on flood risk elsewhere. There is no way of reducing flood risk by implementing any flood defence or mitigation measures on the site. The site currently accepts flood water in the event of a breach which provides valuable flood storage.

3.10 By contrast, if any of the flood defence or mitigation measures are implemented on the site as part of the development, this would exclude flood water from the site (or part thereof) thereby reducing the amount of storage in the floodplain. This would increase flood risk to neighbouring sites as the flood water that would have flowed on the site would be forced elsewhere, potentially putting existing properties in the floodplain at greater risk and/or placing additional properties at risk of flooding. The nearest properties are those along Embankment Gardens. These properties would be impacted the most as flood water flowing behind these properties would back up against the flood defence/mitigation measures on the Gordon House site. We understand that there are basement dwellings in some of the properties on Embankment Gardens. As ‘highly vulnerable’ development any increase in flood risk to these properties could have significant consequences.

3.11 It is therefore the benefit of neighbouring properties for the development of Gordon House to not include any flood defence or mitigation measures.
4 DETAILS OF MITIGATION MEASURES

4.1 The majority of the detailed design work and optineering was done in 2014 and 2015 prior to release of the new Environment Agency tidal breach modelling. It has since been established that the new breach water level on the site is 1m higher than the previous level so any constraints identified below would be amplified for a higher breach level. The knock-on effects of the higher breach water level on the analysis undertaken originally is discussed in each relevant section. The following provides detailed commentary on the three options.

Boundary Wall

4.2 The first and most obvious solution considered was the use of the boundary wall as the primary protection of the site from breach flood water from the River Thames. The approach was to form a continuous ‘barrier’ which could be linked to the higher (northern) portion of the site, preventing waters from entering site and reaching the building facades.

4.3 A structural survey of the southern and western boundary wall has been undertaken that concludes that the existing wall would not be able to withstand the hydrostatic pressure resulting from flood water reaching a level of 4.3m AOD on neighbouring properties. The wall would therefore not be able to withstand the new breach water level of 5.254m AOD.

4.4 It has been determined that significant work would be required to restrain/buttress the wall sufficiently to withstand the hydrostatic pressure. Several options have been considered which require building out of the wall and below ground excavation to construct larger foundations – please see the Alan Baxter sketch drawing in the Appendix (Drawing 1). There are significant portions along the boundary occupied by the Root Protection Area’s (RPAs) of 13 No. existing trees. Drawing 2 shows the Tree Protection Plan for the site. In addition, 30 No. mature trees proposed as part of the development have been installed (Drawing 3) and would be affected by any boundary wall strengthening. We have engaged with the project Arboricultural Consultant to assess the impacts. The advice is that excavations along the boundary wall will endanger tree roots and knotweed treatment – the ALD sketch drawing included in the appendix (Drawing 4) shows the areas along the boundary wall where each option presented by Alan Baxter is and isn’t possible. In addition, the southwest boundary will have limited access meaning a continuous trench in this location would not be possible due to the potential for jeopardising the health of these trees. Constructing individual pad foundations and ‘bridging’ across RPAs was also considered however the continuous nature of overlapping RPAs in certain areas means that this is not feasible.

4.5 Building up levels in front of the existing wall to buttress it has also been considered instead of buttressing with a new structure, however the extent of filling required (>1m height of cover) within RPAs of existing trees could threaten the health of the trees. The reason for avoiding infilling over root zones is that the trees will become starved of oxygen and soils are likely to become compacted and anaerobic.

4.6 In addition, we understand that there are RBKC concerns regarding overlooking over neighbours along the boundary and land raising along the boundary could cause privacy problems.
4.7 Drawing 5 shows sections through the site. The first section illustrates the wall strengthening and bunding that would be required adjacent to the existing boundary wall to achieve the required flood defence level.

4.8 Party Wall rights also need to be considered.

4.9 For all these reasons a feasible solution for ensuring that the boundary wall can defend the property against flooding to a level of 4.3m AOD, without impacting on tree roots in particular, is not possible.

4.10 Extending this analysis, strengthening the existing wall to a height of 5.254m AOD would require larger foundations, greater excavations and/or greater depth of fill.

### Landscaping of the rear garden

4.11 The next preferred option was to landscape the rear garden of the site and raise ground levels to form a continuous line of defence at a minimum level of 4.3m AOD tying into high ground on the western and eastern boundaries. This would also negate the need for any additional measures to protect the building.

4.12 General ground levels in the rear garden of the property vary between approximately 2.5m and 3.5m AOD. In order to achieve the necessary level to prevent flooding of the property based on a peak breach flood water level of 4.3m AOD, ground levels would need to be raised by between 1800mm and 800mm. Tree RPAs are again a key consideration for this option as filling over tree root zones is not recommended as it threatens the health of the trees.

4.13 The design features several steps up and down, to add interest and create height behind the pool area for privacy planting. Taking into account the RPAs, privacy concerns with overlooking and the landscape design it is not possible to create an acceptable bund at a level of 4.3m AOD through the garden.

4.14 A hybrid solution of creating a bund supplemented by demountable barriers was also considered. The tallest practical demountable barrier available is 900mm and a route for a bund at a minimum level of 3.4m AOD was investigated. However, this hybrid solution relies on a continuous flat (or gently sloping) surface free from steps or obstructions in order to install the barriers securely. Despite the lower crest level of a bund this solution still requires up to 800mm of cover in RPAs. This solution also includes the provision of demountable barriers which would take the form of either flood boards slotted into posts or mobile flood pods which fill with floodwater to create a barrier. Both options would require storage and deployment of at least 125m of barriers. This raises concerns regarding the practicality of this type of solution, discussed further below.

4.15 Drawing 6 shows the mountable flood protection and installation route options.

4.16 Establishing a continuous, step-free route clear of obstructions (e.g. trees and plants) is therefore not possible without impacting on trees and the landscape character of the garden. In addition, a hybrid solution has been discounted based on concerns regarding practicalities of deploying a demountable barrier system.

4.17 Again, this analysis can be extended to the higher level of 5.254m AOD. It is not possible to create a bund between 2800mm and 1800mm high through the rear garden. Even a
900mm demountable barrier would still require creating a raised bund to a level of approximately 4.4m AOD.

4.18 Drawing 5 shows a second section illustrating the extent of bunding required to achieve a hybrid flood defence solution through the site.

Property flood proofing

4.19 The third option was to use flood proofing measures to protect the property locally from flood damage. An effective system would incorporate:

- air brick covers on the existing air bricks (permanent measure),
- demountable flood barriers to protect all doors and the arches (temporary measure). The demountable flood barriers would be a temporary measure deployed by trained staff on site and monitored through subscription to the Environment Agency Floodline Warnings Direct service.

4.20 The Flood Risk Assessment concluded that there are two potential flow paths for flood water to enter the house and the basement. These are through the arches and into the internal swimming pool area, as well as through the loggia and into the house.

4.21 Window cill levels on the existing house are set lower than the new breach flood water level of 5.254m AOD so all the windows at lower ground floor level provide a new flow path into the building.

4.22 There are three airbricks around the existing building at the lower ground floor level which will be replaced with an anti-flood air brick such as the UK Flood Barriers Flood Angel. These anti-flood air bricks allow air to freely pass through but under flood conditions the self-activating gate automatically shuts off preventing flood water from flowing through. The first part can therefore be satisfied.

4.23 The second part includes demountable barriers across openings such as across the (proposed) glazed panels of the arches as well as doorways and windows in the proposed Loggia and existing house at lower ground floor level. Further investigations have been undertaken and several suppliers contacted to discuss possible solutions. Deployment of demountable barriers would be reliant on sufficient warning time in order to implement emergency procedures including retrieving and installing barriers and posts. In this case the potential risk of flooding is from a breach in the linear flood defences along Chelsea Embankment. There would be insufficient time to deploy the barriers following a breach in the defences. The other option would be to subscribe to the Environment Agency Floodline flood warning service as described in the Flood Risk Assessment. Subscribing service is recommended for the future owner regardless of the flood mitigation measures installed. In addition, when the Environment Agency issue a ‘Flood Warning’ the barriers could be deployed as a caution in case the defences failed. The Environment Agency have been contacted to retrieve records of the flood warnings along this reach of the Thames to determine how often this may occur. The Environment Agency has confirmed that they have not issued any Alerts, Warnings or Severe Flood Warnings for the Tidal Thames from Blackfriars Bridge to Battersea Bridge. Recorded water levels from within the River Thames at Chelsea Bridge have also been obtained. Over the 10 years that water levels have been recorded (from January 2005), the highest water level within the River Thames at Chelsea Bridge was 4.95m AOD, recorded on 16th December 2005. The
The extreme water level currently predicted by the Environment Agency (i.e. the highest water level permitted by the Thames Barrier) is 4.88m AOD.

4.24 Despite the extreme predicted water level having been exceeded three times in the past 10 years there have been no flood warnings on record. Consequently, even the Environment Agency flood warning service may not provide reliable warnings on which to base a strategy for demountable flood barriers.

4.25 Instead of demountable flood barriers, a Self Activating Flood Barrier (SAFB) has been considered. Due to physical and environmental constraints on the site the only opportunity for using a SAFB would be in front of the arches. The cost of the barrier is £177,000, excluding all the associated ground and civil engineering costs. A demountable barrier system would still be required for the Loggia and existing house at lower ground floor level but as described above a demountable system which is not automatically activated is not appropriate in this case due to the lack of warning time. Therefore it is not reasonable to install a SAFB which would only protect one access point when floodwater could also enter the building via the Loggia and existing house.

4.26 On this basis there is no practical way of installing a flood defence system around the building covering all potential openings.

4.27 The insurers of the property have also been approached and they have confirmed that there would be no change in premium in recognition of an on-site defence system.

Summary

4.28 The approved plans for the development include various uses at levels below 5.254m AOD but there is no sleeping accommodation at these levels. It is proposed that the lower ground floor and basement be confined to 'less vulnerable' use, with all bedrooms being proposed at upper ground floor and above.

4.29 Taking everything into consideration it is concluded that there is an extremely low risk of flooding to the theoretical predicted level of 5.254m AOD on the site resulting from breach of the defences along the River Thames during an extreme flood event. All bedrooms are located at higher levels within the property above the predicted breach water level. By contrast, the costs and potential environmental impacts of implementing an effective, practical flood defence system on the site to defend against flooding from breach of the flood defences are significant. In addition, through this further work no other feasible options have been identified. Therefore, on balance, it is not intended to implement any of the three options.

4.30 Flood resilient measures will however be incorporated to mitigate against flooding from the public sewer system. In order to prevent sewage from the West Road sewer backing up into the site in an event where the sewer is surcharging a non-return valve will be installed in the last manhole before the connection. Covers will also be installed on the air bricks at lower ground floor level.

4.31 Despite the lack of active flood defence or mitigation measures, the proposals represent a significant improvement in the context of the risk to life from flooding relative to the previous development for the following reasons:

- The removal of an existing “Highly Vulnerable” element; and
- A reduction in “More Vulnerable” units within the area at risk of flooding.
the revisions to the original proposals represent a reduction in the risk of flooding into the basement due to a reduced number of external access points

- the annex extension is located outside of the area at risk of flooding, and consequently will not obstruct or displace flood flows

4.32 As noted in Chapter 3, installing flood defence or mitigation measures would also increase flood risk to neighbouring properties. Therefore, in addition to the applicant decision not to defend the property against flooding in the event of a breach due to the extremely low risk, there is robust justification for not defending the property to ensure that there is no increase in flood elsewhere.
APPENDIX

Environment Agency tidal flood data

Environment Agency HNL/20587/JH
Product 4 (Detailed Flood Risk) for: Gordon House, Chelsea, London (Date 22/08/2016)

Structural survey report

Alan Baxter Ltd Garden Boundary Wall Structural Survey. Technical note 1635/20/OF
Report detailing the parameters, assumptions and survey of the existing boundary wall including Drawing 1635/20/103 and 1635/20/SK260.

Drawing 1 – Alan Baxter Ltd sketches showing two options for reinforcing the boundary wall

Option A and Option B

Drawing 2 – Indigo Surveys Drawing Number 11381_A4/TPP/01
Root Protection Plan
Drawing showing the Tree condition category, tree crown spread, Root Protection Area (RPA) and the tree protection specification.

Drawing 3 – ALD Drawing Number PL404 P07
Tree Planting Layout
Drawing showing the approved tree planting plan.

Drawing 4 – ALD Drawing Number ALD633_SK020
Boundary wall works in relation to existing trees
Sketch drawing showing the boundary wall works in relation to the existing trees and in response to the Alan Baxter Ltd structural options for reinforcing the wall.

Drawing 5 – ALD Drawing Number ALD633_ES641a PO2
Section through Loggia, Terrace and Tree Screening Strategy
Drawing showing sections through the site including an illustration of the bunding required to achieve the required level for effective flood defence. Two options are shown, bunding behind the existing boundary wall as well as a hybrid solution of bunding supplemented with temporary barriers.

Drawing 6 – ALD Drawing Number ALD633_SK035 Rev 01
Options for a hybrid flood defence solution

Sketch drawing showing the options for a hybrid flood defence solution of partial raised bund through the rear garden supplemented with demountable flood barriers.
Product 4 (Detailed Flood Risk) for: Gordon House, Chelsea, London
Reference: HNL/20587/JH
Date: 22/08/2016

Contents

- Flood Map for Planning (Rivers and Sea)
- Flood Map Extract
- Thames Estuary 2100 (TE2100)
- Thames Tidal Breach Modelling
- Thames Tidal Breach Modelling Map
- Thames Tidal Upstream Inundation Modelling
- Thames Tidal Upstream Inundation Modelling Map
- Site Node Locations Map
- Defence Details
- Recorded Flood Events Data
- Recorded Flood Events Outlines Map
- Additional Information
- Environment Agency Standard Notice

The information provided is based on the best data available as of the date of this letter. You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/improvements to the data for this location have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

This information is provided subject to the enclosed notice which you should read.
Flood Map for Planning (Rivers and Sea)

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. In addition, the map also shows the location of some flood defences and the areas that benefit from them.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time and also take into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at [https://www.gov.uk/government/organisations/environment-agency](https://www.gov.uk/government/organisations/environment-agency).

At this Site:

The Flood Map shows that this site lies within Flood Zone 3 - with a 0.5% chance of flooding from the sea (tidal flooding) in any given year

Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed modelling of the tidal River Thames through the Thames Tidal Defences Study completed in 2006 by Halcrow Ltd.
Thames Estuary 2100 (TE2100)

You have requested in-channel flood levels for the tidal river Thames. These have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled node closest to your site is 2.28; the locations of nearby nodes are also shown on the enclosed map.

Details about the TE2100 plan

The TE2100 plan is now live and within it are a set of levels on which the flood risk management strategy is based. The plan is the overarching flood management strategy for the Thames Estuary and therefore any development planning should be based on the same underlying data.

Details about the TE2100 in-channel levels

The TE2100 in-channel levels take into account operation of the Thames Barrier when considering future levels. The Thames Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels – for which the Barrier would normally shut for the 2008 epoch – will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upriver of the barrier will increase and the tidal walls will need to be heightened to match.

Why is there no return period for levels upriver of the barrier?

The levels upriver of the barrier are the highest levels permitted by the operation of the Thames Barrier. If levels and flows are forecast to be any higher, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a low level. For this reason the probability of any given water level upriver of the Barrier is controlled and therefore any associated return period becomes irrelevant. The Thames Barrier and associated defence system has a 1 in 1000 year standard which means it ensures that flood risk is managed up to an event that has a 0.1% annual probability. The probability of water levels upriver is ultimately controlled by the staff at the Thames Barrier.
TE2100 2008 levels:

Levels downriver of the Thames Barrier are 0.1% AEP (1 in 1000) and levels upriver are the highest levels permitted by the Thames Barrier, described as the Maximum Likely Water Levels (MLWLs). The defence levels (left defence, right defence) are the minimum levels to which the defences should be built.

<table>
<thead>
<tr>
<th>Location</th>
<th>Node</th>
<th>Easting</th>
<th>Northing</th>
<th>Extreme water level (m)</th>
<th>Left defence (m)</th>
<th>Right defence (m)</th>
<th>Allow for future defence raising to a level of...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Left Bank (m)</td>
</tr>
<tr>
<td>Battersea</td>
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<td>526950</td>
<td>177323</td>
<td>4.88</td>
<td>5.41</td>
<td>5.41</td>
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<tr>
<td></td>
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<td>527631</td>
<td>177547</td>
<td>4.87</td>
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<td>6.35</td>
</tr>
<tr>
<td></td>
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<td>528578</td>
<td>177781</td>
<td>4.87</td>
<td>5.41</td>
<td>5.41</td>
<td>6.35</td>
</tr>
</tbody>
</table>

TE2100 climate change levels:

<table>
<thead>
<tr>
<th>Location</th>
<th>Node</th>
<th>Easting</th>
<th>Northing</th>
<th>Design water level</th>
<th>Defence level (both banks)</th>
<th>Design water level</th>
<th>Defence level (both banks)</th>
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</thead>
<tbody>
<tr>
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<td>526950</td>
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<td>5.83</td>
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<td>177781</td>
<td>5.36</td>
<td>5.85</td>
<td>5.82</td>
<td>6.35</td>
</tr>
</tbody>
</table>
Thames Tidal Breach Modelling

The table below displays site-specific modelled flood levels at your site. These have been taken from the Thames Tidal Breach Modelling Study 2015 completed by CH2M HILL in March 2015. The exact location of the given site-specific levels and the extent of the breach are shown on the enclosed map.

This modelling simulates tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent. A series of 113 tidal models were developed for the Environment Agency at pre-determined breach locations. These were chosen using a risk-based approach by examining critical locations based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

Based on the 2008 TE2100 in-channel levels, the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) annual probability of exceedance tidal events were modelled for all breach locations downriver of the Thames Barrier. These were modelled for the 2014 year epoch, as well as a 2065 and 2100 epoch which include allowances for climate change.

For breaches upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. The levels used are referred to as Maximum Likely Water Levels (MLWLs). Therefore 2014, 2065 and 2100 epochs were modelled on that basis.

Please note that we have produced only a finite number of breach models for the Tidal Thames, based on a number of key locations. Although these modelled levels are site-specific levels at your site, they may not have captured the most critical breach location for this site. Therefore you may need to consider carrying out additional modelling to simulate the breaching of defences in an alternative location.

The modelled levels shown assume that the Thames defences have been breached at location West01 TQ2789577755
<table>
<thead>
<tr>
<th>Node</th>
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<tr>
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<td>No Flood</td>
</tr>
<tr>
<td>6</td>
<td>527938</td>
<td>177893</td>
<td>No Flood</td>
<td>No Flood</td>
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<tr>
<td>7</td>
<td>527942</td>
<td>177887</td>
<td>No Flood</td>
<td>No Flood</td>
</tr>
</tbody>
</table>
Thames Tidal Upstream Inundation Modelling

The enclosed map shows results for the Thames Tidal Upstream Inundation Modelling Study 2015 completed by CH2M HILL in March 2015.

Upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2014, 2065 and 2100 epochs were modelled on that basis.

Using the domains updated as part of the Thames Tidal Breach Modelling Study 2015 completed by CH2M HILL in March 2015, the project generated outputs for water depths, velocity, levels and hazard. However the scenario modelled is that the Thames Barrier is operational but all linear defences have been removed. It uses the TE2100 in-channel levels calculated in 2008 and only provides data for embayments upriver of the Thames Barrier.

<table>
<thead>
<tr>
<th>Point</th>
<th>National Grid Reference</th>
<th>Modelled levels in mAODN</th>
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</thead>
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<td>527938 177893</td>
<td>5.52 5.82</td>
</tr>
<tr>
<td>7</td>
<td>527942 177887</td>
<td>5.52 5.82</td>
</tr>
</tbody>
</table>
Defence Details

The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP; they are designed to defend London up to a 1 in 1000 year tidal flood event. The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure that they are maintained to a crest level of 5.41m AODN (the Statutory Flood Defence Level in this reach of the Thames). We inspect them twice a year to ensure that they remain fit for purpose. The current condition grade for defences in the area is 2 (good), on a scale of 1 (very good) to 5 (very poor). For more information on your rights and responsibilities as a riparian owner, please see our document ‘Living on the edge’ found on our website at: https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities

There are no planned improvements in this area. Please see the ‘Thames Estuary 2100’ document on our website for the short, medium and long term Flood Risk Management strategy for London:


Areas Benefiting from Flood Defences

This site is within an area benefiting from flood defences, as shown on the enclosed extract of our Flood Map. Areas benefiting from flood defences are defined as those areas which benefit from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in 100) chance in any given year, or flooding from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there.
Recorded Flood Events Data

We hold records of historic flood events from rivers and the sea. Information on the floods that may have affected the area local to your site are provided in the enclosed map.

Due to the fact that our records are not comprehensive, we would advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:

- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding and drainage systems that have been overwhelmed.

Other Sources of Flood Risk

The Lead Local Flood Authority for your area are responsible for local flood risk (i.e. surface runoff, ground water and ordinary watercourse) and may hold further information.

You may also wish to consider contacting the appropriate relevant Local Planning Authority and/or water/sewerage undertaker for the area. They may be able to provide some knowledge on the risk of flooding from other sources.
Additional Information

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In England, you should refer to the Environment Agency’s Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

https://www.gov.uk/flood-risk-standing-advice-frsa-for-local-planning-authorities

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.
Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
– from the sea with a 0.5% or greater chance of occurring each year
– or from a river with a 1% or greater chance of occurring each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 0.1% chance of occurring each year.
Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
– from the sea with a 0.5% or greater chance of occurring each year
– or from a river with a 1% or greater chance of occurring each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 0.1% chance of occurring each year.
Thames Tidal Breach Modelling 2015

A modelled representation of tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epochs 2065 and 2100.

Legend
- Site Location
- Breach Locations

Upriver MLWL Outlines
- 2014
- 2065
- 2100
Upstream Inundation Modelling 2015

The modelled scenario is that the Thames Barrier is operational but all linear defences have been removed. The modelling is based on the 2008 TE2100 in-channel levels including an allowance for climate change.

Upstream of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2014, 2065 and 2100 epochs were modelled using Maximum Likely Water Levels (MLWLs).
Modelled Flood Levels for Gordon House, Chelsea, London -22/08/2016 - HNL/20587/JH

Legend
- Site Location
- Points

Thames Tidal Breach Modelling 2015
A modelled representation of tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epochs 2065 and 2100.

Upstream Inundation Modelling 2015
The modelled scenario is that the Thames Barrier is operational but all linear defences have been removed. The modelling is based on the 2008 TE2100 in-channel levels including an allowance for climate change.

Upstream of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2014, 2065 and 2100 epochs were modelled using Maximum Likely Water Levels (MLWLs).
This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

Date Printed: 22/08/2016
Scenario year: 2065
Scenario Annual Chance: 0.5% (1 in 200)
This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

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Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary.
**Gordon House**

**Garden Boundary Wall Structural Survey**

1.0 Introduction

This note has been prepared Alan Baxter Ltd for the Client, Candy & Candy, to support Water Environment’s response to the planning queries submitted by the Royal Borough of Kensington and Chelsea regarding flood risk on the above site. In particular this includes a structural survey of the existing boundary wall.

2.0 Existing Arrangement

The boundary wall extends along the south-eastern boundary of the site and extends up the east and west sides. The wall is typically a freestanding garden wall that acts as a retaining wall between adjacent gardens and as a more substantial retaining wall on the east boundary. For the purposes of this note we have primarily focused on the longer south eastern section of the wall as this is the lowest portion of the site and as such the more onerously affected by the flood water levels.

The south eastern boundary wall has been much altered and repaired through its history resulting in different brick types, mortars and footing arrangement along the length of the wall (see attached photos and summary drawing 1635/20/103). Some areas of the wall appear to have weep holes which all appear to be below ground on the rear side of the wall.

The wall is typically 1 brick thick (215mm) and the top of the wall is at approximately +5.5m AOD. The foundations are generally brick corbelled footings on top of mass concrete strip foundations sat either on the top of the London Clay or in a shallow band of sand directly above the clay. The depth of the footings varies between 0.6m and 1.6m below ground level on the Gordon House side.

3.0 Parameters/Assumptions for assessment of wall

The following are the assumptions made regarding the flood waters that have been used in the assessment of the structural stability of the existing boundary wall – these parameters have been agreed with Water Environment as suitable for this assessment and are summarised on the attached drawing 1635/20/SK260:

1) **Flooding Event and Level** – we have assumed a breach flooding event as noted in the WE report with a maximum level at the site of 4.3m which the rear of the wall will experience.

2) **Duration of flooding event** – the duration of the event has not been considered, the assessment is based on the static condition of the maximum height of water acting on the wall.

3) **Velocity of flood waters** – the assessment is based on a static water head, ie no additional force from water velocity has been considered.

4) **Wall Profile** – the more onerous of the wall profiles recorded was assessed, ie the one with the apparent least capacity for resistance of lateral loads. This was taken as section B-B on drawing 1635/20/103 as the wall here is already retaining 250mm of soil and the garden is at its lowest point (note A-A is similar but the garden is higher).
5) **Weep holes** – it is assumed that due to the rate at which the flood levels will be reached on site in a breach event that the presence of the weepholes in the wall will have a negligible effect on the level of water behind the wall.

4.0 **Structural Survey**

A check was carried out to see if the wall could prevent flood water entering the site based on the assumptions noted above:

- **Results** - It was found that the additional hydrostatic load on the wall from the flood water levels would cause the wall to overturn at the point it meets the ground. The overturning forces outweigh the restoring forces by a factor of approximately 3.5. In reality there is very little ability for the wall to resist lateral pressures other than the soil and wind loads that it currently experiences.

- **Conclusion** – The wall as existing will not be able to resist the predicted flood water levels (4.3m AOD) in their current state and would need to be replaced or significantly strengthened if they are required to. The retained height of water associated with the predicted flood level is considerable. Strengthening the wall to resist this load would require significant and regular additional restraint to be provided. The options for how this can be achieved are also constrained by the presence of the shallow root system of the numerous nearby trees and the desire to preserve the heritage and character of the boundary wall. All options for strengthening that involve new structures in front of the wall to retain it require significant excavations within the zone of the tree roots and we understand these have been discounted on basis of potential damage to the roots.

An alternative approach was considered to raise the ground levels adjacent to the wall however this imposes large lateral frames on the wall in the opposite direction which the wall cannot resist. We understand this option also has further problems associated with tree roots, security and privacy.
215mm thick clay back wall set in weak lime mortar.

Site initially assumed to be dry, local small weep holes with limited capacity, ignored in appraisal.

Made ground:
- Rubble mixed with clayey stilty sand layer
- Shelly sandy gravel
- London clay

Assumptions for assessment of boundary wall:
- Flood waters assumed to be static: no dynamic loading
- Scale (original A4): 1:20

Date: AUG '16
Job: PROJECT BOND
Assumptions for assessment of boundary wall

Rev.

Alan Baxter
75 Chawton Street
London, EC1M 6EL
Tel: 020 7036 1565
Email: info@alanbaxter.co.uk
Website: www.alanbaxter.co.uk

Alan Baxter Ltd is a limited company registered in England and Wales, number 06005096. Registered office as above.
How should tree roots be dealt with in the tree protection zone? (ALD).

Can the earth be built up adjacent to wall to reduce length of toe? (ALD)

Large local pad footings.

Option A: Reinforced concrete piers.

JR: 12th Dec 2014
Scale: 1:40

LARGE LOCAL PAD FOOTINGS.

SECTION A-A.
(Scale 1:40)

LOCAL REINFORCED CONCRETE PIER @ 4 M C/C.

4.0 M C/C.

3.0 M.

2.0 M.

300 mm

LONDON CLAY.

550 mm 300 mm

SERVICE TRENCH.

SAND & GRAVEL.

TREES.

SERVICE TRENCH.

LIGHTWEIGHT FILL MATERIAL.

EXISTING BOUNDARY WALL.

IS A KEY INTO THE LONDON CLAY REQUIRED TO PREVENT WATER ENTERING SITE BY FLOWING UNDER THE RETAINING WALL? (WATER ENVIRONMENT)

550 mm 300 mm

SERVICE TRENCH.

SAND & GRAVEL.

LONDON CLAY.