



Taylor Wimpey Manchester

# Flood Risk and Drainage Assessment

Calderstones Phase 3

Reference: 880162-R02(04)

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## FLOOD RISK AND DRAINAGE ASSESSMENT

### CALDERSTONES PHASE 3

**REPORT NO:**  
**880162-R02(04)**

**Client:**  
**Taylor Wimpey Manchester**

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## 1. INTRODUCTION

RSK LDE Limited has been commissioned by Taylor Wimpey to undertake a Flood Risk Assessment (FRA) and review the constraints on a site located off Pendle Drive in Whalley.

This report has been produced in support of a planning application for a residential development and summarises the items and calculations that have been included in the RSK assessment. This has been produced in accordance with PPS 25 (**Ref. 1**) and the Interim Code of Practice for Sustainable Drainage (**Ref. 2**) with site-specific advice from the Environment Agency (Environment Agency), the LPA and the client.

The Environment Agency have confirmed the extent of the flood zones adjacent to the site, the latest flood map shows the site is located within Flood Zone 1, however due to the area of the site exceeding 1Ha, a flood risk assessment is required under the guidance of PPS 25.

The comments given in this report and the opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

## 2. CONTEXT AND SCOPE OF WORKS

A key element of project development is to prepare a Flood Risk Assessment to establish the risk associated with the proposed development and to propose suitable mitigation, if required to reduce the risk to a more acceptable level.

The scope of work relating to a flood risk assessment is based on the guidance provided in PPS 25 (**Ref. 1**) and the accompanying guidance published by the Communities and Local Government Office (**Ref. 3**) and comprise of the following elements:

- To obtain information on the hydrology and hydrological regime in and around the site.
- To obtain the views of the Environment Agency including scope, location and impacts.
- To determine the extent of new flooding provision and the influence on the site.
- To review site surface water drainage based on the proposed layout. To determine the extent of infrastructure required.
- To review architect plans and planning information and other studies to determine the existing site conditions.
- To assess the impact on the site from global warming effects and anticipated increases in rainfall over a 100 year period for residential use or 60 years for commercial uses.
- Preparation of a report including calculations and summaries of the source information and elements reviewed.

### 3. SITE DESCRIPTION

#### 3.1 SITE LOCATION

The site is located to the east of Whalley and lies approximately 500m to the south of Barrow Brook, 850m to the north of the River Calder and 1.2km to the east of the River Ribble, (see location maps in **Figure 1 and 2**) at grid reference 372517E 437516N.

The site is bounded by:

- North – Directly bounded by a dismantled railway followed by Whalley Moor
- East – Directly bounded by houses and Mitton Road
- South – Directly bounded by Pendle Road
- West – Directly bounded by houses, open land and woodland

The total site area is 2.51Ha currently consisting of an open field with areas of hard standing associated with a number of demolished buildings.

Access to the site is via an existing track extending from Pendle Drive. The proposals supplied by Taylor Wimpey show that a new access road will be constructed to Pendle Drive, **Figure 3**.

#### 3.2 SITE TOPOGRAPHY

The topography of the site is such that most of the site is at an elevation of between approximately 55.87m AOD and 59.24m AOD falling in a northwesterly direction towards the River Ribble and drainage ditch located to the north of the site.

The site falls from the access point to the northern boundary. **Appendix B** shows the topographic survey for the site and surrounding area.

#### 3.3 SITE GEOLOGY AND SPZ

Published geological records indicate the site to be underlain directly by drift deposits consisting of Devensian Till (Boulder Clay). This is underlain in turn by solid geology consisting of the Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated).

A preliminary Phase 2 Geoenvironmental assessment has been carried out on the site, carried out by Clarkebond Geoenvironmental Consulting Engineers (Report Ref. 25608E/R1). This report found that the Ground conditions generally comprise a cover of clayey topsoil (Made Ground) overlying a layer of soft to firm to firm to stiff reworked clay (Made Ground).

Guidance from the Environment Agency indicates that the bedrock underlying the site is deemed to be a minor aquifer overlain by soils of a low leaching potential. There are no records of groundwater and/or surface water abstraction licenses within 1000m of the site. Source Protection information provided by the Environment Agency website indicates the site does not overlie a Groundwater Source Protection Zone.

### 3.4 SITE HYDROLOGY

The nearest main watercourse to the site is the River Calder located to the south of the site which flows into the River Ribble, which is located to the west of the site. Both of these are classed as Main River by the Environment Agency. A smaller watercourse is located to the north of the site, there is also an issue located 135m to the north east of the site, a pond and an unnamed stream are located approximately 320m to the north west of the site, and flows into the River Ribble. A pond is present approximately 300m to the northwest of the site.

No Groundwater Source Protection Zones have been identified within the vicinity of the site.

## 4. SOURCE OF FLOOD RISK

The flood risk elements that need to be considered for any site are defined in PPS25 as the "Forms of Flooding" and are listed as:

- Flooding from Rivers (fluvial flood risk)
- Flooding from the Sea (tidal flood risk)
- Flooding from the Land (overland pluvial flood risk)
- Flooding from Groundwater
- Flooding from Sewers (sewer and drain exceedance, pumping station failure etc)
- Flooding from Reservoirs, Canals and other Artificial Structures

The following section reviews each of these in respect of the subject site.

### 4.1 ENVIRONMENT AGENCY FLOOD ZONE

The Environment Agency (Environment Agency) has produced flood zone maps for much of England and Wales. The site is located within Flood Zone 1, so at little or no risk from fluvial flooding. The current displayed map is reproduced as **Figure 4**. The latest flood zone map shows the flood risk to the site is **low**.

### 4.2 FLOODING FROM RIVERS (FLUVIAL FLOOD RISK)

The main source of fluvial flooding which would potentially affect the site is the River Calder, which runs in a westerly direction towards the River Ribble and is located to the south of the site.

The River Calder, the River Ribble and the small unnamed watercourse located to the north of the site, are all shown to have flood plains associated with them, however these do not extend onto the proposed development site or come within 500m of the site.

Information shown on the Environment Agency's Floodmap shows that the area of the site where development is proposed is not located within an area considered likely to be affected by fluvial flooding from the watercourse stated above, or any other, watercourse.

### 4.3 FLOODING FROM THE SEA (TIDAL FLOOD RISK)

On the coast storm surges and high tides can threaten low lying coastal areas, and can be sometimes large and rapid enough to overtop defence works, causing significantly more damage than river flooding. However tidal flooding is not considered a risk to the site.

### 4.4 FLOODING FROM THE LAND (OVERLAND PLUVIAL FLOOD RISK)

If intense rain is unable to soak into the ground or be carried through man made drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse.

Surface water flows from the site are believed to drain naturally to the local water features, either by overland flow or through infiltration. Flooding from this source is considered low and will be considered within the layout of the site, ensuring properties are not at increased risk.

#### 4.5 FLOODING FROM GROUNDWATER

In some areas underground permeable rocks can become saturated by rainfall, releasing water onto the surface as floods into intermittent channels, or gradually flooding areas as the local water table rises. This can sometimes be a seasonal phenomenon, water tables rising in the wetter winters before dropping again in the summer. It is related to specific geological conditions and rock types. It also is slower to develop and slower to recede than other types of flooding. This is not considered by the Environment Agency to be a significant flood risk factor in the area.

According to the Ribble Valley SFRA (**Ref. 4**); following consultation with the Environment Agency, no evidence of groundwater flooding in the area has been identified. Using the best available information they are not considered to be a significant risk at this time.

#### 4.6 FLOODING FROM SEWERS

Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption (Ref. 4). One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30 year rainfall event. By definition a 1 in 100 year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage. When exceeded, the surcharged pipework will lead to flooding from backed up manholes and gully connections. This will lead to immediate flooding within highways surrounding the site. A copy of the UU sewer records is included as **Appendix C**.

There are no reported incidences of sewer flooding in this area and any new sewerage infrastructure will be designed to Sewers For Adoption standards. Situated in Pendle Drive is an existing sewer, this includes two potential connections to the development site, a 375mm Dia storm sewer laid at 1 in 200 capable of conveying 140.9l/s and a 225mm Dia storm sewer laid at 1 in 150 capable of conveying 41.7l/s. Therefore it would be reasonable to assume that the main sewer within Pendle Drive is capable of receiving a flow of approximately 182.6l/s from the proposed development site.

#### 4.7 FLOODING FROM RESERVOIRS, CANALS AND OTHER ARTIFICIAL STRUCTURES

The Environment Agency has recently published flood risk mapping as a result of potential failure of reservoirs. This map shows that the site is not in an area at risk of flooding from this source. There are no other known structures in the vicinity of the site, which could pose a flood risk to the site.

The site is not thought to be at risk from this source, therefore the flood risk to the site from reservoirs, canals and other artificial structures is low.

## 5. SURFACE WATER DRAINAGE ASSESSMENT

### 5.1 SCOPE

A drainage design strategy should be carried out at the outset to identify the options for the design of the surface water drainage system and how it will affect the site layout.

At this stage the applicant should produce the following information:

- Demonstrate how the principles of Sustainable Drainage Systems have been applied to the development identifying what techniques will be used.
- Set aside land specifically for SUDS.
- Estimate the discharge rate for the site. Greenfield discharge rates should be sought on greenfield sites, and also on brownfield sites (where possible).
- Estimate the volume of 1 in 100 year attenuation to be provided and what techniques will be used to provide the attenuation.
- Take into account PPS 25's climate change requirements.

### 5.2 PRE-DEVELOPMENT SITUATION

Surface water flows from the site are believed to drain naturally to the local water features, either by overland flow or through infiltration.

In terms of estimating the potential runoff from the site, the ICP SuDs method (**Ref. 2**) has been used to estimate the existing runoff from the existing site. Additional information is contained in **Appendix D**.

| Return Period           | Peak flow  |
|-------------------------|------------|
| QBAR <sub>URBAN</sub>   | 18.7 l/sec |
| 1 in 1 year peak flow   | 16.3 l/sec |
| 1 in 30 year peak flow  | 31.3 l/sec |
| 1 in 100 year peak flow | 38.0 l/sec |

TABLE 1: ICP SuDs Surface Water runoff calculations

The existing site is undeveloped. It should be noted that PPS25 (paragraph 5) makes it clear that off-site impacts should not increase flood risk elsewhere. The Practice Guide (**Ref. 3**) States:

*For the range of annual flow rate probabilities up to and including the one per cent annual exceedence probability (1 in 100 years) event, including an appropriate allowance for climate change, the developed rate of run-off into a watercourse, or other receiving water body, should be no greater than the existing rate of run-off for the same event. Run-off from previously developed sites should be compared with existing rates, not greenfield rates for the site before it was developed. Developers are, however, strongly encouraged to reduce run-off rates from previously developed sites as much as is reasonably practicable.*

*Volumes of run-off should also be reduced wherever possible using infiltration and attenuation techniques. Interim guidance on calculation of site run-off rates can be found at*

[http://www.ciria.org/suds/pdf/preliminary rainfall runoff mgt for development.pdf](http://www.ciria.org/suds/pdf/preliminary_rainfall_runoff_mgt_for_development.pdf)

Therefore, it is essential that the volume of runoff generated as a result of redevelopment should either remain the same as the existing discharge rate or be reduced. Preferably the discharge rate should be restricted to near the greenfield runoff rate if possible, by combining the use of SuDS onsite where feasible.

Any drainage system for the site should, therefore be designed such that peak flows are to be restricted to a maximum of 38.0 l/sec for the 1 in 100-year rainfall event (including an allowance for climate change) and 31.3l/s for the 1 in 30-year event to replicate or improve the current discharge. It should be noted that in restricting flows to a given value and providing appropriate attenuation provides additional benefit for storm events in excess of the peak discharge criteria. (i.e. if discharge is limited to the 1 in 100 year existing then runoff for a 1 in 250 year event will be better controlled.)

### **5.3 OFF SITE DISCHARGE**

On all development sites an order of preference exists for drainage receptors. Infiltration drainage should be used where possible. Where this is not possible, or does not provide sufficient capacity, attenuated discharge to watercourses should be sought. Only where neither of these two options is available should discharge to sewers be considered and this is unlikely to be the case for this site.

### **INFILTRATION**

The recently published Flood and Water Management Act has implications for the design, approval, construction and maintenance of SuDS, and affect all new developments. On all development sites discharge of surface water to the ground, or infiltration, is the preferred drainage solution; however the effectiveness of infiltration is completely dependent on the physical conditions at the site.

The Groundwater Vulnerability Map and the Geoenvironmental Report indicates the geology beneath the site to be classified as a minor aquifer, defined as fractured or potentially fractured rocks, which do not have a high primary permeability.

Soakaway testing was conducted on site in line with BRE Digest 365 – Soakaway design. The soakaway tests were ended after a period of 24 hours when no infiltration was recorded. It is considered that due to the cohesive nature of the soils underlying the site, soakaway drainage is unlikely to be suitable for the proposed development.

### **DISCHARGE TO WATERCOURSE**

Infiltration techniques are not suitable at this site therefore the option of discharging to watercourse should be considered. The nearest watercourse to the site is the River Ribble some 500m from the site. Therefore direct discharge to a watercourse is not a feasible option.

## DISCHARGE TO SEWER

As the previous paragraphs have discussed discharge to a sewer is the only suitable option for this site. The proposed point of connection is located within Pendle Drive at the access point to the site. This point of connection and any stipulations on the connection and rate of discharge will be agreed with the sewerage undertaker, United Utilities, if the system is to be adopted. The existing 375mm Dia. Sewer located within the proposed access to the site has been laid with a gradient of 1:200 allowing a full bore capacity of 140.9 l/s, therefore there is sufficient capacity to serve the proposed development should flows be restricted to the 1 in 30-year predevelopment rate of 31.3l/s (to meet the requirements of Sewers For Adoption). This sewer ultimately discharges to the River Ribble.

## 5.4 POST-DEVELOPMENT SITUATION

The proposed discharge from the developed site will be limited to a maximum of **31.3l/s** for the 1 in 30-year event (should UU adoption be sought) as to mimic the pre-development run-off rate for the same rainfall event, any additional run-off will be attenuated on site.

To calculate the potential storage requirement that would be needed on this site has been assessed using WINDES and limiting offsite run-off to the predevelopment Greenfield rate of 31.3l/s for the 1 in 30-year event (should UU adoption be sought).

By limiting the offsite discharge to a maximum of 31.3l/s the required volume of attenuation is estimated to be 390.3m<sup>3</sup> for the 6 hour 1 in 100-year rainfall event including a 20% increase in rainfall due to the impacts of climate change (**Appendix E**). This attenuation will be provided on site and detailed at a later stage of design and it is likely that the drainage system will be designed to attenuate the 30-year rainfall event with no on site flooding, with managed surcharging and overland flow routes (ensuring properties do not flood) for events exceeding this. The storage volume estimate however, does not take into account sustainable drainage features that may be utilised on site such as ponds, swales, bioretention areas and permeable paving. It is therefore likely that SuDS features may offer attenuation throughout the development reducing the need for a single storage structure.

It should be noted that by limiting the off-site discharge to 31.3l/s any rainfall events exceeding the 30-year event, the discharge off the site will be less than the pre-development rates, thus reducing downstream flood risk.

## 6. SEQUENTIAL TEST

The site currently consists of an open field with areas of hard standing associated with a number of demolished buildings, the proposed redevelopment will change its planning designation to residential (highly vulnerable).

From PPS25, a “highly vulnerable ” land use is appropriate within Flood Zone 1. In applying the sequential test, reference is made to the following table (D3), contained within PPS25;

| Flood Risk Vulnerability Classification (Table D2) |                               | Essential Infrastructure | Water Compatible | Highly Vulnerable       | More Vulnerable         | Less Vulnerable         |
|----------------------------------------------------|-------------------------------|--------------------------|------------------|-------------------------|-------------------------|-------------------------|
| Flood Zone (Table D1)                              | Zone 1                        | Appropriate              | Appropriate      | Appropriate             | Appropriate             | Appropriate             |
|                                                    | Zone 2                        | Appropriate              | Appropriate      | Exception Test Required | Appropriate             | Appropriate             |
|                                                    | Zone 3a                       | Exception Test Required  | Appropriate      | Should not be permitted | Exception Test Required | Appropriate             |
|                                                    | Zone 3b functional floodplain | Exception Test Required  | Appropriate      | Should not be permitted | Should not be permitted | Should not be permitted |

**TABLE 2: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

## **7. MITIGATION MEASURES**

### **7.1 CONTEXT**

The site is not a direct risk of tidal or fluvial flooding and hence the mitigation measures relate to the provision of surface water drainage controls.

### **7.2 SURFACE WATER MANAGEMENT**

The volume of surface water runoff from the site will be restricted to maintain existing greenfield runoff rates from across the site. Surface water attenuation and on site flood water management will be provided to accommodate excess runoff generated from events up to and including the 1 in 100 year rainfall event including a 20% increase for climate change.

Surface water in excess of that generated by the 1 in 30 rainfall event will be carefully considered at the detailed design stage and flood routing will be provided to steer flows away from any development.

Overland flow routes will not be impacted by the proposed development and it will allow conveyance of water over the site using roadways and other channels.

## 8. CONCLUSIONS AND RECOMMENDATIONS

This flood risk assessment has been prepared in support of the proposed residential development off Pendle Drive near Whalley.

The site is located within Flood Zone 1 according to the latest Environment Agency flood zone maps, indicating that the site is not at risk from fluvial or tidal sources. Suitable mitigation can be incorporated to ensure that flood risk to the proposed properties remains low and meets the requirements of PPS 25.

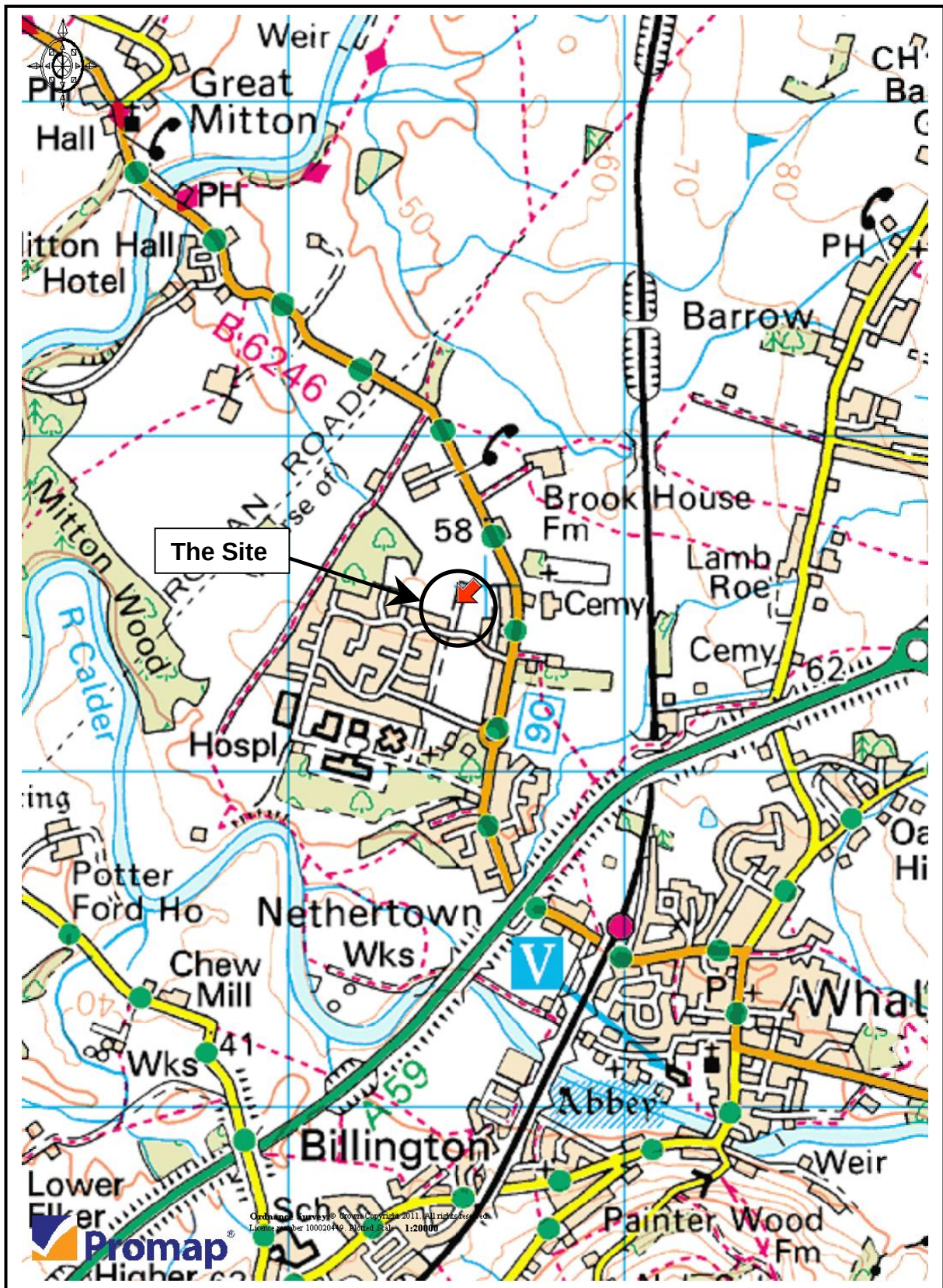
Data obtained from the SFRA also places the site at low risk of flooding from other sources. In accordance with PPS 25 and local policy, this FRA has considered the impact on the surface water regime in the area should development occur. Redevelopment of the site should be possible with careful consideration of the surface water and foul drainage, as well as other possible flooding issues. The proposals should balance the flood storage volumes and should not impede flood flows.

Based on the information available the flood risk to the proposed development is **low** and **development should not be precluded** on flood risk grounds.

## 9. REFERENCES

1. Communities and Local Government "Planning Policy Statement – Development and Flood Risk" PPS 25, Mar 2010.
2. DEFRA "Interim Code of Practice for Sustainable Drainage Systems" National SUDS Working Group, July 2004.
3. Communities and Local Government "Planning Policy Statement 25: Development and Flood Risk Practice Guide", Dec 2009.
4. Ribble Valley Level 1 Strategic Flood Risk Assessment, Adoption Report May 2010
5. Institute of Hydrology (IoH) "Flood Estimation for small catchments" Report 124, 1994
6. BRE, "Soakaway Design" Digest 365, 1991.
7. CIRIA "The SUDS Manual" C697, Mar 2007.

## FIGURES



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## SITE LOCATION PLAN

Client: TAYLOR WIMPEY

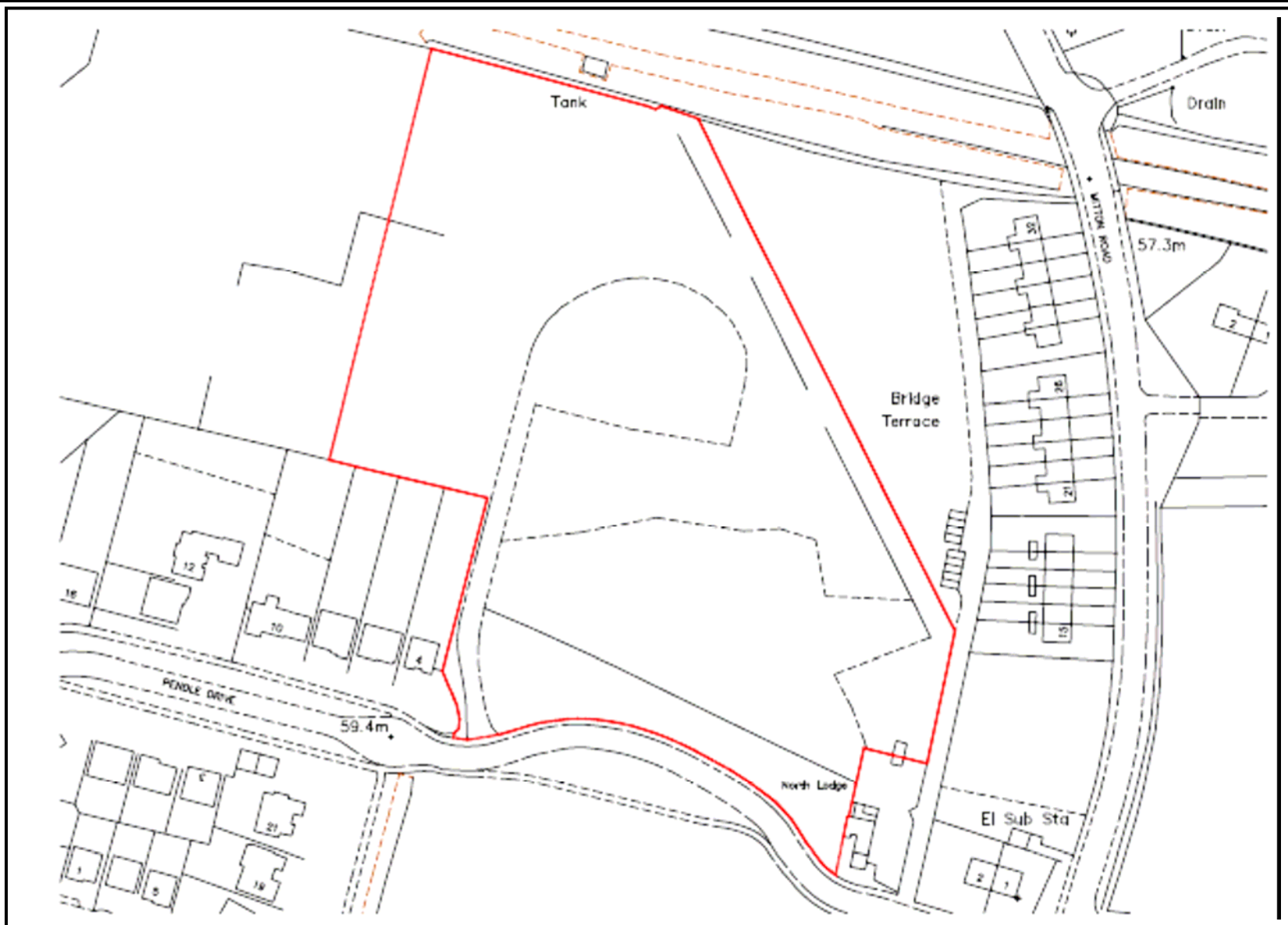
Figure No: 1

Site: CALDERSTONES

Job No: 880162

Scale: NTS

Source: PROMAP



## SITE LOCATION DETAIL

Client: TAYLOR WIMPEY

Figure No: 2

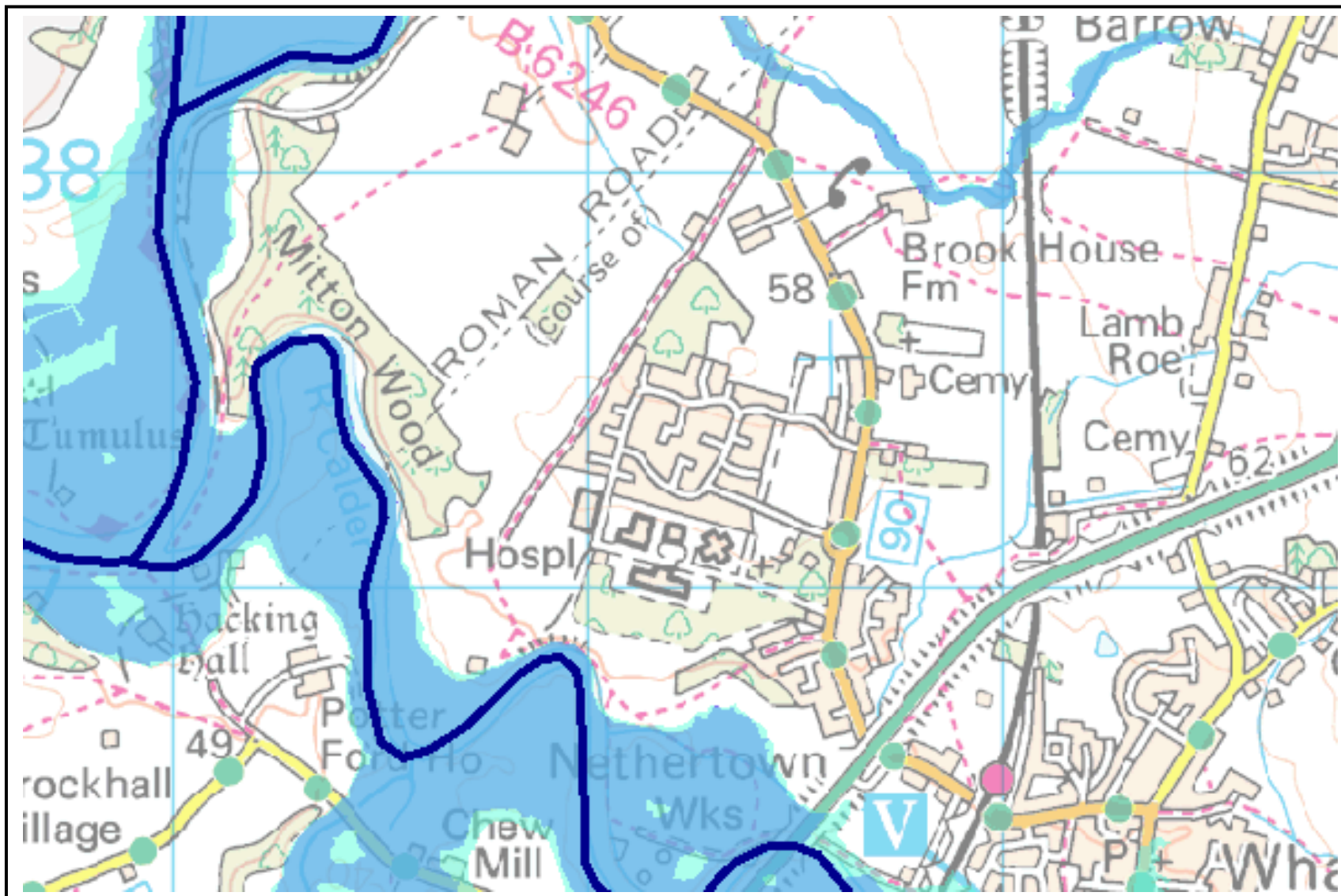
Site: CALDERSTONES

Job No: 880162

Scale: NTS

Source: CLIENT





# ENVIRONMENT AGENCY FLOOD ZONE MAP (WEBSITE)

Client: TAYLOR WIMPEY

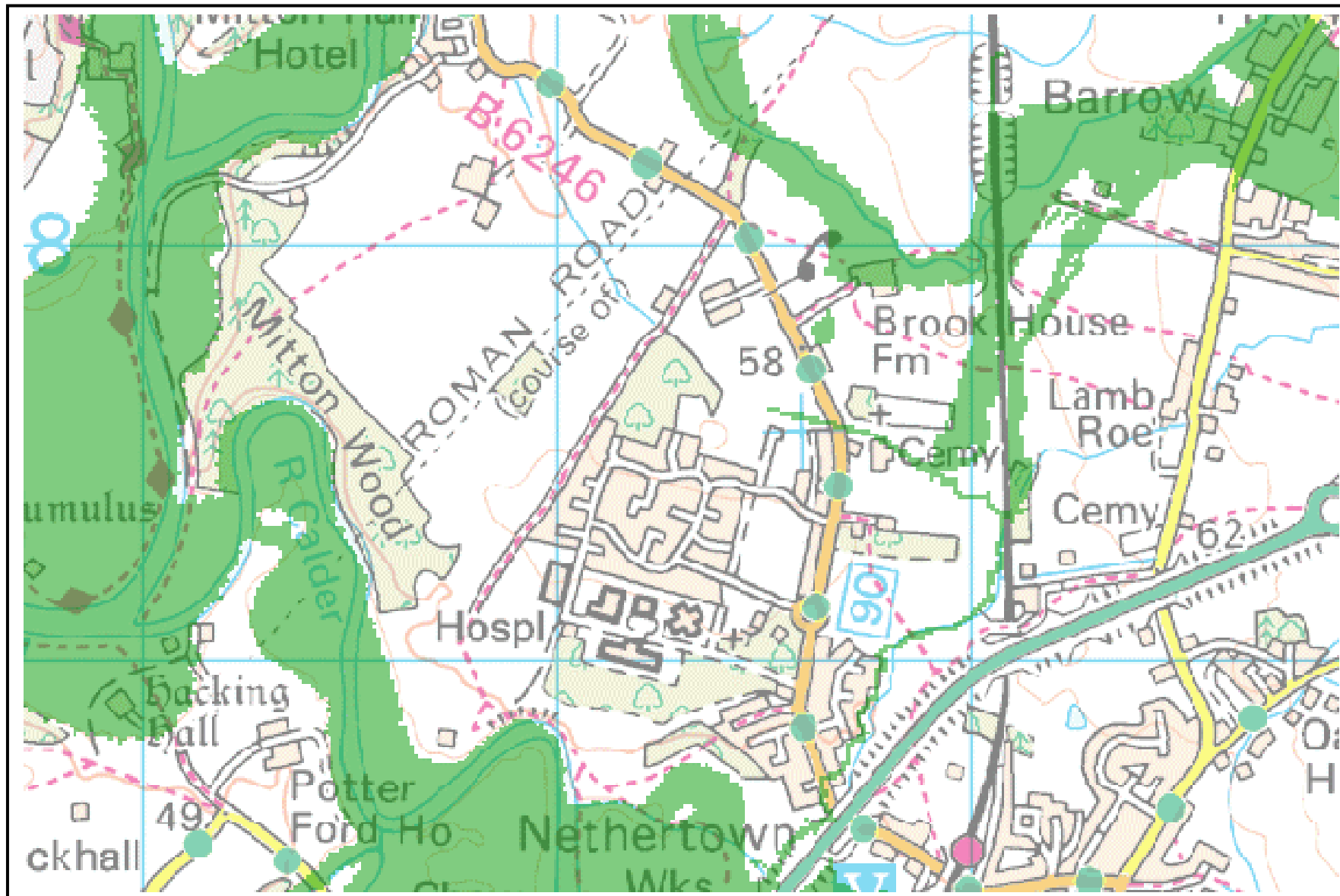
Figure No: 4

Site: CALDERSTONES

Job No: 880162

Scale: NTS

Source: ENVIRONMENT AGENCY



# ENVIRONMENT AGENCY RESERVIOR FLOOD MAP (WEBSITE)

Client: TAYLOR WIMPEY

Figure No: 5

Site: CALDERSTONES

Job No: 880162

Scale: NTS

Source: ENVIRONMENT AGENCY

## APPENDIX A

### Service Constraints

## **RSK GROUP SERVICE CONSTRAINTS**

1. This report and the Drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for Taylor Wimpey (the "client") in accordance with the terms of a contract between RSK and the "client". The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable Civil Engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

## APPENDIX B

### Site Topographic Survey



KEY.

- |         |                          |
|---------|--------------------------|
| BH      | Bollard.                 |
| BPav.   | Borehole                 |
| BS      | Block Paving.            |
| BT      | Bus Stop.                |
| CB      | British Telecom.         |
| Conc.   | Channel Block.           |
| CATV    | Concrete.                |
| EP      | Cable TV.                |
| FH      | Electricity pole.        |
| FP      | Fire Hydrant             |
| FS      | Footpath.                |
| GT      | Footstyle.               |
| GV      | Gate.                    |
| G       | Gas Valve.               |
| IC      | Gully                    |
| LH      | Inspection Chamber.      |
| LP      | Letter Box.              |
| MH      | Lamp Hole                |
| OBM     | Existing Street Light.   |
| OHC     | Manhole.                 |
| PM      | Ordinance Bench Mark.    |
| PO      | Overhead Cable.          |
| PY      | Parking Meter.           |
| RS      | Pole.                    |
| RNP     | Pylon.                   |
| RW      | Road Sign.               |
| RE      | Road Name Plate          |
| Slab.   | Retaining Wall.          |
| SS      | Rodding Eye              |
| SV      | Concrete Paving Slab.    |
| Tar.    | Electricity Sub-Station. |
| TB      | Stop Valve.              |
| TL      | Tarmac.                  |
| TP      | Telephone Box.           |
| WM      | Traffic Lights.          |
| WV      | Telegraph Pole.          |
| No. 1 ▲ | Water Meter.             |
|         | Water valve.             |
|         | Survey Station.          |

LEVEL INFORMATION.

- |         |                       |
|---------|-----------------------|
| CL      | Manhole Cover Level.  |
| IL      | Manhole Invert Level. |
| SL      | Manhole Soffit Level. |
| BL      | Stream Bed Level.     |
| +123.45 | Spot Level.           |
| T.O.K.  | Top of Kerb.          |
| T.O.W.  | Top of Wall.          |
| T.O.B.  | Top of Bank.          |

NOTES.

- Some of these abbreviations may not appear on this drawing.  
Contour interval:- 0.25m.  
All levels in metres according to ordnance datum  
All levels on roads are channel levels unless otherwise stated.  
Trees indicate their maximum spread.

[illegible]

PROJECT CALDERSTONES PHASE 3 WHALLEY

TITLE

TOPOGRAPHICAL SURVEY

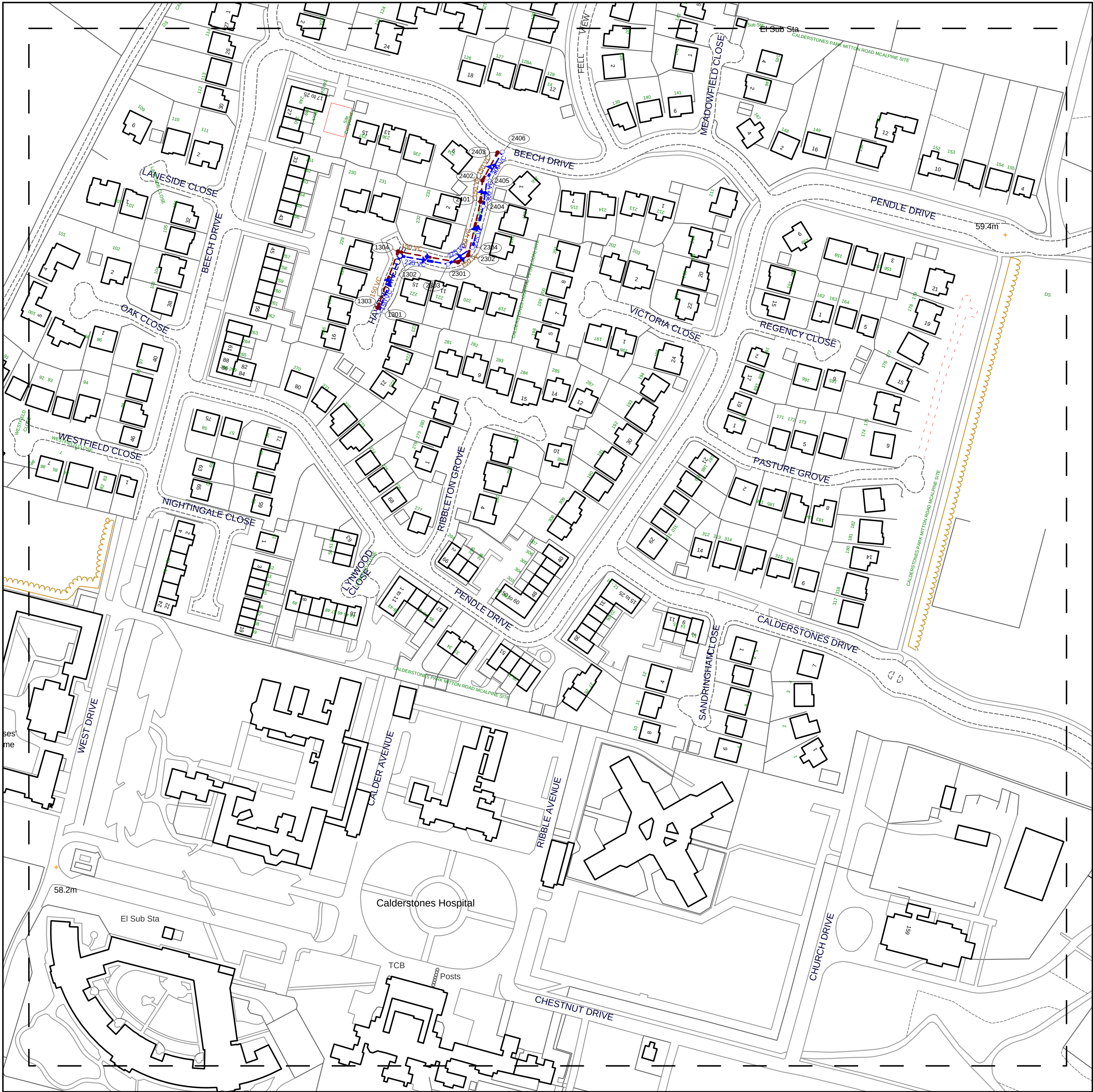
# AUGHTON LAND SURVEYS

2 MILFORD CLOSE  
FORMBY  
MERSEYSIDE  
L37 2FW  
TEL / FAX : 01704 832060  
MOBILE: 0789 9095637  
E-MAIL : ERIC.TASKER@SKY.COM

|                 |       |           |                |     |
|-----------------|-------|-----------|----------------|-----|
| DRN BY<br>ET    | SCALE | LAND CODE | DRAWING NUMBER | REV |
| DATE<br>27/1/11 | 1/500 |           | TWMAN/2/11     |     |

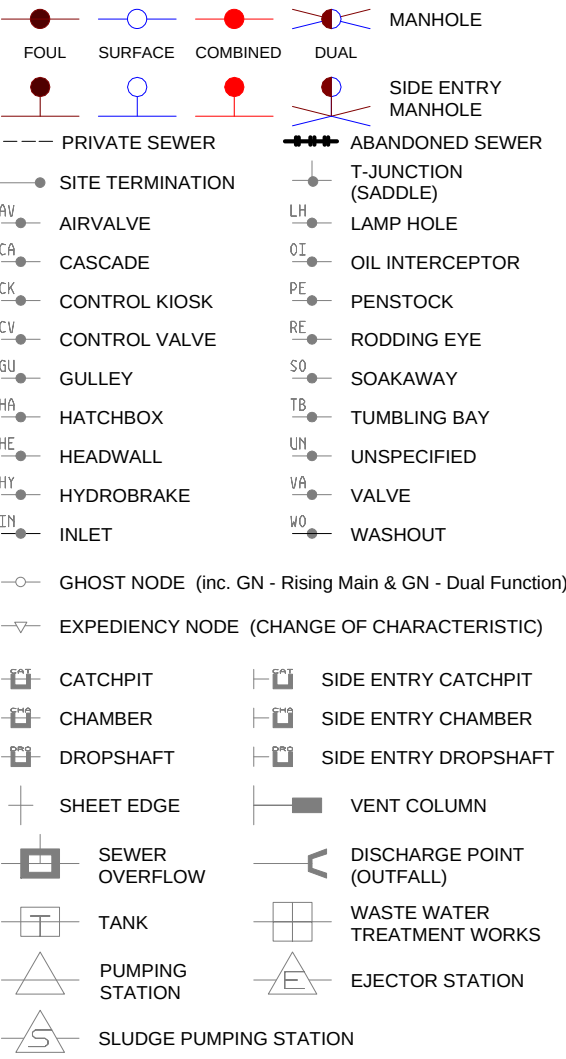
## APPENDIX C

### United Utilities Records



| Refno | Cover | Func | Type | Invert | Size | xSize | y | Shape | Matl | Grad | Length |
|-------|-------|------|------|--------|------|-------|---|-------|------|------|--------|
| 1301  | S     | M    |      | 150    |      |       |   | C     | VC   |      | 28.81  |
| 1302  | S     | M    |      | 225    |      |       |   | C     | VC   |      | 23.58  |
| 1303  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 28.79  |
| 1304  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 29.39  |
| 2301  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 5.98   |
| 2302  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 26.44  |
| 2303  | S     | M    |      | 225    |      |       |   | C     | VC   |      | 14.22  |
| 2304  | S     | M    |      | 225    |      |       |   | C     | VC   |      | 20.45  |
| 2401  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 10.23  |
| 2402  | F     | M    |      | 150    |      |       |   | C     | VC   |      | 15.29  |
| 2403  | F     | M    |      | 300    |      |       |   | C     | VC   |      | 13.76  |
| 2404  | S     | M    |      | 300    |      |       |   | C     | VC   |      | 14.62  |
| 2405  | S     | M    |      | 300    |      |       |   | C     | VC   |      |        |
| 2406  | S     | M    |      |        |      |       |   |       |      |      |        |

WASTE WATER SYMOLOGY



Note - ALL flow direction arrows are BLUE - colour not significant

NODE TABLE ABBREVIATIONS

| MANHOLE FUNCTION    |                             |
|---------------------|-----------------------------|
| F                   | Foul                        |
| S                   | Surface                     |
| C                   | Combined                    |
| T                   | Transition                  |
| O                   | Overflow                    |
| U                   | Unspecified                 |
| MANHOLE / NODE TYPE |                             |
| M                   | Manhole                     |
| J                   | Junction                    |
| L                   | Lamp hole                   |
| H                   | Hatchbox                    |
| R                   | Rodding Eye                 |
| F                   | Outfall                     |
| V                   | Combined Sewer Overflow     |
| P                   | Pumping Station             |
| S                   | Soakaway                    |
| D                   | Dual Function Manhole       |
| W                   | Treatment Works             |
| Z                   | Ghost in Rising Main        |
| C                   | Cascade                     |
| Y                   | Gully                       |
| E                   | Ejector                     |
| O                   | Oil Injector                |
| I                   | Inlet                       |
| B                   | Hydrobrake                  |
| T                   | Vent Column                 |
| X                   | Valve                       |
| U                   | Unspecified                 |
| Q                   | Expediency Node             |
| G                   | Ghost (to allow pipe bends) |

| SEWER SHAPE |             |
|-------------|-------------|
| C           | Circular    |
| E           | Egg         |
| O           | Oval        |
| F           | Flat Top    |
| R           | Rectangular |
| S           | Square      |
| T           | Trapezoidal |
| A           | Arch        |
| B           | Barrel      |
| H           | Horseshoe   |
| U           | Unspecified |

| SEWER MATERIAL |                               |
|----------------|-------------------------------|
| AC             | Asbestos Cement               |
| BR             | Brick                         |
| CI             | Cast Iron                     |
| SI             | Spun (Grey) Iron              |
| CO             | Concrete                      |
| CS             | Concrete Segments (Bolted)    |
| CS             | Concrete Segments (Unbolted)  |
| CC             | Concrete Box Culvert          |
| DI             | Ductile Iron                  |
| GR             | Glass Reinforced Concrete     |
| GR             | Glass Reinforced Plastic      |
| PS             | Plastic / Steel Composite     |
| PV             | Polyvinyl Chloride            |
| PE             | Polythene                     |
| RP             | Reinforced Plastic Matrix     |
| ST             | Steel                         |
| VC             | Vitrified Clay (All Clayware) |
| PP             | Polypropylene                 |
| PF             | Pitch Fibre                   |
| MA             | Masonry - In Regular Courses  |
| MA             | Masonry - Randomly Coursed    |
| U              | Unspecified                   |

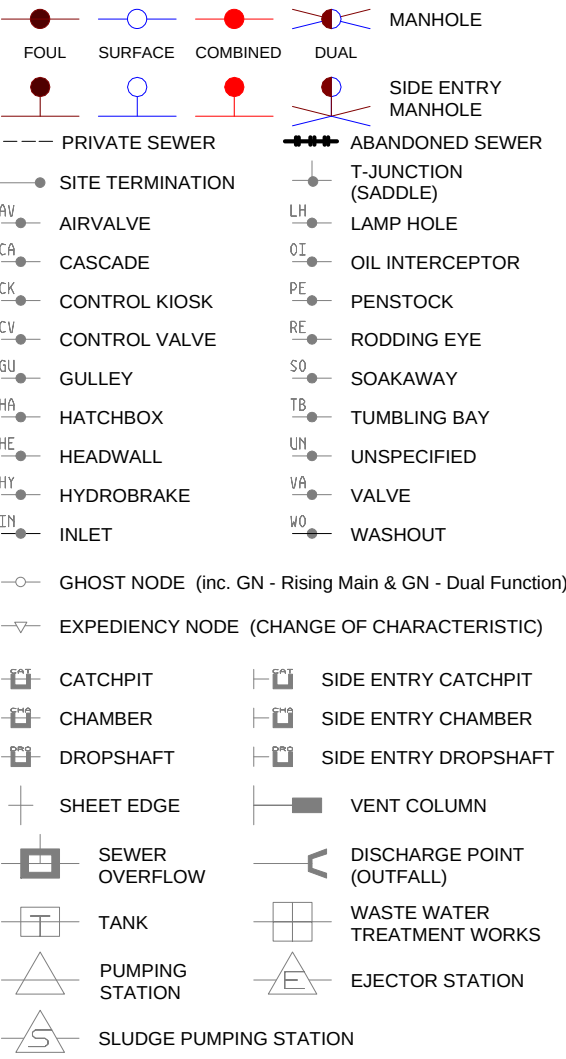
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Scale 1:1250 Date: 18-Jan-2011  
14 Nodes  
Sheet 1 of 1





WASTE WATER SYMBOLOGY



Note - ALL flow direction arrows are BLUE - colour not significant

NODE TABLE ABBREVIATIONS

|                           |                               |
|---------------------------|-------------------------------|
| MANHOLE FUNCTION          |                               |
| F Foul                    | T Transition                  |
| S Surface                 | O Overflow                    |
| C Combined                | U Unspecified                 |
| MANHOLE / NODE TYPE       |                               |
| M Manhole                 | Z Ghost in Rising Main        |
| J Junction                | C Cascade                     |
| L Lamphole                | Y Gully                       |
| H Hatchbox                | E Ejector                     |
| R Rodding Eye             | O Oil Injector                |
| F Outfall                 | I Inlet                       |
| V Combined Sewer Overflow | B Hydrobrake                  |
| P Pumping Station         | T Vent Column                 |
| S Soakaway                | X Valve                       |
| D Dual Function Manhole   | U Unspecified                 |
| W Treatment Works         | Q Expediency Node             |
|                           | G Ghost (to allow pipe bends) |

SEWER SHAPE

|               |               |
|---------------|---------------|
| C Circular    | T Trapezoidal |
| E Egg         | A Arch        |
| O Oval        | B Barrel      |
| F Flat Top    | H Horseshoe   |
| R Rectangular | U Unspecified |
| S Square      |               |

SEWER MATERIAL

|                                  |
|----------------------------------|
| AC Asbestos Cement               |
| BR Brick                         |
| CI Cast Iron                     |
| SI Spun (Grey) Iron              |
| CO Concrete                      |
| CS Concrete Segments (Bolted)    |
| CS Concrete Segments (Unbolted)  |
| CC Concrete Box Culvert          |
| DI Ductile Iron                  |
| GR Glass Reinforced Concrete     |
| GR Glass Reinforced Plastic      |
| PS Plastic / Steel Composite     |
| PV Polyvinyl Chloride            |
| PE Polythene                     |
| RP Reinforced Plastic Matrix     |
| ST Steel                         |
| VC Vitrified Clay (All Clayware) |
| PP Polypropylene                 |
| PF Pitch Fibre                   |
| MA Masonry - In Regular Courses  |
| MA Masonry - Randomly Coursed    |
| U Unspecified                    |

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2 Nodes  
Sheet 1 of 1



Printed by: Liz Bywater

OS Sheet No: SD7237SE  
Scale 1:1250 Date: 18-Jan-2011

## APPENDIX D

### MicroDrainage Predevelopment Site Runoff Calculations

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                            |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------------------------------|-----------------------|-----|------|-------|-----------|-------|-------|-------|-----------|------|---------------|-----------|------------|------|------------|------|------------|------|---------|------|-----------|------|------------|------|
| RSK LDE Ltd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            | Page 1                                                                              |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| 18 Frogmore Road<br>Hemel Hempstead<br>Herts, HP3 9RT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Calderstones<br>Phase 3<br>Existing Runoff |  |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Date 06/06/11<br>File                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Designed By EE<br>Checked By               |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Elstree Computing Ltd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Source Control W.12.5                      |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| <p style="text-align: center;"><u>ICP SUDS Mean Annual Flood</u></p> <p style="text-align: center;">Input</p> <table> <tr> <td>Return Period (years)</td> <td>100</td> <td>Soil</td> <td>0.450</td> </tr> <tr> <td>Area (ha)</td> <td>2.514</td> <td>Urban</td> <td>0.052</td> </tr> <tr> <td>SAAR (mm)</td> <td>1029</td> <td>Region Number</td> <td>Region 10</td> </tr> </table> <p style="text-align: center;"><b>Results    1/s</b></p> <table> <tr> <td>QBAR Rural</td> <td>17.3</td> </tr> <tr> <td>QBAR Urban</td> <td>18.7</td> </tr> <tr> <td>Q100 years</td> <td>38.0</td> </tr> <tr> <td>Q1 year</td> <td>16.3</td> </tr> <tr> <td>Q30 years</td> <td>31.3</td> </tr> <tr> <td>Q100 years</td> <td>38.0</td> </tr> </table> |                                            |                                                                                     | Return Period (years) | 100 | Soil | 0.450 | Area (ha) | 2.514 | Urban | 0.052 | SAAR (mm) | 1029 | Region Number | Region 10 | QBAR Rural | 17.3 | QBAR Urban | 18.7 | Q100 years | 38.0 | Q1 year | 16.3 | Q30 years | 31.3 | Q100 years | 38.0 |
| Return Period (years)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 100                                        | Soil                                                                                | 0.450                 |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Area (ha)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2.514                                      | Urban                                                                               | 0.052                 |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| SAAR (mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1029                                       | Region Number                                                                       | Region 10             |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| QBAR Rural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 17.3                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| QBAR Urban                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 18.7                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Q100 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 38.0                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Q1 year                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 16.3                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Q30 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 31.3                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| Q100 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 38.0                                       |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |
| ©1982-2010 Micro Drainage Ltd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                            |                                                                                     |                       |     |      |       |           |       |       |       |           |      |               |           |            |      |            |      |            |      |         |      |           |      |            |      |

## APPENDIX E

### MicroDrainage Attenuation Calculations

|                                                       |                                                     |                                                                                     |
|-------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------|
| RSK LDE Ltd                                           |                                                     | Page 1                                                                              |
| 18 Frogmore Road<br>Hemel Hempstead<br>Herts, HP3 9RT | Calderstones Ph3<br>Post development<br>Attenuation |  |
| Date July 2011<br>File                                | Designed By CW<br>Checked By                        |                                                                                     |
| Elstree Computing Ltd                                 | Source Control W.12.5                               |                                                                                     |

Summary of Results for 100 year Return Period (+20%)

| <b>Storm<br/>Event</b> | <b>Max<br/>Level<br/>(m)</b> | <b>Max<br/>Depth<br/>(m)</b> | <b>Max<br/>Control<br/>(l/s)</b> | <b>Max<br/>Volume<br/>(m<sup>3</sup>)</b> | <b>Status</b> |
|------------------------|------------------------------|------------------------------|----------------------------------|-------------------------------------------|---------------|
| 360 min Summer         | 57.667                       | 1.567                        | 28.9                             | 360.5                                     | O K           |
| 360 min Winter         | 57.797                       | 1.697                        | 31.2                             | 390.3                                     | O K           |

| <b>Storm<br/>Event</b> | <b>Rain<br/>(mm/hr)</b> | <b>Time-Peak<br/>(mins)</b> |
|------------------------|-------------------------|-----------------------------|
| 360 min Summer         | 13.822                  | 238                         |
| 360 min Winter         | 13.822                  | 254                         |

|                                                       |                                                     |                                                                                     |
|-------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------|
| RSK LDE Ltd                                           |                                                     | Page 2                                                                              |
| 18 Frogmore Road<br>Hemel Hempstead<br>Herts, HP3 9RT | Calderstones Ph3<br>Post development<br>Attenuation |  |
| Date July 2011<br>File                                | Designed By CW<br>Checked By                        |                                                                                     |
| Elstree Computing Ltd                                 | Source Control W.12.5                               |                                                                                     |

#### Rainfall Details

|                       |                   |                       |       |
|-----------------------|-------------------|-----------------------|-------|
| Rainfall Model        | FSR               | Winter Storms         | Yes   |
| Return Period (years) | 100               | Cv (Summer)           | 0.750 |
| Region                | England and Wales | Cv (Winter)           | 0.840 |
| M5-60 (mm)            | 19.400            | Shortest Storm (mins) | 360   |
| Ratio R               | 0.289             | Longest Storm (mins)  | 360   |
| Summer Storms         | Yes               | Climate Change %      | +20   |

#### Time / Area Diagram

Total Area (ha) 0.975

| <b>Time<br/>(mins)</b> | <b>Area<br/>(ha)</b> | <b>Time<br/>(mins)</b> | <b>Area<br/>(ha)</b> | <b>Time<br/>(mins)</b> | <b>Area<br/>(ha)</b> |
|------------------------|----------------------|------------------------|----------------------|------------------------|----------------------|
| 0-4                    | 0.325                | 4-8                    | 0.325                | 8-12                   | 0.325                |

|                                                       |                                                     |                                                                                     |
|-------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------|
| RSK LDE Ltd                                           |                                                     | Page 3                                                                              |
| 18 Frogmore Road<br>Hemel Hempstead<br>Herts, HP3 9RT | Calderstones Ph3<br>Post development<br>Attenuation |  |
| Date July 2011<br>File                                | Designed By CW<br>Checked By                        |                                                                                     |
| Elstree Computing Ltd                                 | Source Control W.12.5                               |                                                                                     |

#### Model Details

Storage is Online Cover Level (m) 59.000

#### Tank or Pond Structure

Invert Level (m) 56.100

| Depth (m) | Area (m <sup>2</sup> ) | Depth (m) | Area (m <sup>2</sup> ) | Depth (m) | Area (m <sup>2</sup> ) |
|-----------|------------------------|-----------|------------------------|-----------|------------------------|
| 0.000     | 230.0                  | 1.700     | 230.0                  | 1.701     | 0.0                    |

#### Depth/Flow Relationship Outflow Control

Invert Level (m) 56.100

**Depth (m) Flow (l/s)**

1.700 31.3000

