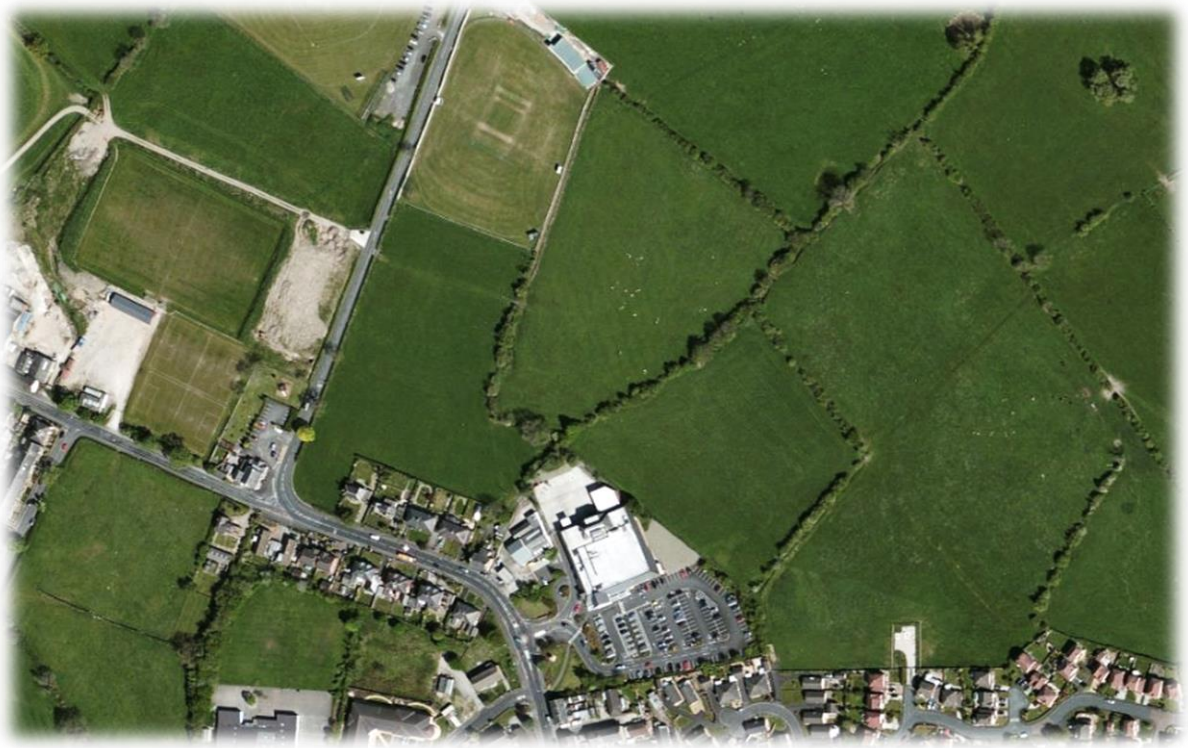
BETTS HYDRO
CONSULTING ENGINEERS

## Chipping Lane, Longridge

# FLOOD RISK ASSESSMENT
# & SUSTAINABLE DRAINAGE ASSESSMENT



For

Barratt Homes
BDW Trading Limited
Barratt House, Cartwright Way,
Forest Business Park, Bardon Hill,
Coalville,
Leicestershire,
LE67 1UF

BARRATT HOMES

**March 2016**

BETTS HYDRO
CONSULTING ENGINEERS

**Chipping Lane, Longridge**
**FLOOD RISK ASSESSMENT**
**& SUSTAINABLE DRAINAGE ASSESSMENT**

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Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
Telephone: 01244 288 178
Fax: 01244 288 516

www.betts-associates.co.uk

# EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) & Sustainable Drainage Assessment has been prepared for a proposed **residential development** and associated infrastructure located at **Chipping Lane, Longridge**. The site is located within **Flood Zone 1** according to the Environment Agency's (EA's) online flood maps. The National Planning Policy Framework (NPPF) requires a FRA for sites greater than 1 ha. The proposals are 'residential' in nature, classified as 'more vulnerable' in Table 2 within the Technical Guidance to the NPPF. This type of development is appropriate in Flood Zone 1.

This FRA has identified the site to be at **low risk** from all sources of flooding including; fluvial, tidal, pluvial, groundwater, sewer related and flooding from artificial sources. The development is accessible during times of extreme flooding as the site is within Flood Zone 1.

The development proposal was granted outline planning application (Nº 3/2014/0764) on the 29th October 2015. This FRA has built upon the FRA submitted with the application completed by RSK (March 2015, Ref: 880500-R1). The previous FRA proposed that run-off rates will be restricted to QBar. In this report, **QBar** is calculated as **8.3 l/s/ha**. See Appendix C for Hydrological Calculations. Any discrepancy between this QBar and the previous figure is due to refined FEH catchment characteristics being utilised within the ICP SuDS method.

The existing site is classed as greenfield. Surface water runoff from the existing site flows overland in a north-westerly direction before outfalling to a land drainage ditch/ordinary watercourse situated along the northern border. This ditch flows west before outfalling via a 600mm dia pipe to contribute to the Higgin Brook catchment.

The ground investigation report carried out by Soiltechnics (Feb 2016, Ref: STN3505NM-G01) indicates that infiltration is **not viable** at this site.

Surface water will outfall via the existing pathways (i.e. to the on-site ordinary watercourse) at a maximum rate of QBar (l/s). The restriction of runoff rates on increased impermeable areas will create storm water storage volumes. These will be retained on-site for events up to and including the 1 in 100 year event plus an allowance for climate change. Sustainable Drainage Systems (SuDS) could be incorporated into the planning layout which will assist in the reduction of surface water runoff from areas of hardstanding.

The nearest public foul sewers are located within Inglewhite Road to the south-east of the site. The conveyance route of foul flows will be determined during detailed design. A pumped solution will likely be required and early liaisons with UU regarding adoptable pump design are recommended.

# CONTENTS

## Figures & Tables



## Specialist Software

- Flood Estimation Handbook FEH CD-ROM (v.3.0) – Determination of Catchment Descriptors and depths of rainfall.
- MicroDrainage WinDES (v.14.1) – Calculation of Greenfield run-off rates IH124/ICP-SUDS, Greenfield run-off volumes, rates of rainfall and stormwater storage estimates.

## Abbreviations & Acronyms

| | | | |
|---|---|---|---|
| AEP | Annual Exceedance Probability | mAOD | Metres Above Ordnance Datum |
| BGL | Below Ground Level | NGR | National Grid Reference |
| BGS | British Geological Survey | NPPF | National Planning Policy Framework |
| CC | Climate Change | NSRI | National Soil Resources Institute |
| EA | Environment Agency | OS | Ordnance Survey |
| FEH | Flood Estimation Handbook | PFRA | Preliminary Flood Risk Assessment |
| FRA | Flood Risk Assessment | PPS | Planning Policy Statement |
| FZ | Flood Zone | QSE | Quick Storage Estimate |
| Ha | Hectare | QBAR | Mean Annual Flood |
| IDB | Internal Drainage Board | SFRA | Strategic Flood Risk Assessment |
| LLFA | Lead Local Flood Authority | SuDS | Sustainable Drainage Systems |
| LPA | Local Planning Authority | UU | United Utilities |

# 1.0 INTRODUCTION

1.1.1 The impact of flooding on the natural and built environment are material planning considerations. The NPPF sets out the Government's objectives for the planning system, how planning should facilitate and promote sustainable patterns of development, avoiding flood risk and accommodating the impacts of climate change. Government policy with respect to development in flood risk areas is contained within the NPPF and the supporting Technical Guidance.

1.1.2 The NPPF requires a FRA for sites greater than 1 ha. The proposals are 'residential' in nature, classified as 'more vulnerable' in Table 2 within the Technical Guidance to the NPPF. This type of development is appropriate in Flood Zone 1.

1.1.3 The development proposal was granted outline planning application (Nº 3/2014/0764) on the 29th October 2015. This FRA has built upon the FRA submitted with the application completed by RSK (March 2015, Ref: 880500-R1).

1.1.4 The NPPF advises that the LPA should consult with the EA for advice on flood issues at a strategic level and in relation to planning applications.

# 2.0 EXISTING SITE LOCATION

## 2.1 Location

2.1.1 The site is located on land off Chipping Lane, Longridge, PR3 2NA. The OS NGR is 360073E, 437980N.

2.1.2 The site is surrounded by greenfield land to the north, east and west and by residential areas to the south. Chipping Lane forms the western site boundary.

## 2.2 Existing and Historical Land Use

2.2.1 The site is currently classed as greenfield. No other land uses have been identified as part of this report.

## 2.3 Topography

2.3.1 The site slopes in a north-westerly direction with levels ranging from around 121m AOD near the eastern border to 102m AOD in the north-west.

# 3.0 DEVELOPMENT PROPOSALS

## 3.1 Nature of the development

3.1.1 The nature of the development is residential and comprises of residential units associated infrastructure. A copy of the development layout for Phase I is included in Appendix A.

# 4.0 SOURCES OF FLOOD RISK

## 4.1 Fluvial Flood Risk

4.1.1 The flood risk of the site has been assessed using EA online Flood Maps.


Flood Zone 1 – Low Risk (<0.1%)

Flood Zone 2 – Medium Risk (1% – 0.1% fluvial, 0.5% – 0.1% tidal)

Flood Zone 3 – High Risk (>1% fluvial, >0.5% tidal)

**Figure 1:** EA Flood Map for Planning (Rivers and Sea).

4.1.2 Figure 1 shows that the site is within Flood Zone 1, which would indicate a **low risk** from fluvial flooding.

## 4.2 Tidal Flooding

4.2.1 As there is no coastline or tidal river near to the site, tidal flood risk is deemed **low**.

## 4.3 Pluvial Flood Risk

4.3.1 Pluvial (surface water) flooding occurs when rainwater is unable to drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

4.3.2 Pluvial flood risk as indicated by the EA map (Figure 2) shows that the site is predominantly at **very low** to **low** risk.

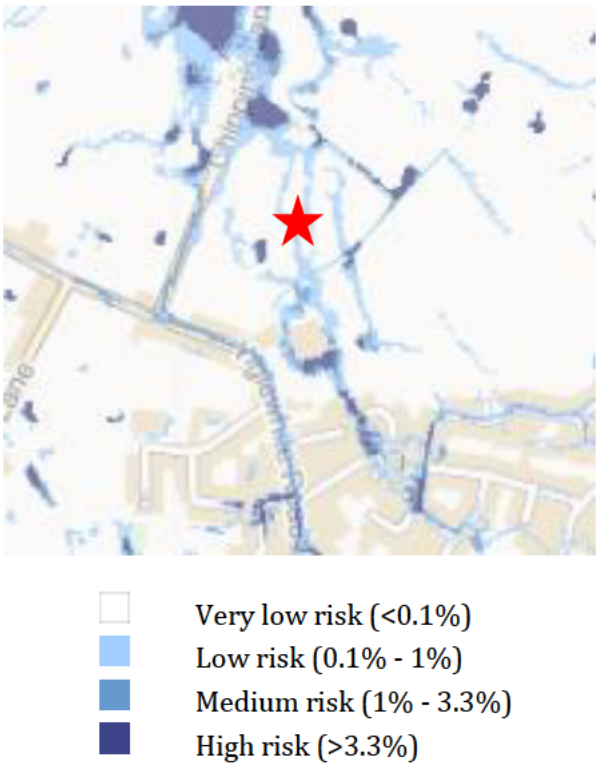


**Figure 2:** The EA's Indicative Surface Water Flood Risk Map.

4.3.3 There are some areas of low to medium risk that appear to follow the direction of overland flow. There is a singular area of medium to high risk located centrally to the site that is indicative of a topographic low point.

4.3.4 The development proposals, although increasing the impermeable area of the site, will provide a betterment on the pre-existing scenario in that any exceedance flows for storm events up to and including the 100 year event plus 30% climate change, will be attenuated on-site prior to a restricted outfall.

4.3.5 Finished floor levels will be raised at least 150mm above the external levels and external areas of hardstanding will comply with building regulations and divert water away from the proposed dwellings. This will further mitigate pluvial flood risk.

4.3.6 Therefore the pluvial flood risk to the development is overall considered to be **low.**

## 4.4 Sewer Related Flood Risk

4.4.1 Rainwater is sometimes drained into combined sewers. Foul water flooding can occur in areas prone to overland flow when the sewer is overwhelmed by heavy rainfall and will continue until the water drains away. It can also occur when the sewer becomes blocked or is of inadequate capacity, this could lead to there being a high risk of internal property flooding with contaminated water.

4.4.2 United Utilities records indicate that there is a 375mm diameter surface water pipe from the eastern site boundary which cuts through the site before outfalling to Higgin Brook near the centre of the site. A 3m easement will apply from this SWS in accordance with UU guidelines.

4.4.3 New sewers will be designed and constructed in accordance with Sewers for Adoption and put up for adoption by United Utilities as part of the detailed design (stc).

4.4.4 Flood Risk from sewer related sources is considered to be **low**. See Appendix B for UU sewer records.

## 4.5 Groundwater Flood Risk

4.5.1 In general terms groundwater flooding can occur from three main sources: - raised water tables, seepage and percolation and groundwater recovery or rebound.

- If groundwater levels are naturally close to the surface then this can present a flood risk during times of intense rainfall.
- Seepage and percolation occur where embankments above ground level hold water. In these cases water travels through the embankment material and emerges on the opposite side of the embankment.
- Groundwater recovery/rebound occurs where the water table has been artificially depressed by abstraction. When the abstraction stops the water table makes a recovery to its original level. There is the potential for groundwater flooding in low lying areas where groundwater levels have been depressed below their pre-pumping conditions, where these were at or close to ground level.

4.5.2 The online BGS maps show that the underlying geology consists of the Bowland Shale Formation, whilst the Soilscapes online Map indicates that the soil has impeded drainage. The presence of surface water flood lines in the direction of overland flow in Figure 2 is also indicative of the presence of poorly permeable underlying clay soils.

4.5.3 Groundwater flood risk is therefore considered to be '**low**', this will be further mitigated by the increase in Finished Floor Levels by at least 150mm above existing external levels.

## 4.6 Artificial Sources of Flood Risk

4.6.1 The site is partially at risk of flooding from the 'Dilworth Upper' reservoir, yet the risk designation is yet 'to be determined' according to the EA online maps and information. Reservoir flooding is extremely rare, therefore the flood risk from artificial sources is deemed **low**.

## 4.7 Flood Risk Mitigation Measures & Residual Risks

4.7.1 Finished Floor Levels will be a minimum of 150mm above the external levels (following any re-grade). External levels within proximity will fall away from proposed dwellings in accordance with building regulations.

4.7.2 Surface water run-off rates will be restricted through the use of vortex flow control devices. The increased volume of run-off for storms greater than the 30 year event can be mitigated through the use of SuDS (evapotranspiration/bio-retention/rainwater re-use).

4.7.3 The development is considered accessible during the extreme storm events as the site is within Flood Zone 1.

# 5.0 SURFACE WATER MANAGEMENT

## 5.1 Pre-Development Surface Water Run-off

5.1.1 The previous FRA completed by RSK (March 2015, Ref: 880500-R1) proposed that run-off rates will be restricted to QBar. In this report, QBar is calculated as 8.3 l/s/ha. See Appendix C for Hydrological Calculations. Any discrepancy between this QBar and the previous figure is due to refined FEH catchment characteristics being utilised within the ICP SuDS method.

5.1.2 The pre-development (greenfield) runoff rates are shown in Table 1. The ICP SuDS method was utilised using FEH catchment characteristics.

| Storm Event | Greenfield Rate (l/s/ha) |
|---|---|
| Q1 year | 7.2 |
| QBar | 8.3 |
| Q30 years | 14.0 |
| Q100 years | 17.2 |

**Table 1:** Greenfield Run-off Rates (ICP SuDS)

## 5.2 Post-Development Surface Water Run-off

5.2.1 The impermeable area will increase as a result of the development and increased run-off rates will be restricted to QBar (l/s/ha) thereby providing **significant betterment** to the downstream catchment for all storm events greater than the average annual event.

5.2.2 Rates will be restricted through the use of a vortex flow control device. Increased run-off volumes for storms greater than the 30 year event can be reduced through the use of SuDS (evapotranspiration/bio-retention/rainwater reuse).

5.2.3 Storm-water storage volumes will be attenuated on-site prior to outfall. Table 2 indicates the estimated volumes of storm-water storage that will be required if flows are restricted to variable discharge rates.

5.2.4 The impermeable area is estimated to be 60% of the total site area. This is a conservative estimation that considers gardens, permeable driveways and landscaped areas.

| Storm Event | Storage Estimate ($m^3$/ha) |
|---|---|
| Q1 year | 32 – 73 |
| QBar (~ 2.3 years) | 45 - 96 |
| Q30 years | 141 – 249 |
| Q100 years + cc | 327 - 507 |

**Table 2:** Quick Storage Estimates

5.2.5 Hydrological Calculations are included within Appendix C. The above figures are estimates only and will be recalculated during detailed design.

## 5.3 Sustainable Drainage Systems (SuDS)

5.3.1 In accordance with the NPPF, SuDS should be used wherever possible to manage surface water and reduce the impact on downstream watercourses and sewers.

5.3.2 SuDS have the ability to address four core objectives; water quantity, water quality, amenity and biodiversity. With the appropriate system specified, all four core objectives can be satisfied. Where possible, peak surface water discharge rates to watercourses and sewers should be reduced.

5.3.3 Preference should always be given to practical SuDS over conventional pipe systems. Opportunities should be taken to provide soft landscaping on site to minimise surface water run-off, improve bio-diversity and increase visual enhancement.

5.3.4 The ground investigation report carried out by Soiltechnics (Feb 2016, Ref: STN3505NM-G01) indicates that infiltration is **not viable** at this site.

5.3.5 There is potential to utilise SuDS on this site, with large areas of POS provided within the layout at the lowest points of the site. Due to the level gradient of the site, shallow SuDS would be preferable to systems such as deep ponds or detention basins. Suitable SuDS would include the use of swales and bio-retention areas.

5.3.7 It is important that SuDS is seen as a multi-use commodity, and that areas that benefit from SuDS, and the additional environmental and aesthetic enhancement they can bring if designed properly, are open to the public.

## 5.4 Methods of Surface Water Management

5.4.1 There are three methods that have been reviewed for the management and discharge of surface water detailed below; these may be applied individually or collectively to form a complete strategy. They should be applied in the order of priority listed below.

5.4.2 **Discharge via Infiltration** - The ground investigation report carried out by Soiltechnics (Feb 2016, Ref: STN3505NM-G01) indicates that infiltration is **not viable** at this site.

5.4.3 **Discharge to Watercourse** – There are several on-site watercourses which the site currently drains to. These are designated 'ordinary watercourses' and ordinary watercourse consent should be applied for with Lancashire County Council prior to any on-site works. As the watercourses are not designated as 'Main River', a 3-5m easement is considered appropriate.

5.4.4 **Discharge to Public Sewer** – Surface water will not outfall to a public sewer.

## 5.5 Climate Change

5.5.1 The UK climate is changing significantly will vary greatly by region with more short duration and high intensity rainfall events as well as more periods of long duration rainfall.

5.5.2 The NPPF Technical Guidance states that the recommended national precautionary sensitivity ranges for increase of peak rainfall intensity is 30% until 2115. The impact of climate change means there is likely to be a long term increase in average sea levels.

5.5.3 An increase in flood water levels means that flooding events will occur more frequently and have a greater impact. Any increase flood risk to the site from climate change is likely to be related to the increase in rainfall intensity and duration.

5.5.4 An additional 30% to accommodate climate change will be incorporated into the design of the stormwater storage attenuation.

## 5.6 Foul Water Management

5.6.1 The nearest public foul sewers are located within Inglewhite Road to the south-east of the site. The conveyance route of foul flows will be determined during detailed design. A pumped solution will likely be required and early liaisons with UU regarding adoptable pump design are recommended. Sewers will be designed and constructed in accordance with Sewers for Adoption.

# 6.0 SUMMARY

## 6.1 Conclusion and Recommendations

6.1.1 This report has been prepared for a development proposal of residential dwellings and associated infrastructure. The site lies within Flood Zone 1. The residential proposals are classified as 'more vulnerable'. This type of development is considered to be appropriate in accordance with the NPPF.

6.1.2 The report has indicated that the site is at **low** risk of flooding from fluvial, tidal, sewer related and artificial sources. There is some medium indicative risk of pluvial flooding which will be reduced and mitigated by the implementation of the development proposal. Flood risk to the surrounding area as a result of the development will be significantly reduced due to the restriction of proposed run-off rates to mimic the existing rate for the average annual event (QBar).

6.1.3 Attenuation will be provided on-site for storm events up to and including the 1 in 100 year event + 30% climate change.

6.1.4 Any residual or unforeseen flood risk to the proposed development will be further mitigated by raising finished floor levels to at least 150mm above external levels. External levels will fall away from dwellings in accordance with Building Regulations.

6.1.5 Applications for sewer adoption will be discussed and submitted during detailed design.

# BIBLIOGRAPHY & REFERENCES

CIRIA 522: Sustainable urban drainage systems – design manual for England and Wales (2000).
CIRIA 523: Sustainable urban drainage systems – best practice manual (2001).
CIRIA 609: Sustainable drainage systems. Hydraulic, structural and water quality advice (2004).
CIRIA 624: Development and flood risk – guidance for the construction industry (2004).
CIRIA 635: Designing for Exceedance in urban drainage: Good practice (2006).
CIRIA 644: Building Greener (2007).
CIRIA 753: The SUDS manual (2015).
Flood Risk to People – Phase 2 (FD2321/TR2), DEFRA and the Environment Agency (2006).
Flood estimation for small catchments: Institute of Hydrology Report No.124, NERC (1994).
Flood Estimation Handbook, Centre for Ecology and Hydrology (1999).
Planning Policy Statement 25: Development and Flood Risk (2006).
Sewers for Adoption 7th Edition, WRc (2012).
Technical Guidance to the National Planning Policy Framework, CLG (2012).

## Web-based References

Bingmaps –www.bing.com/Maps
British Geological Survey – www.bgs.ac.uk/opengeoscience/home.html
CIRIA –www.ciria.org
Cranfield University – www.landis.org.uk/soilscapes
Environment Agency – www.environment-agency.gov.uk
Flood Forum –www.floodforum.org.uk
Google Maps – www.maps.google.co.uk
Streetmap – www.streetmap.co.uk

# Appendix A: Site Plans

| Identifier | Descriptor |
|---|---|
| Betts Associates Ltd | Location Plan |
| Barratt Homes | Proposed Planning Layout (Phase I) |
| Betts Associates Ltd | Indicative Drainage Strategy |

# LOCATION PLAN


OS X (Eastings) 360073

OS Y (Northings) 437980

Nearest Post Code PR3 2NA

Lat (WGS84) N53:50:12 (53.836529)

Long (WGS84) W2:36:30 (-2.608205)

Lat,Long 53.836529,-2.608205

Nat Grid SD600379 / SD6007337980

DO NOT SCALE

KEY

- INDICATIVE SURFACE WATER CONVEYANCE ROUTE
- INDICATIVE FOUL WATER CONVEYANCE ROUTE
- INDICATIVE SUDS POTENTIAL
- WATERCOURSE/SEWER EASEMENT

OUTFALL LOCATION FOR SURFACE WATER. RESTRICTED RATE OF 8.3 L/S/HA.

SUDS LOCATION TO CONTAIN STORM EVENTS EXCEEDING THE 30 YEAR EVENT.

EXCEEDENCE EVENTS TO OVERFLOW INTO OFFLINE STORAGE BASIN. FLOWS WILL THEN BE PERMITTED TO OUTFALL AFTER STORM EVENT ABATES

PHASE I

SURFACE WATER RUN-OFF TO OUTFALL FROM PROPOSED ADOPTABLE PIPE STORAGE WHICH WILL CONTAIN STORM EVENTS UP TO THE 30 YEAR EVENT IN ACCORDANCE WITH UU.

FOUL WATER FLOWS TO PUMP STATION WITHIN PHASE I.

ORDINARY WATERCOURSE CONSENT WILL BE REQUIRED FOR WORKS WITHIN 8m OF THE WATERCOURSE BANK.

PHASE II

EASEMENT WIDTH FOR ORDINARY WATERCOURSE BETWEEN 3-5m.

SEWER AND ASSOCIATED EASEMENT TO BE DIVERTED UNDER A SECTION 185 AGREEMENT WITH UU.

SURFACE WATER CONNECTION FROM PHASE II.

FOUL FLOWS FROM PHASE II ALSO TO POTENTIALLY BE CONVEYED TO PUMP STATION WITHIN PHASE I.

POTENTIAL RISING MAIN TO ALLOW FOUL FLOWS TO CONNECT TO PUBLIC SEWER NETWORK WITHIN INGLEWHITE ROAD.

IL 105.84 (UU Sewer Records)

IL 108.87 (UU Sewer Records)

Longridge Town F.C. Playing Field

Sainsbury Supermarket

Sainsbury Car Park

Entrance to Sainsbury Supermarket Car Park

INGLEWHITE ROAD

BURNSIDE ROAD

ISABELLA STREET

REDWOOD DRIVE

TEMPERLEY AVENUE

| REV | DATE | BY | DESCRIPTION | CHK |
|---|---|---|---|---|
| A | 03.03.16 | HPJ | PRELIMINARY ISSUE FOR REVIEW | RDN |

DRAWING STATUS: INDICATIVE

BETTS HYDRO CONSULTING ENGINEERS
Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk

BARRATT HOMES

PROJECT: CHIPPING LANE LONGRIDGE

TITLE: INDICATIVE DRAINAGE STRATEGY

| DATE: | SCALE @ SIZE: | DRAWN: | CHECKED: |
|---|---|---|---|
| MARCH 16 | 1:1000 @ A1 | HPJ | RDN |

| PROJECT No: | DRAWING No: | REV: |
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| HYD068 | 001 | A |

# Appendix B: Sewer Records

| Identifier | Descriptor |
|---|---|
| United Utilities | Sewer Records |


OS Sheet No: SD6037NE

Scale: 1: 1250 Date: 10/11/2015

Printed By: Property Searches

## WASTE WATER SYMBOLOGY

Foul Surface Combined Overflow

Manhole
Manhole, Side Entry
MainSewer, Public
MainSewer, Private
MainSewer, 1904
Rising Main, Public
Rising Main, Private
Rising Main, 1904
Highway Drain, Private

WW SiteTermination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hatch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Cascade
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
Lamphole
Oil/Grease/Air
Penstock
Pump
Rodding Eye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber

Sludge Main, Public
Sludge Main, Private
Sludge Main, 1904

**ABANDONED PIPE**
MainSewer
Rising Main
Highway Drain
Sludge Main

Screen Chamber
Discharge Point
Outfall
Control Kiosk
Unspecified

## LEGEND

**MANHOLE FUNCTION**

| | |
|---|---|
| FO | Foul |
| SW | Surface Water |
| CO | Combined |
| OV | Overflow |

**SEWER SHAPE**

| | | | |
|---|---|---|---|
| CI | Circular | TR | Trapezoidal |
| EG | Egg | AR | Arch |
| OV | Ovie | BA | Barrel |
| FT | FlatTop | HO | HorseShoe |
| RE | Rectangular | UN | Unspecified |
| SQ | Square | | |

**SEWER MATERIAL**

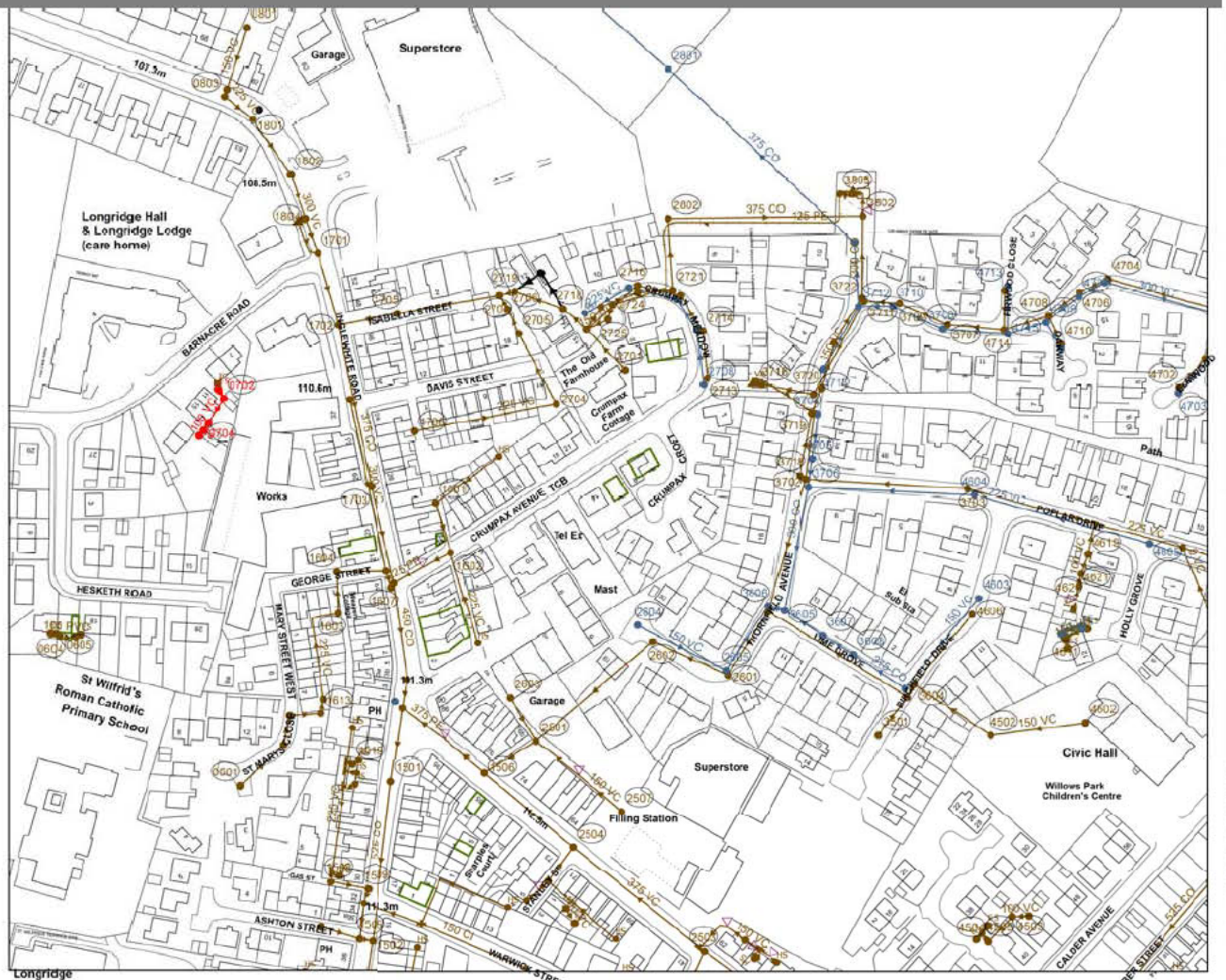
| | | | |
|---|---|---|---|
| AC | Asbestos Cement | DI | Ductile Iron |
| BR | Brick | PVC | Polyvinyl Chloride |
| PE | Polyethylene | CI | Cast Iron |
| RP | Reinforced Plastic Matrix | SI | Spun Iron |
| CO | Concrete | ST | Steel |
| CSB | Concrete Segment Bolted | VC | Vitrified Clay |
| CSU | Concrete Segment Unbolted | PP | Polypropylene |
| CC | Concrete Box Culverted | PF | Pitch Fibre |
| PSC | PlasticSteel Composite | MAC | Masonry, Coursed |
| GRC | Glass Reinforced Concrete | MAR | Masonry, Random |
| GRP | Glass Reinforced Plastic | U | Unspecified |



OS Sheet No: SD6037NE
Scale: 1: 1250 Date: 10/11/2015
158 Nodes
Sheet 1 of 1

United Utilities
helping life flow smoothly

**SEWER RECORDS**




**OS Sheet No: SD6037NW**

Scale: 1: 1250 Date: 10/11/2015

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## WASTE WATER SYMBOLOGY

Foul Surface Combined Overflow

Manhole
Manhole Side Entry
MainSewer, Public
MainSewer, Private
MainSewer, 1904
Rising Main, Public
Rising Main, Private
Rising Main, 1904
Highway Drain, Private

WW SiteTermination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hitch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Catchpit
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
Lamphole
Oil/Grease/Air
Penstock
Pump
Rodding eye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber

Foul Surface Combined Overflow

Screen Chamber
Discharge Point
Outfall

Control Kiosk
Unspecified

ABANDONED PIPE
MainSewer
Rising Main
Highway Drain
Sludge Main

Sludge Main, Public
Sludge Main, Private
Sludge Main, 1904

## LEGEND

**MANHOLE FUNCTION**

| | |
|---|---|
| FO | Foul |
| SW | Surface Water |
| CO | Combined |
| OV | Overflow |

**SEWER SHAPE**

| | | | |
|---|---|---|---|
| CI | Circular | TR | Trapezoidal |
| EG | Egg | AR | Arch |
| OV | Oval | BA | Barrel |
| FT | FlatTop | HO | HorseShoe |
| RE | Rectangular | UN | Unspecified |
| SQ | Square | | |

**SEWER MATERIAL**

| | | | |
|---|---|---|---|
| AC | Asbestos Cement | DI | Ductile Iron |
| BR | Brick | PVC | Polyvinyl Chloride |
| PE | Polyethylene | CI | Cast Iron |
| RP | Reinforced Plastic Matrix | SI | Spun Iron |
| CO | Concrete | ST | Steel |
| CSB | Concrete Segment Bolted | VC | Vitrified Clay |
| CSU | Concrete Segment Unbolted | PP | Polypropylene |
| CC | Concrete Box Culverted | PF | Pitch Fibre |
| PSC | PlasticSteel Composite | MAC | Masonry, Coursed |
| GRC | Glass Reinforced Concrete | MAR | Masonry, Random |
| GRP | Glass Reinforced Plastic | U | Unspecified |



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184 Nodes
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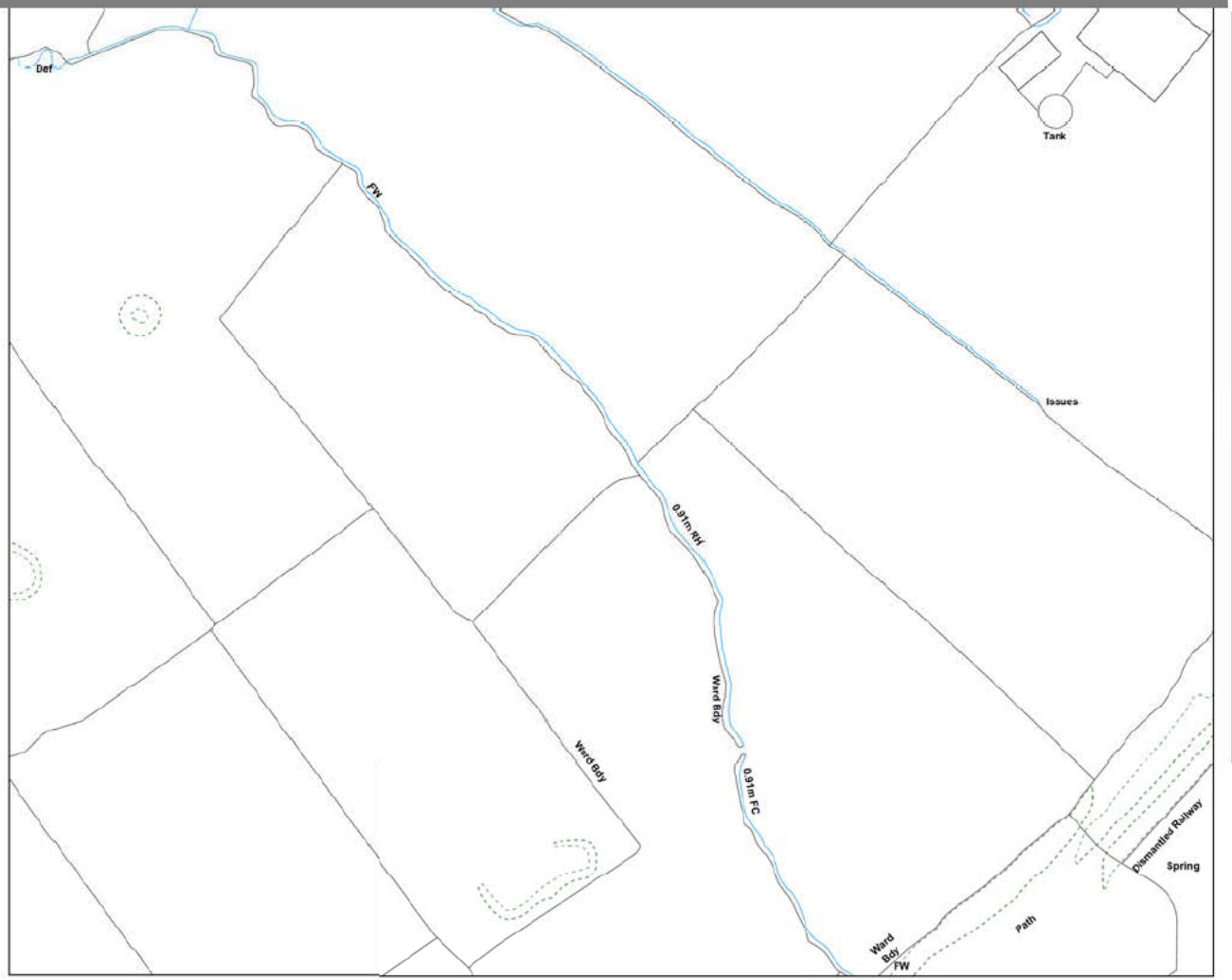
**SEWER RECORDS**




**OS Sheet No: SD6038SE**

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## WASTE WATER SYMBOLOGY

Foul Surface Combined Overflow

Manhole
Manhole, Side Entry
MainSewer, Public
MainSewer, Private
MainSewer, 1104
Rising Main, Public
Rising Main, Private
Rising Main, 1104
Highway Drain, Private

WW SiteTermination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hitch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Catchpit
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
Lamphole
Oil/Detergent Air
Penstock
Pump
Rodding Eye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber

Sludge Main, Public
Sludge Main, Private
Sludge Main, 1104

**ABANDONED PIPE**

MainSewer
Rising Main
Highway Drain
Sludge Main

Foul Surface Combined Overflow

Screen Chamber
Storage Pond
Outlet

Control Kiosk
Unspecified

## LEGEND

**MANHOLE FUNCTION**

FO Foul
SW Surface Water
CO Combined
OV Overflow

**SEWER SHAPE**

CI Circular
EG Egg
OV Oval
FT FlatTop
RE Rectangular
SQ Square
TR Trapezoidal
AR Arch
BA Barrel
HO HorseShoe
UN Unspecified

**SEWER MATERIAL**

AC Asbestos Cement
BR Brick
PE Polyethylene
RP Reinforced Plastic Matrix
CO Concrete
CSB Concrete Segment Bolted
CSU Concrete Segment Unbolted
CC Concrete Box Culverted
PSC Plastic/Steel Composite
GRC Glass Reinforced Concrete
GRP Glass Reinforced Plastic
DI Ductile Iron
PVC Polyvinyl Chloride
CI Cast Iron
SI Spun Iron
ST Steel
VC Vitrified Clay
PP Polypropylene
PF Pitch Fibre
MAC Masonry, Coursed
MAR Masonry, Random
U Unspecified



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0 Nodes
Sheet 1 of 1

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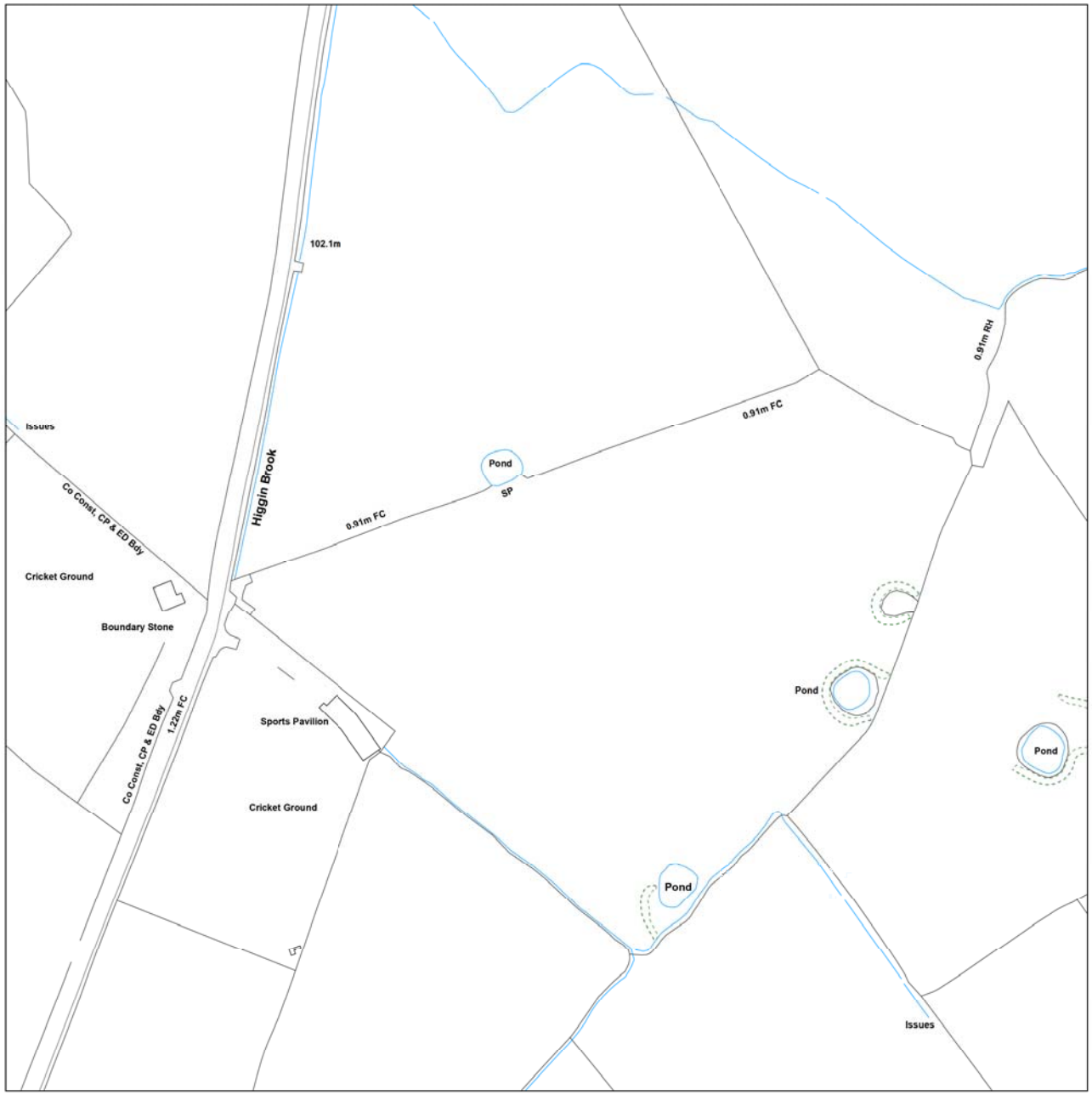
**SEWER RECORDS**




**OS Sheet No: SD6038SW**

Scale: 1: 1250 Date: 10/11/2015

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## WASTE WATER SYMBOLOGY

Foul Surface Combined Overflow

Manhole
Manhole, Side Entry
MainSewer, Public
MainSewer, Private
MainSewer, S104
Rising Main, Public
Rising Main, Private
Rising Main, S104
Highway Drain, Private

Foul Surface Combined

WW Site Termination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hatch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Catchpit
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
LampHole
OilInterceptor
PenStock
Pump
RoddingEye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber
Sluice Valve

Sludge Main, Public
Sludge Main, Private
Sludge Main, S104

**ABANDONED PIPE**

MainSewer
Rising Main
Highway Drain
Sludge Main

Foul Surface Combined Overflow

Screen Chamber
Discharge Point
Outlet

Control Kiosk
Unspecified

## LEGEND

**MANHOLE FUNCTION**

| | |
|---|---|
| FO | Foul |
| SW | Surface Water |
| CO | Combined |
| OV | Overflow |

**SEWER SHAPE**

| | | | |
|---|---|---|---|
| CI | Circular | TR | Trapezoidal |
| EG | Egg | AR | Arch |
| OV | Oval | BA | Barrel |
| FT | Flat Top | HO | HorseShoe |
| RE | Rectangular | UN | Unspecified |
| SQ | Square | | |

**SEWER MATERIAL**

| | | | |
|---|---|---|---|
| AC | Asbestos Cement | DI | Ductile Iron |
| BR | Brick | PVC | Polyvinyl Chloride |
| PE | Polyethylene | CI | Cast Iron |
| RP | Reinforced Plastic Matrix | SI | Spun Iron |
| CO | Concrete | ST | Steel |
| CSB | Concrete Segment Bolted | VC | Vitrified Clay |
| CSU | Concrete Segment Unbolted | PP | Polypropylene |
| CC | Concrete Box Culverted | PF | Pitch Fibre |
| PSC | Plastic/Steel Composite | MAC | Masonry: Coursed |
| GRC | Glass Reinforced Concrete | MAR | Masonry: Random |
| GRP | Glass Reinforced Plastic | U | Unspecified |



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**SEWER RECORDS**

# Appendix C: Hydrological Calculations

| Identifier | Descriptor |
|---|---|
| Betts Associates Ltd | ICP SuDS Greenfield Runoff Rates |
| Betts Associates Ltd | FEH Catchment Characteristics |

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 1 | Soil | 0.450 |
| Area (ha) | 1.000 | Urban | 0.000 |
| SAAR (mm) | 1200 | Region Number | Region 10 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 8.3 |
| QBAR Urban | 8.3 |
| Q1 year | 7.2 |
| Q1 year | 7.2 |
| Q30 years | 14.0 |
| Q100 years | 17.2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| VERSION | FEH CD-RO Version | | 3 | exported a | 16:20:35 | GMT | | Mon | 08-Feb-16 |
| CATCHMEN | GB | 360150 | 438450 | SD 60150 38450 | | | | | |
| AREA | 0.52 | | | | | | | | |
| ALTBAR | 115 | | | | | | | | |
| ASPBAR | 325 | | | | | | | | |
| ASPVAR | 0.65 | | | | | | | | |
| BFIHOST | 0.417 | | | | | | | | |
| DPLBAR | 0.77 | | | | | | | | |
| DPSBAR | 22.3 | | | | | | | | |
| FARL | 1 | | | | | | | | |
| LDP | 1.58 | | | | | | | | |
| PROPWET | 0.51 | | | | | | | | |
| RMED-1H | 10.5 | | | | | | | | |
| RMED-1D | 39.7 | | | | | | | | |
| RMED-2D | 51.6 | | | | | | | | |
| SAAR | 1200 | | | | | | | | |
| SAAR4170 | 1137 | | | | | | | | |
| SPRHOST | 35.03 | | | | | | | | |
| URBCONC1 | 0.964 | | | | | | | | |
| URBEXT19 | 0.1643 | | | | | | | | |
| URBLOC19 | 1.515 | | | | | | | | |
| C | -0.025 | | | | | | | | |
| D1 | 0.40671 | | | | | | | | |
| D2 | 0.33211 | | | | | | | | |
| D3 | 0.41529 | | | | | | | | |
| E | 0.29629 | | | | | | | | |
| F | 2.45864 | | | | | | | | |
| C(1 km) | -0.025 | | | | | | | | |
| D1(1 km) | 0.404 | | | | | | | | |
| D2(1 km) | 0.33 | | | | | | | | |
| D3(1 km) | 0.417 | | | | | | | | |
| E(1 km) | 0.296 | | | | | | | | |
| F(1 km) | 2.453 | | | | | | | | |

# Appendix D: Notes of Limitations

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our l conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

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