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Flood Risk Assessment

Proposed Residential Development at

Land West of Tye Lane, Walberton, Arundel, West Sussex

On behalf of

BDW Southampton

December 2021

Document History and Status

Project Number 23377

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1 Non Technical Summary

- 1.1 This Flood Risk Assessment has been undertaken in accordance with the National Planning Policy Framework on behalf of BDW Southampton in support of an Outline Planning Application for the construction of up to 131 residential dwellings with associated access roads, car parking and landscaping on land west of Tye Lane, Walberton, Arundel, West Sussex.
- 1.2 This Assessment is to be read in conjunction with all planning, architectural and other reports that accompany the Outline Planning Application for the proposed development.
- 1.3 The site is located in Flood Zone 1.
- 1.4 The proposed development will incorporate a sustainable drainage system which will discharge surface water at a suitably restricted rate to the adjacent watercourses and provide storage for all storm return periods up to and including the 1:100 year rainfall event with an allowance for climate change.
- 1.5 Foul drainage from the development can be discharged via gravity into either the existing Southern Water public foul sewer located along the eastern boundary of the site beneath Tye Lane or the existing Southern Water sewer located at the southern boundary of the site below Field Close.
- 1.6 This report concludes that the site is not at risk of flooding from tidal or fluvial sources, overland flows or groundwater.
- 1.7 In terms of flood risk the proposed development is suitable at this location.

2 Planning Policy Context

2.1 National Planning Policy Framework

2.1.1 The National Planning Policy Framework was updated in July 2021.

2.1.2 With regard to planning and flood risk the policy framework states that *‘when determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment.*

Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

- a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- b) the development is appropriately flood resistant and resilient, such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
- c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- d) any residual risk can be safely managed; and*
- e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.’*

2.1.3 With regard to major developments the NPPF states that *‘major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:*

- a) take account of advice from the lead local flood authority;*
- b) have appropriate proposed minimum operational standards;*
- c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and*
- d) where possible, provide multifunctional benefits’*

2.1.4 Major development is defined as follows:

‘For housing, development where 10 or more homes will be provided, or the site has an area of 0.5 hectares or more. For non-residential development it means additional floorspace of 1,000m² or more, or a site of 1 hectare or more, or as

otherwise provided in the Town and Country Planning (Development Management Procedure) (England) Order 2015.'

2.1 Lead Local Flood Authority

2.1.1 West Sussex County Council became a Lead Local Flood Authority under the Flood and Water Management Act 2010 and was given a series of new responsibilities to coordinate the management of local flood risk.

2.1.2 As part of its role West Sussex County Council has commissioned and produced the following documents:

- Strategic Flood Risk Assessment - January 2010
- Preliminary Flood Risk Assessment - May 2011
- Local Flood Risk Management Strategy - May 2014

2.1.3 In addition to the above documents the West Sussex County Council Policy for the Management of Surface Water was updated in November 2018.

2.1.4 The above documents have been reviewed in the preparation of this report.

2.2 Arun District Council

2.2.1 Arun District Council has commissioned and produced the following documents:

- Arun Strategic Surface Water Management Study - October 2016
- Combined Level 1 and Level 2 Strategic Flood Risk Assessment - November 2016

2.2.2 In addition in collaboration with Chichester District Council, Arundel District Council has produced a Surface Water Drainage Proposal Checklist dated November 2019 which outlines both councils' expectations and requirements for Surface Water Drainage proposals.

2.2.3 The above documents have been reviewed in the preparation of this report.

2.3 Local Planning Policy

2.3.1 The Arundel Local Plan 2011 - 2031 was adopted in July 2018.

2.3.2 The following policies are of specific relevance to this Flood Risk Assessment:

2.3.3 **Policy W DM2 – Flood Risk** states that *'development in areas at risk from flooding, identified on the latest Environment Agency flood risk maps and the Council's Strategic Flood Risk Assessment (SFRA) will only be permitted where all of the following criteria have been satisfied:*

- a) *The sequential test in accordance with the National Planning Policy Guidance has been met.*
- b) *A site specific Flood Risk Assessment demonstrates that the development will be safe, including access and egress, without increasing flood risk elsewhere and reduce flood risk overall.*
- c) *The sustainability benefits to the wider community are clearly identified.*
- d) *The scheme identifies adaptation and mitigation measures.*
- e) *Appropriate flood warning and evacuation plans are in place; and*
- f) *New site drainage systems are designed to take account of events which exceed the normal design standard i.e. consideration of flood flow routing and utilising temporary storage areas.*

The reports prepared as part of the criteria above must take into account contingency allowances, taking climate change into account as set out in Flood Risk Assessments: climate change allowances section of the NPPG.

In locations where strategic flood defence or resilient and resistant construction measures are necessary within the site itself, proposals will be required to demonstrate how measures have been incorporated as an intrinsic part of the scheme in a manner which is compatible with the latest Strategic Flood Risk Assessment.

All development proposals must take account of relevant Surface Water Management Plans, Catchment Flood Management Plans and related Flood Defence Plans and strategies such as the Lower Tidal River Arun Strategy. The council may require financial contributions from development on sites where measures to address flood risk or to improve the environmental quality of watercourses have been identified by these Plans and Strategies.'

2.3.4 Policy W DM3 – Sustainable Urban Drainage Systems states that *'to increase the levels of water capture and storage and improve water quality, all development must identify opportunities to incorporate a range of Sustainable Urban Drainage Systems (SUDS), appropriate to the size of development, at an early stage of the design process.*

Proposals for both major and minor development proposals must incorporate SUDS within the private areas of the development in order to provide source control features to the overall SUDS design. These features include:

- *Green roofs*

- *Permeable driveways and parking*
- *Soakaways*
- *Water harvesting and storage features including water butts.*

Proposals for major development must also integrate SUDS within public open spaces and roads, reflecting discussion with the appropriate bodies. SUDS must therefore be integrated into the overall design of a development and must:

- Contribute positively to the appearance of the area, integrating access to allow maintenance of existing watercourses and the system.*
- Effectively manage water (including its quality)*
- Accommodate and enhance biodiversity by making connections to existing Green Infrastructure assets and*
- Provide amenity for local residents (ensuring a safe environment)*
- Retain the existing drainage network of the site and the wider area,*
- Be maintained in perpetuity, supported through a Maintenance and Management Plan/Regime, including its financing, agreed with the Local Planning Authority.*

In order to ensure that SUDS discharge water from the development at the same or lesser rate, as prior to construction, developers must:

- Follow the hierarchy of preference for different types of surface water drainage disposal systems as set out in Approved Document H of the Building Regulations and the SUDS manual produced by CIRIA.*
- Undertake up to six months groundwater monitoring within the winter period.*
- Undertake winter percolation testing in accordance with BRE365.*
- The proposed drainage system must be designed to ensure that there is no flooding on a 1 in 30 year storm event.*
- The design must also take account of the 1 in 100 year storm event plus 30% allowance for climate change, on stored volumes, to ensure that there is no flooding of properties or the public highway or inundation of the foul sewerage system. Any excess flows must be contained within the site boundary, and within designated storage areas.'*

2.3.5 Policy ECC SP1 – Adapting to climate change states that *'the Council will support development which is located and appropriately designed to adapt to impacts arising from climate change such as the increased probability of tidal and*

fluvial flooding; water stress; health impacts as a result of extreme temperatures and a decline in the quality of habitats and richness of biodiversity.

In order to achieve this, development must be designed to take account of the following issues:

- a) Location (in relation to flood risk and vulnerability to coastal erosion);*
- b) Water efficiency;*
- c) Shade, cooling, ventilation, solar gain;*
- d) Connectivity to the green infrastructure network;*
- e) Layout and massing;*
- f) Resilience of buildings and building materials to extreme weather events; and*
- g) Capacity of drainage systems and incorporation of Sustainable urban Drainage Systems (SuDS)'*

3 Existing Site

3.1 Site Location

- 3.1.1 The development site is located on land west of Tye Lane, Walberton at Ordnance Survey reference SU 968 062. The nearest postcode is BN18 0QA.



Image 1: Site Location

- 3.1.2 The site is bound to the north by agricultural farmland, the east by Tye Lane, the south by residential dwellings and the west by an unnamed watercourse and residential dwellings.

- 3.1.3 A copy of the site location plan is located in Appendix 1 at the rear of this report.

3.2 Site Description

- 3.2.1 The site is approximately 8.15ha in area and currently comprises undeveloped agricultural grazing land and fields being used as paddocks for horses.

- 3.2.2 Existing ground levels are highest at the northern site boundary at approximately 22.2m AOD. The site falls towards its southern boundary to a level of approximately 13.4m AOD.

- 3.2.3 A copy of the existing site layout plan is located in Appendix 2 at the rear of this report.

3.3.1 The site currently has no positive surface water or foul water drainage infrastructure.

3.3.2 There are watercourses which flow north to south on the western site boundary and within the eastern half of the site. There is superficial evidence that there was formally a ditch along the southern boundary of the site that appears to have either been filled or has fallen out of use over time.

3.3.3 Rainfall currently discharges in part to ground and in part overland as a greenfield runoff to the existing drainage ditches on the southern boundary of the site and the watercourse on the western boundary of the site.

3.3.4 Pre-developed greenfield runoff rates have been established using the HR Wallingford tool for Greenfield runoff estimation.


HR Wallingford

Greenfield runoff rate estimation for sites

www.ukspds.com | Greenfield runoff tool

Calculated by: **Steve Burgess**

Site name: **Land West of Tye Lane**

Site location: **Wallingford**

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance, 'Rainfall runoff management for developments', SO030219 (2012), the SuDS Manual C-753 (July, 2015) and the non-statutory standards for SuD 9-10 (Feb, 2016). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude: **50.84822° N**

Longitude: **0.62572° W**

Reference: **3646079397**

Date: **Sep 18, 2020 15:07**

Runoff estimation approach

U-F124

Site characteristics

Total site area (ha): **1**

(1) is $Q_{GAR} < 2.0 \text{ l/s/ha?}$

Where $Q_{GAR} < 2.0 \text{ l/s/ha}$ then limiting discharge rates are set at 2.0 l/s/ha .

Methodology

Clear estimation method: **Calculate from SPR and SAAR**

SPR estimation method: **Calculate from SOIL type**

Soil characteristics

	Default	Edited
SOIL type:	1	1
HOST class:	N/A	N/A
SPR/SPRHOST	0.1	0.1

(2) Are flow rates $< 5.0 \text{ l/s?}$

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

Hydrological characteristics

	Default	Edited
SAAR (mm):	780	780
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

(3) Is $SPR/SPRHOST \leq 0.3?$

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{GAR} (l/s):	0.19	0.19
1 in 1 year (l/s):	0.16	0.16
1 in 30 years (l/s):	0.44	0.44
1 in 100 year (l/s):	0.81	0.81
1 in 200 years (l/s):	0.71	0.71

This report was produced using the Greenfield runoff rates estimation tool available at www.ukspds.com. The use of this tool is subject to the terms and conditions of use, which can be found at www.ukspds.com. The tool is provided as a guide only and should not be used as a basis for any legal or financial decisions. The tool is provided as a guide only and should not be used as a basis for any legal or financial decisions.

Image 2: Greenfield Runoff Calculation

3.3.5 The pre-developed greenfield runoff rates are as follows:

- Q_{bar} 0.19 l/s/ha
- 1:100 year 0.61 l/s/ha

3.3.6 There are two existing Southern Water foul sewers to which the site could connect. The first is a 225mm diameter public foul sewer located beneath Tye Lane to the east of the site and the second is a 150mm diameter public foul sewer located beneath Field Close at the southern site boundary.

3.3.7 A copy of the sewer records is located in Appendix 3 at the rear of this report.

3.4 Geology and Groundwater

3.4.1 British Geological Survey maps and borehole information confirm that the site is within an area underlain with River Terrace Deposits (undifferentiated) consisting of Sand, Silt and Clay overlying London Clay Formation.

3.4.2 Ground investigation was undertaken by Geo-Environmental Services Limited in March 2018.

3.4.3 Six trial pits and six boreholes were dug and installed as part of the ground investigation.

3.4.4 The ground investigation report identified London Clay Formation beneath River Terrace Deposits and Raised Beach Deposits within all excavations and borehole tests.

3.4.5 Groundwater level monitoring wells were installed within boreholes WS1 to WS8 which extended to a depth of 3m to 4m below ground and trial pit TP2 which extended to 1.5m below ground.

3.4.6 Groundwater was encountered within all testing locations except WS3 and ranged between 0.33m and 3.7m below ground level.

3.4.7 The highest recorded groundwater level was reached within WS6 at 0.33m below ground.

3.4.8 A summary of the soil conditions encountered is presented is as follows:

Top (m blg)	Base (m blg)	Geology	Position
0	0.25 – 0.60	TOPSOIL: Dark brown organic gravelly sandy CLAY Brown silty CLAY with occasional medium to coarse gravel and rootlets	All
0.40 – 0.60	0.70 – 3.00	Raised Beach Deposits: Intermittent layers of clay sand and gravel. Clays comprise soft to firm dark brown gravelly clay with occasional carbonaceous deposits. Gravel within the clay comprise fine to coarse angular to sub angular flint. Sand comprises orange fine sand.	TP1, TP2, WS2
0.20 – 0.40	3.00	RIVER TERRACE DEPOSITS: Layer of sand, gravel, and clay. Clay comprising soft orange mottled clay with occasional flint gravel.	TP3, TP4, WS1, WS3, WS4, WS5, WS6, WS7, WS8
1.00 – 2.20	4.00	LONDON CLAY FORMATION: Firm to stiff dark sandy CLAY.	WS4, WS7, WS8

Table 1: Summary of Soil Conditions

3.4.9 Infiltration testing was undertaken within trial pits TP1, TP2 and TP4. The tests were aborted due to collapsing ground and running sand.

3.4.10 The online “Magic Map” available from Defra confirms that the site is located above a Secondary A aquifer classified as having a low vulnerability.

3.4.11 Extracts from the Geo-Environmental Services Limited ground investigation are located in Appendix 4 at the rear of this report.

4 Flood Zone and Flood History

4.1 Flood Zone

- 4.1.1 The Environment Agency's online mapping confirms that the site is located in Flood Zone 1 and is not at risk of flooding from rivers or the sea from anything less extreme than a 1:1,000 year flood event.

4.2 Flood History

4.2.1 Environment Agency

- 4.2.1.1 The Environment Agency map of historic flood incidents identifies a short section of The Street and Barnham Lane approximately 150m to the south of the site which has historically suffered localised flooding but does not identify any historic incidents directly affecting the site.

4.2.2 West Sussex County Council

- 4.2.2.1 Neither the Strategic Flood Risk Assessment dated January 2010, the Preliminary Flood Risk Assessment dated May 2011, nor the Local Flood Risk Management Strategy dated May 2014 identify any specific flood incidents in the immediate vicinity of the site.

4.2.3 Arun District Council

- 4.2.3.1 The Strategic Flood Risk Assessment dated November 2016 identifies a short section of The Street and Barnham Lane approximately 150m to the south of the site, (as identified by the Environment Agency mapping), which has historically suffered localised flooding. This is reported to have been primarily a surface water flooding issue brought about by intense rainfall.
- 4.2.3.2 There are however no records of any flood incidents directly affecting the site.
- 4.2.3.3 Copies of the available flood maps are located in Appendix 5 at the rear of this report.

5 Flooding Potential

5.1 Tidal Flooding

5.1.1 The site is located 6.4km from the coast and is not at risk of tidal flooding.

5.2 Fluvial Flooding

5.2.1 The area of the proposed site is within Flood Zone 1 and is not at risk of fluvial flooding from anything less extreme than a 1:1,000 year flood event.

5.3 Groundwater Flooding

5.3.1 There are no records identified within West Sussex County Council's Strategic Flood Risk Assessment dated January 2010, the Preliminary Flood Risk Assessment dated May 2011, nor the Local Flood Risk Management Strategy dated May 2014 of groundwater flooding affecting the site.

5.4 Overland Flow

5.4.1 The Environment Agency maps identify parts of the site to be at low risk of flooding from overland surface water.

5.4.2 The locations identified are however minimal and all are isolated with no apparent flow route.

5.4.3 The flood mapping contained within the various flood documents produced by West Sussex County Council and Arun District Council does not identify any flood risk associated with overland flow routes.

5.5 Flood Routing

5.5.1 The natural route for flood waters to dissipate, should any event occur on the site, is towards the southern boundary of the site.

5.5.2 There is no associated flood risk to the downstream catchment area.

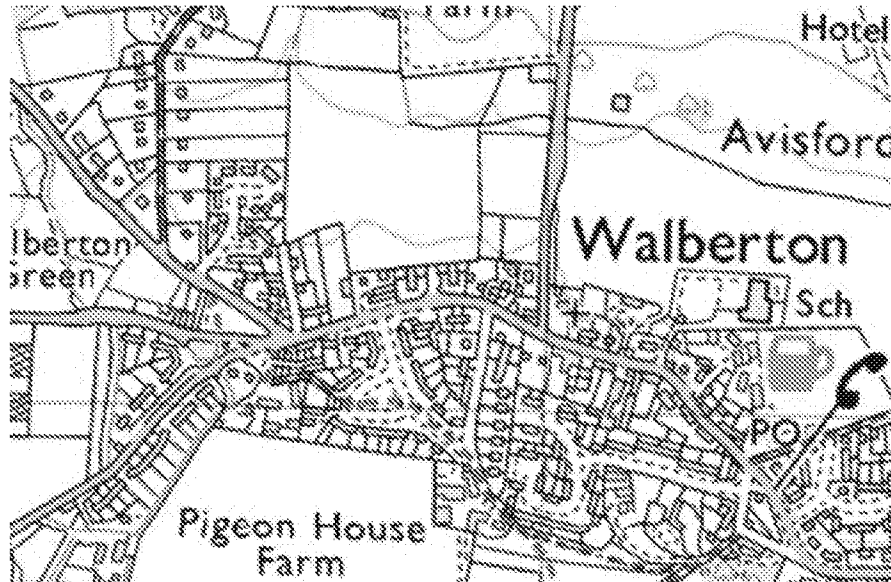


Image 3: Local Topography

6 Development Proposals

6.1 Description

6.1.1 The development proposals are for the construction of up to 131 residential dwellings with associated access roads, car parking and landscaping.

6.2 Impermeable areas

6.2.1 Surface water drainage for the development has been split into two main systems. System 1 will serve the western half of the site with System 2 serving the eastern area.

6.2.2 The impermeable areas for Area 1 of the various elements of the development to be served by System 1 are estimated as follows:

- Roof areas 4,950m²
- Roads, Footways, Driveways and Parking Areas 8,000m²

6.2.3 The impermeable areas for Area 2 of the various elements of the development to be served by System 2 are summarised as follows:

- Roof areas 4,500m²
- Roads, Footways, Driveways and Parking Areas 9,000m²

6.2.4 The total impermeable area of the development is anticipated to be approximately 26,450m².

6.2.5 A copy of the proposed site layout plan together with an impermeable areas plan is located in Appendix 6 at the rear of this report.

6.3 Surface Water Drainage

6.3.1 CIRIA report C753 The SuDS Manual-v6 provides guidance on surface water drainage. The aim for surface water runoff is to match greenfield runoff rates and volumes where reasonably achievable.

6.3.2 For surface water discharge, the drainage hierarchy notes the following list of drainage options in order of preference:

- 1 Infiltration to ground
- 2 Discharge to a watercourse
- 3 Discharge to a surface water sewer
- 4 Discharge to a foul water sewer

- 6.3.3 Due to the ground conditions and presence of high groundwater encountered within the ground investigation undertaken by Geo-Environmental Services Limited infiltration of surface water to ground is deemed unsuitable.
- 6.3.4 The proposed surface water drainage strategy will be based on attenuation of surface water on site within four detention basins with sufficient storage provided to accommodate a 1:100 year storm event including an additional 40% to account for the predicted effects of future climate change.
- 6.3.5 Preliminary calculations have been prepared in order to demonstrate that surface water drainage can be adequately accommodated within the site without any increased flood risk elsewhere.
- 6.3.6 System 1
- 6.3.6.1 Surface water runoff from Area 1 of the development will drain into a detention basin at the south western corner of the site within the public open space area.
- 6.3.6.2 Surface water will then be discharged, via a water treatment swale, into the adjacent watercourse on the western site boundary.
- 6.3.6.3 A restriction of 2.0l/s is proposed.
- 6.3.6.4 Preliminary calculations confirm a storage volume of 1,587m³ will be required.
- 6.3.7 System 2
- 6.3.7.1 Surface water runoff from Area 2 of the development will drain into a detention basin within the western side of public open space area at the south of the site.
- 6.3.7.2 Surface water will then be discharged, via a water treatment swale, into the watercourse which flows north to south through the eastern area of the site.
- 6.3.7.3 A restriction of 2.0l/s is proposed.
- 6.3.7.4 Preliminary calculations confirm a storage volume of 1,675m³ will be required.
- 6.3.8 Further information on the surface water drainage proposals will be confirmed at detailed design stage subject to further site investigations and testing.

6.4 Foul Water Drainage

- 6.4.1 Foul drainage from the development will discharge via gravity into either the 225mm diameter public foul sewer located beneath Tye Lane to the east of the site or to the existing 150mm diameter public foul sewer located beneath Field Close at the southern boundary of the site.
- 6.4.2 A preliminary review of the site levels and invert levels of the public sewers confirms a gravity connection to either sewer is achievable for the site.
- 6.4.3 A copy of the preliminary drainage strategy plan together with copies of the preliminary storage calculations is located in Appendix 7 at the rear of this report.

6.5 Water Quality

- 6.5.1 The proposed development is for residential use. In accordance with CIRIA SuDS Manual 2015 (Report C753), the pollution hazard level for this type of development is between very low and medium depending on the use/area of the site.
- 6.5.2 The surface water scheme will include mitigation to ensure that surface water is suitably treated and any pollution risk adequately managed prior to discharge.
- 6.5.3 Table 26.2 in Chapter 26 of CIRIA report C753 The SuDS Manual provides Pollution Hazard Indices for varying land types. Those of relevance to the development proposals are as follows:

Land Use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car park, low-traffic roads < 300 traffic movements per day	Low	0.5	0.4	0.4
All roads except low traffic roads	Medium	0.7	0.6	0.7

Table 2: Pollution Hazard Indices

- 6.5.4 Where multiple drainage components are used in series the individual mitigation index of secondary and tertiary components is lowered by 50% due to reduced performance associated with primary treatment.

SuDS Type	Total suspended solids (TSS)	Metals	Hydro-carbons
Detention basin	0.5	0.5	0.6
Swale	0.5	0.6	0.6

Table 3: Pollution Mitigation Indices

6.5.5 The proposed use of detention basins and swales will meet the target treatment level required for runoff with very low to medium risk of pollution hazard thus demonstrating that the surface water drainage system for the site can be designed to adequately mitigate against the risk of pollution.

6.5.6 An outline drainage maintenance schedule is located in Appendix 8 at the rear of this report.

7 Safe Development

7.1 Flood Zone Compatibility

7.1.1 The site and its wider area are in Flood Zone 1 and will remain so for the foreseeable future.

7.1.2 With reference to the Government Guidance on Flood Risk and Coastal Change at <https://www.gov.uk/guidance/flood-risk-and-coastal-change>:

- Table 2: Flood Risk Vulnerability Classification

The type of development proposed is residential and therefore classified as More Vulnerable

- Table 3: Flood Risk Vulnerability and Flood Zone Compatibility

More Vulnerable development is appropriate in Flood Zones 1 and 2

7.2 Risk to Others

7.2.1 The proposed surface water drainage system will be designed to current standards incorporating SuDS elements providing treatment, attenuation and storage which will minimise runoff leaving the site during times of heavy rain.

7.2.2 Allowance has been made for a 40% increase in rainfall intensities which accords with the latest figures published by the Environment Agency and in accordance with the requirements under the National Planning Policy Framework.

7.2.3 The proposed drainage system will incorporate sufficient treatment prior to final discharge thus mitigating the risk of pollution from the site.

7.2.4 The risk of surface water flooding to others due to the development proposals is reduced and the resultant risk is negligible.

7.2.5 Sewerage undertakers have an obligation to upgrade the existing networks if a connection to an equivalent or larger sized public sewer is technically achievable.

7.2.6 The residual risk of sewer flooding from this development for the foreseeable future is therefore negligible.

8 Conclusions

- 8.1 The site is located within Flood Zone 1 and is not at risk from any source of flooding.
- 8.2 The Environment Agency map of historic flood incidents identifies a short section of The Street and Barnham Lane approximately 150m to the south of the site which has historically suffered localised flooding but does not identify any historic incidents directly affecting the site.
- 8.3 Due to the ground conditions and presence of high groundwater encountered within the ground investigation undertaken by Geo-Environmental Services Limited infiltration of surface water to ground is deemed unsuitable.
- 8.4 A suitable SuDS drainage system is proposed which accords with the requirements of national and local policy.
- 8.5 Preliminary calculations indicate that surface water runoff generated by the proposed development can be attenuated on site for all rainfall events up to the 1:100 year event including an allowance for climate change.
- 8.6 Water quality improvement will be provided to mitigate against any risk to any receiving waterbody.
- 8.7 Foul drainage from the development will discharge via gravity into one of two available existing Southern Water public foul sewers which are located beneath Tye Lane and Field Close adjacent to the site.
- 8.8 In terms of flood risk planning the proposed development is safe and will not increase flood risk elsewhere and will provide improvement to immediately adjacent sites by managing surface water from all rainfall events up to the 100 year plus climate change event.
- 8.9 The development proposals are suitable at this location.

9 List of Appendices, Images and Tables

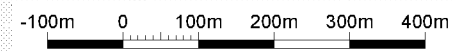
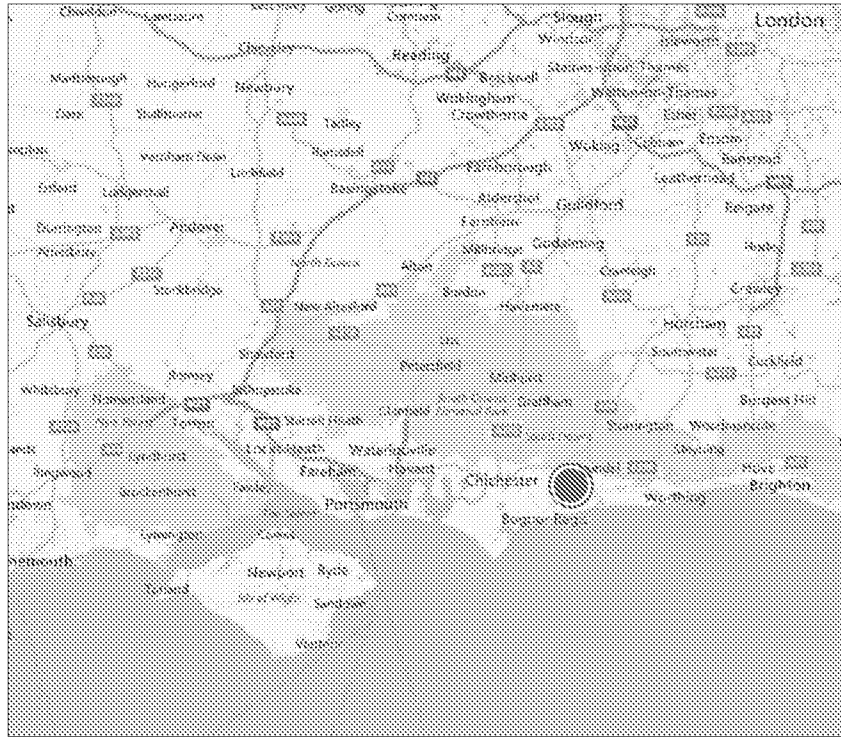
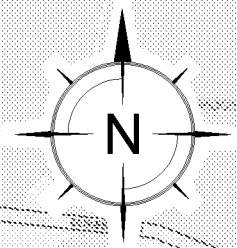
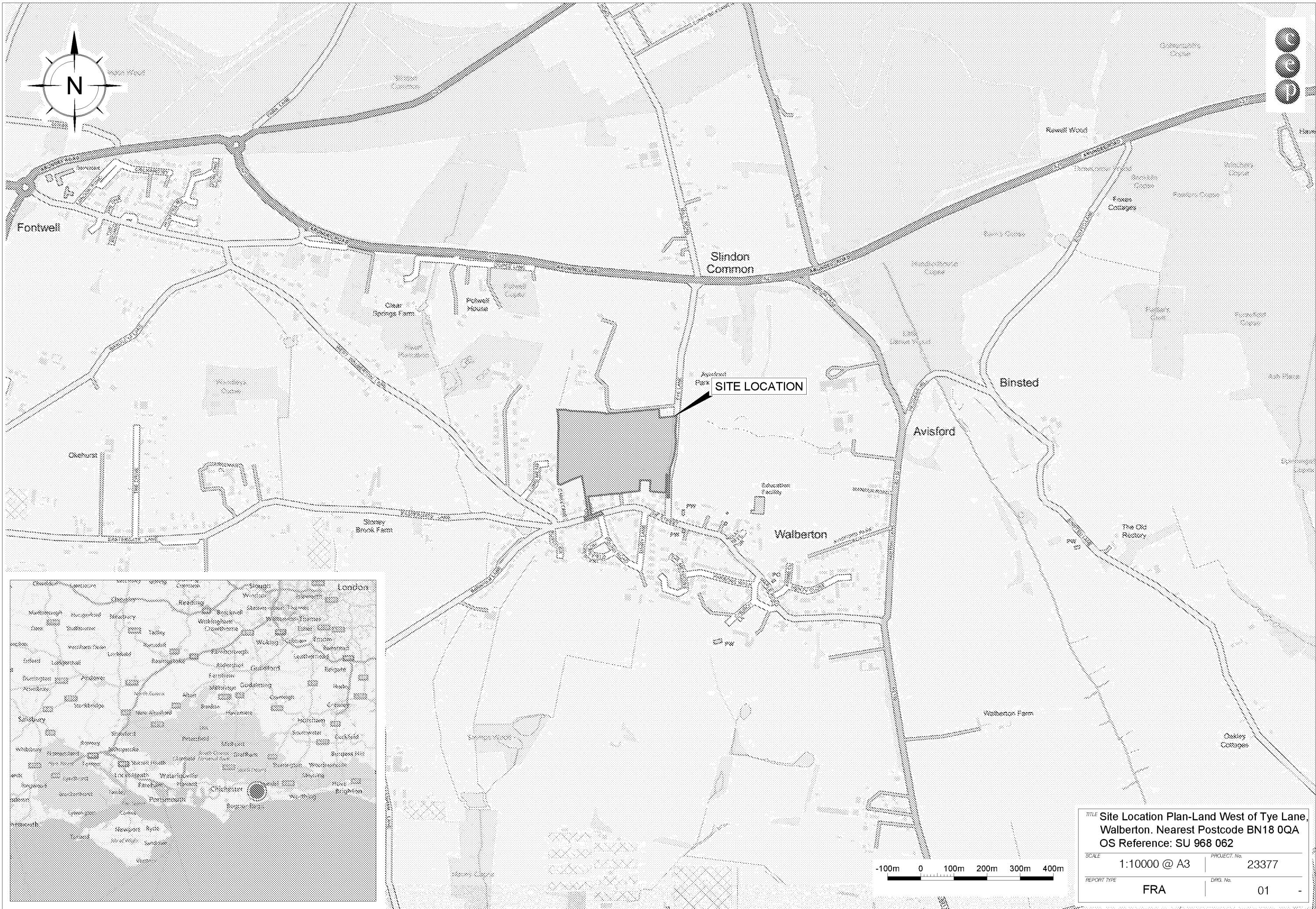
Appendix 1	Site Location Plan
Appendix 2	Existing Site Layout Plan
Appendix 3	Southern Water Sewer Records
Appendix 4	Ground Investigation Report Extracts
Appendix 5	Flood Maps
Appendix 6	Proposed Site Layout and Impermeable Area Plan
Appendix 7	Preliminary Drainage Strategy Plan and Calculations
Appendix 8	Drainage Maintenance Schedule

Image 1	Site Location
Image 2	Greenfield Runoff Calculation
Image 3	Local Topography

Table 1	Summary of Soil Conditions
Table 2	Pollution Hazard Indices
Table 3	Pollution Mitigation Indices

Appendix 1

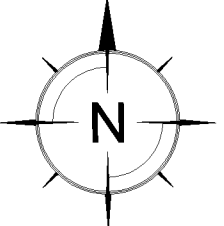
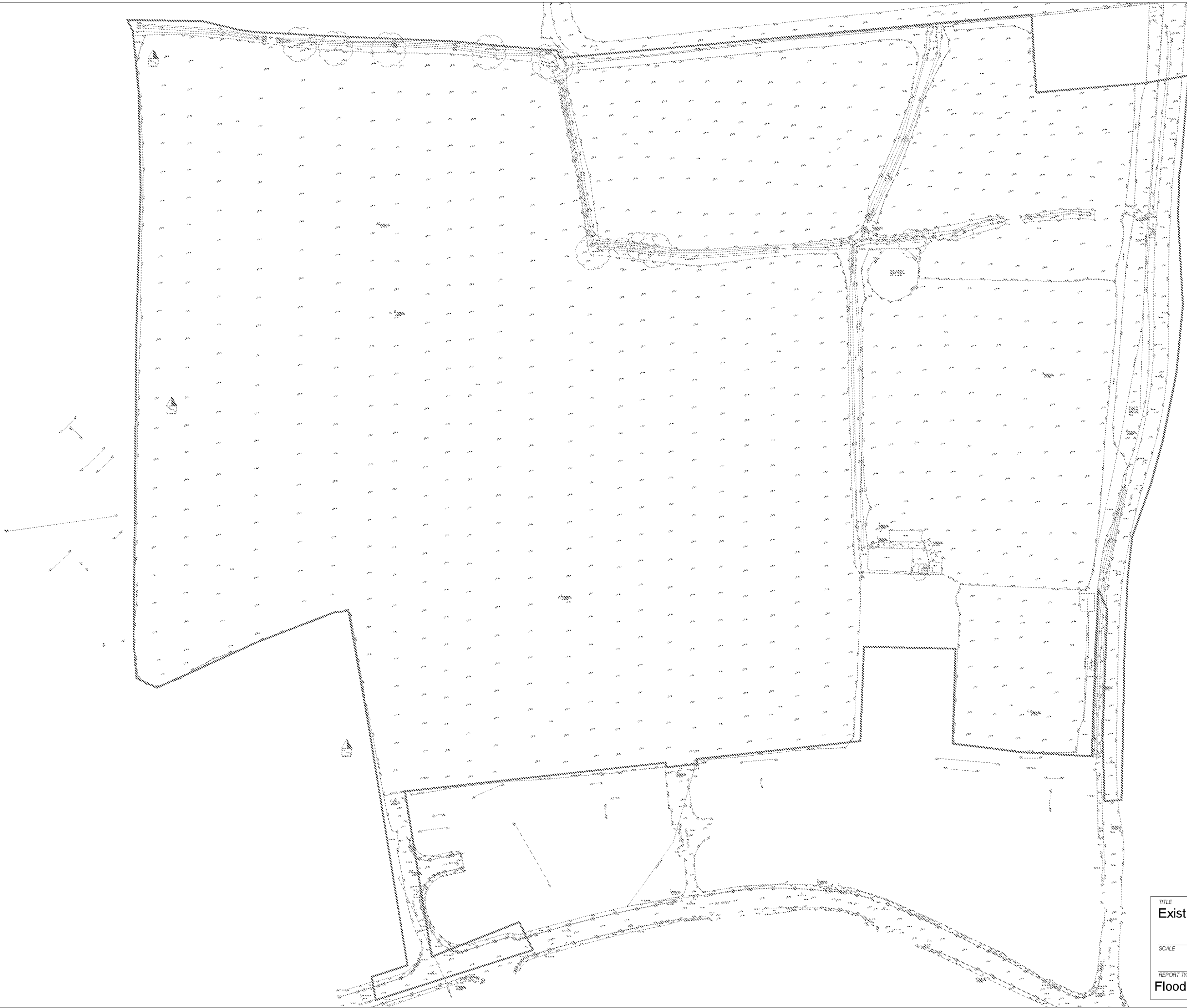
Site Location Plan



TITLE		Site Location Plan-Land West of Tye Lane, Walberton. Nearest Postcode BN18 0QA OS Reference: SU 968 062	
SCALE	1:10000 @ A3	PROJECT No.	23377
REPORT TYPE	FRA	DRG. No.	01

Appendix 2

Existing Site Layout Plan



TITLE Existing Site Layout Plan	
SCALE 1:1,250 @ A3	PROJECT No. 23377
REPORT TYPE Flood Risk Assessment	DRG. No. 02

Appendix 3

Southern Water Sewer Records



(c) Crown copyright and database rights 2020 Ordnance Survey 100031873 Date: 16/09/20 Scale: 1:1250 Map Centre: 496884.106297 Data updated: 18/08/20 Our Ref: 437464 - 1 Wastewater Plan A2

The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determined on site. This plan is produced by Southern Water Services Ltd (c) Crown copyright and database rights 2020 Ordnance Survey 100031873. This map is to be used for the purposes of viewing the location of Southern Water plant only. Any other uses of the map data or further copies is not permitted.

WARNING: BAC pipes are constructed of Bonded Asbestos Cement.

WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement.

150mm Diameter BAC Pipe	150mm Diameter BAC Pipe	150mm Diameter BAC Pipe	150mm Diameter BAC Pipe	150mm Diameter BAC Pipe	150mm Diameter BAC Pipe

mat@civil.co.uk

23377



[illegible][illegible][illegible]

Appendix 4

Ground Investigation Report Extracts



4.0 ENCOUNTERED CONDITIONS

A factual record of the conditions encountered during the physical investigation of the site is presented in the following sections.

For further details of the ground conditions, reference should be made to the engineer's logs presented in Appendix A, groundwater and gas monitoring assessment presented in Appendix B, geotechnical analysis in Appendix C and the geochemical testing results in Appendix D.

The physical ground investigation works were undertaken between 31st January and 2nd February with a return visit for shallow soil sample collection on 19th February. Laboratory testing was undertaken by a UKAS accredited laboratory. Unless stated otherwise, all depths are reported as metres below ground level (m bgl).

4.1 Ground Conditions

The ground conditions encountered within the exploratory holes were slightly different from this anticipated from the review of published geological records in that whilst superficial strata (River Terrace Deposits) were encountered, they differed in composition from those anticipated. The solid geology (Lambeth Group) was not encountered within the exploratory holes. A summary of the encountered soil conditions is presented in table 4.1.

Top (m bgl)	Base (m bgl)	Generalised Description	Position
0.00	0.25 – 0.60	TOPSOIL: Dark brown organic gravelly sandy CLAY with occasional clinker, flint gravel.	All
0.40 - 0.60	0.70 - 3.00	RAISED BEACH DEPOSITS: Intermittent layers of clay sand and gravel. Clays comprise Soft to firm dark brown gravelly clay with occasional carbonaceous deposits. Gravels within the clay comprise fine to coarse angular to sub angular flint. Sand comprises orange fine sand.	TP1, TP2, WS2
0.20 – 0.40	3.00	RIVER TERRACE DEPOSITS: Layer of sand, gravel and clay. Clay's comprise soft orange mottled grey clay with occasional flint gravel	TP3, TP4, WS1, WS3, WS4, WS5, WS6, WS7 and WS8
1.00 – 2.20	4.00	LONDON CLAY FORMATION: Firm to stiff dark sandy CLAY.	WS4, WS7, WS8

Table 4.1 Summary of Ground Conditions

For further details of the ground conditions encountered, reference should be made to the cable percussion borehole and window sampler borehole logs presented in Appendix B.

4.2 Groundwater

Details of groundwater encountered during the investigation and subsequent Groundwater monitoring, undertaken on 19th February 2018, are presented in Table 4.2 below.



Location	Water Strike Depth (m bgl)	Depth to Groundwater after 20 mins (m bgl)	Groundwater Level in Standpipe (m bgl)
TP2	1.40	Collapsed to 1.20m water at 0.90m thereafter	N/A
WS1	0.85	0.62	0.32
WS2	0.90	0.92	0.08
WS3	Dry	Dry	1.18
WS4	3.73	3.60	0.38
WS5	3.10	2.85	3.84
WS6	0.33	0.33	Submerged
WS7	0.63	0.60	-
WS8	0.53	0.50	-

Table 4.2 Summary of Groundwater Conditions

It should be noted that changes in groundwater levels do occur for a number of reasons including effects and variations in drainage. Such fluctuations may only be recorded by the measurement of the groundwater level within a standpipe or piezometer installed within appropriate response zones. Changes in groundwater level can have a direct effect on excavation stability and the more cohesive soils can soften under rising or high groundwater levels.

4.3 Ground Gases

Ground gas monitoring was undertaken within the standpipes installed within WS1 – WS6. The monitoring undertaken comprised spot sampling/measurements on six separate occasions to confirm the findings of the preliminary risk assessment identified in the desk study.

A summary of maximum concentrations, for the first rounds of monitoring undertaken on 19th February 2018, for ground gases and associated NHBC Traffic Light warning is shown in Table 4.3. For oxygen, the results show the lowest concentrations.

Location	Methane (%)	Carbon Dioxide (%)	Oxygen (%)	Characteristic Situation	NHBC Traffic Light
WS1	0.0	1.2	19.3	CS1	Green
WS2	0.0	1.2	13.2	CS1	Green
WS3	0.0	0.2	14.3	CS1	Green
WS4	0.0	0.1	20.2	CS1	Green
WS5	0.0	1.8	18.6	CS1	Green
WS6	Submerged				
Atmospheric pressure during monitoring: 1021mb					

Table 4.3 Maximum Concentrations of Ground Gases and minimum concentrations for Oxygen during monitoring

With exception of WS5, a full round of monitoring (for 2 minutes) was unable to be completed due to the presence of shallow groundwater.

At the time of writing, five monitoring visits are outstanding. These will be presented in an addendum report.

4.4 Obstructions

No artificial obstructions were encountered during the intrusive investigation.

4.5 Geochemical Analysis

In order to assess the general chemical quality of the strata encountered, samples of soils recovered from the exploratory holes were submitted for analysis for a range of potential contaminants selected on the basis of the findings of the desk study and supported by the joint National House Building Council (NHBC), Environment Agency (EA) and Chartered Institute of Environmental Health (CIEH) publication, '*Guidance for the Safe Development of Housing on Land Affected by Contamination*' (2008).

Soil samples were placed into plastic containers for general inorganic analysis and into amber jars for organic analysis. Samples were stored in temperature controlled conditions from sampling until receipt at the laboratory from which time sample preparation and storage was determined by testing requirements and in line with the laboratory's protocols.

Six soil samples were submitted for analysis of a comprehensive suite of common zootoxic and phytotoxic elements based upon determinands listed within the above guidance. In addition, speciated total petroleum hydrocarbons (TPH) analysis and asbestos screens were undertaken on the six samples submitted for analysis.

Additionally, two samples of soil were taken in the arable field in the south-west corner to be submitted for OrganoChlorine Pesticides.

4.6 Geotechnical Laboratory Results

Soil samples were scheduled for geotechnical analysis based on the proposed end use of the area. The main elements included:

- Strength/stiffness profiling (in-situ pocket penetrometer testing and in-situ standard penetration test)
- Soil Classification (shrinkability etc.)
- Aggressive ground conditions (pH SO₄)



	Parameter	Number of Tests	Result	
			Range	Average
River Terrace Deps.	Moisture Content (%)	4	23 – 32	30
	Liquid Limit (%)	4	41 – 48	43
	Plastic Limit (%)	4	19 – 20	20
	Plasticity Index (%)	4	21 – 28	24
	Modified Plasticity Index (%)	4	8 – 20	12
	pH	3	8.20 – 8.22	8.22
	Water soluble sulphate (g/l)	3	0.23 – 0.30	0.26
Raised Beach Deps.	Moisture Content (%)	2	21 – 25	-
	Liquid Limit (%)	2	26 – 43	-
	Plastic Limit (%)	2	21 – 22	-
	Plasticity Index (%)	2	4 – 22	-
	Modified Plasticity Index (%)	2	4 – 13	-
London Clay	Moisture Content (%)	3	30 – 32	31
	Liquid Limit (%)	3	58 – 72	67
	Plastic Limit (%)	3	21 – 26	23
	Plasticity Index (%)	3	37 – 48	44
	Modified Plasticity Index (%)	3	37 – 48	44

Table 4.4 Summary of Geotechnical Testing Results

A particle size distribution tests within a sample of the more granular parts of the Raised Beach Deposits was scheduled. The results of which are summarised in Table 4.5.

Sample Proportions	% Dry mass
Very Coarse	0
Gravel	1.9
Sand	81.4
Fine <0.063mm	16.7

Table 4.5 Summary of Particle Size Distribution (Sieve) Test (TP1 – 3.00m)

Two particle size distribution tests within a samples of the River Terrace Deposits were scheduled. The results of which are summarised in Table 4.6

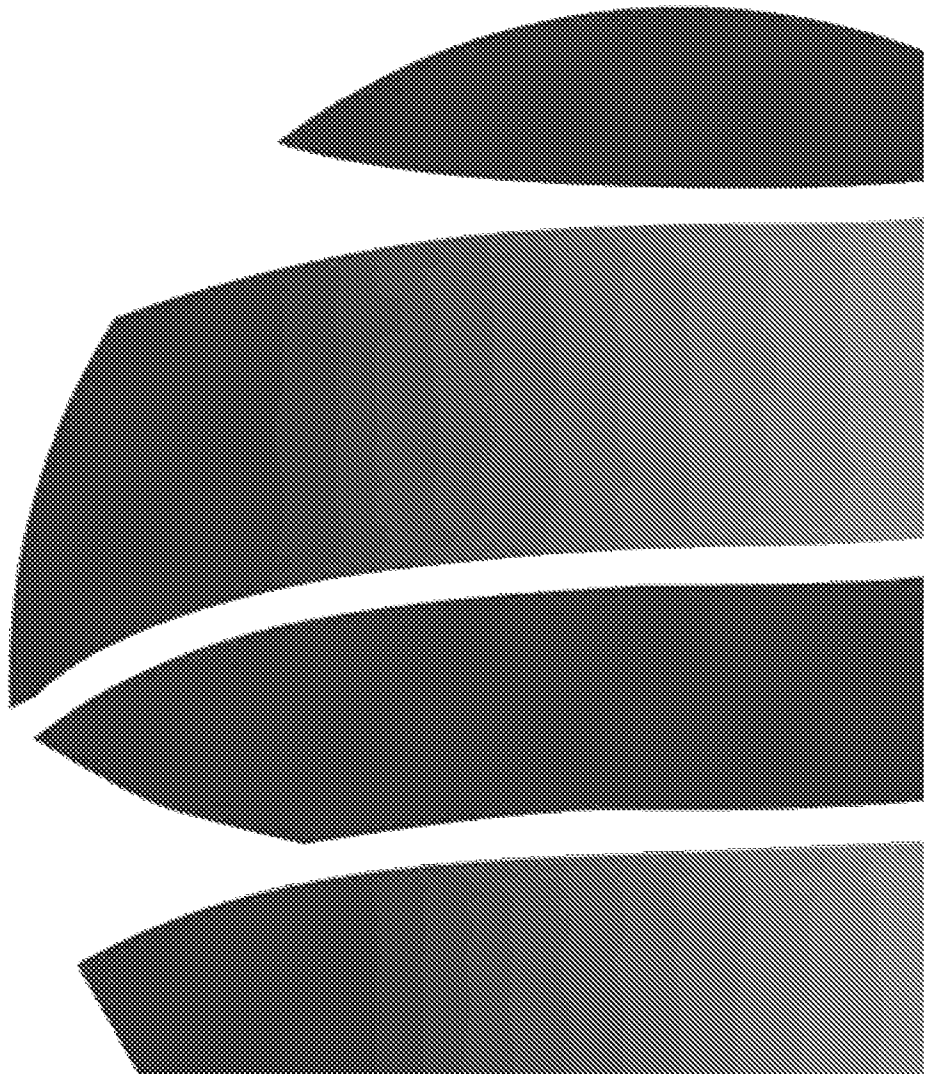
Sample Proportions	% Dry mass
Very Coarse	0
Gravel	0 – 65.0
Sand	11.2 – 22.2
Fine <0.063mm	23.8 – 77.8

Table 4.6 Summary of Particle Size Distribution (Sieve) Test (WS1 – 3.00m & WS6 1.50m)

Soakage tests were undertaken within all four trial pit positions. TP1, TP2 and TP4 were all aborted due to collapsing ground and running sand. A soil infiltration rate of 3.92×10^{-5} was recorded within TP3. The test within TP3 was undertaken in general accordance with BRE365, however, due to time constraints it was unachievable to perform three repeat tests.

APPENDIX B

ENGINEERING LOGS





Unit 7, Danworth Farm
Hurstpierpoint
BN6 9GL

Geo-Environmental

Trial Pit Log

Trial Pit No

TP1

Sheet 1 of 1

Project Name: West Tye Lane, Walberton

Project No.
GE17029

Co-ords: 496824.65 - 106415.83
Level:

Date

Location: Walberton, BN18 0LU

Dimensions (m):

2.00

Scale
1:25

Client: Cannon Consulting Engineeres

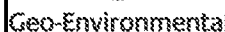
Depth
2.30

0.60

Logged
V. Bennett

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
				0.60			Pale brown mottled grey silty gravelly CLAY. Gravel is rounded to subangular flint. TOPSOIL	
	1.00	PP	PP=0.25kg/cm2				Very soft orange mottled grey CLAY. RAISED BEACH DEPOSITS	1
	1.20	D		1.15			Orange fine SAND. RAISED BEACH DEPOSITS	2
				2.30			End of Pit at 2.30m	3
								4
								5
Water Strike		Remarks						
Depth Strike		Remarks						
		Stability		Collapsing from 1.40m bgl filled in immediately due to instability.				





Geo-Environmenta

Geo-Environmenta

TP2

Geo-Environmenta

Date _____

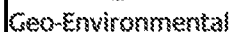
0.60

Remarks

Stability

Collapsing from 0.16m bgl backfilling the pit to 0.70m bgl. No soakage test carried out due to instability.





Trial Pit Log

TP3

Sheet 1 of 1

Project No.
GE17029

Co-ords: 496985.92 - 106194.28
Level:

Date _____

Location: Walberton, BN18 0LU

Dimensions (m): 8 1.75

Scale
1:25

Client: Cannon Consulting Engineer

Depth
3.00

0.60

1.75

Logged
V. Bennett





Unit 7, Danworth Farm
Hurstpierpoint
BN6 9GL

Geo-Environmental

Trial Pit Log

Trial Pit No

TP4

Sheet 1 of 1

Project Name: West Tye Lane, Walberton

Project No.
GE17029

Co-ords: 496763.30 - 106180.35
Level:

Date

Location: Walberton, BN18 0LU

Dimensions (m): 1.55

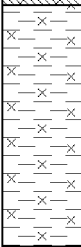
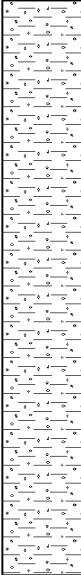
Depth
3.00

0.60

Scale
1:25

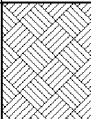
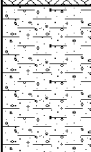
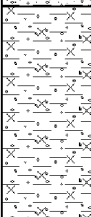
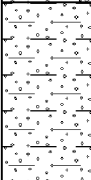
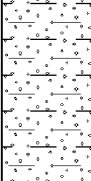
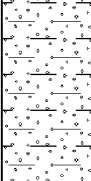
Logged
V. Bennett

Client: Cannon Consulting Engineeres

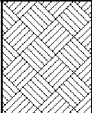
Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.70	PP	PP=1kg/cm2	0.30			Dark brown clayey silt topsoil. TOPSOIL	1
							Firm reddish brown silty CLAY. RIVER TERRACE DEPOSITS	
				1.10			Reddish brown very gravelly CLAY. Gravel is angular flint. RIVER TERRACE DEPOSITS	
				3.00			End of Pit at 3.00m	3
								4
								5
Water Strike		Remarks						
Depth Strike								
		Stability						





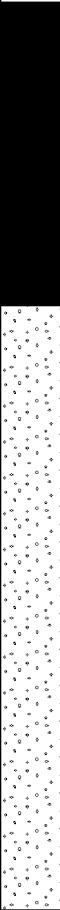
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Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496675E - 106225N				Sheet 1 of 1 Hole Type WLS	
Location: Walberton, BN18 0LU				Level: 0.00				Scale 1:25	
Client: Cannon Consulting Engineers				Dates:				Logged By PC	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.40	-0.40		Dark brown silty slightly gravelly organic clay. With medium flint gravel. TOPSOIL	1
		0.50	D					Soft orangish brown gravelly slightly sandy CLAY. Gravels comprise fmc angular to sub-angular flints. RIVER TERRACE DEPOSITS	
		1.00	D		1.10	-1.10		medium to coarse angular flint horizon	2
		1.50	D		1.80	-1.80		Firm to stiff silty CLAY with rare fine flint gravel. RIVER TERRACE DEPOSITS	
		2.00	D		4.00	-4.00		FMC angular flint GRAVEL with sandy CLAY matrix c.70% gravel. RIVER TERRACE DEPOSITS	3
		2.50	D					Gravel becomes coarse from 2.40m	
		3.00	D						
		3.50	D						4
	4.00	D					End of Borehole at 4.00m		
Casing Diameter Depth (m) Water Strikes (mbgl) Depth Strike Rose to Chiselling (mbgl) Depth from Depth to Remarks									
0.85 0.62 									

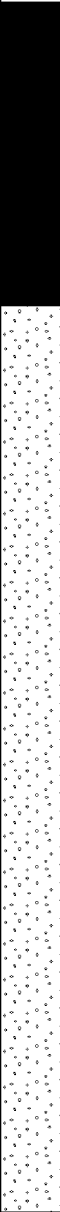
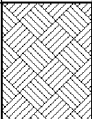
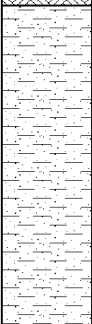
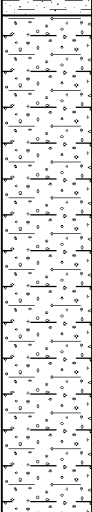
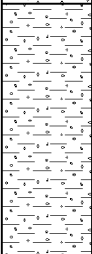
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Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496806E - 106407N		Hole Type WLS	
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25	
Client: Cannon Consulting Engineeres				Dates:		Logged By PC	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D				 Dark brown sandy gravelly clay. With occasional flint and abundant rootless. TOPSOIL		
		0.50	D		0.40	-0.40	 Soft to stiff dark brown sandy gravelly CLAY with occasional carbonaceous deposits. Gravels comprise fmc sub-angular to angular flint. RAISED BEACH DEPOSITS		
					0.70	-0.70	 Occasional black staining between 0.60m - 0.80m.		
		1.00	D				 Orangish brown and grey silty clayey fine SAND with occasional fmc sub-angular flint gravel. RAISED BEACH DEPOSITS	1	
		2.00	D				 Sand becomes very clayey from 2.30m	2	
		3.00	D				 Red staining	3	
		4.00	D		4.00	-4.00	 End of Borehole at 4.00m	4	
								5	

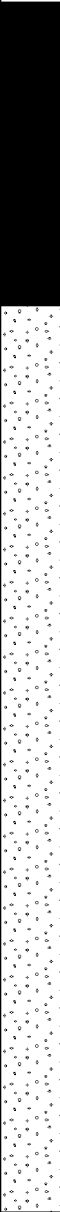
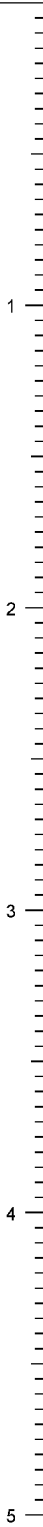
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	
		0.90	0.92			

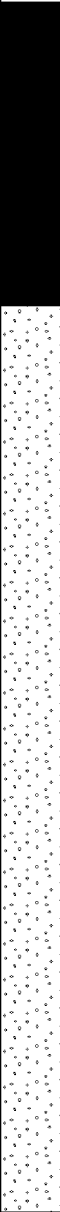
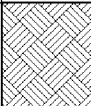
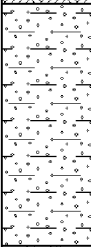
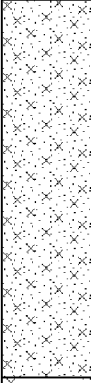
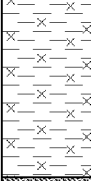


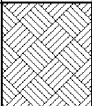
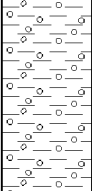
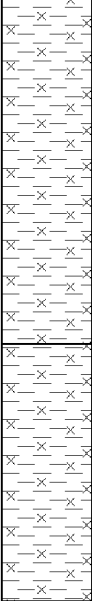
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Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496900E - 106342N		Hole Type WLS		Sheet 1 of 1	
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25			
Client: Cannon Consulting Engineeres				Dates:		Logged By PC			
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.30	-0.30		Dark brown silty organic Clay with occasional fmc angular flint gravel. TOPSOIL	1
		0.50	D					Dark brown gravelly CLAY Gravels comprise fine sub-angular flint. RIVER TERRACE DEPOSITS	
		1.00	D		0.60	-0.60		FMC angular to sub angular flint GRAVEL in a dark brown siltyCLAY matrix. c.70% gravel RIVER TERRACE DEPOSITS	
		1.50	D					Matrix becomes more abundant (c. 40%) and orangish brown	
		2.00	D		1.80	-1.80		Firm orangish brown silty CLAY matrix (c.65%) with fmc sub-angular to angular flint GRAVEL, RIVER TERRACE DEPOSITS	2
		2.50	D						
		3.00	D					Gravels become less abundant from 3.10 more (c. 75% matrix)	3
		3.50	D						
		4.00	D		4.00	-4.00		End of Borehole at 4.00m	4
									5
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks			
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	Collapsed to 3.00m			
									

 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL		Borehole Log				Borehole No. WS04 Sheet 1 of 1				
Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496873E - 106201N		Hole Type WLS				
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25				
Client: Cannon Consulting Engineeres				Dates:		Logged By PC				
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.40	-0.40	 Dark brown sandy clay with fine to medium flint gravel. TOPSOIL	1		
		0.50	D				 Firm brown sandy CLAY with occasional black flecks and with occasional fmc angular flint gravel RIVER TERRACE DEPOSITS			
		1.00	D				<i>Turns orangish brown from 1.05m</i>	2		
		1.50	D			1.50	-1.50		 FMC sub-rounded to angular flint GRAVEL within an orangishbrown sandy CLAY matrix. (c. 75% matrix) RIVER TERRACE DEPOSITS	
		2.00	D						 Firm to stiff sandy slightly gravelly CLAY Gravels comprise fine to medium angular flint. LONDON CLAY	3
		3.00	D			3.15	-3.15			
4.00	D			4.00	-4.00	End of Borehole at 4.00m	4			
								5		
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks				
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to					
		3.73	3.60							

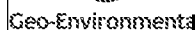


		Unit 7, Danworth Farm Hurstpierpoint BN6 9GJ		Borehole Log				Borehole No. WS05 Sheet 1 of 1		
Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496969E - 106193N		Hole Type WLS				
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25				
Client: Cannon Consulting Engineeres				Dates:		Logged By PC				
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.25	-0.25		Dark brown silty organic clay with rootlets. TOPSOIL		
		0.50	D					Firm to stiff reddish brown gravelly CLAY Gravels comprise fmc sub-angular to angular flint. RIVER TERRACE DEPOSITS		
		1.00	D			0.80	-0.80			Firm to very stiff gravelly CLAY Gravels comprise fmc sub-angular to angular flints. RIVER TERRACE DEPOSITS
		2.00	D			2.15	-2.15			FMC sub-angular to angular flint GRAVEL in a dark brown silty CLAY matrix (c. 20% matrix). RIVER TERRACE DEPOSITS
		3.00	D			3.80	-3.80			Firm to stiff grey and orangish brown with occasional black staining silty CLAY RIVER TERRACE DEPOSITS
		4.00	D		4.00	-4.00	End of Borehole at 4.00m		4	
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks				
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to					
		3.10	2.85							

		Unit 7, Danworth Farm Hurstpierpoint BN6 9GL		Borehole Log				Borehole No. WS06		
Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496908E - 106393N		Hole Type WLS		Sheet 1 of 1		
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25				
Client: Cannon Consulting Engineeres				Dates:		Logged By PC				
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.35	-0.35		Dark brown organic silty CLAY with rootless and occasional flintgravel. TOPSOIL		
		0.50	D					FMC angular flint GRAVEL in a bronze and grey sandy CLAY matrix(c. 60% gravel) RIVER TERRACE DEPOSITS		
		1.00	D			1.15	-1.15			Orangish brown and grey silty clayey fine SAND with rare fm sub-angular flint gravel. RIVER TERRACE DEPOSITS <i>Becomes very clayey with sandy CLAY horizons.</i>
		1.50	D							
		2.00	D			2.40	-2.40			
				2.50	D			3.00		-3.00
		3.00	D			4.00	-4.00	End of Borehole at 4.00m		
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks				
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to					
		0.33	0.33							

 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL		Borehole Log				Borehole No. WS07 Sheet 1 of 1				
Project Name: West Tye Lane, Walberton		Project No. GE17029		Co-ords: 496864E - 106379N		Hole Type WLS				
Location: Walberton, BN18 0LU				Level: 0.00		Scale 1:25				
Client: Cannon Consulting Engineeres				Dates:		Logged By PC				
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					0.35	-0.35		Dark brown silty cay with rootlets TOPSOIL		
		0.50	D					Firm to stiff orangish brown and grey silty CLAY with occasional MC angular to sub-angular flint gravel RIVER TERRACE DEPOSITS		
		1.00	D		1.00	-1.00		Orangish brown and grey silty Clay LONDON CLAY	1	
		1.50	D							
		2.00	D		2.15	-2.15		Soft to firm grey brown silty sandy CLAY. LONDON CLAY	2	
		2.50	D							
		3.00	D		3.00	-3.00			3	
		3.50	D							
4.00	D						4			
End of Borehole at 4.00m										
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks				
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to					
		0.63	0.63							





Borehole Log

WS08

Sheet 1 of 1

Hole Type	WLS
-----------	-----

Scale
1:25

Logged By
PC



Appendix 5

Flood Maps

Flood map for planning

Your reference
Tye Lane

Location (easting/northing)
496843/106303

Created
1 Dec 2021 15:52

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2021 OS 100024198. <https://flood-map-for-planning.service.gov.uk/os-terms>

Flood map for planning

Your reference

Tye Lane

Location (easting/northing)

496843/106303

Scale

1:2500

Created

1 Dec 2021 15:52

-  Selected area
-  Flood zone 3
-  Flood zone 3: areas benefitting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

0 20 40 60m

Page 2 of 2



Extent of flooding from rivers or the sea

High
 Medium
 Low
 Very low
 Location you selected

 Maximum extent of flooding
  Location you selected



Extent of flooding from surface water

High
 Medium
 Low
 Very low
 Location you selected



Surface water flood risk: water depth in a high risk scenario

Flood depth (millimetres)

Over 900mm 300 to 900mm Below 300mm Location you selected



Surface water flood risk: water depth in a medium risk scenario

Flood depth (millimetres)

Over 900mm 300 to 900mm Below 300mm Location you selected



Surface water flood risk: water depth in a low risk scenario

Flood depth (millimetres)

Over 900mm 300 to 900mm Below 300mm Location you selected

data.gov.uk - Historic Flood Map



Appendix 6

Proposed Site Layout and Impermeable Area Plan



TITLE Proposed Site Layout Plan	
SCALE 1:1,250 @ A3	PROJECT No. 23377
REPORT TYPE Flood Risk Assessment	DWG. No. 03



Appendix 7

Preliminary Drainage Strategy Plan and Calculations

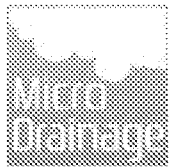


DRAINAGE KEY:	
Existing Sewers	
Existing Foul Sewer	
Proposed Storm Drainage	
Surface Water Manhole	
Proposed Foul Drainage	
Foul Manhole	

TITLE	
Proposed Drainage Strategy Plan	
SCALE	PROJECT No.
1:1,250 @ A3	23377
REPORT TYPE	DWG. No.
Flood Risk Assessment	05

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11 Tungsten Building George Street Fishersgate BN41 1RA		Tye Lane Walberton Arundel			
Date 17/09/2020 File Area 1 Pond.SRCX		Designed by S Burgess Checked by SRM			
Innovyze		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Outflow is too low. Design is unsatisfactory.					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	13.635	0.335	1.8	417.7	O K
30 min Summer	13.745	0.445	1.8	565.0	O K
60 min Summer	13.862	0.562	1.8	725.9	O K
120 min Summer	13.942	0.642	1.8	838.8	O K
180 min Summer	13.995	0.695	1.8	915.6	O K
240 min Summer	14.034	0.734	1.8	972.6	O K
360 min Summer	14.087	0.787	1.8	1050.5	O K
480 min Summer	14.122	0.822	1.8	1103.1	O K
600 min Summer	14.148	0.848	1.8	1142.0	O K
720 min Summer	14.168	0.868	1.8	1172.3	O K
960 min Summer	14.197	0.897	1.8	1216.3	O K
1440 min Summer	14.233	0.933	1.8	1272.5	Flood Risk
2160 min Summer	14.265	0.965	1.8	1322.2	Flood Risk
2880 min Summer	14.284	0.984	1.8	1352.7	Flood Risk
4320 min Summer	14.306	1.006	1.8	1387.1	Flood Risk
5760 min Summer	14.317	1.017	1.9	1403.9	Flood Risk
7200 min Summer	14.329	1.029	1.9	1423.8	Flood Risk
8640 min Summer	14.345	1.045	1.9	1448.2	Flood Risk
10080 min Summer	14.362	1.062	1.9	1475.4	Flood Risk
15 min Winter	13.653	0.353	1.8	440.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	143.920	0.0	151.3	23	
30 min Summer	97.440	0.0	148.1	38	
60 min Summer	62.720	0.0	282.8	68	
120 min Summer	36.400	0.0	262.2	128	
180 min Summer	26.602	0.0	256.8	186	
240 min Summer	21.280	0.0	258.9	246	
360 min Summer	15.447	0.0	266.6	366	
480 min Summer	12.261	0.0	271.1	486	
600 min Summer	10.233	0.0	274.0	604	
720 min Summer	8.820	0.0	275.7	724	
960 min Summer	6.966	0.0	277.1	964	
1440 min Summer	4.999	0.0	275.7	1444	
2160 min Summer	3.608	0.0	558.6	2164	
2880 min Summer	2.879	0.0	558.2	2880	
4320 min Summer	2.119	0.0	546.7	4320	
5760 min Summer	1.724	0.0	1105.2	5592	
7200 min Summer	1.483	0.0	1108.0	6264	
8640 min Summer	1.320	0.0	1101.5	7080	
10080 min Summer	1.202	0.0	1086.8	7864	
15 min Winter	143.920	0.0	151.3	23	
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Date 17/09/2020 File Area 1 Pond.SRCX		Designed by S Burgess Checked by SRM			
Innovyze		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
30 min Winter	13.769	0.469	1.8	596.5	O K
60 min Winter	13.891	0.591	1.8	766.6	O K
120 min Winter	13.975	0.675	1.8	885.9	O K
180 min Winter	14.031	0.731	1.8	967.2	O K
240 min Winter	14.072	0.772	1.8	1027.6	O K
360 min Winter	14.127	0.827	1.8	1110.4	O K
480 min Winter	14.164	0.864	1.8	1166.5	O K
600 min Winter	14.191	0.891	1.8	1208.1	O K
720 min Winter	14.212	0.912	1.8	1240.7	Flood Risk
960 min Winter	14.243	0.943	1.8	1288.4	Flood Risk
1440 min Winter	14.283	0.983	1.8	1350.3	Flood Risk
2160 min Winter	14.319	1.019	1.9	1407.0	Flood Risk
2880 min Winter	14.342	1.042	1.9	1443.6	Flood Risk
4320 min Winter	14.370	1.070	1.9	1489.6	Flood Risk
5760 min Winter	14.388	1.088	1.9	1517.7	Flood Risk
7200 min Winter	14.402	1.102	1.9	1540.9	Flood Risk
8640 min Winter	14.414	1.114	1.9	1561.0	Flood Risk
10080 min Winter	14.430	1.130	1.9	1586.9	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
30 min Winter	97.440	0.0	146.7	37	
60 min Winter	62.720	0.0	274.6	68	
120 min Winter	36.400	0.0	258.7	126	
180 min Winter	26.602	0.0	258.9	184	
240 min Winter	21.280	0.0	265.0	244	
360 min Winter	15.447	0.0	272.8	362	
480 min Winter	12.261	0.0	277.3	480	
600 min Winter	10.233	0.0	280.0	598	
720 min Winter	8.820	0.0	281.6	716	
960 min Winter	6.966	0.0	282.7	954	
1440 min Winter	4.999	0.0	280.6	1426	
2160 min Winter	3.608	0.0	570.2	2120	
2880 min Winter	2.879	0.0	568.8	2824	
4320 min Winter	2.119	0.0	555.1	4188	
5760 min Winter	1.724	0.0	1130.6	5480	
7200 min Winter	1.483	0.0	1131.8	6768	
8640 min Winter	1.320	0.0	1124.1	7944	
10080 min Winter	1.202	0.0	1108.4	8072	
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11 Tungsten Building George Street Fishersgate BN41 1RA	Tye Lane Walberton Arundel	
Date 17/09/2020 File Area 1 Pond.SRCX	Designed by S Burgess Checked by SRM	
Innovyze Source Control 2020.1		

Model Details

Storage is Online Cover Level (m) 14.500

Tank or Pond Structure

Invert Level (m) 13.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1185.0	0.700	1455.1	1.400	0.0	2.100	0.0
0.100	1221.9	0.800	1496.0	1.500	0.0	2.200	0.0
0.200	1259.3	0.900	1537.4	1.600	0.0	2.300	0.0
0.300	1297.4	1.000	1579.4	1.700	0.0	2.400	0.0
0.400	1336.0	1.100	1621.9	1.800	0.0	2.500	0.0
0.500	1375.1	1.200	1665.0	1.900	0.0		
0.600	1414.8	1.201	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0064-2000-1200-2000

Design Head (m) 1.200

Design Flow (l/s) 2.0

Flush-Flo™ Calculated

Objective Minimise upstream storage

Application Surface

Sump Available Yes

Diameter (mm) 64

Invert Level (m) 13.300

Minimum Outlet Pipe Diameter (mm) 100

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.0
Flush-Flo™	0.282	1.8
Kick-Flo®	0.573	1.4
Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.3	7.500	4.7
0.300	1.8	1.600	2.3	4.000	3.5	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.7	8.500	5.0
0.500	1.6	2.000	2.5	5.000	3.9	9.000	5.1
0.600	1.5	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.7	2.400	2.7	6.000	4.2		
1.000	1.8	2.600	2.8	6.500	4.4		

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11 Tungsten Building George Street Fishersgate BN41 1RA		Tye Lane Walberton Arundel			
Date 17/09/2020 File Area 2 Pond.SRCX		Designed by S Burgess Checked by SRM			
Innovyze		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+40%)</u> Outflow is too low. Design is unsatisfactory.					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (mE)	Status
15 min Summer	12.944	0.344	1.8	435.5	O K
30 min Summer	13.058	0.458	1.8	589.1	O K
60 min Summer	13.178	0.578	1.8	757.0	O K
120 min Summer	13.260	0.660	1.8	874.8	O K
180 min Summer	13.315	0.715	1.8	955.0	O K
240 min Summer	13.355	0.755	1.8	1014.5	O K
360 min Summer	13.409	0.809	1.8	1096.0	O K
480 min Summer	13.445	0.845	1.8	1151.2	O K
600 min Summer	13.472	0.872	1.8	1192.1	O K
720 min Summer	13.492	0.892	1.8	1224.1	O K
960 min Summer	13.522	0.922	1.8	1270.6	Flood Risk
1440 min Summer	13.560	0.960	1.8	1330.5	Flood Risk
2160 min Summer	13.594	0.994	1.8	1384.3	Flood Risk
2880 min Summer	13.615	1.015	1.9	1418.1	Flood Risk
4320 min Summer	13.640	1.040	1.9	1457.7	Flood Risk
5760 min Summer	13.653	1.053	1.9	1478.6	Flood Risk
7200 min Summer	13.666	1.066	1.9	1500.4	Flood Risk
8640 min Summer	13.683	1.083	1.9	1527.3	Flood Risk
10080 min Summer	13.701	1.101	1.9	1557.1	Flood Risk
15 min Winter	12.963	0.363	1.8	459.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (mE)	Discharge Volume (mE)	Time-Peak (mins)	
15 min Summer	143.920	0.0	151.3	23	
30 min Summer	97.440	0.0	147.4	38	
60 min Summer	62.720	0.0	278.1	68	
120 min Summer	36.400	0.0	259.7	128	
180 min Summer	26.602	0.0	257.4	186	
240 min Summer	21.280	0.0	262.3	246	
360 min Summer	15.447	0.0	270.2	366	
480 min Summer	12.261	0.0	274.8	486	
600 min Summer	10.233	0.0	277.6	604	
720 min Summer	8.820	0.0	279.3	724	
960 min Summer	6.966	0.0	280.7	964	
1440 min Summer	4.999	0.0	279.2	1444	
2160 min Summer	3.608	0.0	566.6	2164	
2880 min Summer	2.879	0.0	566.0	2884	
4320 min Summer	2.119	0.0	554.1	4320	
5760 min Summer	1.724	0.0	1123.8	5712	
7200 min Summer	1.483	0.0	1126.2	6408	
8640 min Summer	1.320	0.0	1119.3	7168	
10080 min Summer	1.202	0.0	1104.3	7968	
15 min Winter	143.920	0.0	151.2	23	
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Date 17/09/2020 File Area 2 Pond.SRCX		Designed by S Burgess Checked by SRM			
Innovyze		Source Control 2020.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (mE)	Status
30 min Winter	13.082	0.482	1.8	622.0	OK
60 min Winter	13.208	0.608	1.8	799.3	OK
120 min Winter	13.293	0.693	1.8	923.9	OK
180 min Winter	13.351	0.751	1.8	1008.8	OK
240 min Winter	13.393	0.793	1.8	1071.9	OK
360 min Winter	13.450	0.850	1.8	1158.5	OK
480 min Winter	13.488	0.888	1.8	1217.3	OK
600 min Winter	13.516	0.916	1.8	1261.1	Flood Risk
720 min Winter	13.538	0.938	1.8	1295.4	Flood Risk
960 min Winter	13.570	0.970	1.8	1345.8	Flood Risk
1440 min Winter	13.611	1.011	1.8	1411.7	Flood Risk
2160 min Winter	13.649	1.049	1.9	1472.8	Flood Risk
2880 min Winter	13.674	1.074	1.9	1513.0	Flood Risk
4320 min Winter	13.706	1.106	1.9	1564.7	Flood Risk
5760 min Winter	13.726	1.126	1.9	1597.6	Flood Risk
7200 min Winter	13.742	1.142	2.0	1624.9	Flood Risk
8640 min Winter	13.757	1.157	2.0	1648.8	Flood Risk
10080 min Winter	13.773	1.173	2.0	1675.6	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (mE)	Discharge Volume (mE)	Time-Peak (mins)	
30 min Winter	97.440	0.0	145.7	37	
60 min Winter	62.720	0.0	270.3	68	
120 min Winter	36.400	0.0	257.7	126	
180 min Winter	26.602	0.0	262.1	184	
240 min Winter	21.280	0.0	268.6	244	
360 min Winter	15.447	0.0	276.5	362	
480 min Winter	12.261	0.0	281.0	480	
600 min Winter	10.233	0.0	283.7	598	
720 min Winter	8.820	0.0	285.2	716	
960 min Winter	6.966	0.0	286.2	954	
1440 min Winter	4.999	0.0	284.0	1426	
2160 min Winter	3.608	0.0	578.2	2120	
2880 min Winter	2.879	0.0	576.4	2824	
4320 min Winter	2.119	0.0	562.1	4192	
5760 min Winter	1.724	0.0	1148.8	5528	
7200 min Winter	1.483	0.0	1149.5	6776	
8640 min Winter	1.320	0.0	1141.1	7960	
10080 min Winter	1.202	0.0	1124.8	8176	
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11 Tungsten Building George Street Fishersgate BN41 1RA	Tye Lane Walberton Arundel																																					
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Date 17/09/2020 File Area 2 Pond.SRCX	Designed by S Burgess Checked by SRM	
Innovyze Source Control 2020.1		

Model Details

Storage is Online Cover Level (m) 13.800

Tank or Pond Structure

Invert Level (m) 12.600

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1200.0	0.700	1471.7	1.400	0.0	2.100	0.0
0.100	1237.1	0.800	1512.8	1.500	0.0	2.200	0.0
0.200	1274.8	0.900	1554.5	1.600	0.0	2.300	0.0
0.300	1313.1	1.000	1596.7	1.700	0.0	2.400	0.0
0.400	1351.9	1.100	1639.4	1.800	0.0	2.500	0.0
0.500	1391.3	1.200	1682.8	1.900	0.0		
0.600	1431.2	1.201	0.0	2.000	0.0		

Hydro-Brake÷ Optimum Outflow Control

Unit Reference	MD-SHE-0064-2000-1200-2000
Design Head (m)	1.200
Design Flow (l/s)	2.0
Flush-Flow	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	12.600
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.0
Flush-Flow	0.282	1.8
Kick-Flow	0.573	1.4
Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake÷ Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.0	3.000	3.0	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.3	7.500	4.7
0.300	1.8	1.600	2.3	4.000	3.5	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.7	8.500	5.0
0.500	1.6	2.000	2.5	5.000	3.9	9.000	5.1
0.600	1.5	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.7	2.400	2.7	6.000	4.2		
1.000	1.8	2.600	2.8	6.500	4.4		

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Appendix 8

Drainage Maintenance Schedule

Drainage Maintenance Schedule



The Civil Engineering Practice
11 Tungsten Building
George Street
Fishergate
Sussex
BN41 1RA

Project	Land West of Tye Lane, Walberton, West Sussex
Project Number	23377

By Steve Burgess

Date 18 September 2020

1 Schedule of Maintenance

- 1.1 Once appointed the Contractor will prepare a site specific method statement for the control of silt and other pollutants during construction. CIRIA Report C532, Control of water pollution from construction sites, provides further guidance on this.
- 1.2 The Contractor will maintain the proposed drainage system during construction and until the handing over of the site.
- 1.3 Upon completion management of the shared drainage facilities (where not adopted) will be passed on to a Management Company appointed by the developer on behalf of the new residents.
- 1.4 In the event that the Management Company becomes unable to discharge its duties within two years of first appointment the developer will endeavour to appoint an alternative on behalf of the residents.
- 1.5 Maintenance of individual property drainage connections is the responsibility of the individual property owners.
- 1.6 The following maintenance schedule details the typical tasks to be undertaken at different intervals.

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Manage other vegetation and remove nuisance plants – aesthetics	As required
	Litter and debris removal – catch pits and detention basin	Monthly or as required
	Mowing – detention basin	Monthly or as required
	Remove sediment and debris from silt trap chambers, channel drains and inlet chambers	6 monthly
	Surface and foul water pipework – jetting / rodding	Every 2 years or as required
Corrective Maintenance	Remove debris / blockages to silt traps / channel drains	As required
	Repairs to access chambers / manhole covers	As required
	Inspect inlet, outlet from downpipe and gullies for blockages, standing water and clear	As required

Indicative Schedule of Maintenance for the Proposed Drainage System



2 Financing

- 2.1 The regular maintenance of all private drainage, channels, gutters, rainwater pipes and connections will be the responsibility of the individual homeowner.
- 2.2 The regular and corrective maintenance of all shared elements of the drainage system will be managed and funded through the Management Company on behalf of the Residents.

Inspection / Action Required	Gullies, Channels and Gutters	Catchpits	Surface Water Pipework
6 Months	✓	✓	
1 Year			
After leaf fall in Autumn	✓	✓	
2 Years			✓

Drainage System Maintenance Summary