



RIDGE

**BELOW GROUND DRAINAGE
STRATEGY
ST COLUMBA'S CLOSE, GRAVESEND**

GRAVESHAM BOROUGH COUNCIL

October 2022



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ST COLUMBA'S CLOSE, GRAVESEND**

GRAVESHAM BOROUGH COUNCIL

October 2022

Prepared for

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PROJECT NAME: St Columba's Close, Gravesend
PROJECT NUMBER: 5015556
DOCUMENT REFERENCE: 5015556-RDG-XX-XX-DOC-C-9500-02
DOCUMENT STATUS: S2 – Suitable for Information

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Gravesend Borough Council

SECTION 1

INTRODUCTION

1. INTRODUCTION

1.1. Appointment and Brief

This surface and foul water drainage strategy (DS) has been prepared on behalf of Gravesham Borough Council for a proposed development at St Columba's Close, located off Valley Drive, Gravesend, Kent, DA12 4AJ (hereby referred to as the 'Application Site').

The purpose of this document is to outline the development of the proposed DS, providing sufficient detail to enable both a thorough review of design principles adopted and further refinement of the design as part of the ongoing development of the project.

It aims to demonstrate the foul and surface water management at the Application Site, as follows:

- Provide an analysis of the impact of the proposed development on surrounding foul water infrastructure and identify the constraints present on the site in terms of suitability of conventional gravity drainage.
- Demonstrate the principles of surface water management in terms of infiltration design and spatial requirements, describing how these can be accommodated within the development proposals.

The proposed DS outlined herein is subject to further detailed analysis at design stage.

1.2. Aims and Objectives

The DS has been prepared with reference to the following requirements:

- The DS must:
 - Ensure that flood risk to the Application Site and surrounding area is not increased over the lifetime of the Proposed Development;
 - Conform with all relevant National, Kent County Council and Local flood risk policies;
 - Adopt current design standards; and
 - Consider long-term maintenance with respect to practicality, ownership and funding.
- The DS should:
 - Mimic the existing drainage characteristics of the Application Site as far as is practical;
 - Look for opportunities to provide a reduction in flood risk to the Application Site and the surrounding area;
 - Adhere to current best practice guidance;
 - Contribute to the enhanced amenity and aesthetic value of the Application Site; and
 - Propose opportunities for biological enhancement and provide habitats for wildlife in urban areas.

1.3. Limitations

The purpose of this report is outlined in Section 1.2, together with those related matters specifically referred to therein and it is not intended to be used for any other purposes. The report is for the sole benefit and may only be relied upon by the addressee, to whom we will owe a duty of care. The report and any part of it is confidential to the addressee and should not be disclosed to any third party for any purpose, without the prior written consent of Ridge and Partners LLP as to the form and context of such disclosure. The granting of such consent shall not entitle the third party to place reliance on the report, nor shall it confer any third-party rights pursuant to the Contracts (Rights of Third Parties) Act. The report may not be assigned to any third party.

1.4. Reference Information

The following information has been obtained and interrogated as part of this study:

- RSA Group Plc (2022). Ref: JER9191. Phase 1 Preliminary Risk Assessment and Phase 2 Geo-Environmental and Geotechnical Site Investigation Report.
- EDI Surveys Ltd. (2017). Ref: 16204/T/01. Topographic Survey.
- EDI Surveys Ltd. (2017). Ref: 16204/T/01. Underground Services Survey.
- BPTW Ltd (2022). Ref: SCC-BPTW-04-00-DR-A-0210-P01-S3. Proposed Ground Floor Site Plan

In addition, the following documents have been consulted:

- Communities and Local Government Document. (2021). The National Planning Policy Framework;
- Environment Agency. (2022). Flood Risk Assessments: Climate Change Allowances;
- Environment Agency. (2021). Rainfall Runoff Management for Urban Developments;
- CIRIA. (2015). C753 – The SuDS Manual;
- Secretary of State. (2015). Building Regulations Approved Document H;
- Butler & Davies. (2018). 4th Ed. Urban Drainage;
- British Geological Survey Online Mapping Tool;
- DEFRA / EA Interactive online mapping (magic.defra.gov.uk);
- Department for Environment, Food and Rural Affairs. (2015). Non-Statutory Technical Standards for Sustainable Drainage Systems;
- Department for Environment, Food and Rural Affairs & Environment Agency. (2017). Flood Risk Assessment for Planning Applications;
- Gravesham Borough Council (2014). Gravesham Local Plan Core Strategy;
- Gravesham Borough Council (2014). Gravesham Local Plan Core Strategy – Policies Map.
- Aecom Ltd. (2013). Water. People. Places. A guide for master planning sustainable drainage into developments;
- Gravesham Borough Council (2019). Gravesham Local Development Scheme (2019 – 2021);
- Gravesham Borough Council (2020). Part 1: Local Plan core strategy partial review and site allocations;
- Kent County Council (2000). The Soakaway Design Guide.
- Kent County Council (2017-2023) Kent Local Flood Risk Management Strategy.

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SECTION 2

PROJECT BACKGROUND

2. PROJECT BACKGROUND

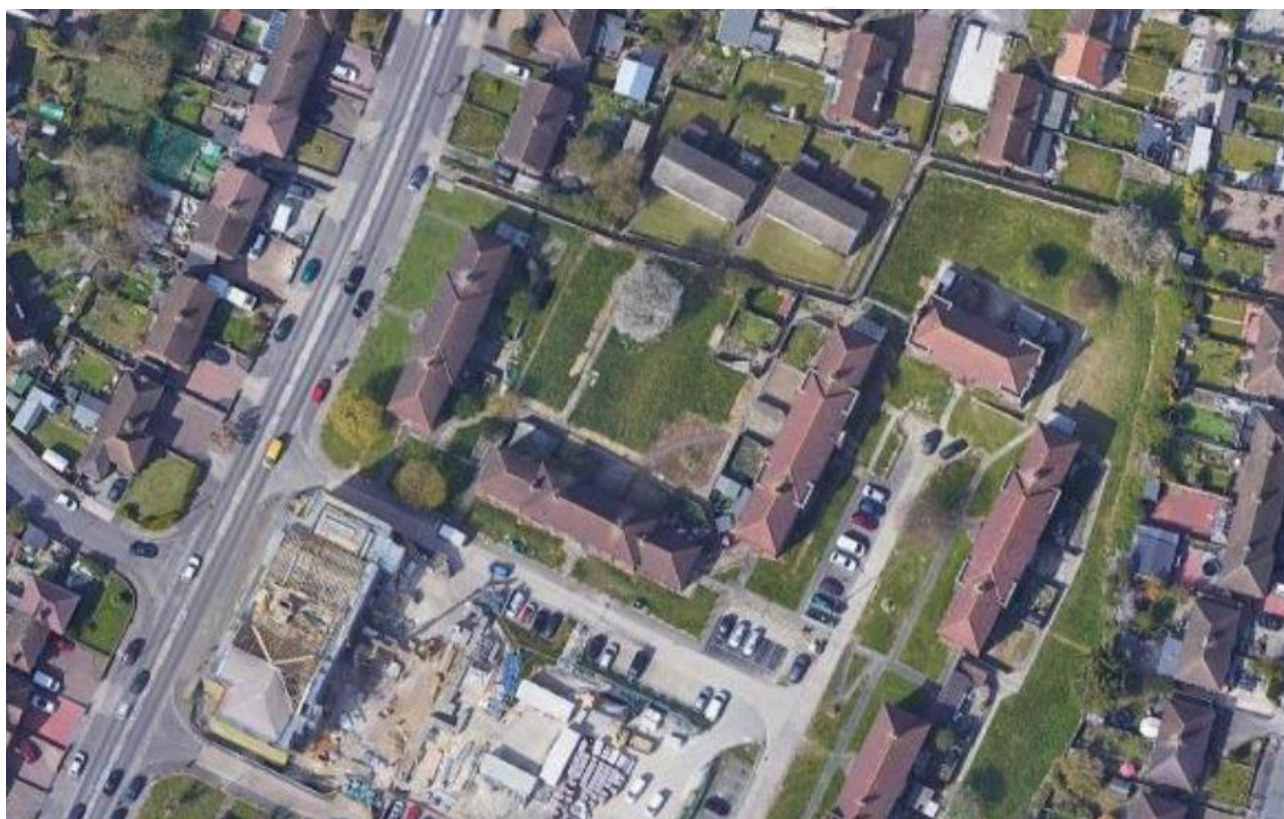
2.1. Site Location and Existing Land Use

The Application site is located off Valley Drive, Gravesend, Kent. The site is bound by residential flats and associated green space to the North, East and South and Valley Drive and low-rise residential housing to the West (see Appendix A).

The Ordinance Survey (OS) grid reference for the application site is approximately 565986 E 172134 N and the nearest post code is DA12 4AJ.

The existing site spans 1.04 hectares and houses approximately 67 dwellings across five blocks of three storey flats and two storey maisonettes.

In addition to the above, the site also includes access roads, car parking areas and amenity spaces.



2.2. Existing Drainage Infrastructure

The Sewerage Undertaker is understood to be Southern Water and a review of their asset records (see Appendix C) suggests the following significant public infrastructure on or within close vicinity of the Application Site:

- To the Southern Boundary:
 - 300 mm diameter foul water sewer within the Application Site flowing East to West within existing amenity space, where it connects to the 750 mm diameter foul sewer within Valley Drive.

- To the Northern Boundary:
 - 150 mm diameter foul water sewers flowing South to North off Valley Drive and St Columba's Close connecting to further foul sewers further north.
- To the Eastern Boundary:
 - 150 mm diameter foul water sewers flowing North to South within the front gardens of the properties off St Patrick's Gardens, connecting to the 375mm foul water sewer within the Application Site that flows from East to West.
- To the Western Boundary:
 - 100 mm diameter foul water sewer flowing North to South within the front gardens of the existing flats off Valley Drive within the Application Site, connecting to the 300mm foul water sewer within the Application Site that flows from East to West.
 - A 750 mm foul water sewer flowing South to North within Valley Drive which appears to serve a significant proportion of local foul water infrastructure.

The mapping reveals that there are no public surface water sewers within the site boundary, or indeed the surrounding area, and this is likely owing to the high permeability of the underlying chalk, where the majority of surface water drains to ground. The existing site is not known to have any surface water flow restriction or benefit from SuDS features.

Investigative works undertaken to-date suggest that the existing buildings within the Application site discharge to the public foul water sewers to the Southern, Western and Eastern boundaries via private drainage networks.

2.3. Topography

The site predominantly slopes from East to West from an elevation of circa 35 m Above Ordinance Datum (AOD) at the Eastern boundary backing onto the properties off St Dunstan's Drive down to circa 24 m at Valley Drive.

A nominal fall of circa 0.5 m is also present from South to North.

2.4. Geology and Hydrogeology

British Geological Survey (BGS) online mapping indicates that the Application Site is situated on a bedrock of Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation Chalk.

Intrusive geotechnical investigations, undertaken by RPS Group, have confirmed ground conditions comprised made ground (and occasionally topsoil) over superficial head deposits (comprising gravelly, sandy silt) on the very western boundary over chalks of the Seaford Chalk Formation.

The Environment Agency's online mapping suggests the underlying bedrock to be classified as a Principal Aquifer, with the site sitting within a Zone 2 (Outer Protection) Source Protection Zone (SPZ).

2.5. Hydrology

No Main Rivers or significant watercourses are known to be present within the curtilage of the Application Site.

The River Thames (a Main River) is approximately 2.25km to the North of the site and is known to rise in Kemble in Gloucestershire flowing generally in a Westerly direction and discharging to the sea via the Thames Estuary to the north of the site.

Existing surface water generated by the Application Site is suspected to discharge to ground which, via both interflow through the vadose zone and aquifer flow through the saturated zone, flows into the River Thames, as outlined above.

2.6. Proposed Development

A planning application is being submitted for circa 46 homes, comprising flats and maisonettes, alongside a new through-road and parking areas (see Appendix B).

The development will involve the demolition of some of the existing northern flats/properties and the relocation of existing residents prior to the construction of the new flats and maisonettes.

2.7. Easements and Other Constraints

Utilities records obtained for the site as well as a Utilities Survey undertaken show the presence of several existing utilities on and within the immediate vicinity of the Application Site, as would be expected based upon its previous brownfield use (see Appendix A).

All of these services may benefit from easements and will therefore require further consideration during the ongoing course of design development.

2.8. Below Ground Drainage Diversions and Other Constraints

The existing Southern 300/375mm foul water sewer bisects the application site and will require diversion as part of a separate Section 185 application. Additionally, the existing 150mm foul sewer serving the flats in St Patrick's Gardens will need diverting as it currently runs under the footprint of Block B.

It is intended to undertake the diversion works on a phased basis, as follows:

- Install new sewers in preparation for the construction phase.
- Install new temporary 'bypass' sewers to connect the existing adopted network to the new sewers.
- Abandon existing sewer within the Application Site.
- Proceed with the construction process.

For the purposes of this DS, it will be assumed that any Section 185 works would be granted, and the public sewer diverted/divested as intended (see Appendix G).

2.9. Assessing Flood Risk

The Department for Environment, Food and Rural Affairs & Environment Agency (2017). *Flood Risk Assessment for Planning Applications* confirms that detailed flood risk assessment is required where the Application Site is:

- Located in Flood Zone 2 or 3, including minor development and change of use; or
- More than 1 hectare (Ha) in Flood Zone 1; or

- Less than 1 Ha in Flood Zone 1, including change of use in a development type to a more vulnerable class, where the development could be affected by sources of flooding other than by rivers and the sea; or
- In an area within Flood Zone 1 that has critical drainage problems as notified by the Environment Agency.

The Government's online Flood Map for Planning indicates that the Application site is predominantly situated within Flood Zone 1. In accordance with Table 1 (Flood Zones) of the NPPF, this classifies the site of having a less than 1:1000 annual probability of river or sea flooding.

The Application Site is approximately 1.04 hectares and therefore a Flood Risk Assessment will be required. Given this it is considered that a detailed analysis of the effects of onsite flooding and determination of mitigation measures is outside the scope of this drainage strategy document and is covered by the Flood Risk Assessment report reference 5015556-RDG-XX-XX-DOC-C-9950.

Notwithstanding the above, it is not envisaged that flooding will present a significant constraint to the development of the drainage strategy.

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SECTION 3

ANALYSIS OF NATIONAL AND LOCAL POLICY

3. ANALYSIS OF NATIONAL, COUNTY AND LOCAL POLICY

3.1. National Policy

National Planning Policy Framework (NPPF)

Communities and Local Government Document. (2021). *The National Planning Policy Framework* requires the Planning Application to demonstrate that the Proposed Development will be safe for the duration of its' design life, taking into account the vulnerability of its' users and without increasing flood risk elsewhere, and where possible, reducing flood risk overall.

Non-Statutory Technical Standards for Sustainable Drainage Systems

Department for Environment, Food and Rural Affairs. (2015). *Non-Statutory Technical Standards for Sustainable Drainage Systems* state that, where a development proposes to discharge to a watercourse/surface water sewer, the peak rate of discharge from a redevelopment during the 1:1 year and 1:100-year rainfall events should be as close as reasonably practical to the corresponding greenfield runoff rate but should never exceed that of the pre-development state.

The standards also recommend that, where reasonably practicable, the runoff volume generated from the 1:100-year, 6-hour rainfall event should be constrained to the corresponding greenfield runoff volume. These measures need not be considered when a development proposes to discharge the entirety of its surface water to ground.

Building Regulations Approved Document H

Secretary of State. (2015). *Building Regulations Approved Document H* establishes a hierarchy for surface water disposal and encourages a SuDS approach. The hierarchy stipulates that surface water runoff which is not collected for re-use must be discharged in the following order of priority:

1. Discharge to ground via infiltration; or, where not reasonably practicable,
2. Discharge to a surface water body (i.e. river, watercourse or the like); or, where not reasonably practicable,
3. Discharge to a surface water sewer, highway drain or other surface water drainage system; or, where not reasonably practicable,
4. Discharge to a combined sewer.

3.2. County Policy

Aecom – Water. People. Places.

Aecom. (2013). *Water. People. Places* outlines strategic planning requirements in relation to the incorporation of SuDS on new developments within the South of England.

The document recommends the adoption of similar principles given within the NPPF and other national policies as stated above.

The report does not incorporate any additional drainage policy constraints or implications to the application site, moreover the report encourages the discharge of surface water to ground specifically discussing the benefits of infiltration within chalk soils. It does reinforce the need to use rainwater harvesting where possible and then follow the normal hierarchy for discharge as in other national policies and building regulations.

Kent County Council – Kent Local Flood Risk Management Strategy.

The Kent County Council Flood Risk Management Strategy focuses on specific strategic planning requirements within Kent with regards to the incorporation of SuDS on new developments within the county.

The document recommends the incorporation of SuDS in accordance with the Aecom Water. People. Places document but also focuses in greater detail on flood risk within the locality, discussing catchment wide flood risk concerns and tactical management of flood risk.

3.3. Local Policy

Gravesham Local Plan Core Strategy

Gravesham Borough council have published their Local Plan Core Strategy 2028 CS, which includes policy 2.10.2 which confirms that all new development will need to use SuDS techniques and be subject to a sequential test. The Flood Risk Assessment which accompanies this Drainage strategy confirms in section 5.1 that the sequential test is considered to be satisfied. The Proposed SuDS techniques are covered in Section 5 of this report.

3.4. Opportunities

The redevelopment of the Application Site will not contribute to an increase in flood risk by emulating the existing discharge to ground. Owing to this method of disposal; runoff volumes and discharge rates need not be considered.

Surface water currently generated by the Application Site is believed to discharge to ground through soakaways/permeable surfacing. The existing surface water drainage strategy has not been analysed; however, the new development shall be designed to latest guidance and industry best practices, ensuring that the system attenuates and infiltrates flows up to an including the 1–100-year event with a suitable allowance for climate change. On the basis of the above, the site will in fact decrease flood risk due to the reduced likelihood of failure of the onsite surface water network.

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SECTION 4

FOUL WATER MANAGEMENT

4. FOUL WATER MANAGEMENT

4.1. Existing Discharge Rates and Points of Connection

The Application Site currently features approximately 67 dwellings across seven blocks of three storey flats and two storey maisonettes.

The exact location and number of existing connections 'per-block' are in accordance with the drain trace and GPR below ground survey found within the appendices of this document.

This said, ultimately each of the private drains serving individual blocks discharge to the existing foul water sewer to the south of the Application Site, prior to discharge to the strategic Main Foul Sewer within Valley Drive, to the West.

High-level estimates of the existing foul water discharge for the Application Site have been prepared in accordance with Butler & Davies. (2018). 4th Ed. *Urban Drainage*, using the Ministry of Housing (1970) Dry Weather Flow (DWF) methodology, assuming the following:

- Infiltration Factor: 1.10
- Peak Flow Factor: 4
- Foul Load:
 - Residential: 4000 l/unit/day

Calculations of the existing properties of St Patrick's Gate (SPG) and St Columba's Close (SCC) are summarised as follows:

EXISTING BLOCKS	QUANTITY	PEAK FLOW (L/S)
1-12 SPG	12	0.55
13-23 SPG	11	0.51
24-35 SPG	12	0.55
28-34 SCC	7	0.32
36-42 SCC	7	0.32
36-41 SPG	6	0.28
42-53 SPG	12	0.55
Totals: 67		3.08

4.2. Proposed Discharge Rates and Points of Connection

The proposed development will provide a total of 46 residential homes which will replace 32 residential homes currently in situ. The existing flats/maisonettes shall be demolished to make way for the new dwellings.

Calculations assuming similar design assumptions and foul loading criteria are as follows:

PROPOSED BLOCKS	QUANTITY	PEAK FLOW (L/S)
Block A	20	0.93
Block B	14	0.65
M01	6	0.28
T01	6	0.28
Totals: 46		2.14

EXISTING BLOCKS TO BE RETAINED	QUANTITY	PEAK FLOW (L/S)
13-23 SPG	11	0.51
24-35 SPG	12	0.55
42-53 SPG	12	0.55
Totals: 35		1.61

A foul water drainage system will be designed and constructed in accordance with the Building Regulations Part H and the Design and Construction Guidance (DCG) and it is intended to connect to new foul water sewers constructed as part of the construction phase.

Primary foul runs have been preliminarily sized as ranging between 100 mm to 150 mm diameter.

4.3. Analysis & Summary

The analysis demonstrates that the Proposed Development will generate a net increase in foul water volume and peak flow to the public foul water sewer network, as summarised below:

DESCRIPTION	RESULT	UNIT
Existing Flow	3.08	l/s
Proposed Flow (Total)	3.75	l/s
Increase / Decrease	+0.67	l/s
%	+21.7	%

The increase is directly attributable to the uplift in new residential units as part of the Proposed Development.

The proximity of the site to the strategic Main Foul Sewer in Valley Drive and current proposals to provide new foul water infrastructure as part of the proposed scheme would suggest that this should not present an issue to the development, assuming enough capacity is present within the strategic sewer.

A capacity check/analysis will need to be progressed with Southern Water to ensure that the existing foul sewer network has sufficient capacity to accommodate the proposed foul water discharge from the proposed development.

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SECTION 5

SURFACE WATER MANAGEMENT

5. SURFACE WATER MANAGEMENT

5.1. Existing Site Location Data

The site location and hydrological data used within this assessment is summarised as follows:

- Grid Reference: TQ 65986 72134 (565986 E, 172134 N)
- Average Annual Rainfall (SAAR): 605
- Soil Index: 0.300
- UK Hydrological Region: Region 7
- Infiltration Rate
 Eastern Site Segment: 3.80×10^{-5} m/s (0.1368m/hr)
 Western Site Segment: 3.49×10^{-6} m/s (0.0125m/hr)

5.2. Design Infiltration Rate

The underlying Seaford Chalk Formation has adequate infiltration characteristics to allow for the tactical disposal of surface water arisings. The RPS Geotechnical Report comprised an Infiltration Assessment constituting 3 trial pits. Each trial pit was excavated in broad alignment with the provisions of BRE Report 365 and, in line with the recommendations of this report, each pit was subjected to 3 infiltration tests, where possible, to determine the design infiltration rate.

The results have been supplied in two formats:

- Interpolation – The determination or estimation of the design value from certain known values of a function.
- Regression analysis – The determination or estimation of the design value from certain known values inputting goodness-of-fit criterion.

The infiltration rates are tabulated below. For the purposes of the design the site has been split into two segments being the Western segment (TP01) and the Eastern segment (TP02 & TP03) owing to the identified underlying geology.

TRIAL PIT	INFILTRATION TEST 1 (INTERPOLATION)	INFILTRATION TEST 2 (INTERPOLATION)	INFILTRATION TEST 3 (INTERPOLATION)
TP01	3.76×10^{-6} m/s	-	-
TP02	6.19×10^{-5} m/s	3.80×10^{-5} m/s	3.94×10^{-5} m/s
TP03	6.00×10^{-5} m/s	4.60×10^{-5} m/s	4.95×10^{-5} m/s

TRIAL PIT	INFILTRATION TEST 1 (REGRESSION)	INFILTRATION TEST 2 (REGRESSION)	INFILTRATION TEST 3 (REGRESSION)
TP01	3.49×10^{-6} m/s	-	-
TP02	6.98×10^{-5} m/s	4.85×10^{-5} m/s	4.76×10^{-5} m/s
TP03	6.85×10^{-5} m/s	5.33×10^{-5} m/s	5.65×10^{-5} m/s

The widespread testing provides sufficient certainty that each half of the site can be characterised as exhibiting certain properties/infiltration characteristics, this is as per CIRIA C753 Section 25.2.1 which states:

"...testing should be as extensive as possible and supported by evidence of wider soil characteristics in order to avoid misinterpretation of relevant soil properties."

As shown the design infiltration rate for the Eastern site segment should be $3.80 \times 10^{-5} \text{m/s}$ (0.1368m/s) and the design infiltration rate for the Western site segment should be $3.49 \times 10^{-6} \text{m/s}$ (0.012564m/s), the selection of the lowest infiltration rate is concurrent with CIRIA C753 specifically Section 25.3 which states:

"The worse-case infiltration rate value should be used (not the mean or any other value) unless a sound justification for doing so is demonstrated."

The proposed segmentation of the site into corresponding infiltration rates is supported by the Soil Characterisation and Particle Size Distribution (PSD) testing in the RPS Geotechnical Report which categorises the virgin chalk soils to the west of the site as Structureless Chalk with supporting PSD testing showing that >80% of particles pass the $425 \mu \text{m}$ sieve, the soil description similar describes the soil as a white and light brown gravelly SILT. To the east of the site the soil is described similarly as a Structureless Chalk with supporting PSD showing that only 11% of particles pass the $425 \mu \text{m}$ sieve, additionally the soil description defines the soil as a silty angular to subrounded GRAVEL and COBBLES.

TRIAL PIT	PARTICLE SIZE DISTRIBUTION – SOIL CLASSIFICATION PERCENTAGE PASSING THE 425MM SIEVE	
CP01	84	CHALK composed of SILT
CP02	85	CHALK composed of SILT
TP02	11	CHALK composed of GRAVEL and COBBLES

5.3. Lateral Spatial Considerations

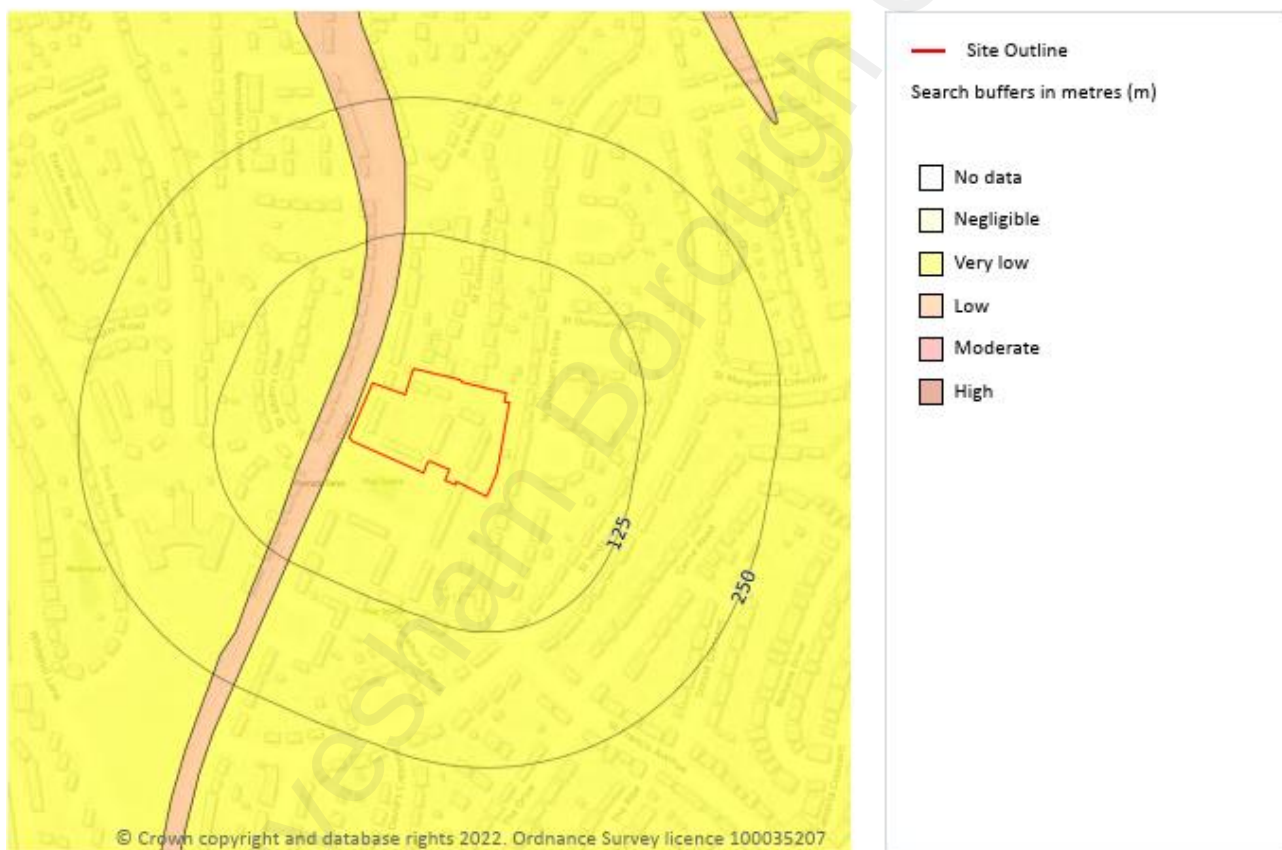
Any proposed soakaway will need to ensure that it meets certain lateral spatial restrictions. Approved Document H places spatial requirements on the proximity of soakaways to buildings/roads. The Kent County Council Soakaway Guide expands on this and analyses the implications of soakaways within the county of Kent, an area synonymous with chalk strata. The Kent County Council Soakaway Guide discusses exclusion zones between 5-15m where soakaways are placed in chalk and emphasises the requirement for more detailed site investigation.

Breakdown of chalk substrates is caused particularly where the chalk strata is overlain by sandy/granular strata such as head deposits. The mechanism of instability arises in the first instance by the washout of the sandy/gravelly lithologies from the drained water being discharged into the underlying strata. Where the soakaway is located in chalk the perforations close to the interface with the overlying superficial deposits allow the water to locally wash away the sand/gravel. The sand/gravel is then transported by the water into fissures within the chalk. These fissures may be open naturally or enlarged further by chemical erosion caused by the drained water. Having been channelled away from the soakaway vicinity the removal of the sand/gravel

forms a small void. The void enlarges naturally until such a point where it is no longer stable and the roof of the void collapses.

With reference to the Groundsure report contained in the RPS Geotechnical Investigation, the likelihood of ground dissolution of soluble rock is Very Low onsite with a Moderate likelihood arising immediately offsite under Valley Drive. The increased risk coincides with the identified prevalence of Head Deposits, further identified within the Groundsure report, and therefore it is reasonable to consider that soakaways could adopt a 5m buffer zones from buildings/highways providing they are not located in areas where the superficial head deposits are identified. The soakaways are to be located in areas that are solely underlain by Made Ground overlying chalk and therefore only a 5m buffer need be considered.

Natural ground subsidence - Ground dissolution of soluble rocks



5.4. Vertical Spatial Considerations

It must be noted that the infiltration tests undertaken were undertaken at depth, below any underlying Made Ground. Therefore, any installed soakaway must be installed at such a depth that there is full penetration of the overlying soils and that the soakaways are placed in the underlying chalk. Additionally, attention needs to be paid to the overall soakaway depth to ensure that the design cover depth of the cellular storage crates is not exceeded. Additionally, the design must ensure that an acceptable number of crates are laid on top of one another as typically cellular storage crates should not be stacked more than 5 high.

5.5. Groundwater Considerations

Close attention needs to be paid to the proximity of the underlying groundwater. Not only does the underlying groundwater risk significantly reducing the attenuation capacity of the cellular storage units and reducing the infiltration capacity of the surrounding soils due to rising groundwater but it also can present a high-risk receptor for contamination if there is an insufficient depth of soil between the base of the infiltration component and the water table. The RPS Geotechnical Investigation undertook groundwater monitoring as part of investigative works. The groundwater monitoring did not encounter groundwater in any of the 3 visits over a 3-week window with onsite monitoring wells to a maximum depth of 10m. Additional neighbouring BGS borehole records have been cited which demonstrate that groundwater is present approximately 20m below site ground level.

Based on the RPS analysis groundwater should not negatively impact the hydraulic design of any onsite soakaways and there would be a significant depth of intermediary soil between the base of the infiltration component and resting groundwater. There are, however, limitations to the analysis undertaken by RPS which leave scope for future investigative work. The groundwater monitoring was only undertaken over a 3-week period and during the summer months which does not provide seasonal variation to the results. Additionally, the monitoring was undertaken during July 2022 during an unprecedented heatwave and drought, the implications of which are not discussed. Additionally, the BGS water well mentioned, TQ67SE148, was read in August 1997, which is also during the summer. On this basis it is recommended that further groundwater monitoring is undertaken over a longer period of time to ensure that the detailed drainage strategy appropriately considers seasonal variations in groundwater levels.

5.6. Proposed Site Impermeable Area & Percentages

The site shall be considered in two segments, being the Eastern side and the Western side. Each side of the site shall discharge to a soakaway which shall be an appropriate distance from adjacent highways/buildings. Total impermeable areas for the proposed soakaways have been calculated as follows.

EASTERN SOAKAWAY – CONTRIBUTING IMPERMEABLE AREA

Item	Area (Sq. M)	Area (hectares)	Total Area + Urban Creep (hectares)
Parking	298.7	0.030	0.030
Buildings	476.2	0.048	0.048
Totals: 774.9		0.078	0.078

WESTERN SOAKAWAY – CONTRIBUTING IMPERMEABLE AREA

Item	Area (Sq. M)	Area (hectares)	Total Area + Urban Creep (hectares)
Roads	754.9	0.075	0.075
Parking	436.5	0.044	0.048
Buildings	1147.9	0.115	0.121
Totals: 2339.3		0.234	0.244

An allowance has been made in the calculations for Urban Creep. Urban Creep is defined as the conversion of permeable surfaces to surfaces over time, such as front gardens for parking, changes to existing buildings and creation of large patio areas. The allowance depends on the size and density of the site as well as the classification of the dwellings/surfacing. As per the LASOO Non-Statutory Technical Standards for Sustainable Drainage: Practice Guidance, no allowance has been included for the apartment blocks as the residents will be leaseholders and therefore will not have control over the footprint of the building or any of the surrounding permeable areas. Furthermore, no allowance has been made for the proposed highway as residents have no control over this feature. The urban creep allowance has therefore only been applied to onsite low-rise houses.

The analysis of impermeable area does not, however, make an allowance for permeable paving which could be considered for parking areas around the site. The reason permeable paving has not been considered is that the depth of made ground is significant in some areas of the site which would lead to a significant quantity of clean, fast draining stone being imported to ensure that permeable paving could be employed. CIRIA C753 frequently references cost-effectiveness in the design methodology for various SuDS components and the likely costs for the installation of permeable paving onsite may well be cost preventative. Therefore. As part of this analysis permeable paving has not been considered.

5.7. Allowance for Climate Change

The DEFRA Climate change allowances for peak rainfall in England map (2022) confirms that a climate change allowance of **40%** should be adopted for the development within the Medway Management Catchment, assuming a lifespan of 100 years for residential development as recommended within the NPPF. All 30 year precipitation events have also had an additional climate change allowance of 35% applied.

5.8. Surface Water Drainage Calculations

The eastern soakaway has been provisionally modelled as an 100m² cellular storage structure 0.4m deep. The western soakaway has been modelled as an 209m² cellular storage structure 1.60m deep. Within the calculations the Structure Type is shown as an Infiltration Basin, this is owing to the fact that the Network module of the Innovyze MicroDrainage design software suite does not model the Half Drain Time for Cellular Storage structures, however, the porosity has been conservatively entered as 94% which is representative of a densely fabricated cellular storage unit. The infiltration tests contained within the RPS Geotechnical Investigation are based on the methodology set out in BRE Report 365, therefore the infiltration rate already makes an allowance for siltation at the base of the soakaway; however, to accommodate for any variation in the underlying strata a factor of safety of 2 has been applied to the calculations. The calculations prove that there would be no flooding onsite or further downstream as a result of the proposed drainage network, including during the 1–100-year precipitation event with a 40% allowance for climate change (Appendix D&E).

EASTERN SOAKAWAY – 1-100 YEAR + CLIMATE CHANGE SIMULATION RESULTS

STRUCTURE	COVER LEVEL (mAOD)	MAXIMUM WATER LEVEL (mAOD)	PIPE OUTFLOW (L/S)	STATUS
SOAKAWAY 1	30.000	29.674	0.0	SURCHARGED

WESTERN SOAKAWAY – 1-100 YEAR + CLIMATE CHANGE SIMULATION RESULTS

STRUCTURE	COVER LEVEL (mAOD)	MAXIMUM WATER LEVEL (mAOD)	PIPE OUTFLOW (L/S)	STATUS
SOAKAWAY 2	26.300	22.280	0.0	OK

The Network package of the MicroDrainage suite was Initially incapable of modelling the Half Drain Times for the structures, the storm run time was dramatically increased to allow it sufficient time to calculate this as it well exceeded the permitted 1440 minute duration. The Half Drain Time for the eastern soakaway was well within the recommended 24-hour (1440 minute) window recommended in BRE Report 365 and CIRIA C753 achieving a Half Drain Time of 180 minutes, however, the western soakaway took over 1440 minutes, achieving a Half Drain Time of 4680 minutes (see Appendix E).

As per the CIRIA Susdrain guidance “Assessing attenuation storage volumes for SuDS”, for larger return periods where the system cannot achieve a Half Drain Time of 24 hours, the system should have enough capacity after 24 hours to accommodate a 1–10-year return period event. To undertake this analysis the water level after 24 hours has been taken from the soakaway calculations and this level has been set as the base of the cellular storage unit for the subsequent simulation. The system has then been modelled again with a 1-10 year event and again no flooding occurs onsite (see Appendix F).

WESTERN SOAKAWAY – SUBSEQUENT 1-10 YEAR SIMULATION RESULTS

STRUCTURE	COVER LEVEL (mAOD)	MAXIMUM WATER LEVEL (mAOD)	PIPE OUTFLOW (L/S)	STATUS
SOAKAWAY 2	26.300	22.484	0.0	OK

5.9. SuDS Management Train & Proposed SuDS Features

In accordance with the discharge hierarchy identified in Section 3, surface water generated by the Proposed Development should be discharged to ground via infiltration, where practicable to do so.

Resulting from this, surface water attenuation will be required to temporarily store surface water on-site prior to the surface water dissipating away entirely. It is likely that these infiltration features will take the form of proprietary cellular storage tanks with opportunities for the incorporation of rain garden areas and permeable paving for interception and source control.

Consideration has been given to the incorporation of alternative infiltration components such as infiltration basins, infiltration trenches, bioretention systems and granular soakaway units, however, owing to the depth of the infiltration component open basins would not be viable, additionally owing to the reductions in porosity associated with infilled infiltration systems, granular/filter medium based infiltration components have not been considered further.

The Proposed Development also has potential for the incorporation of above-ground SuDS features offering complementary benefits, such as rain gardens, tree pits, green roofs, and the like and these will be explored further as part of the ongoing detailed design development. Water Butts could also be proposed to the rear of the proposed houses.

5.10. Water Quality

The Proposed Development intends to discharge the entirety of the developments surface water drainage to ground via soakaways constructed of proprietary cellular storage units.

Car parking areas are understood to serve residents only and are of an insufficient area to constitute a requirement for hydrocarbon interceptors. However, following planning consultee responses from Kent County Council (LLFA) and Southern Water, due to the site being located in a Water Extraction Zone 2, petrol interceptors have been introduced to mitigate any potential risks from Hydrocarbons.

This new construction to modern standards is likely to reduce the risk of overall pollutant loading and therefore the vulnerability of water quality within the wider surface water catchment is low and indeed reduced by the Proposed Development.

It is proposed that where possible roof areas will be passed through a SuDS feature such a rain garden or tree pit. There is also the possibility that parking areas could be constructed of permeable paving, subject to detailed design, which will also act as a level of treatment to the resultant surface water flows.

5.11. Summary

Surface Water management is summarised as follows:

- Surface water will be managed within the Application Site and as close to source as possible.
- The system shall discharge entirely to ground through appropriately sized soakaway units.
- Amenity and biodiversity benefits are to be provided through the proposed SuDS systems which should look to utilise water butts, rain gardens and tree pits.

With the above in consideration, the Proposed Development would therefore contribute to a reduction in flood risk associated with the exceedance of the sewerage network within the vicinity of the Application Site, by providing a significant improvement to the existing drainage infrastructure and reducing the risk of onsite and offsite flooding during significant precipitation events.

SECTION 6

OUTLINE OWNERSHIP AND MAINTENANCE SCHEDULE

6. OUTLINE OWNERSHIP AND MAINTENANCE SCHEDULE

To ensure the long-term performance of the proposed DS, the on-site drainage system will be owned and maintained by the site operator or a maintenance company (MC) in accordance with the indicative schedule below:

ELEMENT / DRAINAGE COMPONENT	OWNERSHIP	MAINTENANCE REQUIREMENTS
Cellular Storage Tanks	Site Operator / MC	To be monitored for silt build-up and cleaned as required using suction methods, ensuring no solid material passes through outlet. Monitored for general condition of the tank and system generally, to suit manufacturer's guidance, check for leaks and displacement of 'cells'. Inspection annually and before / after extreme storm events.
Catchpit Manholes	Site Operator / MC	To be monitored for silt build-up and cleaned as required using suction methods. Inspection annually and before / after extreme storm events.
Rain Garden	Site Operator / MC	Clearance of litter and trash. Inlet and outlet clearing. Vegetation management as required to ensure weeds and invasive plants are controlled. Inspection annually and before / after extreme storm events.
Water Butts	Homeowners/Site Operator/MC	Clearance of leaves / debris from guttering and hopper inlets. Inspection annually and before / after extreme storm events.
Permeable paving	Site Operator / MC	Non-aggressive brushing of the whole surface (avoiding disruption of the jointing material, with suction rates adjusted, based on a trial), either manually or mechanically carried out annually. Top up of the gritstone may be required after cleaning. Weed control – excessive weed growth can be managed by localised spot-treatment with weed killers, in accordance with suppliers' recommendations. Inspection annually.
Rainwater Pipes	Site Operator / MC	Clearance of leaves / debris from guttering and hopper inlets. Rodding points provided to clear blockages via conventional rodding methods. Inspection annually and before / after extreme storm events.
Soil Vent Piles / "Stub Stacks"	Site Operator / MC	Rodding points to be provided to clear blockages via conventional rodding methods.

Inspection annually.		
Gullies (Internal & External)	Site Operator / MC	To be monitored for silt build-up and cleaned as required. Where provided, ensure air traps are primed and sealed to prevent smells. Inspection quarterly.
Surface Water Drainage Channels	Site Operator / MC	To be monitored and cleaned via jetting when any debris / silt reduces the cross-sectional area by 25% or more. Inspection to include both the channel and silt trap / gulley outlets. Inspection annually and before / after extreme storm events.
Below Ground Pipework Generally	Site Operator / MC	To be inspected for reduction in cross-sectional area (i.e. due to blockage, silt or debris build-up, root ingress etc) general condition of materials, pipe displacement and the like. Inspection annually and where appropriate before / after extreme storm events.
Manholes / Inspection Chambers Generally	Site Operator / MC	To be inspected for debris and integrity of chambers and covers generally. Inspection annually and where appropriate before / after extreme storm events.

Gravesham Borough Council

SECTION 7

CONCLUSIONS

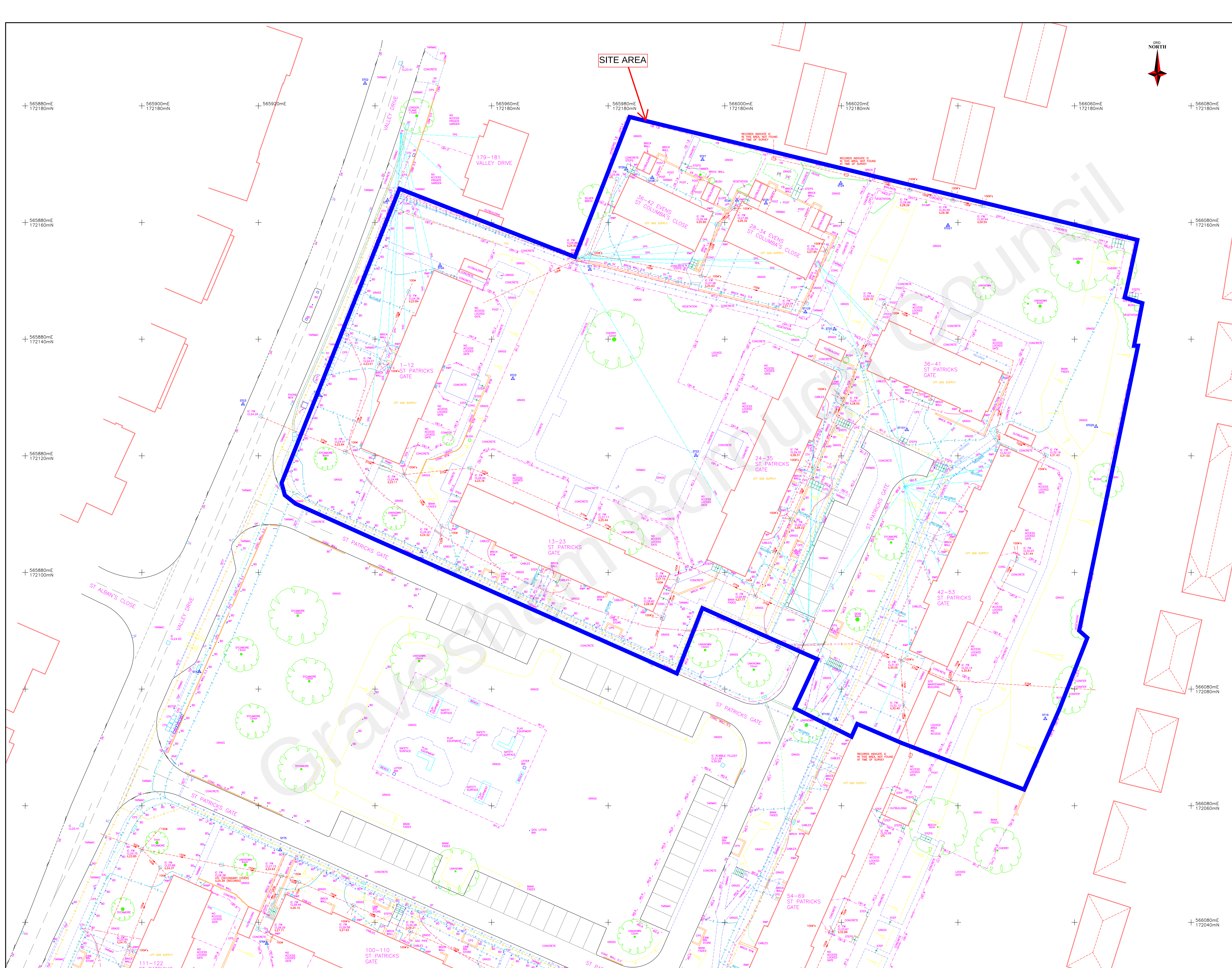
7. CONCLUSIONS

- The scheme proposes the demolition of existing dwellings consisting of three blocks of three storey flats and the construction of 46 residential homes, in addition to new hard and soft landscaping.
- Foul water generated by the site shall discharge to the southern public foul water sewer. Surface water generated by the site shall be discharged to ground through soakaways made of proprietary cellular storage units.
- Surface water will be managed within the application site and as close to source as possible.
- The scheme shall improve the risk of flooding from the existing system by installing a new system designed to latest guidance and best practice.
- Amenity and biodiversity benefits are to be provided through the proposed SuDS systems which will look to utilise, where practicable, a combination of water butts, rain gardens and tree pits.
- The proposed development will present an overall increase in foul water volume and peak flow to the public sewer, which is directly comparable to the increase in units on the site.
- The proximity of the site to the strategic Main Foul Sewer and intention to provide new foul water infrastructure throughout would suggest that this should not present a significant issue to the development, assuming enough capacity is present within the strategic sewer.
- A capacity check/analysis should be progressed with Southern Water to ensure there is adequate capacity in the foul water network to accept the proposed flows.
- It should be noted that this strategy presents one possible solution to demonstrate that the Proposed Development can be sustainably drained and should not be interpreted as the definitive solution.

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APPENDIX A

EXISTING SITE PLAN / SURVEYS



GRID
NORTH



Original Drawing Size: A0

NOTES:

The accuracy and content of this drawing are dependent on the original specification and EDI shall be construed before used at other scales.

No professional services are shown. All responsibilities for design and construction have been taken within the spirit of the original specifications. The user assumes full responsibility for the use of this information the user must consult EDI and notify themselves of the completeness and accuracy of such information. No warranty or liability is assumed by EDI for any errors or omissions caused by conditions imposed by ground conditions and the detection equipment no guarantee can be given that all anomalies have been recorded. This drawing is not intended as a basis for legal action.

All reasonable care has been taken in the survey detail represented on this drawing but, any discrepancies must be reported to EDI immediately.

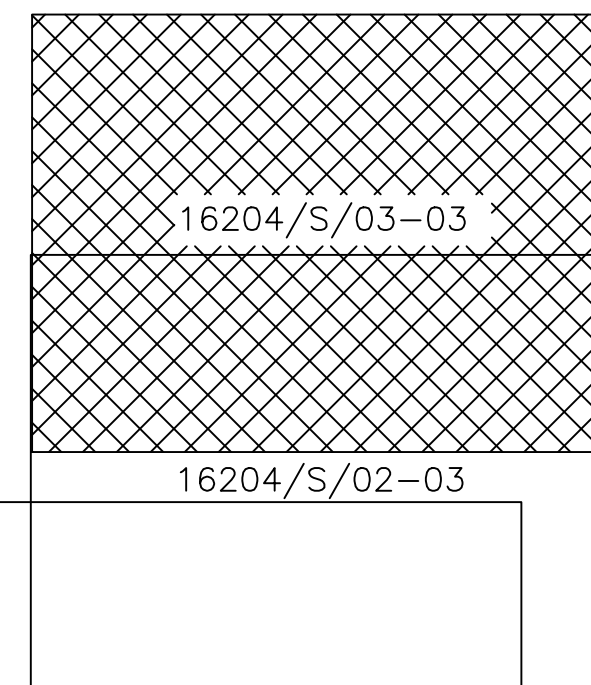
Our aim is to produce the best possible results within the specification and cost constraints of our client's budget.

Levels shown of karts are channel level unless stated.

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Control: All levels and co-ordinates are related to the datums described.

SHEET LAYOUT



16204/S/01-03

[illegible][illegible]

Potter Roper Partnership 10 Lindsey Street London EC1A 9HP	CLIENT
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	PROJECT
Underground Services Survey	
St Columba's Close	
Gravesend	
DA12 4AH	

Job No. 16204	Surveyor G Pugh	Checked RJA	Date March 2017	Scale 1:200
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   		DRAWING No. 16204/S/03-03	REV. -
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APPENDIX B

PROPOSED SITE PLAN



Key:

- Site Boundary
- 1B2P
- 2B3P
- 2B4P
- 3B5P
- 4B6P
- Ancillary

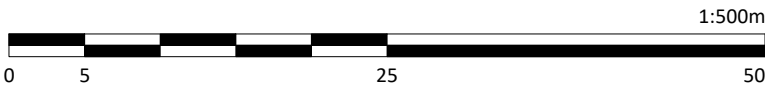
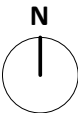
Notes:
Do not scale. All dimensions are in millimetres unless otherwise stated. This drawing should be read in conjunction with all relevant project information and contract documentation. All dimensions to be checked prior to fabrication and/or commencement of works. All works to comply with all relevant legal standards, building regulations and warranty provider requirements. Report any discrepancies, if in doubt ask.

Revisions:		Rev	Status	Date	Description	Drn	Chkd
P01	S3	30.09.22	Stage 2 Issue			HLB	

Client Name:				Gravesham Borough Council			
Project Name:				St Columba's Close			
Drawing Name:				Proposed Ground Floor Site Plan			
Drawing Number:			Rev:		Status:		
SCC-BPTW-04-00-DR-A-0210			P01		S3		
Project No:		RIBA Stage:	Drawn By:	Scale:			
20-169		2	HM	1:500 @ A2			

PRELIMINARY - FOR COMMENT

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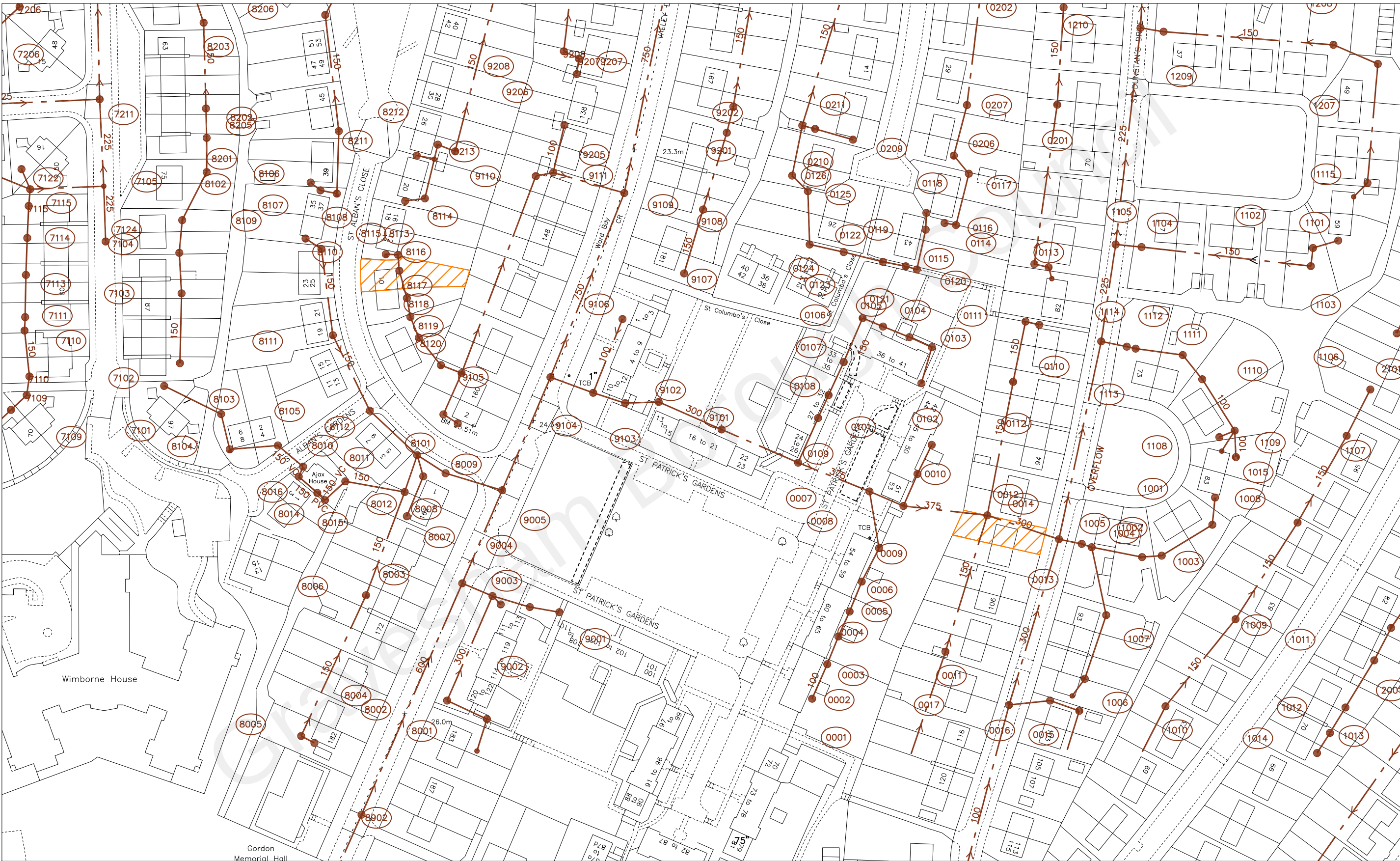
Gravesham Borough Council

APPENDIX C

SOUTHERN WATER ASSET PLANS

SEWER RECORDS PAGE 1 OF 2

172252



171964

65736

O.S. REF. TQ6572SE	Drawn by: yadavsa	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. WARNING: BAC pipes are constructed of Bonded Asbestos Cement WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement	N 	
	Scale: 1:1250			
Title: 232113_St Columbas Close, Grav	Date: 12/01/2017	Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.		

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APPENDIX D

1-100 YEAR + CLIMATE CHANGE EASTERN SOAKAWAY CALCULATIONS AND RESULTS

Ridge and Partners LLP		Page 1
The Cowyards Blenheim Park, Oxford Road Woodstock OX20 1QR	Eastern Soakaway St Columba's Close Gravesend	
Date 22/12/2022 09:01 File 5015556 - 3D MODEL.MDX	Designed by C. Levitt Checked by T. Clark	
Innovyze	Network 2020.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Soakaway 1 NW

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales			
Return Period (years)	100	Foul Sewage (l/s/ha)	0.000
M5-60 (mm)	26.250	Volumetric Runoff Coeff.	0.750
Ratio R	0.426	PIMP (%)	100
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200
		Maximum Backdrop Height (m)	1.500
		Min Design Depth for Optimisation (m)	1.200
		Min Vel for Auto Design only (m/s)	1.00
		Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Ridge and Partners LLP		Page 2
The Cowyards Blenheim Park, Oxford Road Woodstock OX20 1QR	Eastern Soakaway St Columba's Close Gravesend	
Date 22/12/2022 09:01 File 5015556 - 3D MODEL.MDX	Designed by C. Levitt Checked by T. Clark	
Innovyze	Network 2020.1	

Storage Structures for Soakaway 1 NW

Infiltration Basin Manhole: SOAKAWAY1, DS/PN: 1.001

Invert Level (m) 28.720 Infiltration Coefficient Side (m/hr) 0.13680 Porosity 0.94
Infiltration Coefficient Base (m/hr) 0.13680 Safety Factor 2.0

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	0.400	100.0	0.401	0.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 1 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged	Flooded	Flow / Overflow (l/s)	Half Drain	Pipe	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)	Cap.	Time (mins)	Flow (l/s)	Status
1.000	S1	15 Winter	1	+0%	100/60 Winter				29.249	-0.101	0.000	0.23		4.4	OK
2.000	S21	15 Winter	1	+0%	100/15 Summer				29.155	-0.095	0.000	0.29		4.7	OK
1.001	SOAKAWAY1	60 Winter	1	+0%	100/60 Winter				28.798	-0.322	0.000	0.00	46	0.0	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 1 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

									Water	Surcharged	Flooded	Half Drain			Pipe		
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Time (mins)	Flow (l/s)	Status	Level Exceeded
1.000	S1	15 Winter	30	+35%	100/60 Winter				29.298	-0.052	0.000	0.75			14.4	OK	
2.000	S21	15 Winter	30	+35%	100/15 Summer				29.217	-0.033	0.000	0.96			15.7	OK	
1.001	SOAKAWAY1	120 Winter	30	+35%	100/60 Winter				29.037	-0.083	0.000	0.00		136	0.0	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 1 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water			Flow / Overflow Cap.	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)					
1.000	S1	120 Winter	100	+40%	100/60 Winter				29.679	0.329	0.000	0.30		5.7	SURCHARGED	
2.000	S21	120 Winter	100	+40%	100/15 Summer				29.679	0.429	0.000	0.38		6.2	SURCHARGED	
1.001	SOAKAWAY1	120 Winter	100	+40%	100/60 Winter				29.674	0.554	0.000	0.00	180	0.0	SURCHARGED	

APPENDIX E

1-100 YEAR + CLIMATE CHANGE WESTERN SOAKAWAY CALCULATIONS AND RESULTS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Soakaway 2 NW

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales					
Return Period (years)	100	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	26.250	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.426	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Soakaway 2 NW

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	23.620	1.000	23.6	0.015	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	51.896	4.815	10.8	0.108	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	20.000	0.085	235.3	0.025	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	21.134	0.090	234.8	0.022	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.19	28.450	0.015	0.0	0.0	0.0	2.08	36.8	2.0
S1.001	50.00	5.40	27.375	0.123	0.0	0.0	0.0	4.01	159.4	16.7
S2.000	50.00	5.33	22.570	0.025	0.0	0.0	0.0	1.02	72.1	3.4
S1.002	50.00	5.75	22.485	0.170	0.0	0.0	0.0	1.02	72.2	23.0

Network Design Table for Soakaway 2 NW												
PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design	
S3.000	6.500	0.455	14.3	0.034	5.00	0.0	0.600	o	150	Pipe/Conduit		
S1.003	18.235	0.075	243.1	0.009	0.00	0.0	0.600	o	300	Pipe/Conduit		
S4.000	10.607	2.230	4.8	0.031	5.00	0.0	0.600	o	150	Pipe/Conduit		
S1.004	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		
Network Results Table												
PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)		
S3.000	50.00	5.04	23.000	0.034	0.0	0.0	0.0	2.68	47.3	4.6		
S1.003	50.00	6.05	22.395	0.213	0.0	0.0	0.0	1.00	71.0	28.8		
S4.000	50.00	5.04	24.700	0.031	0.0	0.0	0.0	4.65	82.2	4.2		
S1.004	50.00	6.13	22.320	0.244	0.0	0.0	0.0	1.11	78.3	33.0		

Ridge and Partners LLP		Page 3
The Cowyards Blenheim Park, Oxford Road Woodstock OX20 1QR	Western Soakaway St Columba's Close Gravesend	
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Innovyze	Network 2020.1	

Storage Structures for Soakaway 2 NW

Infiltration Basin Manhole: SSOAKAWAY2, DS/PN: S1.004

Invert Level (m) 21.020 Infiltration Coefficient Side (m/hr) 0.01256 Porosity 0.94
Infiltration Coefficient Base (m/hr) 0.01256 Safety Factor 2.0

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	209.0	1.600	209.0	1.601	0.0

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 2 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged	Flooded	Flow / Overflow Cap.	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)					
S1.000	SS31	15 Winter	1	+0%					28.479	-0.121	0.000	0.08		2.8	OK	
S1.001	SS32	15 Winter	1	+0%					27.430	-0.170	0.000	0.13		20.3	OK	
S2.000	SS41	15 Winter	1	+0%	30/15 Summer				22.645	-0.225	0.000	0.07		4.6	OK	
S1.002	SS33	15 Winter	1	+0%	10/15 Summer				22.626	-0.159	0.000	0.45		28.4	OK	
S3.000	SS51	15 Winter	1	+0%	100/15 Summer				23.040	-0.110	0.000	0.16		6.5	OK	
S1.003	SS34	15 Winter	1	+0%	10/15 Summer				22.560	-0.135	0.000	0.58		35.6	OK	
S4.000	SS61	15 Winter	1	+0%					24.728	-0.122	0.000	0.08		5.9	OK	
S1.004	SSOAKAWAY2	960 Winter	1	+0%					21.313	-1.307	0.000	0.00	1296	0.0	OK	

10 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 2 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged	Flooded	Flow / Overflow (l/s)	Half Drain	Pipe	Status	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)		Time (mins)	Flow (l/s)		
S1.000	SS31	15 Winter	10	+0%					28.490	-0.110	0.000	0.16		5.4	OK	
S1.001	SS32	15 Winter	10	+0%					27.461	-0.139	0.000	0.31		47.4	OK	
S2.000	SS41	15 Winter	10	+0%	30/15 Summer				22.822	-0.048	0.000	0.14		8.7	OK	
S1.002	SS33	15 Winter	10	+0%	10/15 Summer				22.811	0.026	0.000	0.95		60.0	SURCHARGED	
S3.000	SS51	15 Winter	10	+0%	100/15 Summer				23.057	-0.093	0.000	0.31		12.4	OK	
S1.003	SS34	15 Winter	10	+0%	10/15 Summer				22.722	0.027	0.000	1.24		75.5	SURCHARGED	
S4.000	SS61	15 Winter	10	+0%					24.739	-0.111	0.000	0.15		11.3	OK	
S1.004	SSOAKAWAY2	1440 Winter	10	+0%					21.544	-1.076	0.000	0.00	2232	0.0	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 2 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 1, 10, 30, 100
Climate Change (%) 0, 0, 35, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged	Flooded	Flow / Overflow Cap.	Time (mins)	Pipe	Status	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)			Flow (l/s)		
S1.000	SS31	15 Winter	100	+40%					28.513	-0.087	0.000	0.37		12.8		OK
S1.001	SS32	15 Winter	100	+40%					27.518	-0.082	0.000	0.73		111.4		OK
S2.000	SS41	15 Winter	100	+40%	30/15 Summer				23.772	0.902	0.000	0.37		23.0	FLOOD RISK	
S1.002	SS33	15 Winter	100	+40%	10/15 Summer				23.752	0.967	0.000	2.26		143.0	SURCHARGED	
S3.000	SS51	15 Winter	100	+40%	100/15 Summer				23.481	0.331	0.000	0.70		28.0	SURCHARGED	
S1.003	SS34	15 Winter	100	+40%	10/15 Summer				23.259	0.564	0.000	2.94		179.6	SURCHARGED	
S4.000	SS61	15 Winter	100	+40%					24.762	-0.088	0.000	0.36		26.5		OK
S1.004	SSOAKAWAY2	1440 Winter	100	+40%					22.280	-0.340	0.000	0.00	4680	0.0		OK

APPENDIX F

1-10 YEAR ADDITIONAL STORM CALCULATIONS AND RESULTS FOR WESTERN SOAKAWAY

Ridge and Partners LLP		Page 1
The Cowyards Blenheim Park, Oxford Road Woodstock OX20 1QR	Western Soakaway St Columba's Close Gravesend	
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Innovyze	Network 2020.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Soakaway 2 NW

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	26.250	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.426	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	0	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Soakaway 2 NW

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	23.620	1.000	23.6	0.015	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	51.896	4.815	10.8	0.108	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	20.000	0.085	235.3	0.025	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	21.134	0.090	234.8	0.022	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.19	28.450	0.015	0.0	0.0	0.0	2.08	36.8	2.0
S1.001	50.00	5.40	27.375	0.123	0.0	0.0	0.0	4.01	159.4	16.7
S2.000	50.00	5.33	22.570	0.025	0.0	0.0	0.0	1.02	72.1	3.4
S1.002	50.00	5.75	22.485	0.170	0.0	0.0	0.0	1.02	72.2	23.0

Network Design Table for Soakaway 2 NW

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.000	6.500	0.455	14.3	0.034	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	18.235	0.075	243.1	0.009	0.00	0.0	0.600	o	300	Pipe/Conduit	
S4.000	10.607	2.230	4.8	0.031	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.004	5.000	0.025	200.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.000	50.00	5.04	23.000	0.034	0.0	0.0	0.0	2.68	47.3	4.6
S1.003	50.00	6.05	22.395	0.213	0.0	0.0	0.0	1.00	71.0	28.8
S4.000	50.00	5.04	24.700	0.031	0.0	0.0	0.0	4.65	82.2	4.2
S1.004	50.00	6.13	22.320	0.244	0.0	0.0	0.0	1.11	78.3	33.0

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The Cowyards Blenheim Park, Oxford Road Woodstock OX20 1QR	Western Soakaway St Columba's Close Gravesend	
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Innovyze	Network 2020.1	

Storage Structures for Soakaway 2 NW

Infiltration Basin Manhole: SSOAKAWAY2, DS/PN: S1.004

Invert Level (m) 21.964 Infiltration Coefficient Side (m/hr) 0.01256 Porosity 0.94
Infiltration Coefficient Base (m/hr) 0.01256 Safety Factor 2.0

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	209.0	1.244	209.0	1.245	0.0

10 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Soakaway 2 NW

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 0.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coefficient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 26.250 Cv (Summer) 0.750
Region England and Wales Ratio R 0.428 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status OFF Inertia Status ON
Analysis Timestep Fine DVD Status ON

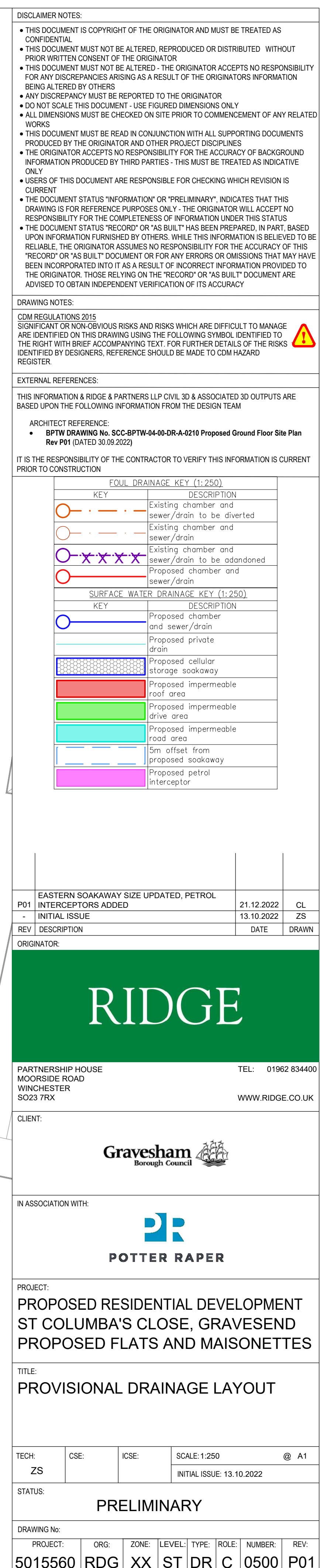
Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 10
Climate Change (%) 0

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Surcharged Flooded				Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
									Level (m)	Depth (m)	Volume (m³)	Flow / Overflow Cap. (l/s)				
S1.000	SS31	15 Winter	10	+0%					28.490	-0.110	0.000	0.16		5.4	OK	
S1.001	SS32	15 Winter	10	+0%					27.461	-0.139	0.000	0.31		47.4	OK	
S2.000	SS41	15 Winter	10	+0%					22.822	-0.048	0.000	0.14		8.7	OK	
S1.002	SS33	15 Winter	10	+0%	10/15 Summer				22.811	0.026	0.000	0.95		60.0	SURCHARGED	
S3.000	SS51	15 Winter	10	+0%					23.057	-0.093	0.000	0.31		12.4	OK	
S1.003	SS34	15 Winter	10	+0%	10/15 Summer				22.722	0.027	0.000	1.24		75.5	SURCHARGED	
S4.000	SS61	15 Winter	10	+0%					24.739	-0.111	0.000	0.15		11.3	OK	
S1.004	SSOAKAWAY2	1440 Winter	10	+0%					22.484	-0.136	0.000	0.00		0.0	OK	

APPENDIX G

BELOW GROUND DRAINAGE STRATEGY



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EXTERNAL REFERENCES:

THIS INFORMATION & RIDGE & PARTNERS LLP CIVIL 3D & ASSOCIATED 3D OUTPUTS ARE CREATED UNDER THE FOLLOWING INFORMATION FROM THE DESIGN TEAM

ARCHITECT REFERENCE:

- BPTW DRAWING No. SCC-BPTW-04-00-DR-A-0210 Proposed Ground Floor Site Plan Rev P01 (DATED 30.09.2022)

IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THIS INFORMATION IS CURRENT PRIOR TO CONSTRUCTION

Foul Drainage Key (1:250)

KEY	DESCRIPTION
	Existing chamber and sewer/drain to be diverted
	Existing chamber and sewer/drain
	Existing chamber and sewer/drain to be abandoned
	Proposed chamber and sewer/drain

Surface Water Drainage Key (1:250)

KEY	DESCRIPTION
	Proposed chamber and sewer/drain
	Proposed private drain
	Proposed cellular storage soakaway
	Proposed impermeable roof area
	Proposed impermeable drive area
	Proposed impermeable road area
	5m offset from proposed soakaway
	Proposed petrol interceptor

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CLIENT:

Gravesham Borough Council

IN ASSOCIATION WITH:

POTTER RAPER

PROJECT:

PROPOSED RESIDENTIAL DEVELOPMENT
ST COLUMBA'S CLOSE, GRAVESEND
PROPOSED FLATS AND MAISONNETTES

TITLE:

PROVISIONAL DRAINAGE LAYOUT

TECH: CSE: ICSE: SCALE:1:250 @ A1

ZS

INITIAL ISSUE: 13.10.2022

STATUS:

PRELIMINARY

DRAWING No:

PROJECT: ORG: ZONE: LEVEL: TYPE: ROLE: NUMBER: REV:

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