Carrow Works, Norwich Drainage & SuDS Strategy

Curtins Ref: 081440-CUR-XX-XX-T-C-92031

Revision: P03 Issue Date: 07 July 2022

Client Name: Fuel Properties (Norwich) Limited Client Address: Fuel Properties (Norwich) Limited 9 South Molten Street London W1K 5QH

Site Address: Carrow Works, Bracondale, Norwich NR1 2DD

Curtins Consulting Limited 40 Compton Street London EC1V 0BD Tel: 020 7324 2240 Email: london@curtins.com

Birmingham • Bristol • Cambridge • Cardiff • Douglas • Dublin • Edinburgh • Glasgow • Kendal • Leeds • Liverpool • London • Manchester • Nottingham



Curtins

Drainage & SuDS Strategy



Rev	Description	Issued by	Checked	Date
P01	Preliminary Issue	ММ	MCS	14/06/22
P02	Updated for Planning	ММ	MCS	21/06/22
P03	Final Issue for Planning	ММ	MCS	07/07/22

This report has been prepared for the sole benefit, use, and information for the client. The liability of Curtins Consulting Limited with respect to the information contained in the report will not extend to any third party.

Author	Signature	Date
Matthew Martin BSc (Hons) EngTech Infrastructure Engineer	Man	07/07/2022

Reviewed	Signature	Date
Michael Smith MEng(Hons) Principal Civil Engineer	Michael Suith	07/07/2022

Drainage & SuDS Strategy



Table of Contents

Project Overview 1
Site Location1
Site Description2
Project Proposal 2
Ianning and Policy Considerations4
National Planning Policy Requirements4
National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) 4
2 DEFRA – Sustainable Drainage Systems 4
Local Planning Policy Requirements4
North-Norfolk District Council Local Plan4
Norwich City Council Local Plan 6
Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (2017 & 2021) 8
Local Flood Risk Management Strategy (2015)9
lood Risk Summary 11
xisting Drainage 12
Public Sewerage 12
Private Drainage13
Surface Water 13
Poul Water 15
roposed Drainage Strategy 16
General16
Surface Water 18
Proposed Site Discharge 19
25 Attenuation
Sustainable Drainage Systems
Sustainable Drainage Systems

Drainage & SuDS Strategy



	5.2.2	Flood Exceedance	31
	5.3	Foul Water	32
	5.3.1	Nutrient Neutrality	32
6.0) Ger	neral Maintenance	33
7.0) Cor	nclusions and Recommendations	34
8.0) App	bendices	
	Appen	dix A – Site wide topographical survey	
	Appen	dix B – Planning Parameter Plan	
	Appen	dix C – Landscape Masterplan	
	Appen	dix D – Public Sewer records	
	Appen	dix E – GPR Survey	
	Appen	dix F – Proposed Catchment Drawing	
	Appen	dix G – Proposed Drainage General Arrangement	
	Appen	dix H – Hydraulic Calculations	
	Appen	dix I – Hydraulic Calculations Including Flood Event Surcharged Outfalls	
	Appen	dix J – Operations and Maintenance manual	

Figures

Figure 1-1 - Site Location1
Figure 4-1 - Anglian Water Mapping Extract12
Figure 4-2 - GPR Extract Retained Outfalls13
Figure 4-3 - GRP Extract Carrow Abbey14
Figure 4-4 - GPR Extract South of Abbey14
Figure 5-1 - Controlled & Uncontrolled Catchments16
Figure 5-2 - Q100 Controlled Rate21
Figure 5-3 - West Outfall Diagram23
Figure 5-4 - Retained Building Catchments24
Figure 5-5 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification27
Figure 5-6: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices
Figure 5-7 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification29
Figure 5-8: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices

Drainage & SuDS Strategy



Tables

Table 1 - Discharge Opportunities	18
Table 2 - Site Discharge Summary	19
Table 3 - Catchment Classification	19
Table 4 - East Outfall Catchments	22
Table 5 - West Outfall Catchments Upstream of Existing Network	23
Table 6 - D & E Catchments	24
Table 7 - SuDS Opportunities	25
Table 8 - AquaTreat Water Treatment Separator Treatment Indices	28



1.0 Introduction

1.1 Project Overview

Curtins have prepared this Drainage Strategy on behalf of Fuel Properties Ltd in support of a hybrid planning application for the redevelopment of the Carrow Works site, Norwich. The Carrow Works site, forms part of the wider East Norwich Masterplan and aims to provide 4,000 new homes.

Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material derivation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.

1.2 Site Location

The Site is located approximately 1.8km southeast of Norwich City Centre on the existing Carrow Works site. The site is bound by the River Wensum to the north, the Great Eastern Main Line to the east and the A147 so south and west. The national grid reference for the site is TG 24260 07387.



Figure 1-1 - Site Location



1.3 Site Description

The existing Carrow Works site currently houses the Grade I listed Carrow Abbey and Cottages located within the centre of the site. The areas surrounding the Abbey and Cottages parcel are existing industrial buildings previously occupied by the Colemans family and more recently Unilever UK Ltd. The hybrid planning boundary has an approximate area of 16.9 ha.

A topographical survey has been carried out by CD Surveys Ltd and is included in **Appendix A**. The survey shows that the Site generally falls from the southwest to the northeast. An existing underpass beneath the Great Eastern Railway Line between the Site and the adjacent Deal Ground site is located in the northeast corner. The lowest point on site is 1.16mAOD which is the level of one of the gullies by the underpass entrance towards the northeast of the site. The level of the underpass itself reaches a level of 0.94mAOD between Carrow Works and the Deal Ground site. The site has a topographical high point of 16.20mAOD in the south-eastern corner of the site.

The northern boundary of the site adjacent to the River Wensum varies in levels from 4.14mAOD in the west to 1.39mAOD in the east. Generally, the northern areas of the site that are occupied by the historic Colemans buildings have a level of between 3.0 - 4.0mAOD. The Carrow Abbey area's levels range from 11.5-13.5mAOD.

1.4 Project Proposal

The hybrid planning application (part full, part outline), alongside Listed Building Consent and Demolition within a Conservation Area seeks to obtain approval for the following:

• Detailed (Full) Component:

"Full application comprising the construction of the principal means of access, the primary internal road and associated public spaces and public realm, including restoration and change of use of Carrow Abbey to former use as residential (Use Class C3), alteration and extension and conversion to residential use (Use Class C3) of the Lodge, Garage and Gardener's Cottage and the Stable Cottages, development of the former Abbey Dining Room for residential use (Use Class C3), adaptation and conversion for flexible uses (Class E and/or and/or C2 and/or and/C1 and/or C3 and/or F1 and/or F2 and/or B2 and/or B8 and/or Sui Generis) for buildings 207, 92, 206, 7 (7a, 8 and 8a), 209, 35, the Chimney and Class E and/or B2 and/or B8 for the retained Workshop (Block 258), enhanced access to Carrow Abbey and Scheduled Ancient Monument and associated ancillary works".

The full component of the application covers a site area of 5.02 ha.



• Outline Component:

"Demolition of existing buildings and replacement with phased residential-led (Use Class C3 and/or Class E and/or F1 and/or F2 and/or C1 and/or C2 and/or B2 and/or B8 and/or Sui Generis), landscaping, open space, new and modified access, car parking and ancillary works." The outline component of the application covers a site area of 11.9 ha.

The existing Abbey grounds, Mustard Seed Driers listed building, and gateway areas are proposed to be retained, with the proposed development constructed around these retained features. Due to the industrial nature of the site, the majority of the sites is impermeable. The Abbey's Grounds make up the majority of the permeable area on site (around 2.5ha). existing Impermeable areas make up the reminder of the site area (approximately 14.4 ha). The hybrid application boundary split can be found in **Appendix B** and the proposed Landscape Masterplan in **Appendix C**.



2.0 Planning and Policy Considerations

2.1 National Planning Policy Requirements

2.1.1 National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG)

In recent years, the Government and local Councils have placed increased priority on the need for developers to take full account for the risks of their development at all stages of the planning process. The National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) identifies how the issue of flooding is dealt with through the planning process and with the creation of a site-specific Flood Risk Assessment (FRA) for sites over 1ha in area or in Flood Zones 2 & 3.

2.1.2 DEFRA – Sustainable Drainage Systems

The Department for Environment, Food and Rural Affairs (DEFRA) national standards for sustainable drainage systems provides technical guidance on the design, construction and maintenance of Sustainable Drainage Systems (SuDS).

2.2 Local Planning Policy Requirements

2.2.1 North-Norfolk District Council Local Plan

The North Norfolk District Council Local Plan was formally adopted in Autumn 2008 and was updated in 2012 following the publication of the NPPF. The current Local Plan is due to be replaced shortly. The Local Plan sets out a vision for the area and, from this, a number of aims and objectives have been identified. Aims include:

- To provide for sustainable development and mitigate and adapt to climate change
- To mitigate and adapt to impacts of coastal erosion and flooding

Strategic and development control policies have been designed in order to achieve the objectives.

Notable policies regarding flood risk are the following:

• Policy SS 1 – Spatial Strategy for North Norfolk

Development in these Coastal Service Villages will support local coastal communities in the face of coastal erosion and flood risk. Land may be identified in or adjacent to these settlements to provide for new development or relocation from areas at risk.

Policy SS 2 – Development in the Countryside
 In areas designated as Countryside development will be limited to that which requires a rural location and is for one or more of the following:



- coastal and flood protection.
- the preservation of Listed Buildings

Proposals which do not accord with the above will not be permitted.

• Policy SS 4 – Environment

All development proposals will contribute to the delivery of sustainable development, ensure protection and enhancement of natural and built environmental assets and geodiversity and be located and designed so as to reduce carbon emissions and mitigate and adapt to future climate change.

The Council will minimise exposure of people and property to the risks of coastal erosion and flooding and will plan for a sustainable shoreline in the long-term, that balances the natural coastal processes with the environmental, social and economic needs of the area. Sustainable Drainage Systems will be encouraged, to reduce flood risk, promote groundwater recharge and improve water quality, enhance biodiversity and provide amenity benefit.)

• Policy EN 10 – Development and Flood Risk

The sequential test will be applied rigorously across North Norfolk and most new development should be located in Flood Risk Zone 1. New development in Flood Risk Zones 2 and 3a will be restricted to the following categories:

- water compatible uses
- o minor development
- changes of use (to an equal or lower risk category in the flood risk vulnerability classification) where there is no operational development (xl); and
- 'Less vulnerable' uses where the sequential test has been passed.

New development in Flood Zone 3b will be restricted to water compatible uses only.

The Strategic Flood Risk Assessment defines zones 2, 3a and 3b in parts of North Norfolk and this will be used to inform the application of the sequential test. Where this information is not available, the Environment Agency Flood Risk Zones and a site specific Flood Risk Assessment will be used to apply the sequential test.

A site-specific Flood Risk Assessment which takes account of future climate change must be submitted with appropriate planning applications (xli) in Flood Zones 2, 3a and 3b and for development proposals of 1 hectare or greater in Flood Zone 1.

Land in Flood Zone 1 that is surrounded by areas of Flood Zones 2 or 3 will be treated as if it is in the higher risk zone and a Flood Risk Assessment will be required to prove that safe access / egress exists for the development or that the land will be sustainable for the duration of the flood period.



Appropriate surface water drainage arrangements for dealing with surface water run off from new development will be required. The use of Sustainable Drainage Systems will be the preference unless, following an adequate assessment, soil conditions and / or engineering feasibility dictate otherwise.

2.2.2 Norwich City Council Local Plan

The Norwich City Council Local Plan was formally adopted in December 2014. The Local Plan is comprised of three documents which together set out the strategic priorities for the greater Norwich area that allow the Council to manage development. The **Joint Core Strategy** sets out the strategy for regeneration and growth in the greater Norwich area up to 2026. The **Site Allocations Plan and Development Management Plan** provide detailed polices to guide and implement this strategy. The Development Management Plan has a number of spatial planning objectives, including Objective 1 – To minimise the contributors to climate change and address its impact. The objective states "*Where new development in such areas is desirable for reasons of sustainability (e.g. in the city centre), flood mitigation will be required and flood protection will be maintained and enhanced.*"

Notable policies regarding flood risk are the following:

- Policy DM3 Design Principles
- Significant weight will be given to the following design principles in assessing development proposals [including]:
 - Energy Efficiency and Climate Change
 - d) promote and facilitate sustainable drainage and mitigate against flood risk from surface water runoff as required by policy DM5.
- Policy DM5 Planning effectively for flood resilience

Flooding

All development proposals will be assessed and determined having regard to the need to manage and mitigate against flood risk from all sources. Development proposals must be supported by the relevant flood risk assessments and show that (where necessary) alternative sites of lower flood risk have been assessed, adopting a sequential approach to site selection according to the requirements of national policy and standing technical advice which supports it.

The sequential site assessment as set out in the NPPF will be expected to consider reasonable alternatives for locating the development in a zone of lower flood risk on any site elsewhere in Norwich, except in the case of:

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



- Proposals within the city centre regeneration areas identified on the Policies map, in which case the assessment need only take account of reasonable alternative sites within the boundary of the relevant regeneration area concerned or (where no such alternative sites exist) alternative regeneration areas elsewhere in the city centre;
- Any other proposal which is consistent with and forms part of a specific allocation for development within the Site allocations plan and other adopted development plan documents, in which case the requirement for the sequential test will not apply.

In the case of proposals in areas of higher flood risk which are within the city centre but which fall outside the regeneration areas identified on the Policies map, the search area for reasonable alternative sites should take account of:

- a) the scale and function of the proposal;
- b) the potential contribution of the use or uses proposed to overall regeneration of the city centre, including through the provision of new housing;
- c) where the proposal is for retail, leisure or other main town centre uses, the suitability of any alternative locations in relation to policy DM18 of this plan;
- d) any objectively identified need for the use proposed which justifies a location in the city centre in order to support the objectives and policies of the development plan.
- For the purposes of this policy "city centre" means the area defined on the city centre Policies map insets, including both the City Centre inset and Northern City Centre Area Action Plan inset.

Sustainable drainage and surface water flooding

Mitigation measures to deal with surface water arising from development proposals should be incorporated to minimise the risk of flooding on the development site and where possible reduce the risk, otherwise at least minimise the risk, within the surrounding area.

Sustainable drainage measures appropriate to the scale and nature of the development shall be incorporated in all development proposals involving the erection of new buildings or the extension of existing buildings until such time as thresholds are established by nationally applicable standards for sustainable drainage. Such measures will be required except where this is not technically feasible or where it can be demonstrated that other factors preclude their use.

Within the critical drainage catchments as identified on the Policies map and in other areas where the best available evidence indicates that a serious and exceptional risk of surface water flooding exists, all development proposals involving new buildings, extensions and additional areas of hard surfacing should ensure that adequate and appropriate consideration has been given to



mitigating surface water flood risk. Developers will be required to show that the proposed development:

- a) would not increase the vulnerability of the site, or the wider catchment, to flooding from surface water run-off from existing or predicted water flows; and
- b) would, wherever practicable, have a positive impact on the risk of surface water flooding in the wider area.

Development must, as appropriate, incorporate mitigation measures to reduce surface water runoff, manage surface water flood risk to the development itself and to others, maximise the use of permeable materials to increase infiltration capacity, incorporate on-site water storage and make use of green roofs and walls wherever reasonably practicable.

The use of permeable materials, on-site rainwater storage, green roofs and walls will be required unless the developer can provide justification to demonstrate that this would not be practicable or feasible within the constraints or configuration of the site, or would compromise wider regeneration objectives.

Surface Treatment

Development proposals will be required to maximise the use of soft landscaping and permeable surfacing materials unless the developer can provide justification to demonstrate that this is not feasible.

Where permission is required, proposals involving the provision of new or replacement paved and other impermeable surfaced areas will only be permitted:

- o a) in areas of impermeable soils as identified in Appendix 1;
- b) in other areas where it can be demonstrated that permeable surfaces are not practicable due to poor soil infiltration capacity, high groundwater levels or risk of subsidence; and
- c) in areas with soils with average or good infiltration capacity, where it can be demonstrated that there is an exceptional and overriding justification for such surfaces.

In cases where poor soil infiltration capacity or other factors preclude the use of permeable surfacing materials, development proposals should seek to manage and minimise the impact of surface water run-off by suitable measures for water storage on-site.

2.2.3 Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (2017 & 2021)

The Level 1 SFRA (2017) aims to provide up to date information and guidance on all sources of flood risk throughout the Greater Norwich area, taking into account the latest flood risk information and

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



national planning policy. The SFRA aims to ensure all sources of flood risk are understood so they can be managed effectively throughout the planning process, taking into account the potential impacts of climate change. The SFRA provides a broad yet detailed assessment of flood risk, providing the evidence base for policies, recommendations, and guidance to help ensure the effective management of flood risk.

The Level 1 SFRA also provides guidance regarding the application of the Exception Test, aiding Norwich City Council in identifying when the Exception Test is required. It provides information on when a more detailed Level 2 SFRA will be required with regards to strategic site allocations.

The Level 2 SFRA (2021) provides a detailed assessment of all sources of flooding for sites identified by the Greater Norwich Planning Policy team as being potential allocation sites. It builds upon the Level 1 SFRA, providing site-specific assessments to provide the necessary information required to support the application of the Exception Test. All 26 sites proposed by the Greater Norwich Planning Policy team required a Level 2 assessment of flood risk.

2.2.4 Local Flood Risk Management Strategy (2015)

The aim of the Local Flood Risk Management Strategy (LFRMS) is to serve as a tool to better understand and manage flood risk within the area. For the city of Norwich, Norfolk County Council are the Lead Local Flood Authority, covering planning applications with regards to surface water drainage for the entire county of Norfolk. The aim of the document is:

"To work with organisations, businesses and communities to manage flood risk and, where it is practicable, affordable and sustainable to do so, to reduce risk to life, property and livelihoods that may arise from local surface runoff, ordinary watercourse and groundwater flooding."

The document outlines the challenges and the objectives Norfolk have identified to coordinate flood risk management on a day-to-day basis. Additional information is provided regarding flood risk sources and the Risk Management Authorities who are responsible different flood risk management activities.

Norfolk conducted a Local Flood Risk Management Strategy Policy Review in 2021. Since the adoption of the 2015 LFRMS, Norfolk has experienced wide spread flooding, experienced significant growth and development, and has seen a change in the legislative landscape. As a result, the 2015 Strategy's policies were reviewed against new and emerging national strategies and policies. This resulted in 3 new policies and minor updates to the existing policies.

2.2.5 Surface Water Management Plan (2011)

The Surface Water Management Plan (SWMP) provides an assessment of surface water flood risk and outlines a long-term action plan for managing surface water. Norfolk produced five SWMPs, including a Plan for the Norwich Urban Area. Both historic and predicted flooding from different flood risk sources are assessed, including sources which have been identified as surface water, sewer and groundwater



flooding. This assessment has been used to identify 3 Critical Drainage Areas (CDA) across the Norwich Urban Area. The proposed development does not fall within a CDA.

2.2.6 Preliminary Flood Risk Assessment (2011)

The Preliminary Flood Risk Assessment (PFRA) serves as high level screening exercise to help Norfolk County Council identify areas of flood risk across the borough. Historic and predicted flood risk data has been assessed to identify areas at risk of flooding from surface water runoff, groundwater, and ordinary watercourse. The PFRA was used to inform the LFRMS by identifying areas potentially at flood risk that may require more detailed studies. Norwich ranked first on the PFRA Settlement Priority Ranking in Norfolk, with a number of people, critical infrastructure, and non-residential properties above the flood risk threshold.



3.0 Flood Risk Summary

A detailed site-specific Flood Risk Assessment (FRA) has been written for this site (081440-CUR-XX-XX-T-C-92031). The FRA outlines the existing flood risk posed to the site, as well as evaluating how the proposed development will affect these risks



4.0 Existing Drainage

4.1 Public Sewerage

Anglian Water are responsible for the public sewerage in Norwich. Anglian Water mapping for the site has been obtained, this mapping indicates the site is bisected by an existing 600mm diameter foul water sewer. The sewer is located west of the retained Carrow Abbey building and flows from north to south. Mapping indicates that sewers outfalls to the 1050mm Diameter public sewer in A147. An extract of the mapping can be found below in Figure 4-1 and the mapping can be found in **Appendix D**.



Figure 4-1 - Anglian Water Mapping Extract

A ground penetrating radar (GPR) survey of the site was carried out in November 2018 by WYG, this survey identified manholes and pipework that appears to align with the above mapping; however due to covers being unable to be lifted the route and diameter was unable to be confirmed. GPR survey can be found in **Appendix E**.



As this existing foul water sewer serves the Carrow Works site exclusively, it is anticipated to be removed as part of the development. A new foul water drainage network is proposed to be developed following development of the outline portion of the scheme.

4.2 Private Drainage

As discussed in the Section 4.1, a GPR survey was carried out in November 2018, this survey indicated that the site is served by both private surface and foul water systems.

4.2.1 Surface Water

The existing private drainage system contains two outfall methods: disposing of surface water via infiltration through soakaways and discharging surface water into the River Wensum. It can be seen that the northern area of the site discharges to the River Wensum, whereas the southern area (including the Abbey) discharges to the ground via infiltration.

The drainage system to the north has multiple outfalls to the River Wensum. It is proposed to retain and reuse three outfalls to the river in the northwest corner of the site. The retained outfalls have been identified in Figure 4-2 below.



Figure 4-2 - GPR Extract Retained Outfalls



Carrow Abbey and the surrounding vegetated landscape is indicated to outfall via multiple soakaways, these soakaways have been identified in Figure 4-3. The vegetated area and highway south of the Abbey is also indicated to outfall via soakaways, see Figure 4-4. It is proposed that these existing systems are to be retained and left in situ as part of the scheme. At the time of writing no infiltration testing had been carried out, the reuse of the existing soakaways is subject to receipt of acceptable infiltration results. The proposals to maintain these soakaways is due to the sensitive nature of the Abbey Site and the Carrow Priory ruins.



Figure 4-3 - GRP Extract Carrow Abbey



Figure 4-4 - GPR Extract South of Abbey

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



4.2.2 Foul Water

The GPR survey did not include a definitive outfall for foul water on site, at the time of writing a CCTV survey had not been carried out therefore the existing foul water on site requires further investigation.

However, it is envisioned that the proposed development will be designed with a new below ground foul water system to serve each of the housing development. The foul water network is proposed to be developed following planning and following receipt of detailed above ground information. The exception is where existing buildings are proposed to be retained, these areas will look to reuse the existing below ground infrastructure.

An existing pump can be seen to be located in the underpass in the northeast corner of the site, it is proposed to remove the existing foul water pump and install a surface water pump to convey run off in the underpass to the proposed surface water system.

Where sewers are proposed to be abandoned or removed, works are to be carried out in accordance with building regulations Part H.



5.0 Proposed Drainage Strategy

5.1 General

The drainage strategy proposes to follow the existing site arrangement by disposing of surface water via infiltration and via outfalls to the River Wensum. Where surface water runoff is proposed to outfall to the River Wensum, it is intended to do so at a controlled 1 in 100 greenfield run-off rate (Q100) for all new build areas and for all storms (these areas are identified in Figure 5-1 below by red hatches). Where existing outfalls are proposed to be reused the existing catchment entering system is proposed to remain uncontrolled (shown in blue below); this is to avoid deep excavations adjacent to listed buildings that may affect their foundations. The River Wensum is tidal in this area and the overall site discharge is proposed to be heavily reduced.



Figure 5-1 - Controlled & Uncontrolled Catchments

The hybrid planning application submitted is as such that the majority of the proposed plots are located within the outline planning areas of the site. Only with highways, the Abbey and a small area of existing commercial buildings fall within the full planning area.

To allow pipes and attenuation to be sized in the full planning network, plots have been assigned a controlled flow rate before discharging into highway system. Areas highlighted in the red in Figure 5-1



are proposed to be controlled at the Q100 rate, this approach was discussed and agreed with the LLFA during a pre planning meeting. Catchments and their classification can be found in **Appendix F**.

In line with the updated government guidance for the area, the surface water drainage has been designed to cater for up to the 1 in 100 year return period + 45% climate change. A general arrangement drawing of proposed drainage system can be found in **Appendix G**.

As discussed in Section 4.2.2, it is envisioned that the existing foul water serving the Abbey will be left in situ and foul water for the proposed development and remining retained buildings Is envision to also outfall to this existing public sewer Drainage & SuDS Strategy



5.2 Surface Water

In line with the Drainage Hierarchy, surface water run off from a site should endeavour to be controlled as close to the source as possible. Discharge from site should be via one of the methods detailed in **Table 1**, in descending priority;

Table 1 - Discharge Opportunities

Sustainable Drainage Hierarchy	Site Specific Application
Store rainwater for later use	Proposed residential plots fall within the outline planning application, as plots are progressed in detail rainwater harvesting techniques are to be reviewed by M&E engineer.
Use infiltration techniques, such as porous surfaces in non-clay areas	Where existing catchments drain via infiltration it is proposed to either reuse the infiltration system or provide a new system (subject to infiltration testing results). Due to the previous site usage, the majority of the site is at an elevated contamination risk therefore not appropriate for infiltration. Infiltration has only be used in areas where existing infiltrating devices are used and contamination risk is known to be low.
Attenuate rainwater in ponds or open water features for gradual release	Spatial constrains on site limit opportunities to include ponds or open water on site.
Attenuate rainwater by storing in tanks or sealed water features for gradual release	The proposed drainage strategy proposes to attenuate surface water within below ground cellular storage.
Discharge rainwater direct to a water course	Where infiltration is not a viable outfall method due to previous commercial land use or proximity to proposed/existing listed building, it is proposed to discharge surface water to the River Wensum via a proposed outfall and an existing retained outfall.
Discharge rainwater to a surface water sewer/drain	The drainage strategy proposes to outfall runoff using infiltration and to the River Wensum.
Discharge rainwater to a combined sewer	The proposed drainage strategy proposes to outfall runoff using infiltration and to the River Wensum.



5.2.1 Proposed Site Discharge

Overview

The aggregation of the majority of the positively drained areas across the site is equal to the 1 in 100 year greenfield run-off rate. However, as described throughout this section, two catchments are proposed to freely discharge. A summary of the total site discharge is provided below. The below tables should be read in conjunction with the Catchment Plan contained in **Appendix F**.

Table 2 - Site Discharge Summary

Catchment Name	Total Area (ha)	Method of Discharge	Discharge Rate (I/s)
A,B,C,D,E,F,G,H, I, J	9.48	Controlled (Q100)	96.73
K, L, M, N, Q, R,	6.17	Infiltration	N/A
O, P, S	1.25	Uncontrolled	914.92

As per Table 1 the site proposed to outfall via two methods of discharge: infiltration and discharging directly into the River Wensum. Table 3 indicates each catchment area, the size of the catchment, planning classification of the catchment and the discharge method of the catchment. The table is an extract for the Catchment plan in **Appendix F**.

Table 3 - Catchment Classification

Catchment Name	Catchment (ha)	Discharge Method/Location	Planning Classification
A1	0.85	Proposed East Outfall	Outline
A2	0.99	Proposed East Outfall	Outline
A3	1.18	Proposed East Outfall	Outline
В	0.56	Proposed East Outfall	Outline
C1	0.63	West Outfall	Outline
C2	0.58	West Outfall	Outline

Drainage & SuDS Strategy



Catchment Name	Catchment (ha)	Discharge Method/Location	Planning Classification
C3	0.39	West Outfall	Outline
D	0.79	West Outfall	Outline
E	1.08	West Outfall	Outline
F	0.98	Proposed East Outfall	Outline
G	0.20	West Outfall	Full
н	0.21	West Outfall	Full
I	0.31	Proposed East Outfall	Full
J	0.73	Proposed East Outfall	Full
к	2.38	Existing Infiltration	Full
L	1.08	Existing Infiltration	Outline
М	0.53	Existing Infiltration	Outline
N	0.61	Existing Infiltration	Outline
0	0.73	Existing Outfall	Full
Р	0.39	West Outfall	Full
Q	1.28	Proposed Infiltration	Outline
R	0.29	Existing Infiltration	Full
S	0.13	Existing Outfall	Outline

Table 3 indicates that an area of 6.17ha is proposed to be disposed of via infiltration utilising either existing infiltration systems or where this is not possible reinstalled systems.

This leaves a remaining 10.73 ha that outfalls to the River Wensum, of which 9.48 ha is proposed to be controlled to the Q100 rate. The Q100 rate has been calculated using MicroDrainage as 10.2 l/s/ha see Figure 5-2 below. The Q100 rate has been selected as this will provide a significant betterment when compared with the existing uncontrolled discharge from the site. This approach is seen as acceptable

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



as the River Wensum in this location is tidal and less susceptible to fluvial flood events. However, following consultation with the LLFA it was agreed that although the river is tidal a significant betterment would be provided.

	ICP SUDS						
MOO	ICP SUDS Input (FSF	R Method)					Results
	Return Period (Yeara) Area (ha) SAAR (hm) Sol Growth Curve	800 1.000 602 0.400	(None)	Intranised Ca Region 5	Achement (QB/ 0.000 Calcul	en la	GBAR rural (/s) 2.9 GBAR urban (/s) 2.9
	Return Period Flood	1					
IH 124	Return Period Flood Region	QBAR (1/5)	Q (100yrs) (1%)	Q (1 yrs) (lis)	Q (30 yrs) (1s)	Q (100 yrs) (IS)	
IH 124	Return Period Flood Region Region 1	QBAR (1%) 2.9	Q (100yrs) (1%) 7.1	Q (1 yrs) (lis) 2.4	Q (30 yrs) (1s) 5.4	Q (100 yrs) (IS) 7.1	
IH 124 ICP SUDS	Return Period Flood Region Region 1 Region 2	QBAR (1%) 2.9 2.9	Q (100yrs) (05) 7.1 7.5	Q (1 yrs) (IS) 2.4 2.5	Q (30 yrs) (1s) 5.4 5.4	Q (100 yrs) (IS) 7.1 7.5	
IH 124 ICP SUDS ADAS 345	Return Period Flood Region Region 1 Region 2 Region 3	QBAR (1/5) 2.9 2.9 2.9	Q (100yrs) (15) 7.1 7.5 5.9	Q(tyrs) (IS) 24 25 25	Q (30 yrs) (13) 5.4 5.4 5.0	Q (100 yrs) (IS) 7.1 7.5 5.9	
IH 124 KCP SUDS ADAS 345	Return Period Flood Region Region 1 Region 2 Region 3 Region 4	QBAR (05) 2.9 2.9 2.9 2.9 2.9 2.9 2.9	Q (100yrs) (15) 7.1 7.5 5.9 7.3	Q(1 yrs) (IS) 2.4 2.5 2.5 2.4	Q (30 yrs) (1s) 5.4 5.0 5.6	Q (100 yrs) (is) 7,1 7,5 5,9 7,3	
IH 124 KCP SUDS ADAS 345 FEH	Return Period Flood Region Region 1 Region 2 Region 3 Region 4 Region 5	GBAR (05) 2.9 2.9 2.9 2.9 2.9 2.9 2.9	Q (100yrs) (IS) 7.1 7.5 5.9 7.3 10.2	Q(1 yrs) (I3) 24 25 25 24 25 24 25	Q (30 yrs) (13) 5.4 5.0 5.6 6.9	Q (100 yrs) (is) 7,1 7,5 5,9 7,3 10,2	
IH 124 ICP SUDS ADAS 345 FEH ReFH2	Return Period Flood Region Region 1 Region 2 Region 3 Region 4 Region 5 Region 6/Region 7	GBAR ()(5) 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9	Q (100yrs) (15) 7.1 7.5 5.9 7.3 10.2 9.1	Q(1 yrs) (I3) 24 25 25 24 25 24 25 24	Q (30 yrs) (13) 5.4 5.4 5.0 5.6 6.9 6.5	Q (100 yrs) (83) 7,1 7,5 5,9 7,3 10,2 8,1	
IH 124 ICP SUDS ADAS 345 FEH ReFH2	Return Period Flood Region Region 1 Region 2 Region 3 Region 4 Region 5 Region 6/Region 7 Region 8	GBAR ()(5) 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9	Q (100yrs) (15) 7,1 7,5 5,9 7,3 10,2 9,1 6,9	Q(1 yrs) (ls) 24 25 25 25 24 25 24 25 24 25 24 22	Q (30 yrs) (13) 5.4 5.0 5.6 6.9 6.5 5.4	Q (100 yrs) (83) 7,1 7,5 5,9 7,3 10,2 8,1 6,9	
IH 124 ICP SUDS ADAS 345 FEH ReFH2 Dreenfield Volume	Return Period Flood Region Region 1 Region 2 Region 3 Region 4 Region 4 Region 5 Region 6/Region 7 Region 8 Region 9	GBAR ()(5) 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9 2.9	Q (100yrs) (15) 7,1 7,5 5,9 7,3 10,2 9,1 6,9 6,9 6,2	Q(1 yrs) (ls) 24 25 25 25 24 25 24 25 24 22 25	Q (30 yrs) (1s) 5.4 5.0 5.6 6.9 6.5 5.4 5.0	Q (100 yrs) (83) 7,1 7,5 5,9 7,3 10,2 8,1 6,9 6,2	

Figure 5-2 - Q100 Controlled Rate

The Q100 rate is the proposed final outfall rate from the proposed drainage system for the east outfall. The west outfall has a combined outfall rate of 378.8 l/s of which the proposed plots contribute a total controlled rate of 39.58 l/s. Plots have been assigned controlled outfall rates on a plot by plot bases, taking into account spatial constraints of the plot, location of outfall and spatial constraints of the road.

A hydraulic model has been designed for the site with the catchment areas associated with the outline planning plots assigned to a single point of outfall per catchment. A control has been modelled limiting the catchment to its assigned discharged rate, this approach allows the strategic system to be assessed and sized sufficiently whilst also provided an indication of the attenuation required for each plot.

Due to the outline status of the plots, it has been assumed that the entire plot is impermeable, therefore no allowance for landscaping has been included. This is seen as conservative.

The hydraulic modelled has been assed line with government guidance for the area, the surface water drainage has been designed to cater for up to the 1 in 100 year return period + 45% climate change. A general arrangement drawing of proposed drainage system can be found in **Appendix G** and hydraulic calculations can be found in **Appendix H**.



East Outfall

The east outfall is a proposed outfall is controlled to a discharge rate of 57.15 l/s before outfalling directly into the River Wensum. The table below outlines the plots that are proposed to outfall to the east network, the catchment area, the flow rate and attenuation required on plot. Due to the size of Catchment A three outfalls have been provided.

Catchment Name	Catchment (ha)	Controlled Discharge Rate (I/s)	Attenuation Required (m ³)
A1	0.85	15.00	472
A2	0.99	12.00	618
A3	1.18	15.00	720
В	0.56	15.00	276
F	0.98	7.33	694

Table 4 - East Outfall Catchments

West Outfall

The west outfall is proposed to reuse an existing outfall to the River Wensum and as such the final outfall rate to the River Wensum is made up of both controlled and uncontrolled rates. Catchment areas G, H and C are proposed to discharge upstream of the existing pipework and therefore the controlled rate from these areas has been prorated based on catchment area and a vortex control chamber provided. Catchment areas D & E are proposed to discharge downstream of the vortex control and will be controlled separately on each plot.

The maximum flow rate from the west outfall is 378.8 l/s, of which 39.58 l/s is controlled from the proposed drainage network. See Figure 5-3 for diagram.



Drainage & SuDS Strategy



Figure 5-3 - West Outfall Diagram

Catchment C is the only plot proposed to discharge upstream of the retained network and outfall (highlighted in Figure 5-3), due to the size of Catchment C three outfalls have been provided. The table below outlines the outfall from Catchment C identifying the catchment area, the flow rate and attenuation required on plot.

Catchment Name	Catchment (ha)	Controlled Discharge Rate (I/s)	Attenuation Required (m ³)
C1	0.39	10.00	193
C2	0.73	11.00	319
С3	0.48	20.00	286

Table 5 - W	Vest Outfall	Catchments U	pstream of	Existina	Network
	oot outrail	outonnonto o	pourounn or	Exioting	



The remaining controlled catchment areas D and E are detailed in the table below -

Table 6 - D & E Catchments

Catchment Name	Catchment (ha)	Controlled Discharge Rate (I/s)	Attenuation Required (m ³)
D	0.79	5.96	561
E	1.08	8.11	763

As identified in Figure 5-3 the existing retained buildings are proposed to utilise the existing arrangement and outfall uncontrolled (Catchment Area O & P) as per the existing regime on site. Due to spatial constraints in this area and the historic nature of the buildings, any attenuation associated with it would be required to be below ground and deep. The construction of these features may pose a risk to be structural integrity of the building and therefore have not been included. As the River Wensum is tidal and the existing system discharges freely, the risk of instability due to the installation of attenuation has been assessed to outweigh the risk of flooding. The catchment areas associated with these buildings are identified below.



Figure 5-4 - Retained Building Catchments

Drainage & SuDS Strategy



5.2.2 Attenuation

As discussed in Section 5.2.1 separate attenuation is to be provided within the highways and on plot. Where attenuation is provided in the highways this is proposed to be in the form of below ground cellular storage crates.

The plots fall within the outline planning classification of the application and therefore the details of attenuation in these areas will be confirmed at a later design stage. However, it is envisioned that it will be provided via permeable paving, bioretention, blue/green roofs or below ground cellular storage.

The required attenuation has been calculated using Causeway Flow for the 100 year return period + 45% climate change, calculations can be found in **Appendix H**.

The west outfall requires a total of 2,919m³ of storage, 797m³ of which is proposed to be provided using below ground cellular storage and the remaining 2,122m³ on plot as part of the outline panning extents, the form of which is to be confirmed at a later design stage.

The east outfall requires a total of 4,024m³ of storage, 1,315m³ of which is proposed to be provided within the detailed planning boundary using below ground cellular storage and the remaining 2,709m³ on plot as part of the outline planning extents, the form of which is to be confirmed at a later design stage.

5.2.3 Sustainable Drainage Systems

Developments should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. As mentioned previously, the design should aim to reduce run-off rates and ensure that run-off is managed as close to its source as possible as per the drainage hierarchy (see Table 1).

The SuDS Hierarchy sets out the preferred method of discharging and managing water from a development site and aims to highlight why each item has been utilised or discounted.

Table 7 analyses the SuDS hierarchy and the appropriate techniques with specific focus on this project.

SuDS Technique	Site Specific Analysis
Rainwater Harvesting	Proposed residential plots fall within the outline planning application, as plots are
	progressed in detail rainwater harvesting techniques are to be reviewed by M&E
	engineer at a later design stage.
Living or Roofs/Areas	It is envisioned that blue/green roofs will be included within in the on plot drainage
	designs, as these areas fall within the outlining planning area this will be confirmed at a later design stage.
	The buildings within the full planning area are retained listed building and as such blue/green roofs are not proposed.

Table 7 - SuDS Opportunities

Drainage & SuDS Strategy



SuDS Technique	Site Specific Analysis
Basins and Ponds	Due to spatial constraints basins or ponds are not proposed within the full planning area.
	It is envisioned that the potential of including basins and ponds will also be limited due to spatial constraints, however as the plot designs progress the options will be reviewed.
Bio-retention and	Bio-retention areas are proposed within the full planning application boundary, it is
Swales	proposed that parts of the highways will runoff directly into the bio-retention areas.
	The bio-retention areas are to be used for treatment only and not proposed to be used as storage.
Infiltration Devices	It is proposed to reuse existing infiltration structures on site where suitable. These are
	shown on the Drainage General Arrangement in Appendix G .
Permeable Surfaces	Permeable paving is envisioned to be included within the on-plot outline drainage strategy.
	Porous sub-base with impermeable surfacing is proposed In the surround areas of the
	existing buildings to the northwest corner of the site around the listed building in the northwest corner of the site (Catchments Q&P), it is proposed to outfall runoff via linear
	channels to a granular sub base where this will enter the below ground drainage
	system. This is intended to slow the flow of run-off in the uncontrolled portion of the
	scheme, provide some additional attenuation and reduce flood risk, without installing
	large attenuation tanks adjacent to the foundations of listed buildings.
Tanked Systems	Tanked systems are proposed within both the full and outline planning areas on the
	site. Within the full planning area tanked systems are proposed to provide a total of
	2,112111 01 Storage.



5.2.1 Water Quality – Full Planning Area

The proposed drainage strategy manages pollution risk for the site based on a simple qualitative method as defined in the CIRIA SuDS Manual C753, consisting of an assessment of likely pollution hazard levels for the site and SuDS performance capacities:

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro- carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non- residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.82	0.82	0.9*

Step 1. Allocate suitable pollution hazard indices for the proposed land use

Figure 5-5 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification

For the development that falls within the full planning application this has been identified as 'Commercial Yards/All Other Roads', the existing retained buildings are classified as 'Commercial Yard' and the highway as 'All Other Roads'.



Step 2. Select SuDS with a total pollution mitigation index that is equal or exceeds the pollution hazard index.

۰.		Nitigation indices ²				
	Type of SuDS component	TSS	Metals	Hydrocarbons		
	Filter strip	0.4	0.4	0.5		
	Filter drain	0.42	0.4	0.4		
	Swale	0.5	0.6	0.6		
	Bioretention system	0.8	0.8	0.8		
	Permeable pavement	0.7	0.6	0.7		
	Detention basin	0.5	0.5	0.6		
	Pond"	0.71	0.7	0.5		
	Wetland	0.8*	0.8	0.8		
	Proprietary treatment systems ^{1,4}	These must demonstrate t acceptable levels for frequ	hat they can address each ent events up to approxime	of the contaminant types stely the 1 in 1 year return		

Figure 5-6: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices

The 'Commercial Yards' are proposed to drain via linear channels that outfall to a granular subbase before entering the wider strategic network, for the purpose of the indices matrix this can be viewed as 'Permeable Paving'.

All Other Roads' (Highways) are proposed to drain via roadside bioretention that outfall to a granular subbase before entering the wider strategic network.

Both permeable paving and bioretention areas provide sufficient treatment for their respective land use and pollution hazard level.

Due to spatial and arboriculture constraints the retained highways are proposed to drainage via road gulley's, it is proposed that before entering the downstream system where SuDS components are present these catchments is proposed to pass through a full retention petrol interceptor. Mitigation indices for a AquaTreat Water Treatment Separator can be found –

Table 8 - AquaTreat Water Treatment Separator Treatment Indices

TSS	Metals	Hydrocarbons
0.85	0.64	0.99



5.2.1 Water Quality – Outline Planning Area

The proposed drainage strategy manages pollution risk for the site based on a simple qualitative method as defined in the CIRIA SuDS Manual C753, consisting of an assessment of likely pollution hazard levels for the outlining planning area and SuDS performance capacities:

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro- carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non- residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with Irequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented orry approaches to industrial estates, waste sites), sites where chemicals and luels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.82	0.9²

Step 1. Allocate suitable pollution hazard indices for the proposed land use

Figure 5-7 - Extract of CIRIA SuDS Manual C753. Pollution Hazard Indices for Land Use Classification

The development that falls within the outline planning application has been identified as '*Residential* Roofs', '*Individual Property Driveways*' or '*Commercial Yards*,.



Step 2. Select SuDS with a total pollution mitigation index that is equal or exceeds the pollution hazard index.

ABLE	Indicative SuDS mitigation indices for discharges to surface waters				
26.3			Mitigation indices ¹		
	Type of SuDS component	TSS	Metals	Hydrocarbons	
	Filter strip	0.4	0.4	0.5	
	Filter drain	0.42	0.4	0.4	
	Swale	0.5	0.6	0.6	
	Bioretention system	0.8	0.8	0.8	
	Permeable pavement	0.7	0.6	0.7	
	Detention basin	0.5	0.5	0.6	
	Pond ⁴	0.73	0.7	0.5	
	Wetland	0.83	0.8	0.8	
	Proprietary treatment systems ^{1.0}	These must demonstrate t acceptable levels for frequ period event, for inflow co	that they can address each ent events up to approximate ncentrations relevant to the	of the contaminant types to ately the 1 in 1 year return contributing drainage area.	

Figure 5-8: Extract of CIRIA SuDS Manual C753. Pollution Mitigation Indices

The above figure provides an indication of how treatment may be provided within the outlining planning area, however the exact details of the SuDS components used within these areas will be confirmed at a later design stage.

Permeable paving, bioretention areas (blue/green roofs) and filter strips provide sufficient treatment for their respective land use and pollution hazard level. Where areas are identified at the later design stages that are not covered by these, bypass or full retention separators will be used to ensure the hazard indices are met for all areas of the development.

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



5.2.2 Flood Exceedance

Information taken from the Carrow Bridge TS Norwich Monitoring Station (TG2390007700) indicates that the typical high tide level for the River Wensum at this location is 0.99mAOD. The proposed eastern outfall from the site is proposed at a level of 1.00mAOD, this sits above the typical high tide level.

The western outfall from the site proposes to reuse an existing outfall. The outfall level is unknown however the next upstream invert level is 0.64mAOD, therefore it has been assumed that the pipe is laid at a grade of 1 in 100.

Both the known upstream level and assumed downstream outfall level sits below the typical high tide level, to allow for this within the design a surcharged outfall has been modelled for all return periods and durations. Calculations can be found in **Appendix H**.

Using the climate change allowances provided by the Environment Agency for the fluvial and pluvial flood risk to the site, a further assessment has been undertaken into the impact of the design rainfall event (1 in 100 year +45%CC) occurring simultaneously with the design river flooding event (1 in 100 year +11%CC). Surcharged outfall for both the west and east outfalls have been modelled to simulate river levels in the Wensum during a 1 in 100 year fluvial event occurring in the 2080s. Calculations can be found in **Appendix I**.

This model indicated that a total of 677m³ of flooding would occur at the east outfall (MH 29), however levels indicate that should flooding occur at this manhole the exceedance flows would flow towards and enter the River Wensum.

The west outfall indicates the system would flood (511m³) at its lowest point (MH SW36), where flood water would be located within the highway and surrounding areas.

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy



5.3 Foul Water

As discussed in Section 4.2.2 it is envisioned that the that the existing foul water serving the Abbey building is to be retained. A new foul water network is proposed to serve the new developments across the site with existing sewerage being retained where feasible. An assessment into the foul water loading is to be undertaken following planning and during the detailed developments of the plot drainage. The existing Anglian Water sewer that bisects the site will be retained from the Abbey to its outfall in the south and abandoned or diverted to the north.

Foul water on sire proposed to be designed in accordance with Building Regulations Part H and is believed to remain private.

5.3.1 Nutrient Neutrality

Guidance has also been provided by Natural England with regards to the potential to affect water quality by treated foul effluent resulting in adverse nutrient impacts on habitat sites. The proposed development will result in a net increase in population served by the Anglian Water wastewater system. At this stage it is known that there are various options available for the mitigation of this impact, however, currently no specific mitigation measure has been opted for.

The detailed aspect of this application does not include any new buildings, therefore it is proposed that nutrient neutrality is considered and conditioned at the reserved matters application stage, where the new housing developments will be brought forward for assessment.



6.0 General Maintenance

It is assumed that all drainage within the site will be maintained as a private network. A suitable maintenance strategy will be included within handover documentation by the contractor once final details and suppliers have been chosen for the individual drainage elements. This strategy should be adopted to ensure the drainage network is cleaned regularly and the routine maintenance and cleansing regime should be documented.

An Operation and Maintenance Manual has been written by Curtins and should be referenced for general maintenance, this can be found in **Appendix J**.



7.0 Conclusions and Recommendations

This report is intended to provide further details on the design of the drainage systems for the proposed redevelopment of the Carrow Works site and to act as additional information in support of the planning application. The conclusions to be drawn from this report are as follows:

- The southern area of the site proposes to outfall via infiltration through either existing soakaway structure, where existing structures cannot be retained existing soakaways are to be reinstalled or cleaned.
- The northern area proposes to outfall to the River Wensum at a Controlled rate of Q100.
- The northwest of the site (Catchments O&P) that are proposed refurbishments of existing listed buildings are proposed to discharge as per the existing regime.
- Where attenuation is required, it is provided via below ground cellular storage in the full planning application area.
- Further details of the drainage strategy for the outline planning areas will be provided at the reserved matters application stage. The discharge rates and attenuation volumes required have been outlined in this report.
- To combat flooding due to high tides, outfalls are proposed to be installed above the typical high tide level or a surcharged outfall has been modelled using the typical high tide level.
- Permeable paving, bioretention and Petrol interceptors are proposed to treat run off within the full planning application area before it is discharged into the River Wensum.
- It is envisioned that Foul Water will utilise the existing connections to the public sewer located on site.



Appendix A – Site wide topographical survey



307700N	Legend: Fences Buildings Walls Overhead E Hedges Overhead P Trees Gate Trees Gate BolLARD BO BRITISH TELECOM IC BT CONCRETE PAVING SLABS CPS COVER LEVEL CL DROP KERB DK ELECTRICTY POLE EP FIRE HYDRANT FFE FOOTPATH FFE FOOTPATH FFE GAS VALVE CV VINSPECTION COVER IC PIPE INVERT LEVEL L KERB OUTLET KO MAN HOLE MH	Fences: Barbed Wire Fence Corrugated Iron Fence Closed Board Fence Iron Railing Fence Post and Chain Fence Post dire Fence Interwoven Chain Link Fence Larch Lap Fence Wire Mesh Fence Wire Mesh Fence Wire Mesh Fence Road NAME PLATE ROAD NAME PLATE ROAD NAME PLATE ROAD SIGN RODDING EYE RETAINING WALL RAINWATE PIPE SOIL VENT PIPE SOIL VENT PIPE STOP VALVE TELEGRAPH POLE TRAFFIC UGH UNABLE TO LIFT VENT PIPE WATER MEITER	₩ W B C C C V P P P P C C V P P P P P C C V P P P P P P P P P P P P P	Notes: Whilst e identify that an final de All infor (includin verified Grid co on a pla	every effort has b species of trees arborologist be c cisions are made mation contained ng digital data) sh prior to any fabri ordinates are bas ane grid with a sc	een made to corre on the site, we adv onsulted before ar d in this drawing nould be checked a cation or construct sed on an OS GNS ale factor of 1.000	ectly vise ny and tion. SS system 0.
		L					
I		č					
		_	307680N	Stn	Coordi Easting	Northing	Level
			-	RC1 RC10 RC11	624190.337 624450.249 624485.811	307611.342 307577.504 307557.457	4.832 4.601 3.619
				RC12 RC13 RC15	624472.992 624431.089 624362.846	307505.592 307516.490 307523.290	5.235 5.089 5.021
				RC16 RC17 RC18	624338.487 624325.864 624309.030	307468.131 307471.037 307474.774	5.256 5.093 5.063
	Part ZZ6.5	gget 99		RC19 RC2 RC21 RC25	624300.886 624243.598 624219.933 624173.654	307488.617 307601.733 307553.964 307554.226	4.992 4.801 4.794 5.021
				RC3 RC31 RC35	624324.448 624131.053 624238.767	307593.554 307566.721 307506.239	4.784 5.225 5.153
				STN1 STN10 STN11	624408.946 624089.489 624204.934	307268.178 307583.140 307546.594	6.934 4.067 3.302
		_	307660N	STN12 STN13 STN13A	624260.866 624345.517 624314.815	307526.574 307498.227 307526.408	3.226 3.231 3.167
			.	STN13B STN14 STN15 STN16	624320.373 624393.167 624470.483 624478.261	307550.213 307527.487 307527.726 207420 885	3.311 3.408 3.653 2.706
				STN16 STN17 STN1R STN2	624478.361 624466.896 624438.720 624327.608	307430.885 307357.893 307310.810 307198.860	3.706 6.775 8.710 7 392
				STN2 STN3 STN3A STN3Z	624245.087 624212.223 624260.562	307155.000 307257.967 307195.780 307256.565	10.932 10.000 10.165
				STN4 STN4A STN4A1	624158.281 624138.728 624132.076	307285.589 307293.833 307279.935	13.569 14.147 15.588
				STN4B STN5 STN6	624163.933 624112.684 624104.385	307256.096 307322.867 307433.428	14.232 15.230 8.517
				STN7 STN7A STN7B STN7C	624126.108 624097.573 624147.259 624162.885	307475.591 307485.526 307493.761 207506.250	6.006 6.178 4.793
				STN8 STN8A STN8A1	624042.883 624077.341 624075.158	307502.770 307502.116 307484.405	4.584 5.308 5.105 6.582
		_	307640N	STN8B STN9 STN9A	624116.044 624037.369 624046.336	307502.915 307576.782 307591.864	4.794 5.554 5.463
				STN9B STN9C STN9D	624012.632 623994.743 623997.720	307600.059 307585.870 307563.436	6.576 6.047 5.835
				STN9E STNB1 STNBR1 STNC1	624031.039 624191.286 624205.110 624088.520	307555.217 307243.035 307263.539 207611.604	5.424 13.384 11.901 2.887
				STNC10 STNC10A STNC10B	624088.529 624518.683 624528.065 624520.898	307571.198 307565.700 307554.534	<u> </u>
				STNC11 STNC11A STNC12	624470.275 624473.400 624479.8261	307564.288 307585.466 307595.4946	2.317 1.756 1.5447
				STNC13 STNC14 STNC14A	624507.4054 624472.2326 624489.3552	307597.2299 307512.9358 307517.4921	1.6217 3.6401 3.5595
Mooring Post 1.67				STNC19 STNC2 STNC20	624450.8611 624099.6354 624340.4121	307553.4420 307635.0375 307489.8376	3.3378 3.9449 3.3313
Metal Stairs	Line of 3.47 Posts STNC4 51 Metal STNC4 51 Sheer	Mgori	ing	STNC21 STNC22 STNC22A STNC23	624356.3641 624347.5215 624345.2797 624297.3791	307486.2783 307466.6815 307455.1947 307477.6708	3.4183 3.7155 4.7870 3.6695
	Underside of Overhana=Print	In Pos	3.36	STNC23 STNC24 STNC24A STNC2A	624302.0432 624292.1747 624049.2924	307477.0708 307498.4798 307504.4669 307647.1517	3.3561 3.3343 3.9085
Ridge 24.16	 		+	STNC2B STNC3 STNC30	624041.0212 624125.2265 624101.4878	307624.6973 307628.0419 307570.7955	4.4369 1.6708 3.8321
3.61	MH Post 5.56 Syrap	√ [₩] 4 ₆ Tarmac		STNC31 STNC4 STNC40	624116.3712 624146.9360 624270.5552	307593.1521 307622.3406 307289.7571	3.9503 3.5638 10.3060
Eques	uilding 0.5.054 Inopy Post	, , , , , , , , , , , , , , , , , , ,	/ / / Parapet /	STNC41 STNC41A STNC42 STNC42	624286.3119 624282.8617 624280.6199 624275.7233	307275.7697 307286.3612 307259.8963 307253.9066	9.4804 9.8426 9.4843 9.7601
図 / /Parapet / / 19.83 / / /	3.58 11111	and the second	28.35 /	STNC43 STNC44 STNC45 STNC5	624275.7235 624265.2724 624239.1039 624279.6126	307252.9808 307269.7593 307595.4977	9.7601 9.9885 10.6611 3.2085
Ridge / 9.36 / /				STNC5A STNC6 STNC7	624273.0914 624371.5767 624430.0166	307555.5582 307593.2387 307594.4400	3.2730 3.0596 3.1651
					Sheet	Layout	
6 6 6 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	±4.35 et l Parapet 31.83				1 4 7	23 56 89	
$B0_{23,56} = \frac{3,56}{125}$				Rev. Suffix	Date Initial	Revision D	Details
		_		Surveyor PD/M	IB By AL/LW Ope	rator TJH Approved By A	RL Date 23.08.18 B36
					To an [OS GNSS Datum	
3.49 46	444.1.			Client	•	0.147	
Ht=1.10m / 3.49 BC	3.49 0 GV (2) 3.41 B0 (7) 3.43	Tarmac Vin	egar NKS Parapet	Cı	ushman L	& Wake LP	field
57		3.533.47/ 3.470 B0 / 333 3.43-	28.36 43.47 6 /B0	Location	Carro	w Works	
, J.53 'S SO	+ 3.55		·		Norwich	, NR1 2DE)
-, <u>3,49</u> -, <u>3,49</u> -, <u>-, -, -, -, -, -, -, -, -, -, -, -, -, -</u>		+ 3.5 ₁		Drawing T	ritle opograp	hical Sur	vey
+3.51 3.52	3.47 Tarmac VR Ht=1.42	inage Channel	BO		Shee	et 1 of 9	
	3.46	3.42+1 \$3.39 3.42+1 \$3.39	<u>5.43 I/R</u> <u>Ht=1.10m</u> 5.39 5.12	Job No.	1805022 Number	Old Job No. Revision Suffix	
		Ht=1.701 Tom Ht=	4.99 + 3. VR 1.10m	CW/	1805022/1	Date	
				1:20	00m (A0)	August	2018
				PENTIRE FORDBR SUNBUR MIDDLES	CD SU LAND, BUILDI - STABLE 1 IDGE ROAD, Y-ON-THAMES SEX, TW16 6AX	KVEYS NG & SITE ENG Tel (0' Fax (0' Email: mail@cc Visit us at: www.cc	SLTD INEERING 1932) 761196 1932) 786419 dsurveys.com dsurveys.com







307580N

307560N

307540N

307520N

307500N

307480N

307460N

307600N





307440N

307420N

307400N

307380N

307360N

307340N

307320N

307300N

Notes:

Whilst every effort has been made to correctly identify species of trees on the site, we advise that an arborologist be consulted before any final decisions are made.

All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction. Grid coordinates are based on an OS GNSS system on a plane grid with a scale factor of 1.0000.

Legend: Fences Buildings Fences: Barbed Wire Fence Corrugated Iron Fence Closed Board Fence Chestnut Paling Fence Iron Railing Fence Post and Chain Fence Post Wire Fence Interwoven Chain Link Fence Larch Lap Fence Wire Mesh Fence Overhead Electric Walls _____ Hedges Trees Overhead Phone Gate Abbreviations: BOLLARD BRITISH TELECOM IC CONCRETE PAVING SLABS COVER LEVEL DROP KERB ELECTRICITY POLE FIRE HYDRANT FLOWER BED FOOTPATH GAS VALVE GULLY MARKER PARKING METER ROAD NAME PLATE ROAD SIGN RODDING EYE RETAINING WALL RAINWATER PIPE SOIL VENT PIPE SOIL VENT PIPE TELEGRAPH POLE TRAFFIC LIGHT UNABLE TO LIFT VENT PIPE WATER METER gully Inspection Cover Pipe Invert Level Kerb Outlet Man Hole Sheet Layout Rev. Suffix Date Initial **Revision Details** A/ CAD TJH Approved ARL Date 23.08.18

 Surveyor
 PD/MB
 By
 AL/LW
 Operator
 TH
 Py By
 ARL
 Date
 23.08

 Levelling
 GNSS
 Datum
 OSGB36

 To an OS GNSS Datum

 Client

 Client

 Location

 Carrow Works Norwich, NR1 2DD

 Drawing Title

 Topographical Survey Sheet 6 of 9

Sheet 6 of 9Job No.1805022Old Job No.Drawing NumberRevision SuffixCW/1805022/6Date

1:200m (A0)

PENTIRE - STABLE 1 FORDBRIDGE ROAD, FORDBRIDGE FORDBRIDGE ROAD, FORDBRIDGE FORDBRIDE FORDBRIDGE FORDBRIDGE FORDBRIDGE FORDBRIDGE FORDB

August 2018

PENTIRE - STABLE 1Tel (01932) 761196FORDBRIDGE ROAD,Fax (01932) 786419SUNBURY-ON-THAMESEmail: mail@cdsurveys.comMIDDLESEX, TW16 6AXVisit us at: www.cdsurveys.com

T	ree	S	ch	ec	dul	e	

307280N

307260N

307240N

307220N

Tree Schedule

Pt No	Spread	Bole	Height	Species
142 166	8.0 4.0	0.35 0.25	10.0 8.0	TREE UNKOWN SILVER BIRCH
167 168	4.0 6.0	0.30	8.0 8.0	SILVER BIRCH SILVER BIRCH
385 539	9.0	0.40	10.0 15.0	MAPLE
540 542	6.5	0.40	15.0	PINE
543	7.0	0.50	15.0	PINE
544 545	5.0 7.0	0.30	11.0	BIRCH
546 752	7.0 5.0	0.30 0.35	11.0 7.0	BIRCH FIELD MAPLE
753 770	4.0 9.0	0.30	9.0 14.0	CYPRESS TREE UNKOWN
771 772	7.0 10.0	0.30 0.45	10.0 14.0	TREE UNKOWN TREE UNKOWN
800 801	9.0 9.0	0.40	13.0 13.0	MAPLE MAPLE
803 848	8.0 6.0	0.35 0.45	12.0 12.0	MAPLE CYPRESS
849 850	6.0 4.0	0.45	12.0 10.0	CYPRESS CYPRESS
851 852	4.0	0.35	10.0	CYPRESS
853 858	7.0	0.40	11.0	TREE UNKOWN
920	9.0	0.40	13.0	TREE UNKOWN
1052	5.0	0.30	8.0 10.0	CYPRESS
1054 1118	8.0	0.40	10.0 12.0	BEECH
1136 1142	10.0 7.0	0.50 0.30	13.0 11.0	BEECH BEECH
1143 1151	7.0 9.0	0.30 0.50	4.0 11.0	BEECH BEECH
1528 1529	9.0 7.0	0.45 0.35	14.0 12.0	TREE UNKOWN FIELD MAPLE
1530 1531	7.0	0.35	12.0 15.0	MAPLE MAPLE
1532	10.0	0.45	15.0	MAPLE
1535	4.0	0.40	14.0	MAPLE
1539 1540	10.0	0.60	14.0 14.0	BEECH BEECH
1541 1542	10.0 9.0	0.45	14.0 14.0	BEECH BEECH
1543 1544	7.0 7.0	0.30 0.45	12.0 13.0	BEECH BEECH
1545 1547	8.0 9.0	0.50 0.60	13.0 14.0	BEECH BEECH
1548 1549	9.0 9.0	0.40 0.65	14.0 14.0	BEECH BEECH
1550 1551	8.0 6.0	0.35	14.0 12.0	BEECH BEECH
1552 1553	10.0	0.55	14.0 13.0	BEECH BEECH
1554	9.0	0.45	13.0	BEECH EIELD MARLE
1556	10.0	0.75	14.0	BEECH
1557	10.0	0.50	14.0 16.0	BEECH BEECH
1559 1560	10.0	0.45	15.0	BEECH BEECH
1561	9.0	0.75	16.0	BEECH
1845 1846	9.0 7.0	0.35 0.35	13.0 13.0	BEECH SILVER BIRCH
1847 2210	7.0 11.0	0.35	13.0 15.0	SILVER BIRCH BEECH
2211 2212	11.0 10.0	0.55 0.55	14.0 14.0	BEECH SYCAMORE
2216 2221	11.0 8.0	1.30 0.40	14.0 13.0	SYCAMORE TREE UNKOWN
2404 2405	8.0 4.0	0.60	13.0 13.0	BEECH PINE
2407 2418	13.0 8.0	0.70	15.0 10.0	BEECH BEECH
3767	8.0 7.0	0.50	10.0	CYPRESS TREE UNKOWN
3779	14.0	1.20	17.0	TREE UNKOWN
40834 41103	8.0	0.20	8.0	SILVER BIRCH
41104 41107	9.0	0.30	11.0	PINE
41522 41523	18.0 18.0	1.20	19.0 19.0	BEECH BEECH
41524 41541	11.0 8.0	0.40	14.0 8.0	YEW HOLLY
41965 41981	8.0 10.0	0.40	11.0 12.0	MAPLE WILLOW
41990 41991	8.0	0.40	8.0	CHERRY TREE UNKOWN
41992 41993	8.0 12.0	0.30	9.0 10.0	HORSE CHESTNUT PLANE
41994 41995	9.0	0.30	7.0	CHERRY
41996 42137	9.0	0.20	10.0 8 0	PLANE MADIF
42138	11.0	0.20	0.0 9.0	PLANE
42240 42360	5.0 8.0	0.30	9.0	BEECH
42370 42392	9.0 11.0	0.30 0.50	11.0 15.0	OAK MAPLE
42393 42501	16.0 6.0	0.80	18.0 7.0	BEECH BEECH
42502 42529	7.0 6.0	0.30	9.0	BEECH PINE
42547 42550	9.0 9.0	0.40 0.50	12.0 12.0	PINE YEW
42551 42552	9.0 9.0	0.50	12.0	YEW YFW
42554	6.0 8.0	0.30	9.0	HOLLY SILVER RIDCH
42559	10.0	0.30	12.0	SYCAMORE
42561	7.0 15.0	0.30	10.0	BEECH BEECH
42562 42563	5.0 9.0	0.40	15.0 8.0	PINE TREE UNKOWN
42564 42565	10.0 5.0	0.60	16.0 6.0	PINE YEW
42569 42570	10.0 7.0	0.30	15.0 14.0	SYCAMORE SYCAMORE
42571 42573	6.0 6.0	0.50	17.0	PINE YEW
42579 42580	9.0	0.50	16.0 10.0	BEECH YFW
42583	9.0	0.30	14.0	SYCAMORE
1~000	0.0	0.00	15.0	STORIVIORE
42599	11.0	0.30	15.0	SYCAMORE

	I	ree So	cneaule	•
Pt No	Spread	Bole	Height	Species
42603	6.0	0.30	9.0	YEW
42613	11.0	0.20	16.0	OAK
42615 42616	12.0 7.0	0.40	16.0 14.0	TREE UNKOWN SYCAMORE
42618	10.0	0.40	15.0	SYCAMORE
42620	8.0 6.0	0.30	9.0	HOLLY
42622 42623	6.0 6.0	0.30	9.0 9.0	HOLLY
42657	9.0	0.30	13.0	BEECH
42658 42659	14.0 14.0	0.60	16.0 16.0	BEECH BEECH
42743	5.0	0.30	8.0	BEECH HOPSE CHESTNUT
42744	9.0	0.30	8.0	SWEET CHESTNUT
43194 43222	12.0 8.0	0.30	14.0 11.0	MAPLE MAPLE
43223	12.0	0.40	14.0	MAPLE
43224 43225	7.0	0.30	9.0	MAPLE
43281 43282	15.0 12.0	0.50	15.0 14.0	TREE UNKOWN SYCAMORE
43283	12.0	0.30	14.0	SYCAMORE
43284 43285	12.0	0.30	14.0	SYCAMORE
43286 43346	12.0 5.0	0.30	13.0 6.0	SYCAMORE PINE
43347	4.0	0.30	7.0	PINE
43348	9.0 8.0	0.30	8.0	PALM
43378 43379	8.0 9.0	0.30	8.0 8.0	MAPLE MULBERRY
43383	5.0	0.30	5.0	PINE
43385	5.0	0.30	5.0	PINE
43386 43387	7.0	0.30	9.0 15.0	BEECH MAPLE
43388	9.0	0.30	13.0	MAPLE
43369	5.0	0.30	4.0	CHERRY
43465 43489	7.0	0.20	6.0 15.0	CHERRY CEDAR
82582	5.0	0.30	12.0	SYCAMORE
82584	5.0	0.30	12.0	SYCAMORE
82585 82586	5.0 5.0	0.20	12.0 12.0	SYCAMORE SYCAMORE
82587 82588	5.0	0.20	12.0	SYCAMORE
82589	5.0	0.20	12.0	SYCAMORE
82590 82591	5.0 5.0	0.20	12.0 12.0	SYCAMORE SYCAMORE
82592 82621	5.0	0.20	12.0	SYCAMORE
82674	6.0	0.40	12.0	SYCAMORE
85904 85914	18.0 12.0	0.60	24.0 18.0	OAK PINE
85916 85917	8.0 8.0	0.40	16.0 16.0	SYCAMORE SYCAMORE
85918	8.0	0.30	16.0	SYCAMORE
85919 85920	8.0 8.0	0.30	16.0 16.0	SYCAMORE SYCAMORE
85921 85922	8.0 8.0	0.40	16.0 16.0	SYCAMORE SYCAMORE
85923	6.0	0.20	16.0	SYCAMORE
85924 85925	6.0 6.0	0.20	16.0 16.0	SYCAMORE SYCAMORE
86123 86124	12.0 12.0	0.40	18.0 18.0	YEW
86125	8.0	0.40	16.0	YEW
86127 86128	8.0	0.30	26.0	LIME
86182 86183	6.0 14.0	0.30	12.0 26.0	YEW SYCAMORE
86246	10.0	0.30	26.0	SYCAMORE
86247 86248	10.0	0.30	26.0	SYCAMORE
86249 86283	4.0	0.20	7.0 12.0	LAUREL YEW
86284	8.0	0.40	12.0	YEW
86286	6.0	0.40	12.0	YEW
86287 86288	10.0	0.60	24.0 15.0	PINE PINE
86289	5.0	0.20	9.0	HOLLY
86293	10.0	0.40	26.0	SYCAMORE
86294 86299	12.0	0.40	26.0 8.0	LAUREL
86300 86301	7.0	0.20	8.0	LAUREL
86319	7.0	0.50	14.0	YEW
86320 86330	10.0	0.30	16.0 9.0	SYCAMORE YEW
86331 86351	5.0 8.0	0.30	7.0	HAWTHORN VFW/
86352	14.0	1.20	28.0	OAK
86367	8.0 8.0	0.30	16.0 16.0	BEECH BEECH
86369 86370	8.0 8.0	0.30	16.0 16.0	BEECH BEECH
86371	8.0	0.30	16.0	BEECH
86378 86390	14.0 9.0	0.40	18.0 16.0	ASH
86394 86395	6.0 9.0	0.30	10.0	FRUIT
86396	5.0	0.40	12.0	CYPRESS
86442 86443	14.0	0.30	24.0 24.0	BEECH BEECH
86444 86445	14.0	0.30	24.0	BEECH
86479	8.0	0.30	7.0	CYPRESS
86484 86485	8.0 12.0	0.40	12.0 12.0	POPLAR SYCAMORE
86504 86510	14.0 10.0	0.50	18.0 22.0	BEECH BEECH
86511	10.0	0.40	22.0	BEECH
86512 86513	10.0 10.0	0.40	22.0 22.0	BEECH BEECH
86567 86568	8.0	0.20	5.0	YEW PINF
86588	10.0	0.40	22.0	BEECH
86589 86590	10.0 10.0	0.40	22.0 22.0	BEECH BEECH
86591 86689	10.0	0.50	22.0 14.0	BEECH BEECH
86724	10.0	0.50	12.0	CYPRESS
86726	9.0	0.40	12.0	CYPRESS
100016 100155	13.0 13.0	0.40	11.0 15.0	OAK LIME
100156	10.0	0.30	10.0	OAK

307180N

_

307200N

	Tree Schedule					
Pt No	Spread	Bole	Height	Species		
100196	14.0	0.70	16.0	SYCAMORE		
100197	7.0	0.30	8.0	HOLLY		
100198 100199	7.0 14.0	0.30	8.0 18.0	YEW PINE		
100289	7.0	0.40	8.0 6.0	CYPRESS		
100291 100292 100294	8.0 5.0 8.0	0.40	6.0 7.0	CHERRI CYPRESS TRFF UNKOWN		
100294 100295 100296	10.0	0.50	7.0	CHERRY WILLOW		
100297	14.0	0.60	12.0	PLANE		
100298	5.0		8.0	CYPRESS		
100299	14.0	0.50	12.0	SYCAMORE		
100346	8.0		4.0	CHERRY		
100347	7.0	0.50	9.0	CYPRESS		
100348	8.0	0.30	4.0	CHERRY		
100396	8.0	0.30	5.0	CHERRY		
100397	5.0	0.60	10.0	CYPRESS		
100398 100414	7.0 16.0	0.30	7.0 16.0	TREE UNKOWN BEECH		
100443 100594	17.0 16.0	0.80	17.0	OAK MAPLE		
100595	7.0 8.0 20.0	0.30	7.0 18.0	YEW REECH		
100007 100741 100742	18.0 8.0	1.10	18.0	BEECH YEW		
100749	16.0	0.80	16.0	BEECH		
100759	16.0		14.0	MAPLE		
100760 100770	8.0 13.0	0.30	7.0 14.0	YEW PLANE		
100839	5.0	0.10	6.0	BEECH		
100909	7.0	0.30	10.0	YEW		
101001	7.0	0.30	9.0	YEW		
101002	13.0	0.50	16.0	MAPLE		
101051	12.0	0.70	15.0	LIME		
101097	5.0		7.0	MAPLE		
101163	13.0	0.50	16.0	BEECH		
101171	13.0		16.0	BEECH		
101233 101234 101225	13.0 13.0 20.0	0.90	10.0 16.0 18.0			
101236	14.0	0.60	13.0	OAK		
101451	3.0		4.0	LAUREL		
101482 101521	7.0 20.0	0.30	6.0 20.0	MAGNOLIA BEECH		
101677	3.0	0.10	5.0	EUCALYPTUS		
101678	3.0		5.0	EUCALYPTUS		
101681	5.0	0.30	6.0	HOLLY		
101717	14.0	0.70	14.0	OAK		
101748	12.0	0.60	10.0	HORSE CHESTNUT		
101749	6.0		10.0	CYPRESS		
101851	7.0	0.30	8.0	SILVER BIRCH		
101854	6.0		5.0	WHITEBEAM		
101855 101856 101863	6.0 6.0	0.30	5.0	WHITEBEAM		
101000 101940 101973	6.0 8.0	0.60	15.0 10.0	SPRUCE CEDAR		
101988	12.0	1.00	12.0	CEDAR		
102010	6.0	0.40	7.0	HOLLY		
102042	14.0	0.70	15.0	BEECH		
102050	6.0	0.60	13.0	CYPRESS		
102069	13.0	0.80	17.0	LIME		
102070	13.0		17.0	LIME		
102082	8.0	0.30	14.0	SWEET CHESTNUT		
102083	8.0		14.0	LIME		
102084 102085 102131	15.0	0.70	18.0	BEECH		
102101 102132 102133	12.0 5.0	1.00	9.0 8.0	LIME		
102134	6.0	0.50	7.0	CYPRESS		
102135	13.0	0.30	13.0	SYCAMORE		
102136	15.0	0.60	17.0	BEECH		
102137	13.0	0.70	18.0	PINE		
102150 102210	7.0 12.0	0.30	7.0 12.0	ASH TULIP		
102225	18.0	0.70	17.0	MAPLE		
102405	8.0		7.0	MULBERY		
102505 102506	6.0 6.0 7.0	0.30	8.0 8.0	HOLLY		
102508 102509	8.0	0.50	8.0	HOLLY PINE		
102510	12.0	0.50	8.0	YEW		
102511	14.0		8.0	OAK		
102512	12.0	0.60	15.0	PINE		
102513	10.0	0.50	15.0	BEECH		
102514 102538	12.0 12.0	0.60	15.0 15.0	PINE SYCAMORE		
102539	10.0	0.50	9.0	CYPRESS		
102540	28.0		18.0	BEECH		
102544 102545 102546	13.0 18.0 14.0	0.30	0.0 20.0 16.0			
102547	6.0	0.40	15.0	CYPRESS		
102549	12.0		16.0	SYCAMORE		
102550 102567	7.0	0.40 0.50	11.0 14.0	CYPRESS PINE		
102568	8.0	0.30	14.0	PINE		
102577	7.0		15.0	SILVER BIRCH		
102578	8.0	0.30	15.0	SYCAMORE		
102579	8.0		15.0	SYCAMORE		
102580	8.0	0.30	15.0	SYCAMORE		
102581	8.0		15.0	SYCAMORE		
102604 102605	7.0 8.0	0.40	10.0 12.0	CYPRESS ASH		
102006 102607 102608	10.0 12.0 10.0	0.50	12.0 14.0 16.0	POPLAR I IMF		
102609 102610	7.0	0.40	12.0 13.0	CYPRESS SYCAMORE		
102611 102612	8.0	0.30	11.0 9.0	SYCAMORE HOLLY		
102613	14.0	0.50	16.0	OAK		
102618	13.0		16.0	SYCAMORE		
102631	13.0	0.50	14.0	SYCAMORE		
102632	7.0	0.30	9.0	CYPRESS		
102633	8.0	0.50	11.0	CYPRESS		
102634	8.0		11.0	CYPRESS		
102635 102655	8.0 14.0	0.50	11.0 14.0	BEECH		
102050 102661 102665	o.u 13.0 12.0	0.40	14.0 14.0 13.0	HORSE CHESTNUT		
102670	8.0	0.40	12.0	HORSE CHESTNUT		
102671	8.0		9.0	HOLLY		
102672	16.0	0.50	17.0	OAK		
102673	14.0		8.0	CHERRY		
102674	14.0	1.00	17.0	HORSE CHESTNUT		

F-----

307160N

307140N

Notes:

Whilst every effort has been made to correctly identify species of trees on the site, we advise that an arborologist be consulted before any final decisions are made.

All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction. Grid coordinates are based on an OS GNSS system on a plane grid with a scale factor of 1.0000.

Legend: Fences Buildings Fences: Barbed Wire Fence Corrugated Iron Fence Closed Board Fence Chestnut Paling Fence Iron Railing Fence Post and Chain Fence Post Wire Fence Interwoven Chain Link Fence Larch Lap Fence Wire Mesh Fence Overhead Electric Walls Hedges Trees Overhead Phone Gate Abbreviations: BOLLARD BRITISH TELECOM IC COVER LEVEL DROP KERB ELECTRICITY POLE FIRE HYDRANT FLOWER BED FOOTPATH GAS, VALVE GULLY MARKER PARKING METER ROAD NAME PLATE ROAD SIGN RODDING EYE RETAINING WALL RAINWATER PIPE SOIL VENT PIPE SOIL VENT PIPE TELEGRAPH POLE TRAFFIC LIGHT UNABLE TO LIFT VENT PIPE WATER METER GULLY INSPECTION COVER PIPE INVERT LEVEL KERB OUTLET MAN HOLE Sheet Layout 4 6 Rev. Suffix Date Initial Revision Details Surveyor PD/MB Verified By AL/LW CAD Operator TJH Approved By ARL Date 23.08.18 Levelling GNSS Datum OSGB36 To an OS GNSS Datum Client Cushman & Wakefield LLP Location Carrow Works Norwich, NR1 2DD Drawing Title Topographical Survey Sheet 9 of 9 Job No. 1805022 Old Job No. Drawing Number Revision Suffix CW/1805022/9 Date Scale 1:200m (A0) August 2018 PENTIRE - STABLE 1 FORDBRIDGE ROAD, SUNBURY-ON-THAMES MIDDLESEX, TW16 6AX CD SURVEYS LTD LAND, BUILDING & SITE ENGINEERING Tel (01932) 761196 Fax (01932) 786419 Email: mail@cdsurveys.com Visit us at: www.cdsurveys.com

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy

Appendix B – Planning Parameter Plan

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy

Appendix C – Landscape Masterplan

 notes

 1. Read in conjunction with all relevant Architects, Engineers & design team drawings & specifications

 2. Any discrepancies must be drawn to the attention of the lead consultant in writing

 3. All dimensions are in millimeters unless otherwise noted & are subject to checking on site prior to fabrication or ordering of materials

 4. This drawing is the copyright of Bowles & Wyer (and other consultants where referenced)

key

Orig 17.06.22 FL n/a rev date by chk notes

5 Williams Court, Tunnel Way, Pitstone, Nr. Leighton Buzzard, LU7 9GJ Tel: 01296 662439 Fax: 01296 663959 Email: admin@bowleswyer.co.uk

project title CARROW WORKS, NORWICH

drawing ILLUSTRATED LANDSCAPE MASTERPLAN drawing number job number

2962-11-13

2962

FOR COMMENT

0 1000 2000

081440-CUR-XX-XX-T-C-92031 – Carrow Works, Norwich Drainage & SuDS Strategy

Appendix D – Public Sewer records

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is	Foul Sewer Surface Sewer	 Outfall*	e	Sewa
accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2022 Ordnance Survey 100022432. This map is to be used for the purposes of viewing the location of Anglian Water reprinted. This plan only, any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or	Final Effluent Rising Main*	 Inlet*	€	Publi
personal injury resulting from negligence.	Private Sewer* Decommissioned Sewer*	Manhole*	•	Deco

Sewage Treatment Works	
Public Pumping Station	

- Decommissioned Pumping Station

mike.smith9293@gmail.com

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
0306	624079	307301	С	16.871	13.946	2.925
1206	624170	307232	C	12.06	9.06	3
1207	624151	307249	C	-	-	2.845
2105	624211	307191		9.99	6.84 34 205	3.15
7202	623770	307278	C	-	-	2.25
7204	623785	307296	С		-	2.03
7301	623750	307397	С	-	-	2.04
7401	623776	307434	С	-	-	1.83
7407	623762	307474	С	-	-	3.33
7408	623739	307487	C	-	-	4.825
7411	623742	307495		-	-	-
7504 7602	623778	307518	C	-	- 30 125	2.59
7603	623775	307686	C	9.822	8.007	1.815
8302	623831	307351	C	29.44	27.68	1.76
8303	623834	307355	С	29.43	27.64	1.79
8304	623837	307379	С	28.69	27	1.69
8305	623845	307379	С	28.39	-	1.55
8311	623892	307393	C	25.45	22.49	2.96
8312	623831	307370		28.79	27.2	1.59
8314	623825	307327	C	-	-	1.2
8401	623821	307440	C	-	-	1.22
8405	623851	307480	C	32.54	30.71	1.83
8407	623852	307410	С	-	-	3.355
8413	623869	307403	С	-	-	-
8415	623828	307497	С	31.271	29.556	1.715
8501	623838	307588	C	26.005	24.69	1.315
8502	623902	307551	C	-	-	1.45
8603	023893	307670	C	- 8 259	- 6 580	- 1 67
8604	623898	307650	C	9.281	6.906	2.375
8702	623807	307751	C	5.38	-4.56	9.94
8709	623821	307731	С	6.184	4.539	1.645
9305	623924	307380	С	23.46	20.61	2.85
9307	623999	307352	С	21.13	17.53	3.6
9502	623956	307590	C	11.333	9.318	2.015
9507 9508	623934	307536	C	-	-	-
9508	623932	307534	C	-	- -4 788	- 15.65
0201	624098	307279	F	15.489	13.599	1.89
0202	624096	307283	F	15.579	13.844	1.735
0301	624061	307308	F	17.89	15.19	2.7
0304	624030	307325	F	19.855	17.725	2.13
0305	624026	307328	F	19.958	17.698	2.26
0308	624006	307354	F	20.622	0.962	19.66
0309	624010	307378	F	-	-	17.83
0310	624005	307378	F	-	- 18 256	24.5
0501	624005	307556	F	-	-	-
0602	624057	307677	F	1.45	-3.6	5.05
0603	624024	307615	F	5.84	-4.1	9.94
0604	624085	307690	F	2.44	-2.65	5.09
0605	624040	307624	F	4.55	-4.15	8.7
0607	624044	307648	F	4.07	-4.09	8.16
0608	624056	307674		-	-	-
0609	624045	307651	F	-	-	-
0700	624009	307713	F	-	-	-
0701	624092	307716	F	-	-	-
0702	624074	307723	F	-	-	-
0703	624055	307733	F	-	-	-
0704	624035	307746	F	-	-	-
1201	624142	307252	F	13.2	-	-
1203	624118	307264		-	-	4.01
1204	024135 624172	307251	F	-	-	3.00 13.715
1209	624135	307257	F	13.29	-5.71	19
1301	624164	307334	F	13.8	0.85	12.95
1401	624188	307493	F	4.62	-	2.95
1402	624183	307454	F	12.5	1.33	11.17
1501	624200	307546	F	-	-	•
1701	624135	307753	F	1.61	-2.2	3.81
2102 2501	624207	307529	F	-	-	-
4101	624450	307558	F	-	-	7.85
5201	624508	307242	F	-	-	•
5203	624543	307293	F	-	-	-
5302	624588	307355	F	-	-	-
6401	624630	307404	F	-	-	-
6402	624670	307459	F	-	-	-
7402	623784	307446	F	-	-	3.645
7503	023739 623705	307524	F	-	-	+.4∠ -
7705	623787	307724	F	-	-	-
7706	623790	307726	F	-	-	-
7707	623786	307725	F	-	-	-
8202	623836	307256	F	-	-	1.19
8203	623844	307272	F	-	-	0.89
8204	623863	307294	F	-	-	1.42
8205	623820	307228	F	•	-	1.29
8206	623888	307294	F	29.33	23.94	5.39
8208	023852	307280	F	-	-	3.015
8301	623865	307338	F	-	-	1.445
8306	623880	307355	F	26.15	23.57	2.58
8307	623887	307386	F	-	-	2.765
8309	623879	307377	F	25.75	24.65	1.1
8315	623861	307397	F	-	-	-
8410	623818	307424	F	-	-	3.34
8412	623812	307428	F	-	-	-
8414	623842	307406	F	28.98	-	-

Manhole Reference	Easting	Northing	Liquid Type
8416	623836	307467	F
8417	623836	307429	F
8418	623867	307442	F
8419	623860	307416	F
8605	623817	307698	F
8701	623846	307709	F
8704	623820	307741	F
8706	623814	307738	F
8708	623800	307756	F
8710	623891	307708	
9201	623993	307260	
9202	623978	307270	
9203	623960	307269	F
9204	623951	307270	F
9205	623953	307290	F
9206	623905	307276	F
9207	623905	307235	
9200	623961	307292	F
9209	623961	307290	F
9301	623994	307342	F
9302	623914	307369	F
9303	623968	307350	F
9304	623972	307351	F
9309	623912	307376	F
9310	623963	307305	F
9510	623952	307503	F
9503	623972	307593	F
9504	623969	307568	F
9505	623980	307541	F
9509	62300	307525	F
9510	623020	307510	F
9910	623025	307519	F
0450	624002	307/004	C
0450	624050	307644	0 0
0652	624050	307641	<u>о</u>
0653	624048	307646	S
0654	624049	307644	S
1750	624136	307757	S
1751	624134	307756	S
3750	624393	307767	S
5351	624515	307306	S
5352	624531	307367	S
5451	624560	307474	S
5452	624563	307487	S
5551	624563	307503	S
5552	624565	307520	S
5553	624566	307536	5
5554 7050	624568	307553	5
7352	623795	307326	S
7755	623794	307768	S
8251	623890	307295	S
8254	623829	307298	S
8351	623882	307354	S
8354	623816	307317	S
8655	623817	307656	S
9251	623952	307295	S
9252	623950	307272	S
9253	623993	307262	S
9254	623977	307272	S
9255	623960	307271	S
9256	623907	307235	S
9259	623906	307277	S
9451	623993	307462	S
9552	623962	307583	S
9555	623979	307522	
	020010		S
	020070		S
	020010		S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S
			S

	_	-	
ре	Cover Level	Invert Level	Depth to Invert
	-	-	-
	-	-	-
	_	-	
	-	-	-
	-	-	-
	-	-	-
	1.01/	5.397	1.62
	5.8 5.050	-0.19	5.99
	5.852	3.452	2.4
	5.24	2.94	2.3
	-	-	-
	-	-	0.7
	-	-	1.2
	27.37	24.97	2.4
	-	-	2.4
	27.08	25.12	1.96
	29.7	24.29	5.41
	30.85	28.93	1.92
	-	-	-
	-	-	-
	-	-	-
	-	-	2.58
	-	-	2.39
	-	-	2.44
	-	-	2 29
	23.05	21.97	2.23
	23.93	21.07	2.00
	-	-	-
	11.187	-0.483	11.67
	10.092	-4.558	14.65
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	10.943	7.878	3.065
	-	-	-
	3.87	0.83	3.04
	3.95	1.5	2.45
	3.87	1.65	2.22
	1.49	-	
	1 40	0.03	1 46
	1.43 2	0.00	1.40
	<u>د</u>	0.22	1.70
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	-
	-	-	1.15
	4.881	3.201	1.68
	29.39	24.23	5.16
	-		1.1
	_	_	2 31
	-	-	2.31
	-	-	1.05
	8.732	8.73	0.002
	26.99	25.56	1.43
	-	-	2.1
	26.29	25.59	0.7
	-	-	0.89
	27.38	25.22	2.16
	30.84	29.12	1.72
	29.67	24.6	5.07
	16.1	14.68	1.42
	-	-	-
	13.92	12.48	1.44

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert