

Tim Johnson

Willows Caravan Park, Woodgate, West Sussex

Flood Risk Assessment & Surface Water Drainage Strategy



MLM.

Group

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Appendix A - Existing & Proposed Site

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Greenfield calculations

MLM drawing 6101275-MLM-ZZ-XX-DR-C-0001 – Surface Water Drainage Strategy

MicroDrainage calculations

1 Introduction

MLM Consulting Engineers Limited (MLM) has been appointed by Tim Johnson to undertake a Flood Risk Assessment (FRA) & Surface Water Drainage Strategy to support a full planning application for the proposed residential development at Willows Caravan Park, Woodgate, West Sussex PO20 3SU.

This report has been prepared for the sole use of Tim Johnson and the contents should not be relied upon by others without the express written authority of MLM. If any unauthorised third party makes use of this report they do so at their own risk and MLM owes them no duty of care or skill.

This report has been completed in accordance with the National Planning Policy Framework (NPPF) and its accompanying Planning Practice Guidance (PPG) and is an assessment of flood risk to the development, from on and off-site sources, and to off-site receptors caused by the development at the site.

The site is shown on the EA *Flood map for planning* (see Figure 1) to lie in Flood Zone 1 (low risk). Flood Zone 1 is the area described as having less than a 0.1% annual probability of fluvial or tidal flooding. All land uses are appropriate in this flood zone.

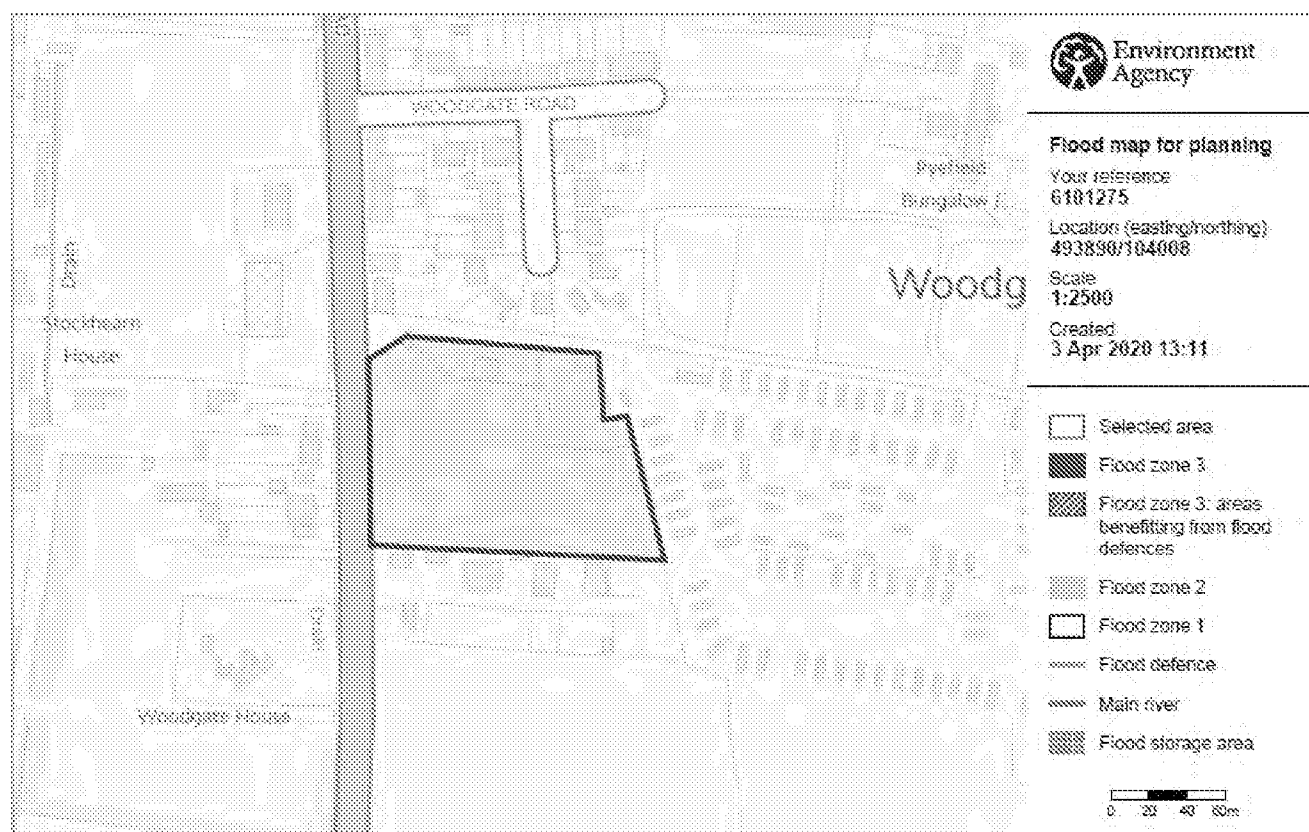


Figure 1 – EA *Flood map for planning*

This report includes a surface water drainage strategy for the site which sets out how the proposals will not increase off-site flood risk. The report also discusses the use of SuDS features at the site for the attenuation and removal of pollutants prior to discharge. The surface water drainage strategy has been prepared in accordance with the guidelines set out in the DEFRA guidance *Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems* dated March 2015, CIRIA 753 *The SuDS Manual* (C753) and the *West Sussex LLFA Policy for the Management of Surface Water* dated November 2018.

The report concludes that in flood risk context, the proposals are safe and appropriate and do not cause increased on or off-site flood risk.

2 Site Description

2.1 Existing site

The site comprises greenfield land and lies to the south of Westergate in a predominantly residential area. The site extends to approximately 1.5 hectares (ha) and is centred on Ordnance Survey (OS) grid reference SU938040.

The site is bound to the north, south and west by rural/residential development and is bound to the east by the caravan park. Access to the site is off Lidsey Road to the west of the site.

The site is classified as 'Less vulnerable' in accordance with *Table 2: Flood Risk Vulnerability Classification* of the PPG.

2.2 Topography

A review of OS mapping and the topographical survey shows the site to fall towards the south-east corner (see Photograph 1). Ground levels in the north-west are circa 8.60 metres above Ordnance datum (mAOD) falling to circa 6.50 mAOD in the south-east.



Photograph 1 – The site

2.3 Hydrology

The closest Main River lies approximately 475 metres (m) east of the site.

A stream runs along the eastern boundary of the site (see Photograph 2). The topographical survey also shows the stream to flow in a southerly direction and has a bed level of approximately 5.30 mAOD.



Photograph 2 – Stream running on the eastern side of the site

2.4 Geology

British Geological Survey (BGS) mapping shows the site as being underlain by London Clay Formation (Clay, Silt and Sand). Superficial deposits are recorded to be River Terrace Deposits (undifferentiated) (Sand, Silt and Clay).

2.5 Proposed site

Site proposals comprise of a housing development of around 30 new dwellings, with associated access off the A29 Lidsey Road (see Proposed Site Plan in Appendix A).

The proposed residential site classification is 'More Vulnerable' in accordance with the PPG *Table 2: Flood Risk Vulnerability Classification*. As the site is located in Flood Zone 1, the proposed development is shown to be appropriate in accordance with *Table 3: Flood risk vulnerability and flood zone 'compatibility'* of the PPG and no Exception Test is required.

3 Flood Risk

The NPPF requires flood risk from the following sources to be assessed:

- ✧ Tidal sources (flooding from the sea);
- ✧ Fluvial sources (flooding from a river);
- ✧ Pluvial sources (flooding resulting from overland flows);
- ✧ Groundwater sources;
- ✧ Artificial sources, canals, reservoirs etc., and;
- ✧ Increase in surface water discharge.

Each of the sources are assessed separately below.

3.1 Tidal & fluvial

Tidal flooding is typically the result of extreme tidal conditions caused by severe weather which may cause a storm surge where water is pushed onshore through elements such as high winds and other storms. Fluvial flooding occurs when excessive rainfall over an extended period of time or heavy snow melt causes a river to exceed its capacity.

The closest Main River lies approximately 475 metres (m) east of the site. OS mapping shows the river to lie below the 5m contour line which is lower than on-site ground levels and therefore the river should not pose a flood risk to the site.

The site is shown on the EA *Flood map for planning* (see Figure 1 above) to lie in the low probability flood zone (Flood Zone 1).

The site is not at any significant risk of flooding from this source.

3.2 Pluvial

There is always a potential risk of surface water flooding from very high intensity rainfall events exceeding the capacity of drainage systems and causing flooding, especially in urban areas. Surface water run-off can be channelled either by natural features such as valley lines or by artificial features such as highways, to low points in the topography. If surface water is not able to flow away from the low points then pluvial flooding can occur.

Land to the north of the site is at a higher elevation than the site and as such surface water could be shed towards the site from this direction. Surface water is most likely to be intercepted by natural/existing drainage features before reaching the site.

Land to the south of the site is at a lower elevation than the site and should not pose any flood risk to the site.

The GOV.UK *Extent of flooding from surface water* map (see Figure 2) shows that the majority of the site is at a low risk of flooding with small areas to the north-east of the site to have a high risk of flooding from surface water. The potential flood water appears to follow the natural contours of the land and when compared to the topographical survey; it can be seen that whilst there are localised low points in these areas, surface water run-off would flow in a south-easterly direction through the site and into the stream adjacent to the site.

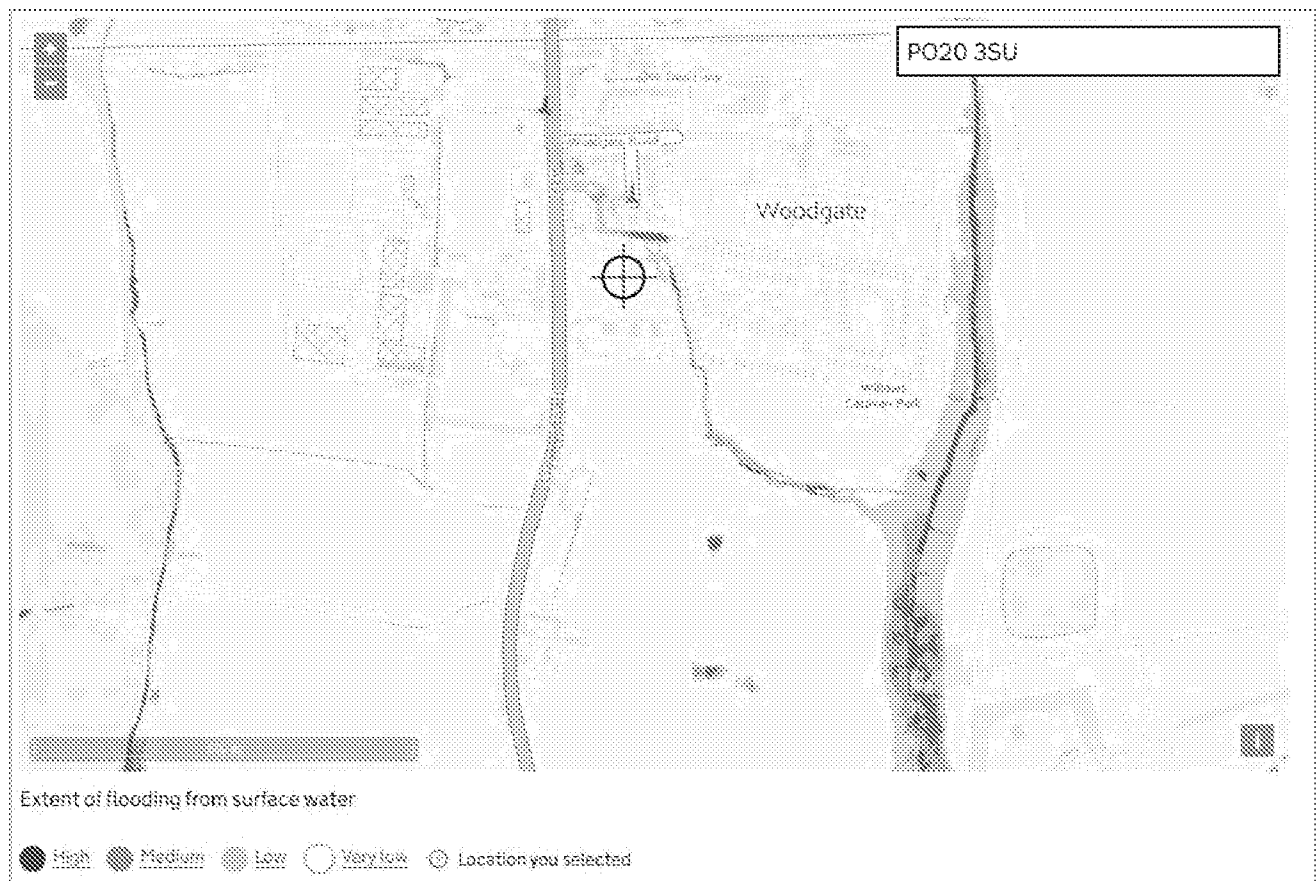


Figure 2 (target denotes site location)

Some small areas to the east of the site are also shown to be at a high risk of flooding, however, the site is elevated above these areas (see Photograph 1) and as such they should pose no significant risk to the site.

Proposed building finished floor levels should adhere to normal good practice and be raised above surrounding ground level with falls away from buildings. This should minimise the risk of any minor localised ponding or overland surface water flow from entering the proposed buildings.

No flooding is shown in the area of the site where the proposals are located (south/south-west) and as such the site is considered to be at low risk of flooding from this source.

3.3 Groundwater

As described in Section 2, BGS mapping shows the site as being underlain by London Clay Formation with superficial deposits of River Terrace Deposits. The underlying geology is expected to be of relatively low permeability. In the unlikely event that groundwater were to express at the surface then it would be routed around buildings as described above.

The site is not considered to be at significant risk of flooding from groundwater.

3.4 Water bodies

There are no significant water bodies (lakes, large ponds, reservoirs etc.) within the immediate vicinity of the site that appear likely to pose a risk to the site.

The GOV.UK *Extent of flooding from reservoirs* map (see Figure 3) shows that the site is not at risk of flooding from reservoir failure.



Figure 3 (target denotes site)

The site is considered to be at a low risk of flooding from water bodies.

3.5 Infrastructure flooding

If surcharging or blockage of the sewers/drains on or off-site did occur it is possible that there may be localised surface flooding in areas surrounding the site. This risk is similar to that described above and mitigation measures carried out would provide the same protection from this source.

The Southern Water (SW) asset plans (see Appendix B) shows sewers located on Lidsey Road and to the north of the site.

The existing Willows Caravan Site has a foul water pumping station and rising main, which is located along the northern boundary of the site, the exact location of the main will need to be confirmed on-site. It is anticipated that in accordance with Building Regulation requirements, an emergency storage is provided in the event of pump failure.

Should infrastructure failure occur then any flood water would be diverted away from the site by the natural topography.

The site is considered to be at low risk of flooding from infrastructure failure.

3.6 Increased surface water run-off

The proposed development will increase the impermeable area at the site and as such the volume and rate of surface water run-off from the site will increase unless managed.

Careful design of levels should be carried out to ensure that any overland flows are directed away from and around the proposed building and by ensuring that any low ground levels adjacent to the buildings have a suitable overland flood flow route and do not rely entirely on piped drainage systems.

Surface water run-off generated by the site is collected and directed to an open attenuation basin prior to being discharged at a restricted rate to the adjacent watercourse (see Section 4 for further information on the surface water drainage strategy).

Provided that these measures are implemented then the site will be at low risk of flooding from this source.

3.7 Flood risk summary

The site is considered to be at a low risk of flooding from all sources.

4 Surface Water Drainage Strategy

4.1 Existing surface water drainage

There is no formal surface water drainage at the site. As the site is greenfield land it is assumed that surface water run-off flows overland at greenfield run-off rates towards the existing drainage ditches/watercourse following the topography of the land.

4.2 Proposed surface water drainage

The proposed development will increase the impermeable area at the site and as such the volume and rate of surface water run-off from the site will increase. Surface water run-off generated by the development should therefore be properly managed in order to not increase off-site flood risk and comply with planning requirements for the development of sites.

The SuDS hierarchy requires that surface water run-off is controlled and preferably re-used wherever possible. In the event that it cannot be re-used it should be disposed of to a receptor in the order of preference described in Building Regulations Part H and C753:

- ✧ Infiltration;
- ✧ Watercourse;
- ✧ Sewer.

Ground conditions at the site are unlikely to be suitable for the use of infiltration drainage due to the clayey characteristics. It is therefore proposed to discharge surface water to the watercourse on the site's eastern boundary.

Discharge of surface water run-off from the site should be restricted to greenfield run-off rates in accordance with C753 and the *West Sussex LLFA Policy for the Management of Surface Water*.

The greenfield run-off discharge rate has been calculated using the ICP SuDS method within MicroDrainage (see Greenfield Calculations in Appendix C). The greenfield rates applicable to the site are based on the proposed impermeable area of 0.637 ha and are summarised in Table 1.

Table 1: Greenfield run-off rates

AEP	Greenfield Discharge Rate (l/s)
100%	2.1
Qbar	2.4
3.3%	5.5
1%	7.7

The surface water drainage strategy (see Appendix C) shows the use of rain gardens, permeable paving and an attenuation basin.

Surface water from roofs is directed to the rain gardens or permeable paving and surface water from the hardstanding areas is collected by the permeable paving. Both the rain gardens and permeable paving sub-base provide temporary storage of surface water prior to this being directed towards the attenuation basin (which also provides some additional storage) and finally being discharged from the site to the adjacent watercourse.

MicroDrainage calculations demonstrating the size of the various attenuation elements and the range of water levels modelled for a variety of events are included in Appendix C. The attenuation elements (rain gardens, permeable paving and basin) have been sized to cater for rainfall events up to and including the 1% AEP event inclusive of 40% climate change.

Discharge to the watercourse will be restricted to no more than equivalent existing greenfield run-off rates, in compliance with the West Sussex 2018 LLFA policy 5.4.1. The modelled discharge rates are summarised below in Table 2.

Table 2: Proposed maximum discharge rates

AEP	Modelled Discharge rate (l/s)	Greenfield rate (l/s)
100%	1.8	2.1
3.3%	3.8	5.5
1% + CC*	5.8	7.7 (1%)

* = 40% climate change

4.3 Surface water treatment

C753 requires that surface water drainage systems are designed to provide an adequate level of treatment for pollution. The level of treatment required depends on the pollution hazard indices for the land uses; it must be demonstrated that the proposed pollution mitigation indices exceed the required pollution hazard indices. Table 3 below assesses suitability of SuDS features for the site based upon C753.

Table 3: SuDS site suitability

SuDS Component	Site Suitability	Comments
Green roof	✗	Not suitable due to nature/use of site.
Soakaway	✗	Not suitable due to low soil permeability.
Rainwater harvesting system	?	Could be utilised for W.C. flushing etc to reduce the use of potable water for the development, subject to financial viability.
Filter strip	✗	Not suitable due to site layout.
Filter trench	✗	Not suitable due to site layout.
Infiltration trench	✗	Not suitable due to low soil permeability.
Swale	✓	Could be incorporated into the layout, but possibly insufficient space as rain gardens are used already.
Bioretention	✗	Not suitable due to nature/use of site.
Pervious pavement	✓	Could be used with positive outfall to basin.
Geocellular system	✓	Suitable but not preferred.
Infiltration basin	✗	Not suitable due to low infiltration rates.
Detention basin	✓	Suitable.
Pond	✓	Suitable.
Stormwater wetlands	✗	Not suitable due to size of development.
Proprietary device	✓	Suitable but not preferred.
Rain garden	✓	Suitable.

An example of how the treatment may work in line with Chapter 26 of C753 is provided below.

The appropriate pollution hazard indices for residential land use from Table 26.2 of C753 are shown in Figure 4 below:

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.3 (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, farm tracks 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	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, ferry ports, highly frequented ferry 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	High	0.8	0.8	0.9

Figure 4 – Table 26.2 of C753

The maximum pollution hazard indices for the proposed site are:

- TSS 0.5;
- Metals 0.4;
- Hydrocarbons 0.4.

Mitigation for the above pollutants should be achieved based on the SuDS mitigation indices given in Table 26.3 of C753 (see Figure 5).

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters				
Type of SuDS component	Mitigation indices ¹			
	TSS	Metals	Hydrocarbons	
Filter strip	0.4	0.4	0.5	
Filter drain	0.4 ²	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 ³	0.7 ²	0.7	0.5	
Wetland ⁴	0.8 ²	0.8	0.9	
Proprietary treatment systems ^{2,4}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.			

Figure 5 – Table 26.3 of C753

The surface water drainage strategy drawing (refer to Appendix C) proposes permeable paving and an attenuation basin to provide treatment to surface water run-off. Table 4 outlines the pollution mitigation indices associated with the chosen SuDS techniques which are also provided on the data sheet in Appendix B.

Table 4: Proposed mitigation indices

Mitigation \ Pollutant	TSS	Metals	Hydrocarbons
1 Permeable paving	0.7	0.6	0.7
2 Basin [#]	0.25	0.25	0.3
Total	0.95	0.85	1.0

[#] 2nd mitigation indices halved as per C753

As demonstrated by Table 4, the SuDS components proposed at the site provide a level of treatment that exceeds the minimum levels of treatment required for the land uses according to C753.

4.4 Management & maintenance

To ensure that the SuDS features remain optimised and fully functional for the lifetime of the development, thus minimising flood risks on and off site, maintenance of the SuDS system is crucial across the short, medium and long term. It is proposed that the SuDS features are maintained by the site owner as part of an on-going maintenance regime of the site.

5 Conclusions

The site is shown to lie in the low probability flood risk area (Flood Zone 1) according to the EA flood maps.

Other flood risks to the site have been assessed as low and the site is therefore considered to be at low risk from all sources of flooding.

Surface water will be attenuated on-site through the use of open attenuation and discharge to an existing watercourse at a rate restricted to less than the greenfield equivalent in accordance with C753 and the *West Sussex LLFA Policy for the Management of Surface Water*.

Further opportunities should be investigated to incorporate SuDS into the development where practicable. These can provide the benefits of slowing the discharge of surface water run-off, removal of pollutants from the run-off and providing ecological benefits to the development.

Careful thought should be given to the levels design on the site in accordance with normal good practice to ensure that there is no likely flooding caused by overland flow and that any overland flow is directed around buildings in the event of a failure to the piped drainage system.

Appendix A - Existing & Proposed Site

Truplan drawing 33212 – Topographic Survey (2 Sheets)

ZST drawing - Existing Site Plan

ZST drawing 1428-P-100 – Proposed Site Plan

The measured survey displayed on this page does not form part of a structural survey. Whilst we have taken every care to produce the property, we have not measured any areas that are hidden or concealed or where reasonable access is unreasonable.

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Willows Caravan Park
Lidsey Road
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Chichester PO20 3SU

Drawn on: 10-07-

STILES HAROLD WIL





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Project:

Wilkes Caravan Park
Liberty Road
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Chichester PO18 3SU

Job No: 2015
Revision: 001
Drawn on: 10-07-2017
Drawn by: AW

Client:

STILES HARDOLD WILLIAMS

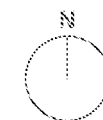
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1428 LIDSEY ROAD FIELD, WOODGATE FEASIBILITY

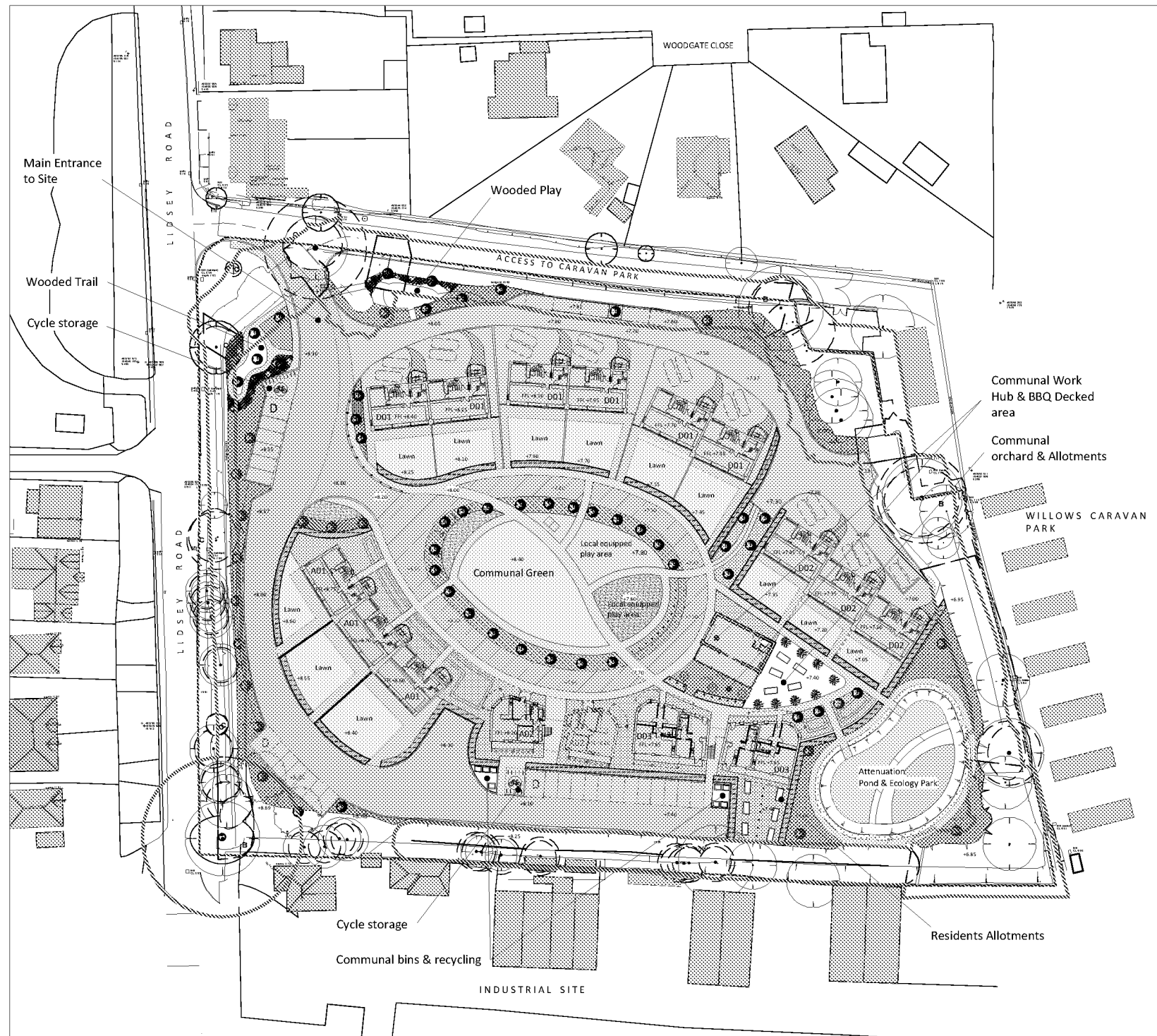
Existing Site Plan Scale: 1:1000



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Proposed Site Plan 1:500

- KEY:**
- Grass paving to parking areas and emergency access road
 - Shared surface access road
 - Footpaths
 - Areas of permeable hard landscaping
 - Tree root protection zone
 - Site Boundary
 - Affordable Housing
 - Mix of 4 bed, 3 bed, 2 bed and 1 bed housing

For full details of planting areas and landscaping specifications see Landscape Architects' drawings

Overall Housing Mix

- 9x 3 bed houses
- 3x 4 bed houses
- 2x 3 bed apartments
- 6x 2 bed apartments
- 2x 1 bed apartments
- Communal work hub

Housing Mix

- D01 3 Bed House**
135.87 m2 or 1462.49ft2
- D02 4 Bed House**
155.66 m2 or 1675.51ft2
- D03 Apartment block comprising:**
1x 3 bed 110.9m2 or 1193.7 ft2
1x 2 bed 68.5m2 or 737.32 ft 2
1x 1 bed 42 m2 or 452.08 ft 2

Affordable Housing Mix

- A01 3 Bed House**
135.87 m2 or 1462.49ft2
- A02 2 Bed Apartment**
67.22m2 or 723.55 ft2

Communal Work Hub

65.7 m2 or 707.18 ft2

1:500 0m 25 50

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Revisions:		
P	12/09/2017	issued to client for comment
P	19/09/2017	issued for integration and comment
	21/09/2017	issued to planning
		Checked



TO BE ISSUED
Dwg No. 1428-P-100

Drawing Title: Proposed Site Plan
Address: Land at Woodgate, Westergate
Client: Tim Johnson
Scale: 1:500
Stage: PLANNING
Drawn by: sjd
Checked by: ns

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Appendix B - Southern Water

Sewer Records (2 Pages)

SEWER RECORDS PAGE 1 OF 2

104300



103722

493399

O.S. REF.

SU9304SE

Title: 252279 Willow Caravan Park, Li

Drawn by: yadavsai

Scale: 1:2500

Date: 10/07/2017

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: Unknown (UNK) materials may include Bonded Asbestos Cement

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494341

SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape	Node	Cover	Invert	Size	Material	Shape
0102X	8.99	5.36	225	VC	CIRC																		
1101X	8.71	5.22	225	VC	CIRC																		
2101X	7	4.95	225	VC	CIRC																		
3001X	2.99	0.43	225	VC	CIRC																		
3701X	1.24	-1.08	450	CP	CIRC																		
7001X	9.33	8.08	150	PF	CIRC																		
7002X	8.98	6.83	150	VC	CIRC																		
7003X	8.9	6.75	150	VC	CIRC																		
7101X	8.9	6.48	150	VC	CIRC																		
7102X	8.23	6.3	225	VC	CIRC																		
7201X	8.46	6.85	150	VC	CIRC																		
7901X	9.41	8.33	150	PF	CIRC																		
7902X	9.02	7.97	150	PF	CIRC																		
7903X	9.32	7.32	150	PF	CIRC																		
790DX			150	PF	CIRC																		
8001X	8.24	6.39	150	PF	CIRC																		
8101X	8.05	6.18	150	PF	CIRC																		
8102X	8.31	5.99	225	VC	CIRC																		
810DX	8.75	5.83	225	VC	CIRC																		
8202X	8.85	7.47	150	PF	CIRC																		
8203X	8.53	7.2	150	PF	CIRC																		
8204X	9.14	7.25	150	PF	CIRC																		
8205X	9.42	7.88	150	VC	CIRC																		
8206X	9.48	7.81	150	PF	CIRC																		
8901X	8.95	8.21	150	PF	CIRC																		
9101X	7.89	6.48	150	PF	CIRC																		
9102X	8.98	5.72	225	VC	CIRC																		
9103X	9.16	5.52	225	VC	CIRC																		
9150X			UNK	VC	CIRC																		
9202X	9.48	8.35	150	VC	CIRC																		

LINE STYLES / COLOURS

Brown	-----	Foul
	-----	Foul Siphon Sewer
	-----	Foul Vacuum Main
	-----	Foul Rising Main
Red	-----	Combined
	-----	Combined Siphon Sewer
	-----	Combined Rising Main
Orange	-----	Lateral Drain
	-----	Building Over Agreement Area
Dark Blue	-----	Treated Effluent
Purple	-----	Sludge
	-----	Sewer Catchment
	-----	Section 104 Area
Light Blue	-----	Surface Water
	-----	Surface Water Rising Main
Yellow	-----	Private
Green	-----	Access Shaft
	-----	Decommissioned

MATERIALS

AK	Alkaline
BAC	Bonded Asbestos Cement
BRD	Brick (Common)
BRE	Brick (Engineering)
CC	Concrete Box Culvert
CI	Cast Iron
CO	Concrete (In-Situ)
CP	Concrete (Pre-Cast)
CSB	Concrete Segments (bolted)
CSU	Concrete Segments (unbolted)
DI	Ductile Iron
GRG	Glass Reinforced Concrete
GRP	Glass Reinforced Plastic
MAC	Masonry in regular Courses
MAR	Masonry in random Courses
PE	Polyethylene
PF	Pitch Fibre
PP	Polypropylene
PVC	Polyvinyl Chloride
RFW	Reinforced Plastic Matrix
SI	Spun Iron
ST	Steel
VC	Verified Clay
XXX	Other
ZZZ	Unknown

Manhole (SW)
Manhole (F&C)
Lamp hole (SW)
Lamp hole (F&C)
Pumping Station (SW)
Pumping Station (F&C)
Side entry manhole (SW)
Side entry manhole (F&C)
Blind shaft (SW)
Blind shaft (F&C)
Ejector station (SW)
Ejector station (F&C)
Watertight door (SW)
Watertight door (F&C)
Flushing ch. Min-e (SW)
Flushing ch. Min-e (F&C)
Flushing ch. No-e (SW)
Flushing ch. No-e (F&C)
Demonstration Chamber

LEGEND - SEWERS

Washout (SW)
Washout (F&C)
Rodding Eye (SW)
Rodding Eye (F&C)
Gauging point (SW)
Gauging point (F&C)
Intercept chamber (SW)
Intercept chamber (F&C)
Storm Tank (SW)
Storm Tank (F&C)
Vortex chamber (SW)
Vortex chamber (F&C)
Label ellipse
Dummy/S24 manhole
Outfall
Penstock chamber
Demiboards
Storm Overflow
Backdrop manhole

Other (s)
Other
Change In sewer (s)
Change In sewer
Rafflux valve
Flap valve
Cascade
Anode
Valve
Closed Valve
Air Valve
Hatch box (SW)
Hatch box (F&C)
Direction arrow
Emptying valve
Catchpit
Soakaway
Inlet
Balancing Pond

Wastewater treatment works
Marine treatment works
Outfall headworks
Vent
Vent column
Tidal storage tank
Blank end
Head of Public Sewer
Micro Pumping Station
SHAPES (S)
A Arched
B Barrel
C Circular
E Egg
H Horseshoe
R Rectangular
S Square
T Trapezoidal
U U Shape
X Other

NODE REFERENCING SYSTEM
1st digit: hundred metre easting identifier
2nd digit: hundred metre northing identifier
3rd digit: sewer type identifier
4th digit: next sequential node

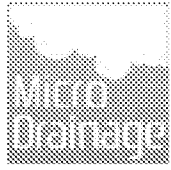
Drawn by:	yadavs	
Title:	252279_Willow Caravan Park, Li	
Date:	10/07/2017	

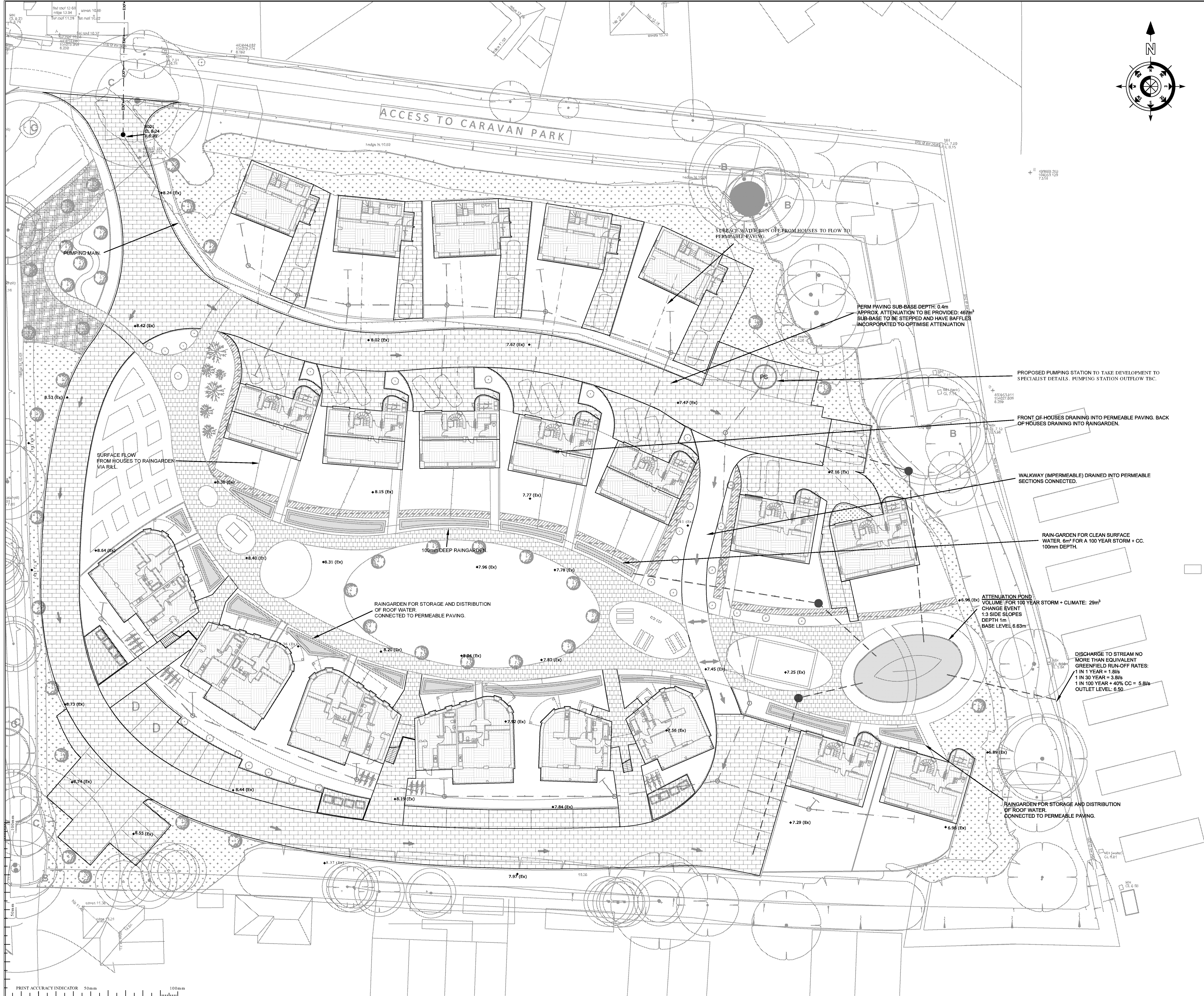
Appendix C - Surface Water Drainage Strategy

Greenfield calculations

MLM drawing 6101275-MLM-ZZ-XX-DR-C-0110 – Foul and Surface Water Drainage Strategy

MicroDrainage calculations

MLM		Page 1
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Greenfield Run-off Rates	
Date 20/04/20 File	Designed by CB Checked by JRC	
XP Solutions		Source Control 2019.1
<u>ICP SUDS Mean Annual Flood</u> Input Return Period (years) 100 SAAR (mm) 767 Urban 0.000 Area (ha) 0.637 Soil 0.400 Region Number Region 7 Results 1/s QBAR Rural 2.4 QBAR Urban 2.4 Q100 years 7.7 Q1 year 2.1 Q30 years 5.5 Q100 years 7.7		
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- NOTES**
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEERS, ARCHITECTS AND SPECIALISTS DRAWINGS AND THE SPECIFICATION.
 - DO NOT SCALE FROM THIS DRAWING MANUALLY OR ELECTRONICALLY. WRITTEN PERMISSION MUST BE OBTAINED FROM MLM PRIOR TO SCALING ELECTRONICALLY OR USING THIS ELECTRONIC FILE.
 - THIS DRAINAGE STRATEGY DRAWING SHOWS HOW SURFACE WATER RUN-OFF COULD BE MANAGED ON SITE WITH A RESTRICTED OFF-SITE DISCHARGE. FOR ALL RAINFALL EVENTS UP TO AND INCLUDING THE 100 YEAR RETURN PERIOD EVENT PLUS 40% CLIMATE CHANGE TO ENSURE NO INCREASED FLOOD RISK TO OTHERS AS A RESULT OF THE PROPOSED DEVELOPMENT.
- THIS IS NOT INTENDED TO BE A DETAILED DESIGN AT THIS STAGE. PLEASE NOTE THAT THE FINAL LAYOUT MAY BE SUBJECT TO REFINEMENT TO MEET CERTAIN TECHNICAL CRITERIA.

- EXP — EXISTING FOUL WATER SEWER
- WATER FLOW DIRECTION
- FOUL WATER RISING MAIN
- FOUL WATER PRIVATE DRAIN
- — — SURFACE WATER DRAIN
- — — RILL CHANNEL
- — — — SURFACE WATER SEWER
- PS PUMPING STATION FOR FOUL DRAINAGE.
- LINED PERMEABLE PAVING FOR PATH/WALK WAY
- LINED PERMEABLE PAVING FOR VEHICLE USE
- SURFACE AREAS FLOWING INTO PAVED SECTIONS
- SURFACE AREAS FLOWING INTO PERMEABLE PAVING SUB-BASE
- SURFACE AREAS FLOWING INTO RAIN-GARDEN

CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015

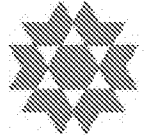
DESIGNERS HAZARD INFORMATION FOR CONSTRUCTION

- IF YOU DO NOT FULLY UNDERSTAND THE RISKS INVOLVED DURING THE CONSTRUCTION OF THE ITEMS INDICATED ON THIS DRAWING ASK YOUR MANAGER, HEALTH & SAFETY ADVISOR OR A MEMBER OF THE DESIGN TEAM BEFORE PROCEEDING.
- TO BE COMPLETED AT DETAILED DESIGN.

THE ABOVE NOTES REFER SPECIFICALLY TO THE INFORMATION SHOWN ON THIS DRAWING.

REFER TO THE HEALTH AND SAFETY PLAN FOR FURTHER INFORMATION.

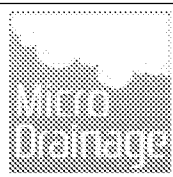
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REV	DATE	REVISION	MADE	CHK	APP
PURPOSE OF ISSUE					
PRELIMINARY/COMMENT					
STATUS					
SUITABLE FOR					



MLM.
Group
Part of Sweco

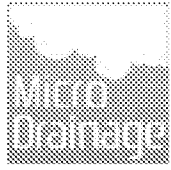
North Kiln, Felaw Maltings,
46 Felaw Street, Ipswich,
Suffolk IP2 8PN
Tel: 01473 231100
Website: www.mlmgroupp.com

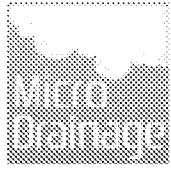
CLIENT	TIM JOHNSON		
PROJECT	WILLOWS CARAVAN PARK, WOODGATE		
DRAWING TITLE	FOUL & SURFACE WATER DRAINAGE STRATEGY		
SCALE	1:250 @ A1	DRAWN/DESIGN	MLM REF
		CB	6101275
DRAWING REFERENCE		REVISION	P01
6101275- MLM-ZZ-XX-DR-S-0110			

MLM			Page 1				
North Kiln Felaw Maltings		6101275					
46 Felaw Street		Willows Caravan Park					
Ipswich IP2 8PN		Perm Paving - 100 Year + CC					
Date 21/04/20		Designed by CB					
File 6101275-MLM-ZZ-XX-CA-C-0...		Checked by SJC					
XP Solutions		Source Control 2019.1					
<u>Summary of Results for 100 year Return Period (+40%)</u> Half Drain Time : 827 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	7.083	0.133	0.0	3.0	3.0	162.5	O K
30 min Summer	7.115	0.165	0.0	3.5	3.5	201.3	O K
60 min Summer	7.152	0.202	0.0	4.0	4.0	246.6	O K
120 min Summer	7.194	0.244	0.0	4.4	4.4	297.6	O K
180 min Summer	7.220	0.270	0.0	4.7	4.7	328.6	Flood Risk
240 min Summer	7.237	0.287	0.0	4.9	4.9	350.1	Flood Risk
360 min Summer	7.260	0.310	0.0	5.1	5.1	377.5	Flood Risk
480 min Summer	7.272	0.322	0.0	5.2	5.2	393.2	Flood Risk
600 min Summer	7.280	0.330	0.0	5.3	5.3	402.7	Flood Risk
720 min Summer	7.287	0.337	0.0	5.3	5.3	410.6	Flood Risk
960 min Summer	7.278	0.328	0.0	5.2	5.2	400.0	Flood Risk
1440 min Summer	7.263	0.313	0.0	5.1	5.1	381.0	Flood Risk
2160 min Summer	7.240	0.290	0.0	4.9	4.9	353.7	Flood Risk
2880 min Summer	7.219	0.269	0.0	4.7	4.7	328.2	Flood Risk
4320 min Summer	7.202	0.252	0.0	4.5	4.5	306.6	Flood Risk
5760 min Summer	7.183	0.233	0.0	4.3	4.3	283.6	O K
7200 min Summer	7.165	0.215	0.0	4.1	4.1	262.4	O K
8640 min Summer	7.150	0.200	0.0	3.9	3.9	243.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	158.032	0.0	122.9	19			
30 min Summer	96.434	0.0	156.8	34			
60 min Summer	58.846	0.0	228.9	64			
120 min Summer	35.909	0.0	286.1	122			
180 min Summer	26.898	0.0	324.7	182			
240 min Summer	21.912	0.0	354.6	242			
360 min Summer	16.413	0.0	400.4	360			
480 min Summer	13.371	0.0	435.3	480			
600 min Summer	11.405	0.0	463.3	548			
720 min Summer	10.016	0.0	486.4	604			
960 min Summer	7.777	0.0	497.4	722			
1440 min Summer	5.444	0.0	505.8	982			
2160 min Summer	3.811	0.0	583.2	1388			
2880 min Summer	2.959	0.0	596.8	1792			
4320 min Summer	2.210	0.0	653.5	2592			
5760 min Summer	1.797	0.0	727.7	3352			
7200 min Summer	1.530	0.0	765.3	4112			
8640 min Summer	1.342	0.0	794.7	4848			
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MLM							Page 2	
North Kiln Felaw Maltings			6101275					
46 Felaw Street			Willows Caravan Park					
Ipswich IP2 8PN			Perm Paving - 100 Year + CC					
Date 21/04/20			Designed by CB					
File 6101275-MLM-ZZ-XX-CA-C-0...			Checked by SJC					
XP Solutions			Source Control 2019.1					
<u>Summary of Results for 100 year Return Period (+40%)</u>								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	
10080 min Summer	7.136	0.186	0.0	3.8	3.8	226.5	O K	
15 min Winter	7.101	0.151	0.0	3.3	3.3	184.5	O K	
30 min Winter	7.137	0.187	0.0	3.8	3.8	228.1	O K	
60 min Winter	7.179	0.229	0.0	4.3	4.3	279.0	O K	
120 min Winter	7.226	0.276	0.0	4.8	4.8	336.6	Flood Risk	
180 min Winter	7.255	0.305	0.0	5.0	5.0	371.8	Flood Risk	
240 min Winter	7.275	0.325	0.0	5.2	5.2	396.4	Flood Risk	
360 min Winter	7.302	0.352	0.0	5.4	5.4	428.7	Flood Risk	
480 min Winter	7.318	0.368	0.0	5.6	5.6	448.1	Flood Risk	
600 min Winter	7.327	0.377	0.0	5.7	5.7	460.0	Flood Risk	
720 min Winter	7.333	0.383	0.0	5.7	5.7	467.2	Flood Risk	
960 min Winter	7.320	0.370	0.0	5.6	5.6	451.5	Flood Risk	
1440 min Winter	7.298	0.348	0.0	5.4	5.4	424.5	Flood Risk	
2160 min Winter	7.265	0.315	0.0	5.1	5.1	384.4	Flood Risk	
2880 min Winter	7.235	0.285	0.0	4.8	4.8	347.8	Flood Risk	
4320 min Winter	7.205	0.255	0.0	4.5	4.5	310.8	Flood Risk	
5760 min Winter	7.177	0.227	0.0	4.2	4.2	276.2	O K	
7200 min Winter	7.152	0.202	0.0	4.0	4.0	246.4	O K	
8640 min Winter	7.131	0.181	0.0	3.7	3.7	221.0	O K	
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)				
10080 min Summer	1.201	0.0	815.9	5552				
15 min Winter	158.032	0.0	141.7	19				
30 min Winter	96.434	0.0	179.0	33				
60 min Winter	58.846	0.0	260.5	62				
120 min Winter	35.909	0.0	324.5	120				
180 min Winter	26.898	0.0	367.7	180				
240 min Winter	21.912	0.0	401.1	238				
360 min Winter	16.413	0.0	452.2	352				
480 min Winter	13.371	0.0	490.8	464				
600 min Winter	11.405	0.0	521.5	572				
720 min Winter	10.016	0.0	546.3	672				
960 min Winter	7.777	0.0	558.6	758				
1440 min Winter	5.444	0.0	566.0	1056				
2160 min Winter	3.811	0.0	659.0	1512				
2880 min Winter	2.959	0.0	675.1	1932				
4320 min Winter	2.210	0.0	740.1	2764				
5760 min Winter	1.797	0.0	824.6	3568				
7200 min Winter	1.530	0.0	868.8	4320				
8640 min Winter	1.342	0.0	903.8	5096				
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MLM			Page 3																												
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN		6101275 Willows Caravan Park Perm Paving - 100 Year + CC																													
Date 21/04/20 File 6101275-MLM-ZZ-XX-CA-C-0...		Designed by CB Checked by SJC																													
XP Solutions		Source Control 2019.1																													
<u>Summary of Results for 100 year Return Period (+40%)</u> <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Σ Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>10080 min Winter</td><td>7.114</td><td>0.164</td><td>0.0</td><td>3.5</td><td>3.5</td><td>199.7</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>10080 min Winter</td><td>1.201</td><td>0.0</td><td>930.1</td><td>5760</td></tr></table>						Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	10080 min Winter	7.114	0.164	0.0	3.5	3.5	199.7	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	10080 min Winter	1.201	0.0	930.1	5760
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MLM		Page 4																																								
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Perm Paving - 100 Year + CC																																									
Date 21/04/20	Designed by CB																																									
File 6101275-MLM-ZZ-XX-CA-C-0...	Checked by SJC																																									
XP Solutions		Source Control 2019.1																																								
<u>Rainfall Details</u> <table> <tr> <td>Rainfall Model</td> <td>FEH</td> </tr> <tr> <td>Return Period (years)</td> <td>100</td> </tr> <tr> <td>FEH Rainfall Version</td> <td>1999</td> </tr> <tr> <td>Site Location</td> <td>GB 494300 103750 SU 94300 03750</td> </tr> <tr> <td>C (1km)</td> <td>-0.026</td> </tr> <tr> <td>D1 (1km)</td> <td>0.407</td> </tr> <tr> <td>D2 (1km)</td> <td>0.240</td> </tr> <tr> <td>D3 (1km)</td> <td>0.400</td> </tr> <tr> <td>E (1km)</td> <td>0.309</td> </tr> <tr> <td>F (1km)</td> <td>2.317</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> </tr> <tr> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Climate Change %</td> <td>+40</td> </tr> </table> <u>Time Area Diagram</u> Total Area (ha) 0.623 <table> <tr> <td>Time (mins)</td> <td>Area</td> </tr> <tr> <td>From:</td> <td>To: (ha)</td> </tr> <tr> <td>0</td> <td>4 0.623</td> </tr> </table>			Rainfall Model	FEH	Return Period (years)	100	FEH Rainfall Version	1999	Site Location	GB 494300 103750 SU 94300 03750	C (1km)	-0.026	D1 (1km)	0.407	D2 (1km)	0.240	D3 (1km)	0.400	E (1km)	0.309	F (1km)	2.317	Summer Storms	Yes	Winter Storms	Yes	Cv (Summer)	0.750	Cv (Winter)	0.840	Shortest Storm (mins)	15	Longest Storm (mins)	10080	Climate Change %	+40	Time (mins)	Area	From:	To: (ha)	0	4 0.623
Rainfall Model	FEH																																									
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Time (mins)	Area																																									
From:	To: (ha)																																									
0	4 0.623																																									
©1982-2019 Innovyze																																										

MLM		Page 5																								
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Perm Paving - 100 Year + CC																									
Date 21/04/20 File 6101275-MLM-ZZ-XX-CA-C-0...	Designed by CB Checked by SJC																									
XP Solutions Source Control 2019.1																										
<u>Model Details</u> Storage is Online Cover Level (m) 7.500 <u>Porous Car Park Structure</u> <table> <tr> <td>Infiltration Coefficient Base (m/hr)</td> <td>0.00000</td> <td>Width (m)</td> <td>64.0</td> </tr> <tr> <td>Membrane Percolation (mm/hr)</td> <td>1000</td> <td>Length (m)</td> <td>63.5</td> </tr> <tr> <td>Max Percolation (l/s)</td> <td>1128.9</td> <td>Slope (1:X)</td> <td>0.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Depression Storage (mm)</td> <td>5</td> </tr> <tr> <td>Porosity</td> <td>0.30</td> <td>Evaporation (mm/day)</td> <td>3</td> </tr> <tr> <td>Invert Level (m)</td> <td>6.950</td> <td>Cap Volume Depth (m)</td> <td>0.400</td> </tr> </table> <u>Orifice Outflow Control</u> Diameter (m) 0.068 Discharge Coefficient 0.600 Invert Level (m) 6.950			Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	64.0	Membrane Percolation (mm/hr)	1000	Length (m)	63.5	Max Percolation (l/s)	1128.9	Slope (1:X)	0.0	Safety Factor	2.0	Depression Storage (mm)	5	Porosity	0.30	Evaporation (mm/day)	3	Invert Level (m)	6.950	Cap Volume Depth (m)	0.400
Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	64.0																							
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Invert Level (m)	6.950	Cap Volume Depth (m)	0.400																							
©1982-2019 Innovyze																										

MLM				Page 1	
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN		6101275 Willows Caravan Park Pond - 1 Year			
Date 21/04/20 File		Designed by CB Checked by SJC			
XP Solutions		Source Control 2019.1			
<u>Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 1 Year.srcx</u>					
Upstream Structures			Outflow To Overflow To		
6101275-MLM-ZZ-XX-CA-C-0001-PERMEABLEPAVING - 1 Year.srcx			(None)	(None)	
6101275-MLM-ZZ-XX-CA-C-0002-RAINGARDEN- 1 Year.srcx					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	6.649	0.019	0.1	0.4	O K
30 min Summer	6.653	0.023	0.2	0.5	O K
60 min Summer	6.659	0.029	0.3	0.7	O K
120 min Summer	6.668	0.038	0.5	0.9	O K
180 min Summer	6.680	0.050	0.8	1.2	O K
240 min Summer	6.685	0.055	0.9	1.3	O K
360 min Summer	6.691	0.061	1.1	1.5	O K
480 min Summer	6.697	0.067	1.2	1.6	O K
600 min Summer	6.701	0.071	1.4	1.8	O K
720 min Summer	6.705	0.075	1.5	1.9	O K
960 min Summer	6.707	0.077	1.5	1.9	O K
1440 min Summer	6.707	0.077	1.5	1.9	O K
2160 min Summer	6.707	0.077	1.5	1.9	O K
2880 min Summer	6.705	0.075	1.5	1.9	O K
4320 min Summer	6.705	0.075	1.5	1.9	O K
5760 min Summer	6.704	0.074	1.4	1.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	23.082	0.0	1.9	17	
30 min Summer	15.303	0.0	5.1	31	
60 min Summer	10.145	0.0	16.3	62	
120 min Summer	6.726	0.0	29.3	124	
180 min Summer	5.288	0.0	39.2	182	
240 min Summer	4.459	0.0	47.3	242	
360 min Summer	3.506	0.0	60.4	360	
480 min Summer	2.956	0.0	70.8	420	
600 min Summer	2.590	0.0	79.6	468	
720 min Summer	2.324	0.0	87.3	516	
960 min Summer	1.868	0.0	93.3	660	
1440 min Summer	1.373	0.0	100.4	936	
2160 min Summer	1.009	0.0	124.8	1364	
2880 min Summer	0.810	0.0	129.7	1748	
4320 min Summer	0.635	0.0	145.8	2508	
5760 min Summer	0.535	0.0	173.5	3272	
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North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 1 Year	
Date 21/04/20 File	Designed by CB Checked by SJC	
XP Solutions		

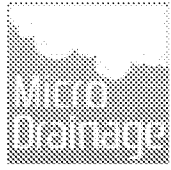
Source Control 2019.1

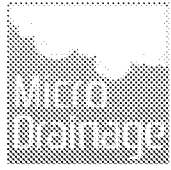
Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 1 Year.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	6.699	0.069	1.3	1.7	O K
8640 min Winter	6.696	0.066	1.2	1.6	O K
10080 min Winter	6.693	0.063	1.1	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.468	0.0	217.3	4160
8640 min Winter	0.419	0.0	226.8	4944
10080 min Winter	0.382	0.0	233.3	5664

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<u>Time Area Diagram</u> Total Area (ha) 0.011 <table> <tr> <td>Time (mins)</td> <td>Area</td> </tr> <tr> <td>From: To: (ha)</td> <td></td> </tr> <tr> <td>0 4</td> <td>0.011</td> </tr> </table>			Time (mins)	Area	From: To: (ha)		0 4	0.011																												
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<u>Cascade Model Details for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 1 Year.srcx</u> Storage is Online Cover Level (m) 7.630 <u>Tank or Pond Structure</u> Invert Level (m) 6.630 <table> <thead> <tr> <th>Depth (m)</th> <th>Area (m²)</th> <th>Depth (m)</th> <th>Area (m²)</th> </tr> </thead> <tbody> <tr> <td>0.000</td> <td>22.7</td> <td>1.000</td> <td>115.0</td> </tr> </tbody> </table> <u>Orifice Outflow Control</u> Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 6.630			Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	0.000	22.7	1.000	115.0
Depth (m)	Area (m ²)	Depth (m)	Area (m ²)							
0.000	22.7	1.000	115.0							
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North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 30 Year				
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Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 30 Year.srcx					
Upstream Structures		Outflow To Overflow To			
6101275-MLM-ZZ-XX-CA-C-0001-PERMEABLEPAVING - 30 Year.srcx		(None)			
6101275-MLM-ZZ-XX-CA-C-0002-RAINGARDEN- 30 Year.srcx		(None)			
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	6.693	0.063	1.1	1.5	O K
30 min Summer	6.721	0.091	1.9	2.3	O K
60 min Summer	6.773	0.143	2.5	3.9	O K
120 min Summer	6.818	0.188	3.0	5.4	O K
180 min Summer	6.841	0.211	3.2	6.2	O K
240 min Summer	6.855	0.225	3.3	6.7	O K
360 min Summer	6.871	0.241	3.4	7.3	O K
480 min Summer	6.877	0.247	3.5	7.5	O K
600 min Summer	6.881	0.251	3.5	7.7	O K
720 min Summer	6.885	0.255	3.6	7.8	O K
960 min Summer	6.888	0.258	3.6	7.9	O K
1440 min Summer	6.888	0.258	3.6	7.9	O K
2160 min Summer	6.880	0.250	3.5	7.6	O K
2880 min Summer	6.869	0.239	3.4	7.2	O K
4320 min Summer	6.844	0.214	3.2	6.3	O K
5760 min Summer	6.822	0.192	3.0	5.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	71.912	0.0	40.0	33	
30 min Summer	47.856	0.0	63.8	56	
60 min Summer	30.497	0.0	107.5	102	
120 min Summer	18.853	0.0	140.5	158	
180 min Summer	14.061	0.0	160.7	206	
240 min Summer	11.359	0.0	175.2	254	
360 min Summer	8.416	0.0	197.2	360	
480 min Summer	6.793	0.0	213.5	432	
600 min Summer	5.749	0.0	226.4	494	
720 min Summer	5.014	0.0	237.0	560	
960 min Summer	4.038	0.0	253.6	696	
1440 min Summer	2.972	0.0	275.4	970	
2160 min Summer	2.184	0.0	328.7	1376	
2880 min Summer	1.754	0.0	347.5	1768	
4320 min Summer	1.286	0.0	368.7	2548	
5760 min Summer	1.031	0.0	405.0	3272	
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MLM

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North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 30 Year	
Date 20/04/20 File	Designed by CB Checked by SJC	
XP Solutions		

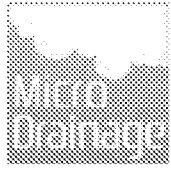
Source Control 2019.1

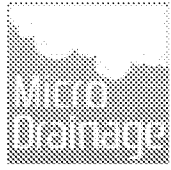
Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 30 Year.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
7200 min Winter	6.785	0.155	2.7	4.2	O K
8640 min Winter	6.764	0.134	2.4	3.6	O K
10080 min Winter	6.746	0.116	2.2	3.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.869	0.0	478.3	4136
8640 min Winter	0.756	0.0	488.5	4816
10080 min Winter	0.672	0.0	493.9	5560

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North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 30 Year																									
Date 20/04/20 File	Designed by CB Checked by SJC																									
XP Solutions		Source Control 2019.1																								
<u>Cascade Rainfall Details for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 30 Year.srcx</u>																										
<table> <tr> <td>Rainfall Model</td> <td>FSR</td> <td>Winter Storms</td> <td>Yes</td> </tr> <tr> <td>Return Period (years)</td> <td>30</td> <td>Cv (Summer)</td> <td>0.750</td> </tr> <tr> <td>Region</td> <td>England and Wales</td> <td>Cv (Winter)</td> <td>0.840</td> </tr> <tr> <td>M5-60 (mm)</td> <td>19.800</td> <td>Shortest Storm (mins)</td> <td>15</td> </tr> <tr> <td>Ratio R</td> <td>0.350</td> <td>Longest Storm (mins)</td> <td>10080</td> </tr> <tr> <td>Summer Storms</td> <td>Yes</td> <td>Climate Change %</td> <td>+0</td> </tr> </table>			Rainfall Model	FSR	Winter Storms	Yes	Return Period (years)	30	Cv (Summer)	0.750	Region	England and Wales	Cv (Winter)	0.840	M5-60 (mm)	19.800	Shortest Storm (mins)	15	Ratio R	0.350	Longest Storm (mins)	10080	Summer Storms	Yes	Climate Change %	+0
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<u>Time Area Diagram</u> Total Area (ha) 0.011 <table> <tr> <th align="left" colspan="3">Time (mins) Area</th> </tr> <tr> <th align="left">From:</th> <th align="left">To:</th> <th align="left">(ha)</th> </tr> <tr> <td align="center">0</td> <td align="center">4</td> <td align="center">0.011</td> </tr> </table>			Time (mins) Area			From:	To:	(ha)	0	4	0.011															
Time (mins) Area																										
From:	To:	(ha)																								
0	4	0.011																								
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MLM		Page 5
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 30 Year	
Date 20/04/20 File	Designed by CB Checked by SJC	
XP Solutions Source Control 2019.1		

Cascade Model Details for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 30 Year.srcx

Storage is Online Cover Level (m) 7.630

Tank or Pond Structure

Invert Level (m) 6.630

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	22.7	1.000	115.0

Orifice Outflow Control

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 6.630

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MLM

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North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 100 Year + CC	
Date 21/04/20 File	Designed by CB Checked by SJC	
XP Solutions		
Source Control 2019.1		

Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 100 Year
+CC.srcx

Upstream Structures	Outflow To	Overflow To
6101275-MLM-ZZ-XX-CA-C-0001-PERMEABLEPAVING - 100 Year+CC.srcx	(None)	(None)
6101275-MLM-ZZ-XX-CA-C-0002-RAINGARDEN - 100 Year+CC.srcx		

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	6.865	0.235	3.4	7.1	O K
30 min Summer	6.917	0.287	3.8	9.1	O K
60 min Summer	6.974	0.344	4.2	11.7	O K
120 min Summer	7.034	0.404	4.6	14.6	O K
180 min Summer	7.070	0.440	4.8	16.5	O K
240 min Summer	7.096	0.466	5.0	18.0	O K
360 min Summer	7.134	0.504	5.2	20.2	O K
480 min Summer	7.159	0.529	5.3	21.7	O K
600 min Summer	7.177	0.547	5.4	22.9	O K
720 min Summer	7.189	0.559	5.5	23.6	O K
960 min Summer	7.174	0.544	5.4	22.7	O K
1440 min Summer	7.149	0.519	5.3	21.1	O K
2160 min Summer	7.114	0.484	5.1	19.0	O K
2880 min Summer	7.081	0.451	4.9	17.1	O K
4320 min Summer	7.052	0.422	4.7	15.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	158.032	0.0	131.0	56
30 min Summer	96.434	0.0	166.6	72
60 min Summer	58.846	0.0	241.6	100
120 min Summer	35.909	0.0	301.7	156
180 min Summer	26.898	0.0	342.2	212
240 min Summer	21.912	0.0	373.7	270
360 min Summer	16.413	0.0	421.8	382
480 min Summer	13.371	0.0	458.5	492
600 min Summer	11.405	0.0	488.0	604
720 min Summer	10.016	0.0	512.4	720
960 min Summer	7.777	0.0	524.1	838
1440 min Summer	5.444	0.0	533.6	1078
2160 min Summer	3.811	0.0	613.6	1468
2880 min Summer	2.959	0.0	628.3	1852
4320 min Summer	2.210	0.0	688.6	2640

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MLM			Page 2		
North Kiln Felaw Maltings		6101275			
46 Felaw Street		Willows Caravan Park			
Ipswich IP2 8PN		Pond - 100 Year + CC			
Date 21/04/20		Designed by CB			
File		Checked by SJC			
XP Solutions		Source Control 2019.1			
<u>Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 100 Year +CC.srcx</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
5760 min Summer	7.019	0.389	4.5	13.8	O K
7200 min Summer	6.989	0.359	4.3	12.3	O K
8640 min Summer	6.961	0.331	4.1	11.0	O K
10080 min Summer	6.936	0.306	3.9	9.9	O K
15 min Winter	6.895	0.265	3.6	8.2	O K
30 min Winter	6.951	0.321	4.1	10.6	O K
60 min Winter	7.012	0.382	4.5	13.5	O K
120 min Winter	7.078	0.448	4.9	16.9	O K
180 min Winter	7.118	0.488	5.1	19.2	O K
240 min Winter	7.147	0.517	5.2	21.0	O K
360 min Winter	7.190	0.560	5.5	23.7	O K
480 min Winter	7.220	0.590	5.6	25.7	O K
600 min Winter	7.241	0.611	5.7	27.2	O K
720 min Winter	7.257	0.627	5.8	28.3	O K
960 min Winter	7.243	0.613	5.7	27.3	O K
1440 min Winter	7.207	0.577	5.6	24.9	O K
2160 min Winter	7.159	0.529	5.3	21.7	O K
2880 min Winter	7.110	0.480	5.0	18.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
5760 min Summer	1.797	0.0	766.3	3416	
7200 min Summer	1.530	0.0	806.4	4152	
8640 min Summer	1.342	0.0	837.9	4880	
10080 min Summer	1.201	0.0	860.8	5640	
15 min Winter	158.032	0.0	150.7	60	
30 min Winter	96.434	0.0	190.0	77	
60 min Winter	58.846	0.0	274.8	106	
120 min Winter	35.909	0.0	342.0	164	
180 min Winter	26.898	0.0	387.4	224	
240 min Winter	21.912	0.0	422.5	282	
360 min Winter	16.413	0.0	476.2	394	
480 min Winter	13.371	0.0	516.8	502	
600 min Winter	11.405	0.0	549.1	610	
720 min Winter	10.016	0.0	575.8	720	
960 min Winter	7.777	0.0	588.6	924	
1440 min Winter	5.444	0.0	597.0	1160	
2160 min Winter	3.811	0.0	693.2	1584	
2880 min Winter	2.959	0.0	710.4	1996	
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MLM

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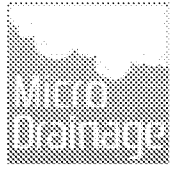
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 100 Year + CC	
Date 21/04/20 File	Designed by CB Checked by SJC	
XP Solutions	Source Control 2019.1	

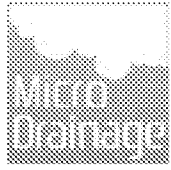
Cascade Summary of Results for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 100 Year
+CC.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
4320 min Winter	7.059	0.429	4.7	15.9	O K
5760 min Winter	7.009	0.379	4.4	13.3	O K
7200 min Winter	6.965	0.335	4.2	11.3	O K
8640 min Winter	6.928	0.298	3.9	9.6	O K
10080 min Winter	6.896	0.266	3.7	8.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Winter	2.210	0.0	779.5	2808
5760 min Winter	1.797	0.0	867.9	3584
7200 min Winter	1.530	0.0	914.8	4344
8640 min Winter	1.342	0.0	952.1	5104
10080 min Winter	1.201	0.0	980.5	5848

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MLM		Page 4																																								
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 100 Year + CC																																									
Date 21/04/20	Designed by CB																																									
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MLM		Page 5
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN	6101275 Willows Caravan Park Pond - 100 Year + CC	
Date 21/04/20 File	Designed by CB Checked by SJC	
XP Solutions Source Control 2019.1		

Cascade Model Details for 6101275-MLM-ZZ-XX-CA-C-0003-POND - 100 Year+CC.srcx

Storage is Online Cover Level (m) 7.630

Tank or Pond Structure

Invert Level (m) 6.630

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	22.7	1.000	115.0

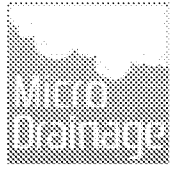
Orifice Outflow Control

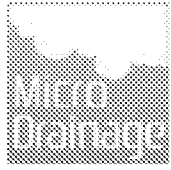
Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 6.630

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MLM			Page 1		
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN		6101275 Willows Caravan Park Rain Garden - 100 Year			
Date 21/04/20 File 6101275-MLM-ZZ-XX-CA-C-0...		Designed by CB Checked by SJC			
XP Solutions		Source Control 2019.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	7.296	0.086	2.9	4.4	Flood Risk
30 min Summer	7.300	0.090	3.1	4.6	Flood Risk
60 min Summer	7.300	0.090	3.2	4.6	Flood Risk
120 min Summer	7.295	0.085	2.9	4.3	Flood Risk
180 min Summer	7.290	0.080	2.6	3.9	Flood Risk
240 min Summer	7.285	0.075	2.3	3.6	Flood Risk
360 min Summer	7.277	0.067	2.0	3.2	Flood Risk
480 min Summer	7.271	0.061	1.8	2.8	Flood Risk
600 min Summer	7.267	0.057	1.6	2.6	Flood Risk
720 min Summer	7.264	0.054	1.4	2.5	Flood Risk
960 min Summer	7.259	0.049	1.1	2.2	Flood Risk
1440 min Summer	7.252	0.042	0.8	1.8	Flood Risk
2160 min Summer	7.245	0.035	0.6	1.5	Flood Risk
2880 min Summer	7.241	0.031	0.5	1.3	Flood Risk
4320 min Summer	7.237	0.027	0.3	1.1	Flood Risk
5760 min Summer	7.234	0.024	0.3	1.0	Flood Risk
7200 min Summer	7.232	0.022	0.2	0.9	Flood Risk
8640 min Summer	7.231	0.021	0.2	0.8	Flood Risk
10080 min Summer	7.230	0.020	0.2	0.8	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Summer	158.032	0.0	5.6	14	
30 min Summer	96.434	0.0	6.9	22	
60 min Summer	58.846	0.0	8.4	40	
120 min Summer	35.909	0.0	10.2	72	
180 min Summer	26.898	0.0	11.5	102	
240 min Summer	21.912	0.0	12.5	134	
360 min Summer	16.413	0.0	14.0	194	
480 min Summer	13.371	0.0	15.2	254	
600 min Summer	11.405	0.0	16.2	314	
720 min Summer	10.016	0.0	17.1	374	
960 min Summer	7.777	0.0	17.7	494	
1440 min Summer	5.444	0.0	18.6	736	
2160 min Summer	3.811	0.0	19.5	1104	
2880 min Summer	2.959	0.0	20.2	1468	
4320 min Summer	2.210	0.0	22.7	2204	
5760 min Summer	1.797	0.0	24.6	2928	
7200 min Summer	1.530	0.0	26.1	3584	
8640 min Summer	1.342	0.0	27.5	4408	
10080 min Summer	1.201	0.0	28.7	5032	
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MLM					Page 2
North Kiln Felaw Maltings 46 Felaw Street Ipswich IP2 8PN		6101275 Willows Caravan Park Rain Garden - 100 Year			
Date 21/04/20 File 6101275-MLM-ZZ-XX-CA-C-0...		Designed by CB Checked by SJC			
XP Solutions		Source Control 2019.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	7.303	0.093	3.3	4.9	Flood Risk
30 min Winter	7.305	0.096	3.5	5.0	Flood Risk
60 min Winter	7.304	0.094	3.4	4.9	Flood Risk
120 min Winter	7.294	0.084	2.8	4.3	Flood Risk
180 min Winter	7.286	0.076	2.4	3.7	Flood Risk
240 min Winter	7.279	0.069	2.1	3.3	Flood Risk
360 min Winter	7.270	0.060	1.7	2.8	Flood Risk
480 min Winter	7.265	0.055	1.4	2.5	Flood Risk
600 min Winter	7.261	0.051	1.2	2.3	Flood Risk
720 min Winter	7.259	0.049	1.1	2.2	Flood Risk
960 min Winter	7.253	0.043	0.9	1.9	Flood Risk
1440 min Winter	7.246	0.036	0.6	1.5	Flood Risk
2160 min Winter	7.240	0.030	0.4	1.2	Flood Risk
2880 min Winter	7.236	0.026	0.3	1.1	Flood Risk
4320 min Winter	7.233	0.023	0.2	0.9	Flood Risk
5760 min Winter	7.231	0.021	0.2	0.8	Flood Risk
7200 min Winter	7.229	0.019	0.2	0.7	Flood Risk
8640 min Winter	7.228	0.018	0.2	0.7	Flood Risk
10080 min Winter	7.227	0.017	0.1	0.7	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15 min Winter	158.032	0.0	6.3	15	
30 min Winter	96.434	0.0	7.7	24	
60 min Winter	58.846	0.0	9.4	42	
120 min Winter	35.909	0.0	11.4	74	
180 min Winter	26.898	0.0	12.9	106	
240 min Winter	21.912	0.0	14.0	138	
360 min Winter	16.413	0.0	15.7	196	
480 min Winter	13.371	0.0	17.1	256	
600 min Winter	11.405	0.0	18.2	318	
720 min Winter	10.016	0.0	19.2	376	
960 min Winter	7.777	0.0	19.8	500	
1440 min Winter	5.444	0.0	20.8	736	
2160 min Winter	3.811	0.0	21.9	1100	
2880 min Winter	2.959	0.0	22.6	1444	
4320 min Winter	2.210	0.0	25.4	2156	
5760 min Winter	1.797	0.0	27.5	2928	
7200 min Winter	1.530	0.0	29.3	3656	
8640 min Winter	1.342	0.0	30.8	4392	
10080 min Winter	1.201	0.0	32.2	5040	
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MLM		Page 3																																								
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MLM		Page 4
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Date 21/04/20 File 6101275-MLM-ZZ-XX-CA-C-0...	Designed by CB Checked by SJC	
XP Solutions Source Control 2019.1		

Model Details

Storage is Online Cover Level (m) 7.310

Tank or Pond Structure

Invert Level (m) 7.210

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	37.1	0.100	71.0

Orifice Outflow Control

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 7.210

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