

Land at Dalefield Way (West) Gravesend

Flood Risk Assessment Note & Preliminary Drainage Strategy

O'Halloran & O'Brien Ltd

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1.0 Introduction

Manhire Associates have been appointed by O'Halloran & O'Brien Ltd to prepare a Flood Risk Assessment (FRA) and Surface Water Drainage Strategy in support of a Planning Application for the redevelopment proposals for open storage (Use Class B8) for the western plot within the larger existing industrial land plot.

The application site is on Dalefield Way, Gravesend, Kent DA12 2JH in an area known as Dalefield Way Industrial Estate. The wider industrial estate includes the offices, workshops and storage areas used by B&T plant hire, O'Halloran & O'Brien & Keady Construction.

This report describes the existing and proposed development, the implications of flooding and the impact the development will have on the flood plan in accordance with the governments guidance document; National Planning Policy Framework (NPPF) and its Planning Practice Guidance (PPG).



Figure 1 - Arial Image of site.

Proposals are to construct 1615m² of asphalt surfacing and associated drainage that will connect into the overall SuDS system already constructed and provides 10923m² of permeable hardstanding for storage.

The purpose of this report is to provide a review of existing Flood Risk Assessments and to demonstrate to the planning authority and consultees that the industrial element has been assessed and is considered to be safe throughout its design life. It also confirms how surface water run off from the development can be dealt with within the existing sites sustainable drainage network previously constructed for the original development.

2.0 Baseline Parameters

The site and surrounding area has been subject to a number of planning applications, in 1999 an outline application for 165 residential dwellings known as Phase 1 & 2 under ref GR99/168. During the application it was identified that approximately 650m of the watercourse needed improvement to provide the necessary on-line attenuation to accommodate the development.

The above-mentioned measures involved improvement to 650m of the existing watercourse and provision of 2 outfall structures that were limited to the greenfield discharge. The approved works were implemented in early 2003.

The application site was granted consent for industrial development use classes B2 & B8, approval was given to the outline application on the 22 June 2001. A new outline application was permitted on 23rd October 2007 for industrial development classes B2 & B8. In 2013 an application was made to renew the 2007 permission, it was granted on 14th June 2013.

Also, of note there have been a number of planning applications adjoining the application site. In 2013 outline consent was granted for an industrial development of 7,000 sqm of B2 & B8 uses to the east of the application site, and on 14th September 2016 permission was granted for 3 industrial units on that site. To the southeast of the application site outline permission was granted on 27th March 2014 for 130 residential units.

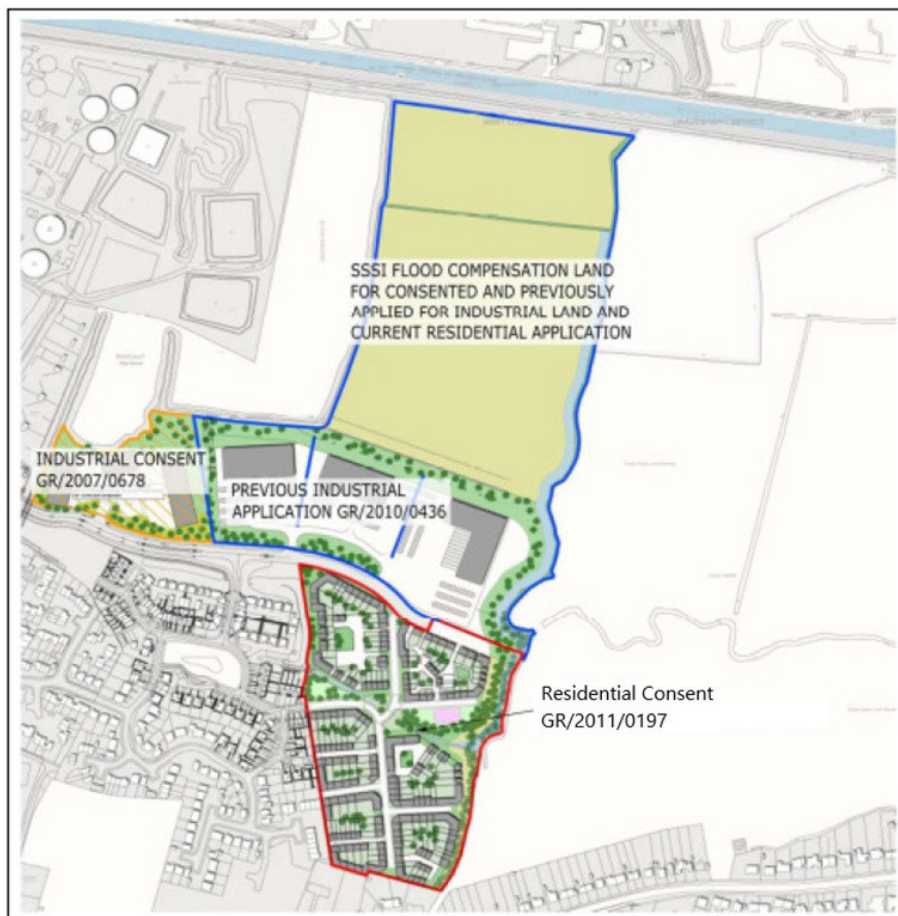


Figure 2 - Extant Planning Applications

3.0 Review of previous Flood Risk Assessments

A site-specific Flood Risk Assessment was prepared for the wider development which included the application site referenced as phase 3a. A site-specific Flood Risk Assessment was prepared for the application site by Ardent Consulting Engineers in July 2007 to support the planning application for consent to implement the Phase 3A industrial development scheme which was previously granted consent in 2001. The 2001 consent expired in 2006 and was re submitted in 2007 (Planning reference GR/2007/0678), this was granted, and renewal of the application was consented in 2013.

The site-specific Flood Risk Assessment prepared by Ardent Consulting Engineers in 2007 established that the site lies within Flood Zone 3 but benefits from flood defences.

During the determination of the neighbouring planning applications 2010/0436 (Industrial) and 2010/0197 (residential) Gravesham Borough Council (BC) identified that portions of the tidal flood defences around Gravesend may be at a lower level than that stated in the HR Wallingford Technical Note MCM57553/01 published in 2007.

A Flood Risk Addendum was prepared to support the Planning Applications and the Hydraulic Modelling, with the latter having been previously approved by the Environment Agency. At that time the proposals were confirmed as being safe. On receipt of the information from Gravesham BC a joint meeting was held with senior representatives of the Council, the Environment Agency and Ardent Consulting Engineers. The meeting was held at the Environment Agency's offices on the 12 October 2011. During this meeting the impact of the lowered defence levels was discussed, and it was agreed that:

- Gravesham Borough Council, would benefit from further evidence to support the Sequential Test for the Site from the Applicant; and,
- The impact of the lowered defences needs to be agreed with the Environment Agency.

An addendum to the Site-Specific Flood Risk Assessment was prepared by Ardent Consulting Engineers in November 2011, and reissued again in May 2016 following the receipt of new data from the Environment Agency on the existing flood defence crest heights. The Addendum concluded that the existing flood defence infrastructure and alignment of the railway line provide an adequate level of flood defence for the residential and industrial proposals up to 2055. Consequently, the industrial element is considered to be safe throughout its design life.

4.0 Flood Risk

The current flood risk has been reviewed on the EA's flood mapping website and it confirms there has been no change since the 2007 application in that the site is located in flood zone 3 as indicated in figure 3 below, but is still within the area protected by the river defences as indicated in the EA's long term flood risk mapping figure 4 below.



Figure 4 demonstrates that the site is still protected from flooding by the river defences even when climate change allowances have been factored in.

The surface water flood risk has also been reviewed and there is only limited pockets on site where surface water flooding might occur. Figure 5 below shows the extent of surface water flooding in the area of the application site. The surface water flood risk is considered low.

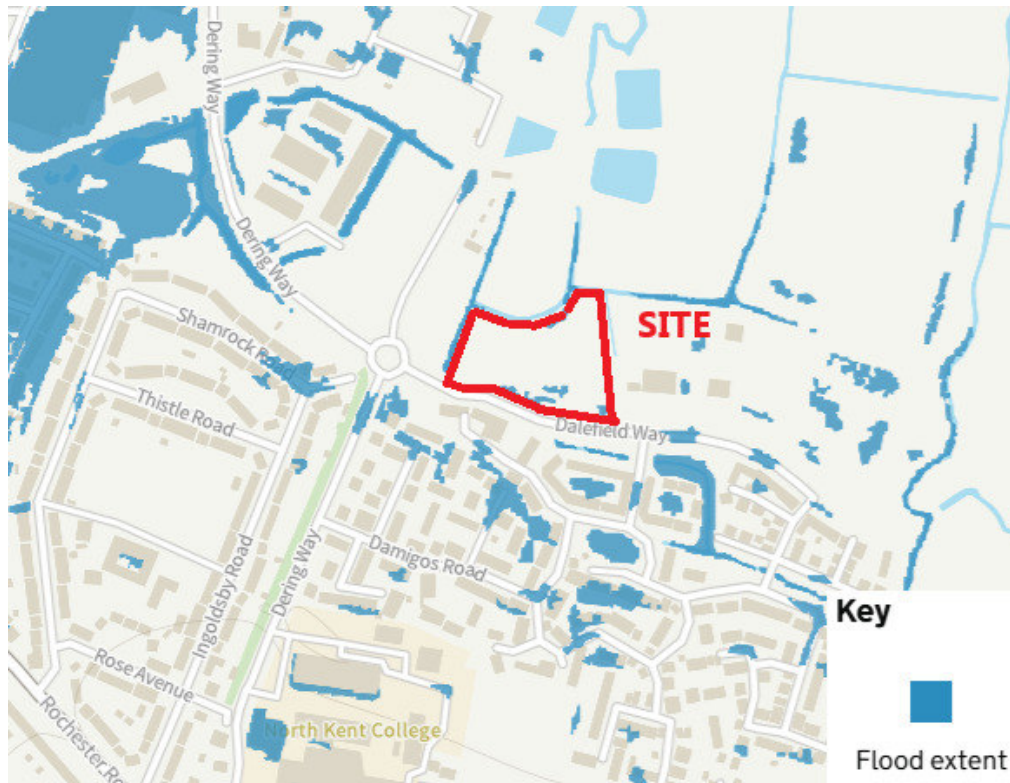


Figure 5 – Surface Water Flood Maps

5.0 Review of Previous Surface Water Drainage Strategy

As part of the various Flood Risk Assessment prepared for the planning applications drainage strategies for each site was included. Buchanan Consulting Engineers prepared an FRA for the allocated site PM9 of the adopted Gravesham Local Plan (1996), planning reference (GR/1999/0168). The application site was part of the PM9 allocated site and also included the erection of 165 dwellings, open space and distributor / estate road.

Buchanans agreed the greenfield runoff rates with Environment Agency and English Nature for the whole allocated site. The greenfield discharge rate was agreed at 7l/s/ha. Drawing M591-07 included in Appendix A shows the discharge rates for the relevant areas of the site. drawing M591/05 rev B included in Appendix B shows the wider ditch and drainage network for the allocated site.

The application site forms part of the 5.15ha catchment area to the west of the allocation. The discharge from this area is 36.05l/s which equals 7l/s/ha. Following applications on this site developed the principles set out in the 1999 application.

Ardent Consulting Engineers prepared the FRA in support of an industrial development on the application site, for a 3,333m² building, 60 parking spaces and service area totalling 9,200m² of impermeable area. Based on discharge rate of 10l/s (7l/s/ha) and a return period of 1in100+20% it was estimated that 455m³ of storage was required to achieve the agreed discharge rate.

6.0 Proposed Drainage Strategy

As described in section 5.0 the existing site drainage networks currently discharges into the watercourses and flood levee corridors that were designed and implemented as part of the site wide strategy and subsequent planning applications for each phase of development.

The proposals seek approval for an impermeable hardstanding of 1615m² and 10923m² of permeable hardstanding. The application site is currently covered by a standing area with a permeable surface. The application site has a total area of 1.25ha.

Under the national standards for sustainable drainage systems Standard 1 the SuDS hierarchy has been applied, the proposals are for an open storage area so there is no need for the reuse of non-potable water on site, the ground conditions and high-water table means infiltration is not possible so has been discounted. Next on the hierarchy is the discharge to surface water body, there is a number of ditches around the site and these will be used to discharge runoff from the development.

The drainage strategy for the development is therefore to use a permeable construction of the tarmac hard standing, which will be lined and have restricted discharge to the to the adjacent ditch. The highest form of SuDS will be employed in the design as the reuse and infiltration of runoff is not viable and therefore meets the requirements of Standard 1.

10m² of the site will be retained as hard standing as per the current situation with permeable surface. This existing hardstanding area will be retained and regraded to provide a level surface for external storage of items. The permeability of this area will not be altered by these proposals so the drainage regime for this 10923m² of the site will allow runoff to soak into the ground as it does currently.

1615m² of the site will be replaced with a permeable tarmac construction for storage of materials etc. This area will be positively drained, and a gravel subbase will be provided to attenuate the runoff from the development. The existing and proposed permeable paved areas are shown on drawing PSK801 & PSK802 included in Appendix C & D.

The previous 2007 application agreed a discharge rate of 10l/s from the site. This discharge rate of 7l/sec/ha was agreed and set the greenfield rate. The LLFA have rejected this and insist on the development being restricted to greenfield rates, the national standards under Standard 3 set the discharge rates from pervious and undeveloped site. Under the standards the discharge from the development should be restricted to greenfield rate or 3 l/sec/ha which ever is the greater.

The LLFA also object to the use of Cv's of 0.75 & 0.84, and requested the calculations are based on Cv's of 1 for both winter and summer events plus current climate change allowances.

The EA have published climate change allowances to be factored into the drainage designs. The level of allowance to be applied depends on the development's vulnerability classification, the management catchment area and life expectancy of the development.

The site is a less vulnerable use with life expectancy of 50 years, the PPG guidance recommends the use of the central allowance for the 2070s epoch for development with a lifetime up to 2100. The site is located in the Medway Management Catchment so a climate change allowance of 20% should be factored into the drainage design for a 3.3% and 1% annual exceedance rainfall event.

The greenfield discharge rate from the site has been estimated at 0.5 l/sec refer to calculations in Appendix F, however at 3 l/sec/ha for the 1.25 ha the discharge rate would be 3.75 l/sec, therefore the discharge from the site will be restricted to 3.75 l/sec in compliance with Standard 3.

The drainage strategy has therefore been based on the above principles and to achieve the required discharge the permeable paving thickness has been set at 400mm thick. This will accommodate a 1 in 100 year storm event plus 20% allowance for climate change. The proposed hard standing will have falls towards the perimeter ditches so any exceedance flows will be directed to ditches. A drainage strategy has been prepared for the site and is included in Appendix E as drawing PKS800. The full supporting calculations are also included in Appendix F.

The proposed development will employ permeable construction techniques for the capture and retention of runoff from the site. Standard 2 sets out that the SuDS approach should achieve the interception of the first 5mm of rainfall that it should be retained on site. The proposed development will have permeable surfaces so under the standard all permeable surfaces, whether lined or not, shall be assumed to comply provided there is no additional area drained to the pavement, the proposed strategy is compliant with standard 2.

Water quality with specific reference to the methodologies and requirements set out in the SuDS Manual C753, focuses on the assessment of pollution hazard indices and verification that the proposed SuDS treatment train delivers the necessary level of treatment in accordance with the Manual.

The SuDS Manual introduces the concept of pollution hazard indices to assess the potential risk to water quality from different land uses and site activities. Each land use is assigned hazard indices for three pollutant categories:

- Suspended solids
- Metals
- Hydrocarbons

For the proposed development of open storage area is considered under the SuDS manual to present a medium pollution hazard. The hazard indices should be determined by referencing Table 26.2 in the SuDS Manual, which provides guidance for various land uses. A medium risk hazard is considered to have indices of 0.7 for suspended solids, 0.6 for metals, and 0.7 for hydrocarbons.

According to the SuDS Manual, permeable pavements are effective at removing pollutants through filtration, sedimentation, and microbial breakdown within the sub-base and geotextile layers. The treatment performance of permeable pavements is typically summarised by their "SuDS mitigation indices," which should be compared against the pollution hazard indices for the site.

As per Table 26.3 in the SuDS Manual C753, the mitigation indices for a well-designed and maintained permeable pavement are generally:

- Suspended solids: 0.7
- Metals: 0.6
- Hydrocarbons: 0.7

These values indicate that the permeable pavement provides a level of treatment that meets or exceeds the pollution hazard indices for medium-risk. The proposals will provide an adequate level of treatment from medium risk areas, a petrol interceptor will also be incorporated in the treatment train as well in case of spillage so the proposals comply with Standard 4 of the national standard.

The amenity considerations are a matter being agreed with the planning authority. The proposed measures are deemed adequate to satisfy planning requirements. Accordingly, it has been determined that standard 5 has been satisfied as there is no requirement for SuDS (Sustainable Drainage Systems) measures to supplement amenity provisions in this instance.

Biodiversity matters are presently under negotiation between the applicant and the planning authority. The proposed mitigation and enhancement measures have been assessed as adequate to satisfy statutory planning obligations and Standard 6 of the national standard. Consequently, no further biodiversity interventions by way of SuDS are considered necessary to augment the current proposals at this juncture.

The development will involve very limited drainage works the main drainage will use permeable surfaces to collect and store runoff, however effective protection and maintenance of installed drainage systems are vital during construction activities to prevent environmental pollution, maintain site safety, and ensure the long-term functionality of installed drainage networks.

The following measures will be implemented, construction traffic and activities will be direct away from the installed drainage system, where possible the installed drainage will be fenced off to prevent any damage. Also removal of construction debris, soil, and rubbish from around drainage inlets will be undertaken regularly and monitored to prevent blockages.

Drainage of the construction works themselves is crucial to prevent waterlogging, erosion, and pollution. This will be achieved through:

- Site Grading: Grade the site to promote positive drainage and avoid ponding of water near sensitive areas or drainage inlets.
- Silt Fencing: Install silt fences or sediment barriers around stockpiles, exposed soil, and drainage inlets to trap sediment before it can enter the drainage network.
- Sediment Traps and Settlement Tanks: Use sediment traps, settlement tanks, or silt socks to filter runoff water before it is discharged into the drainage system.
-

- Wheel Washing: Provide wheel-washing facilities at site exits to prevent mud and silt from being tracked onto public roads and into drains.
- Minimise Exposed Soil: Limit the extent and duration of exposed soil areas by phasing works and promptly re-vegetating or covering bare ground.
- Spill Prevention: Store fuels, oils, and chemicals in bunded areas away from drainage lines, and have spill kits readily available on site.

By implementing robust protection and maintenance measures, providing adequate site drainage, and installing effective silt and pollution controls, construction projects can safeguard drainage infrastructure and prevent environmental contamination in compliance with standard 7. These practices will form an integral part of site management plans and be communicated to all staff and subcontractors involved in the works.

7.0 Conclusions

A review of the various Flood Risk Assessments for the site from 1999, 2007 to 2016 and Addendums concluded that the existing flood defence infrastructure and alignment of the railway line provide an adequate level of flood defence for the residential and industrial proposals up to 2055. Consequently, the industrial element is considered to be safe throughout its design life.

As part of the Flood Risk Assessment prepared by Ardent Consulting Engineers in January 2007 & 2011 to support the planning application for consent to implement the industrial development on the application site a surface water drainage strategy was devised to demonstrate that the scheme can be suitably implemented without increasing the level of flood risk when the drainage system experiences a 1:100 year rainfall event (including an additional allowance for any potential climate change impacts).

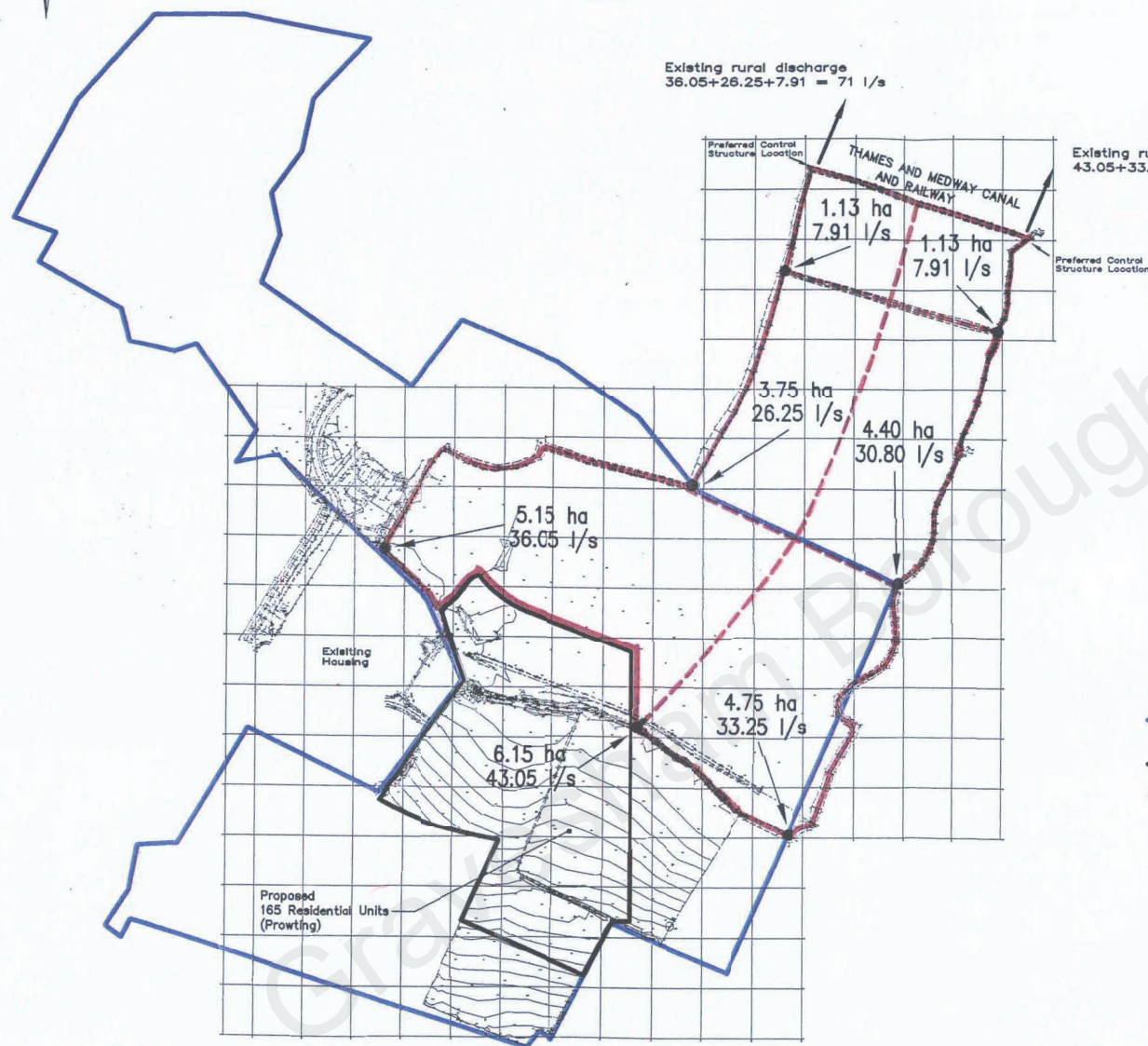
Surface Water run-off from the site will freely discharge into the receiving open channel watercourses and will be restricted to 3.75 litres/sec as per national standards for SuDS.

To meet the agreed discharge rate attenuation of the runoff from the permeable tarmac area will be provided in the 400mm thick granular subbase, this will discharge to the adjacent ditch at the greenfield restricted rate via a hydrobrake with a restricted rate of 3.75 l/sec. A petrol inceptor will also be included on the outfall after the hydrobrake for additional treatment of the runoff from the development.

The introduction of 1615m² of asphalt surfacing and 10923m² of permeable hardstanding will be compliant with the national standards for SuDS and will have no adverse impact on the existing watercourses and flood levee corridors.

The overall conclusion of the initial FRA's remain applicable to overall flood risk within the terms and requirements of National Planning Policy Framework.

Appendix A – Site Wide Agreed Greenfield Rates



Key

- Development Area Boundary PM9 as per Gravesham Local Plan
- Proposed Site Boundary (165 Units)
- Assumed Contributing Natural Catchment

NOTES:

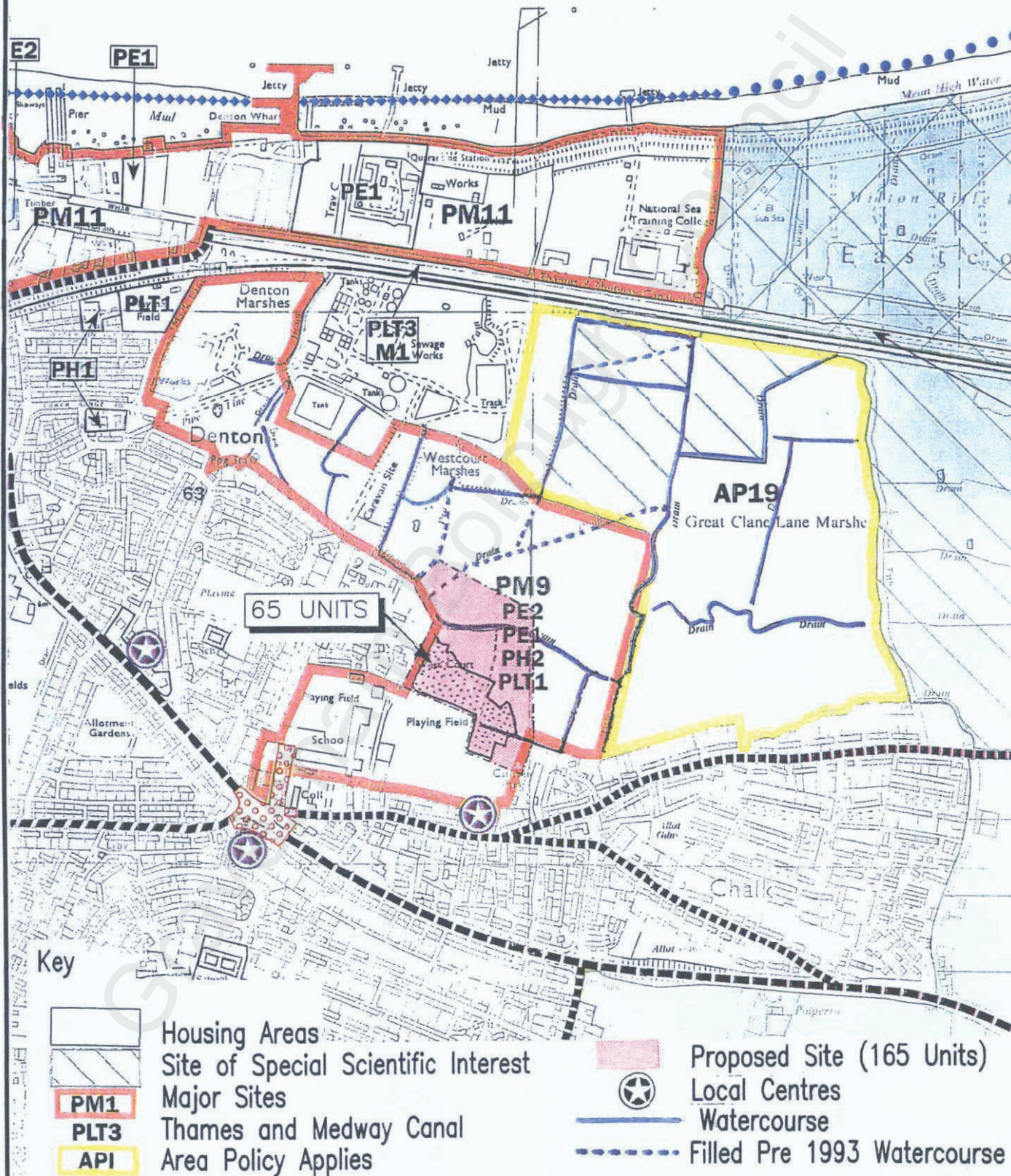
1. DRAWING TO BE READ IN CONJUNCTION WITH SUPPORTING CALCULATIONS AND TECHNICAL SUBMISSIONS TO THE ENVIRONMENT AGENCY – FEBRUARY 1999.
2. DRAWING TRANSCRIBED FROM GRAVESHAM BOROUGH COUNCIL PROPOSALS MAP 1992 AND SITE SURVEY UNDERTAKEN –
3. ALLOWABLE DISCHARGES ARE BASED UPON 7 L/S/ha AS AGREED WITH THE ENVIRONMENT AGENCY –

Scale 1:5000	Date February 1999	Client Prowting Homes	Job Title Proposed Development PM9	Buchanan Consulting Engineers Newcombe House 43-45 Notting Hill Gate London W11 3QD Telephone 0171 309 9055 Fax 0171 309 9056	
Drawn SAF	Checked SAP		Drawing Title Predevelopment Catchment Boundaries and Associated Allowable Discharge	Job No. M591	Drawing No. M591-07

Appendix B — Existing Drainage Network



River Thames
Gravesend Reach



Key



Housing Areas
Site of Special Scientific Interest
Major Sites
Thames and Medway Canal
Area Policy Applies



Proposed Site (165 Units)
Local Centres
Watercourse
Filled Pre 1993 Watercourse

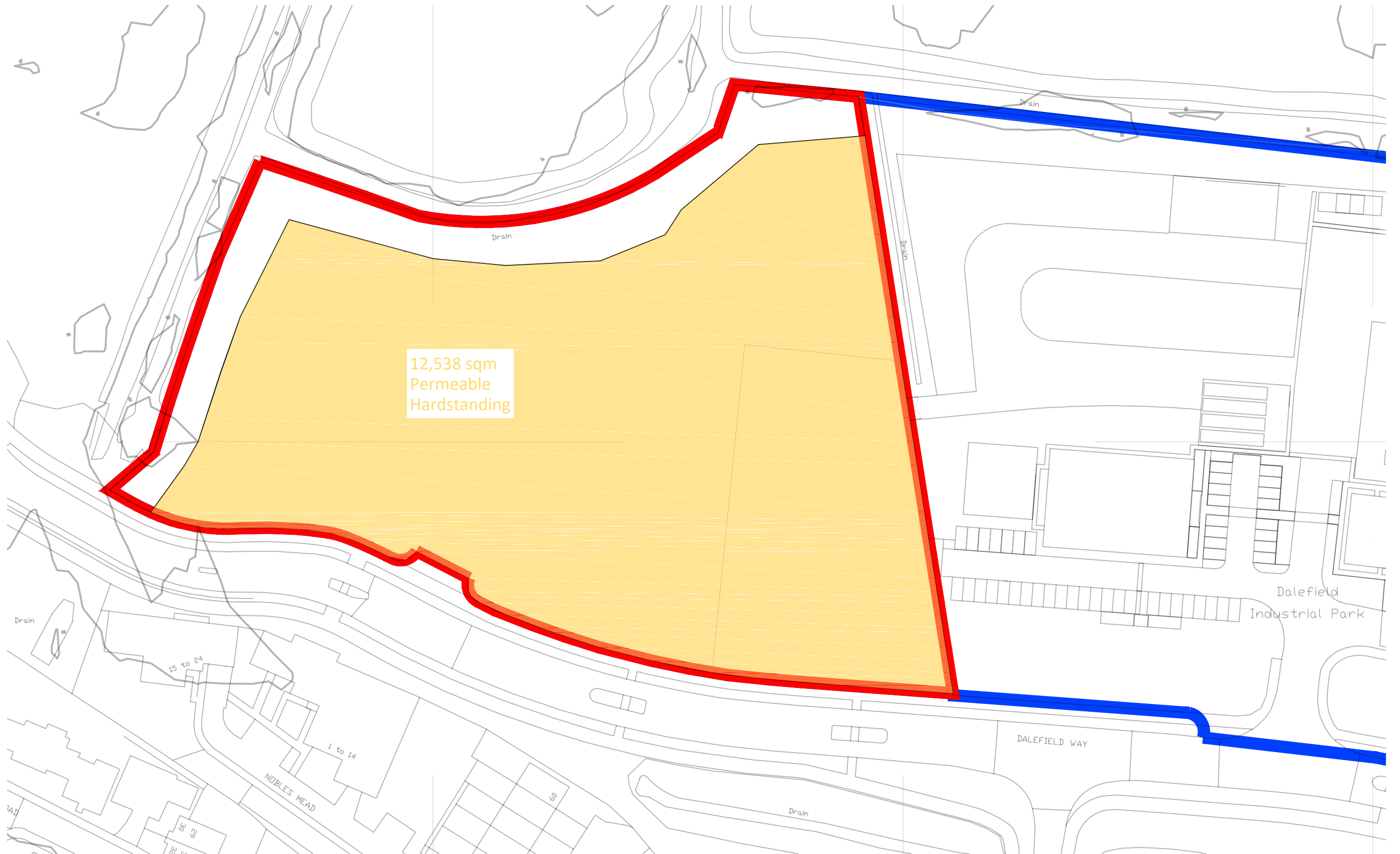
Scale NTS
Date December 1998
Drawn SAF

Job Title
Proposed Development PM9
Drawing Title
Watercourse
Location Plan

Buchanan Consulting Engineers
NEWCOMBE HOUSE
43-45 NOTTING HILL GATE LONDON W11 3QD
Tel. 0171 309 9055 Fax. 0171 309 9058

Job No M591 Drawing No M591/05 B

Appendix C – Existing Site Area Plan



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Surrey, KT3 3LZ

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E: enquiries@manhireassociates.co.uk

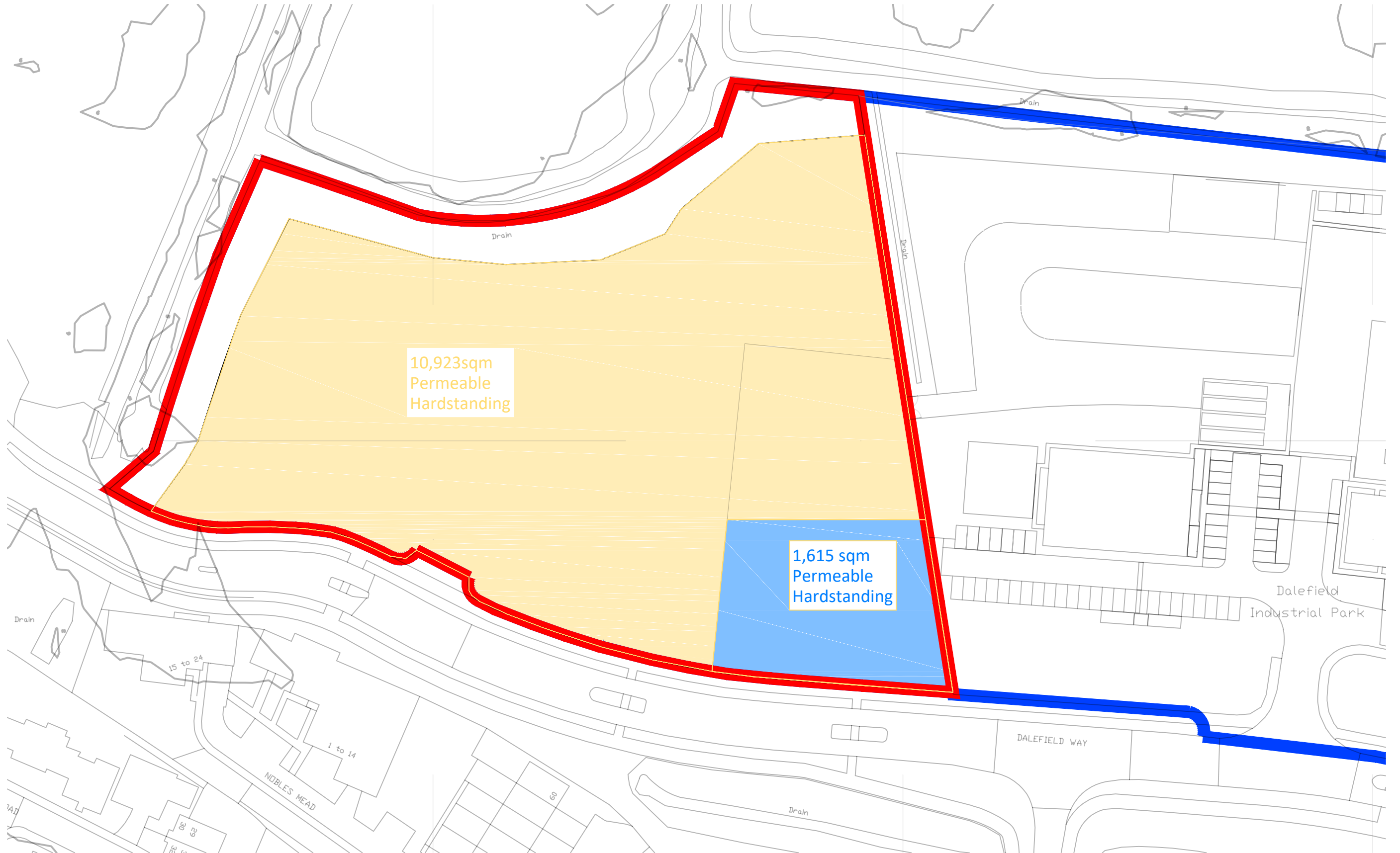
NOTES

REV	DATE	DESCRIPTION	BY

PROJECT	LAND AT DALEFIELD WAY (WEST) GRAVESEND
TITLE	EXISTING HARDSTANDING AREAS

PROJECT NO	24054
DRG NO	PSK801
DATE	DEC 25
REV	01
BY	GMC
CHK	—

Appendix D – Proposed Site Area Plan



Manhire Associates
CONSULTING ENGINEERS

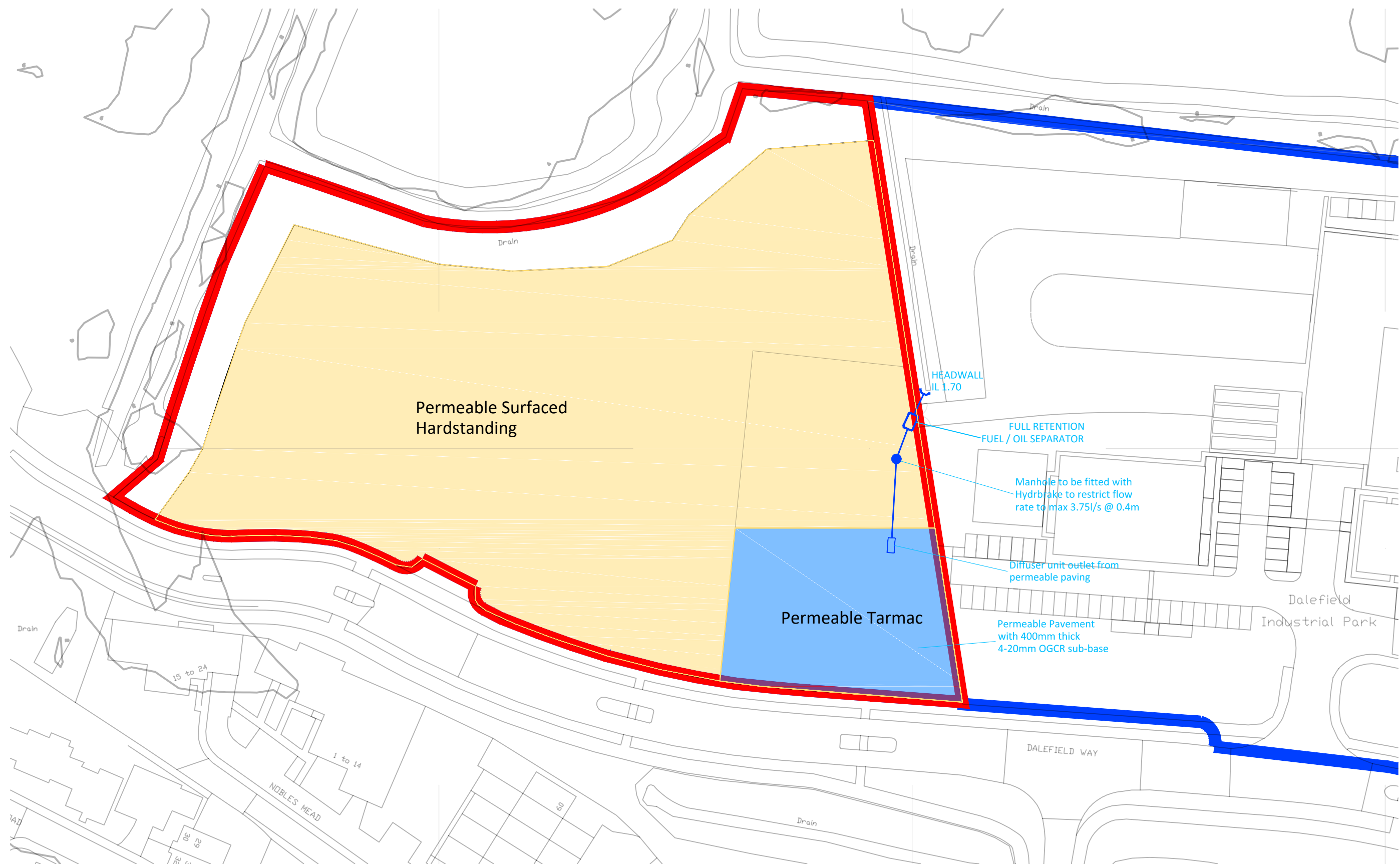
Manhire Associates Limited
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50 Kingston Road, New Malden
Surrey, KT3 3LZ

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NOTES

REV	DATE	DESCRIPTION	BY	PROJECT	LAND AT DALEFIELD WAY (WEST) GRAVESEND		PROJECT NO	24054
					DRG NO	PSK802		
				TITLE	PROPOSED HARDSTANDING AREAS		DATE	DEC 25
					REV	01		
				BY	GMC	CHK		—

Appendix E – Proposed Drainage Strategy



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NOTES

REV	DATE	DESCRIPTION	BY

PROJECT	LAND AT DALEFIELD WAY (WEST) GRAVESEND				PROJECT NO	24054
	PRELIMINARY DRAINAGE STRATEGY				DRG NO	PSK800
					DATE	DEC 25
				REV	02	
				BY	GMC	CHK -

Appendix F – Drainage Calculations

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Project details

Date	08/12/2025
Calculated by	KBL
Reference	24054
Model version	2.2.2

Location

Site name	Dalefield Way West
Site location	Gravesend



Site easting (British National Grid)	566882
Site northing (British National Grid)	173499

Site details

Total site area (ha)	1.25
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Greenfield runoff

Method

Method	FEH statistical (2025)
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FEH statistical (2025)

	<u>My value</u>	<u>Map value</u>
SAAR9120 (mm)	554	mm
BFIHOST19scaled	0.777	
QMed-QBar conversion	1.136	1.136
QMed (l/s)	0.5	l/s
QBar (FEH statistical 2025) (l/s)	0.6	l/s

Growth curve factors

	<u>My value</u>	<u>Map value</u>
Hydrological region	7	7
1 year growth factor	0.85	
2 year growth factor	0.88	
10 year growth factor	1.62	
30 year growth factor	2.3	
100 year growth factor	3.19	
200 year growth factor	3.74	

Results

Method	FEH statistical (2025)
Flow rate 1 year (l/s)	0.5
Flow rate 2 year (l/s)	0.5
Flow rate 10 years (l/s)	1.0
Flow rate 30 years (l/s)	1.4
Flow rate 100 years (l/s)	1.9
Flow rate 200 years (l/s)	2.2

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent ‘zero’ figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

Disclaimer

This report was produced using the Greenfield runoff rate estimation tool (2.2.2) developed by HR Wallingford and available at uksuds.com (<https://www.uksuds.com/>). The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at uksuds.com/terms-conditions (<https://www.uksuds.com/terms-conditions>). The outputs from this tool have been used to estimate Greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, Centre for Ecology and Hydrology, Wallingford Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

Network Details

Manhole Schedule

Manhole	Catchment Area (ha)	Diameter (m)	Type	CL (m)	IL (m)	Depth To Soffit (m)	Easting (m)	Northing (m)
S1	0.162	1.350	Type C	3.600	3.070	0.380	566895.708	173581.189
S2	0.000	1.350	Type C	3.600	2.907	0.543	566896.673	173597.448
S3	0.000	1.350	Type C	2.600	1.700	0.750	566902.398	173611.385

Pipe Schedule

Pipe Number	US Manhole	US IL (m)	DS Manhole	DS IL (m)	Shape	Dimension (m)	Length (m)	Gradient (1:x)	Roughness (mm)	US Depth To Soffit (m)	DS Depth To Soffit (m)
1.000	S1	3.070	S2	2.907	Circ	0.15mØ	16.288	99.9	0.600	0.380	0.543
1.001	S2	2.907	S3	1.700	Circ	0.15mØ	15.067	12.5	0.600	0.543	0.750

Permeable Paving Schedule

Permeable Paving	Assigned Manhole	Effective Storage Volume (m3)	CL (m)	IL (m)	Storage Infil Rate (m/hr)	Safety Factor	Easting (m)	Northing (m)
Permeable Paving1	S1	258.607	3.600	3.070	0.00000000	2.00	566889.548	173565.726

Outfall Details

Outfall Manhole S3 : Free Discharge

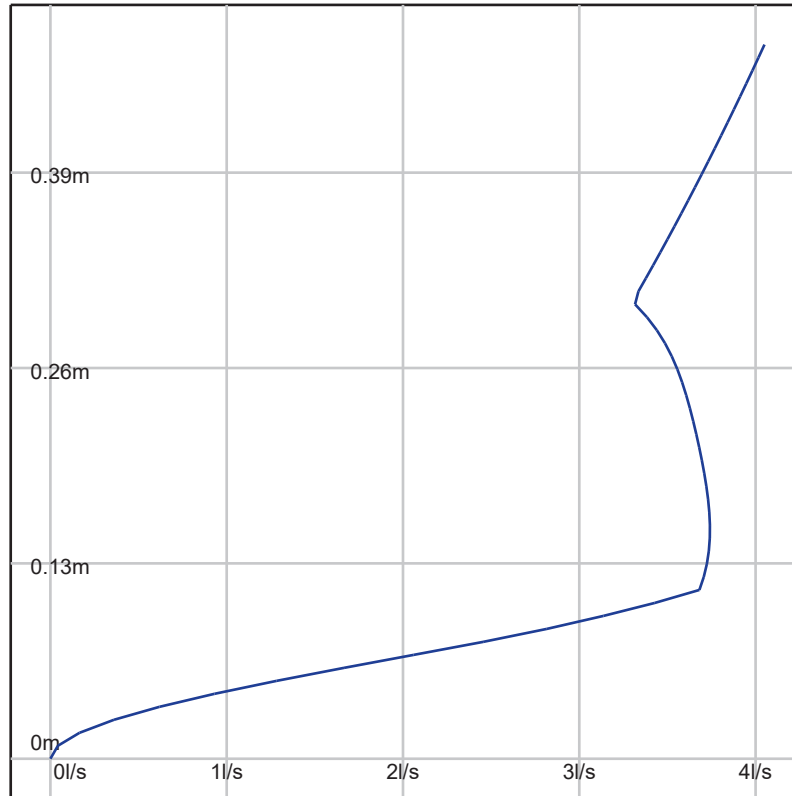
Flow Control Details

Controls within Manhole S2

Hydro-Brake® Optimum Control at Manhole S2

Model Ref	Design Depth (m)	Design Flow (l/s)	Depth Above Invert (m)	FF Head (m)	FF Flow (l/s)	KF Head (m)	KF Flow (l/s)
SHE-0100-3750-0400-3750	0.400	3.750	0.000	0.152	3.741	0.304	3.300

Hydro-Brake® Optimum Control at S2



Simulation Settings

FEH2022 (point): Filename=FEH_Point_Descriptors_566811_173616_v5_1_0.xml

Summer (Cv: 1.00), Winter (Cv: 1.00)

Global Time of Entry: 5.0 mins

Durations (mins): 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080

Return Periods (yrs) + Climate Change: (1, +0%), (10, +0%), (30, +0%), (30, +20%), (100, +0%), (100, +20%)

Simulated Rainfall Events

Storm	Average Intensity (mm/hr)	Runoff Continuity %	Flow Continuity %	Storm	Average Intensity (mm/hr)	Runoff Continuity %	Flow Continuity %
1Yr 15Min Winter	13.907	0.00	0.00	30Yr+20% 15Min Summer	91.817	0.00	0.00
1Yr 15Min Summer	13.907	0.00	0.00	30Yr+20% 15Min Winter	91.817	0.00	0.00
1Yr 30Min Winter	9.003	0.00	0.00	30Yr+20% 30Min Summer	59.608	0.00	0.00
1Yr 30Min Summer	9.003	0.00	0.00	30Yr+20% 30Min Winter	59.608	0.00	0.00
1Yr 60Min Winter	5.561	0.00	0.00	30Yr+20% 60Min Summer	36.866	0.00	0.00
1Yr 60Min Summer	5.561	0.00	0.00	30Yr+20% 60Min Winter	36.866	0.00	0.00
1Yr 120Min Summer	4.426	0.00	0.00	30Yr+20% 120Min Summer	22.376	0.00	0.00
1Yr 120Min Winter	4.426	0.00	0.00	30Yr+20% 120Min Winter	22.376	0.00	0.00
1Yr 180Min Winter	3.771	0.00	0.00	30Yr+20% 180Min Summer	16.610	0.00	0.00
1Yr 180Min Summer	3.771	0.00	0.00	30Yr+20% 180Min Winter	16.610	0.00	0.00
1Yr 240Min Summer	3.144	0.00	0.00	30Yr+20% 240Min Summer	13.384	0.00	0.00
1Yr 240Min Winter	3.144	0.00	0.00	30Yr+20% 240Min Winter	13.384	0.00	0.00
1Yr 360Min Summer	2.447	0.00	0.00	30Yr+20% 360Min Summer	9.856	0.00	0.00
1Yr 360Min Winter	2.447	0.00	0.00	30Yr+20% 360Min Winter	9.856	0.00	0.00
1Yr 480Min Summer	2.029	0.00	0.00	30Yr+20% 480Min Summer	7.935	0.00	0.00
1Yr 480Min Winter	2.029	0.00	0.00	30Yr+20% 480Min Winter	7.935	0.00	0.00
1Yr 600Min Summer	1.727	0.00	0.00	30Yr+20% 600Min Summer	6.702	0.00	0.00
1Yr 600Min Winter	1.727	0.00	0.00	30Yr+20% 600Min Winter	6.702	0.00	0.00
1Yr 720Min Summer	1.502	0.00	0.00	30Yr+20% 720Min Summer	5.835	0.00	0.00
1Yr 720Min Winter	1.502	0.00	0.00	30Yr+20% 720Min Winter	5.835	0.00	0.00
1Yr 960Min Summer	1.210	0.00	0.00	30Yr+20% 960Min Summer	4.698	0.00	0.00
1Yr 960Min Winter	1.210	0.00	0.00	30Yr+20% 960Min Winter	4.698	0.00	0.00
1Yr 1440Min Winter	0.892	0.00	0.00	30Yr+20% 1440Min Summer	3.461	0.00	0.00
1Yr 1440Min Summer	0.892	0.00	0.00	30Yr+20% 1440Min Winter	3.461	0.00	0.00
1Yr 2160Min Summer	0.657	0.00	0.00	30Yr+20% 2160Min Summer	2.543	0.00	0.00
1Yr 2160Min Winter	0.657	0.00	0.00	30Yr+20% 2160Min Winter	2.543	0.00	0.00
1Yr 2880Min Summer	0.531	0.00	0.00	30Yr+20% 2880Min Summer	2.034	0.00	0.00
1Yr 2880Min Winter	0.531	0.00	0.00	30Yr+20% 2880Min Winter	2.034	0.00	0.00
1Yr 4320Min Summer	0.401	0.00	0.00	30Yr+20% 4320Min Summer	1.484	0.00	0.00
1Yr 4320Min Winter	0.401	0.00	0.00	30Yr+20% 4320Min Winter	1.484	0.00	0.00
1Yr 5760Min Summer	0.334	0.00	0.00	30Yr+20% 5760Min Summer	1.191	0.00	0.00
1Yr 5760Min Winter	0.334	0.00	0.00	30Yr+20% 5760Min Winter	1.191	0.00	0.00
1Yr 7200Min Summer	0.293	0.00	0.00	30Yr+20% 7200Min Summer	1.014	0.00	0.00
1Yr 7200Min Winter	0.293	0.00	0.00	30Yr+20% 7200Min Winter	1.014	0.00	0.00
1Yr 8640Min Summer	0.265	0.00	0.00	30Yr+20% 8640Min Summer	0.897	0.00	0.00
1Yr 8640Min Winter	0.265	0.00	0.00	30Yr+20% 8640Min Winter	0.897	0.00	0.00
1Yr 10080Min Summer	0.245	0.00	0.00	30Yr+20% 10080Min Summer	0.814	0.00	0.00
1Yr 10080Min Winter	0.245	0.00	0.00	30Yr+20% 10080Min Winter	0.814	0.00	0.00
10Yr 15Min Summer	58.140	0.00	0.00	100Yr 15Min Summer	98.007	0.00	0.00
10Yr 15Min Winter	58.140	0.00	0.00	100Yr 15Min Winter	98.007	0.00	0.00
10Yr 30Min Summer	37.385	0.00	0.00	100Yr 30Min Summer	64.152	0.00	0.00
10Yr 30Min Winter	37.385	0.00	0.00	100Yr 30Min Winter	64.152	0.00	0.00
10Yr 60Min Summer	23.009	0.00	0.00	100Yr 60Min Summer	39.969	0.00	0.00
10Yr 60Min Winter	23.009	0.00	0.00	100Yr 60Min Winter	39.969	0.00	0.00
10Yr 120Min Summer	14.366	0.00	0.00	100Yr 120Min Summer	24.020	0.00	0.00
10Yr 120Min Winter	14.366	0.00	0.00	100Yr 120Min Winter	24.020	0.00	0.00
10Yr 180Min Summer	10.807	0.00	0.00	100Yr 180Min Summer	17.819	0.00	0.00
10Yr 180Min Winter	10.807	0.00	0.00	100Yr 180Min Winter	17.819	0.00	0.00
10Yr 240Min Summer	8.689	0.00	0.00	100Yr 240Min Summer	14.457	0.00	0.00
10Yr 240Min Winter	8.689	0.00	0.00	100Yr 240Min Winter	14.457	0.00	0.00
10Yr 360Min Summer	6.397	0.00	0.00	100Yr 360Min Summer	10.809	0.00	0.00
10Yr 360Min Winter	6.397	0.00	0.00	100Yr 360Min Winter	10.809	0.00	0.00
10Yr 480Min Summer	5.138	0.00	0.00	100Yr 480Min Summer	8.829	0.00	0.00
10Yr 480Min Winter	5.138	0.00	0.00	100Yr 480Min Winter	8.829	0.00	0.00
10Yr 600Min Summer	4.315	0.00	0.00	100Yr 600Min Summer	7.555	0.00	0.00

Simulated Rainfall Events

Storm	Average Intensity (mm/hr)	Runoff Continuity %	Flow Continuity %	Storm	Average Intensity (mm/hr)	Runoff Continuity %	Flow Continuity %
10Yr 600Min Winter	4.315	0.00	0.00	100Yr 600Min Winter	7.555	0.00	0.00
10Yr 720Min Summer	3.733	0.00	0.00	100Yr 720Min Summer	6.651	0.00	0.00
10Yr 720Min Winter	3.733	0.00	0.00	100Yr 720Min Winter	6.651	0.00	0.00
10Yr 960Min Summer	2.978	0.00	0.00	100Yr 960Min Summer	5.430	0.00	0.00
10Yr 960Min Winter	2.978	0.00	0.00	100Yr 960Min Winter	5.430	0.00	0.00
10Yr 1440Min Summer	2.171	0.00	0.00	100Yr 1440Min Summer	4.033	0.00	0.00
10Yr 1440Min Winter	2.171	0.00	0.00	100Yr 1440Min Winter	4.033	0.00	0.00
10Yr 2160Min Summer	1.588	0.00	0.00	100Yr 2160Min Summer	2.951	0.00	0.00
10Yr 2160Min Winter	1.588	0.00	0.00	100Yr 2160Min Winter	2.951	0.00	0.00
10Yr 2880Min Summer	1.274	0.00	0.00	100Yr 2880Min Summer	2.336	0.00	0.00
10Yr 2880Min Winter	1.274	0.00	0.00	100Yr 2880Min Winter	2.336	0.00	0.00
10Yr 4320Min Summer	0.947	0.00	0.00	100Yr 4320Min Summer	1.661	0.00	0.00
10Yr 4320Min Winter	0.947	0.00	0.00	100Yr 4320Min Winter	1.661	0.00	0.00
10Yr 5760Min Summer	0.776	0.00	0.00	100Yr 5760Min Summer	1.298	0.00	0.00
10Yr 5760Min Winter	0.776	0.00	0.00	100Yr 5760Min Winter	1.298	0.00	0.00
10Yr 7200Min Summer	0.671	0.00	0.00	100Yr 7200Min Summer	1.080	0.00	0.00
10Yr 7200Min Winter	0.671	0.00	0.00	100Yr 7200Min Winter	1.080	0.00	0.00
10Yr 8640Min Summer	0.601	0.00	0.00	100Yr 8640Min Summer	0.936	0.00	0.00
10Yr 8640Min Winter	0.601	0.00	0.00	100Yr 8640Min Winter	0.936	0.00	0.00
10Yr 10080Min Winter	0.550	0.00	0.00	100Yr 10080Min Summer	0.835	0.00	0.00
10Yr 10080Min Summer	0.550	0.00	0.00	100Yr 10080Min Winter	0.835	0.00	0.00
30Yr 15Min Summer	76.514	0.00	0.00	100Yr+20% 15Min Summer	117.609	0.00	0.00
30Yr 15Min Winter	76.514	0.00	0.00	100Yr+20% 15Min Winter	117.609	0.00	0.00
30Yr 30Min Summer	49.673	0.00	0.00	100Yr+20% 30Min Summer	76.982	0.00	0.00
30Yr 30Min Winter	49.673	0.00	0.00	100Yr+20% 30Min Winter	76.982	0.00	0.00
30Yr 60Min Summer	30.722	0.00	0.00	100Yr+20% 60Min Summer	47.962	0.00	0.00
30Yr 60Min Winter	30.722	0.00	0.00	100Yr+20% 60Min Winter	47.962	0.00	0.00
30Yr 120Min Summer	18.646	0.00	0.00	100Yr+20% 120Min Summer	28.824	0.00	0.00
30Yr 120Min Winter	18.646	0.00	0.00	100Yr+20% 120Min Winter	28.824	0.00	0.00
30Yr 180Min Summer	13.842	0.00	0.00	100Yr+20% 180Min Summer	21.383	0.00	0.00
30Yr 180Min Winter	13.842	0.00	0.00	100Yr+20% 180Min Winter	21.383	0.00	0.00
30Yr 240Min Summer	11.154	0.00	0.00	100Yr+20% 240Min Summer	17.348	0.00	0.00
30Yr 240Min Winter	11.154	0.00	0.00	100Yr+20% 240Min Winter	17.348	0.00	0.00
30Yr 360Min Summer	8.213	0.00	0.00	100Yr+20% 360Min Summer	12.971	0.00	0.00
30Yr 360Min Winter	8.213	0.00	0.00	100Yr+20% 360Min Winter	12.971	0.00	0.00
30Yr 480Min Summer	6.612	0.00	0.00	100Yr+20% 480Min Summer	10.595	0.00	0.00
30Yr 480Min Winter	6.612	0.00	0.00	100Yr+20% 480Min Winter	10.595	0.00	0.00
30Yr 600Min Summer	5.585	0.00	0.00	100Yr+20% 600Min Summer	9.067	0.00	0.00
30Yr 600Min Winter	5.585	0.00	0.00	100Yr+20% 600Min Winter	9.067	0.00	0.00
30Yr 720Min Summer	4.862	0.00	0.00	100Yr+20% 720Min Summer	7.981	0.00	0.00
30Yr 720Min Winter	4.862	0.00	0.00	100Yr+20% 720Min Winter	7.981	0.00	0.00
30Yr 960Min Winter	3.915	0.00	0.00	100Yr+20% 960Min Summer	6.516	0.00	0.00
30Yr 960Min Summer	3.915	0.00	0.00	100Yr+20% 960Min Winter	6.516	0.00	0.00
30Yr 1440Min Summer	2.884	0.00	0.00	100Yr+20% 1440Min Summer	4.840	0.00	0.00
30Yr 1440Min Winter	2.884	0.00	0.00	100Yr+20% 1440Min Winter	4.840	0.00	0.00
30Yr 2160Min Summer	2.119	0.00	0.00	100Yr+20% 2160Min Summer	3.541	0.00	0.00
30Yr 2160Min Winter	2.119	0.00	0.00	100Yr+20% 2160Min Winter	3.541	0.00	0.00
30Yr 2880Min Summer	1.695	0.00	0.00	100Yr+20% 2880Min Summer	2.803	0.00	0.00
30Yr 2880Min Winter	1.695	0.00	0.00	100Yr+20% 2880Min Winter	2.803	0.00	0.00
30Yr 4320Min Summer	1.237	0.00	0.00	100Yr+20% 4320Min Summer	1.993	0.00	0.00
30Yr 4320Min Winter	1.237	0.00	0.00	100Yr+20% 4320Min Winter	1.993	0.00	0.00
30Yr 5760Min Summer	0.992	0.00	0.00	100Yr+20% 5760Min Summer	1.558	0.00	0.00
30Yr 5760Min Winter	0.992	0.00	0.00	100Yr+20% 5760Min Winter	1.558	0.00	0.00
30Yr 7200Min Summer	0.845	0.00	0.00	100Yr+20% 7200Min Summer	1.296	0.00	0.00
30Yr 7200Min Winter	0.845	0.00	0.00	100Yr+20% 7200Min Winter	1.296	0.00	0.00
30Yr 8640Min Summer	0.748	0.00	0.00	100Yr+20% 8640Min Summer	1.124	0.00	0.00
30Yr 8640Min Winter	0.748	0.00	0.00	100Yr+20% 8640Min Winter	1.124	0.00	0.00
30Yr 10080Min Summer	0.678	0.00	0.00	100Yr+20% 10080Min Winter	1.002	0.00	0.00
30Yr 10080Min Winter	0.678	0.00	0.00	100Yr+20% 10080Min Summer	1.002	0.00	0.00

Simulation Results

Return Period Yrs: 1.0

Climate Change %: 0

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	2160 min Summer	1312	3.086	0.016	0.444		OK
S2	2160 min Summer	1313	2.946	0.039	0.444		OK
S3	2160 min Summer	1314	1.710	0.010	0.444		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	2160 min Summer	1313	S1	S2	0.027	0.201	0.444	0.025	OK
1.001	2160 min Summer	1314	S2	S3	0.010	0.884	0.444	0.009	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	2160 min Summer	1311	3.095	0.025	0.444		OK

Return Period Yrs: 10.0

Climate Change %: 0

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	600 min Summer	390	3.103	0.033	1.894		OK
S2	600 min Summer	392	2.992	0.085	1.894		OK
S3	600 min Summer	392	1.720	0.020	1.894		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	600 min Summer	391	S1	S2	0.059	0.293	1.894	0.107	OK
1.001	600 min Summer	392	S2	S3	0.020	1.373	1.894	0.037	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	600 min Summer	390	3.132	0.062	1.896		OK

Return Period Yrs: 30.0

Climate Change %: 0

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	600 min Summer	383	3.110	0.040	2.792		OK
S2	600 min Summer	384	3.017	0.110	2.792		OK
S3	600 min Summer	384	1.724	0.024	2.792		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	600 min Summer	384	S1	S2	0.075	0.317	2.792	0.157	OK
1.001	600 min Summer	384	S2	S3	0.024	1.543	2.792	0.055	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	600 min Summer	383	3.149	0.079	2.767		OK

Return Period Yrs: 30.0

Climate Change %: 20

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	480 min Summer	311	3.116	0.046	3.638		OK
S2	480 min Summer	312	3.045	0.138	3.638		OK
S3	480 min Summer	312	1.727	0.027	3.638		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	480 min Summer	312	S1	S2	0.092	0.324	3.638	0.205	OK
1.001	480 min Summer	312	S2	S3	0.027	1.669	3.638	0.072	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	480 min Summer	310	3.164	0.094	3.668		OK

Return Period Yrs: 100.0

Climate Change %: 0

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	720 min Summer	453	3.146	0.076	3.680		OK
S2	720 min Summer	453	3.142	0.235	3.680		Surcharged
S3	480 min Winter	414	1.727	0.027	3.741		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	720 min Summer	453	S1	S2	0.113	0.363	4.588	0.259	OK
1.001	480 min Winter	414	S2	S3	0.028	1.683	3.741	0.074	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	720 min Summer	452	3.177	0.107	3.681		OK

Return Period Yrs: 100.0

Climate Change %: 20

Manholes

Manhole	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
S1	720 min Summer	466	3.173	0.103	3.625		OK
S2	720 min Summer	467	3.168	0.261	3.625		Surcharged
S3	360 min Summer	431	1.727	0.027	3.741		Outfall

Conduits

Pipe No.	Critical Storm	Peak (mins)	US Manhole	DS Manhole	Flow Depth (m)	Max Velocity (m/s)	Max Flow (l/s)	Flow / Capacity	Status
1.000	720 min Summer	466	S1	S2	0.127	0.367	4.640	0.262	OK
1.001	360 min Summer	431	S2	S3	0.028	1.683	3.741	0.074	OK

Permeable Paving Storage

Permeable Paving	Critical Storm	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Flood (m3)	Status
Permeable Paving1	720 min Summer	465	3.203	0.133	3.631		OK