

**Land at Dalefield Way (East) Gravesend**

**Flood Risk Assessment Note & Preliminary Drainage Strategy**

**O'Halloran & O'Brien Ltd**

**Status:** Information  
**Revision:** Rev 02

**Project No.:** 24055\_WP01  
**Date:** October 2025

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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 eastern 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 - Aerial Image of site.**

Proposals are to construct 1,333m<sup>2</sup> of asphalt surfacing and associated drainage that will connect into the overall SuDS system already constructed and provide 7,900m<sup>2</sup> of 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.

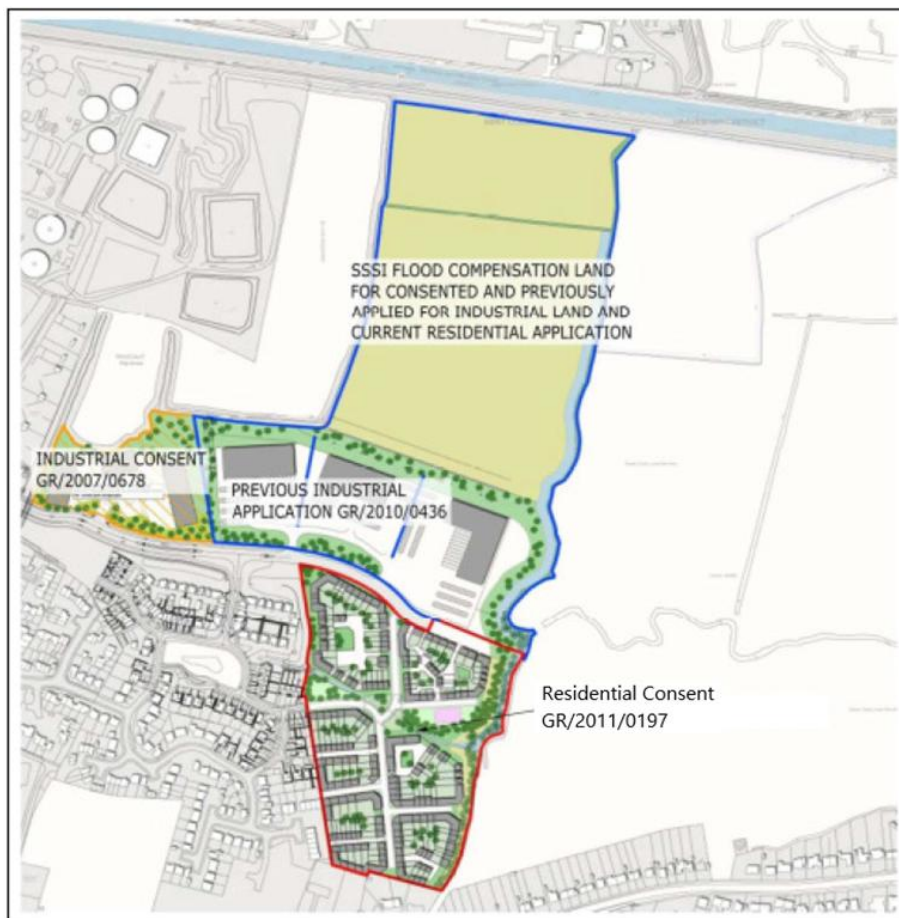
## **2.0 Baseline Parameters**

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 formed part the application granted consent for industrial development use classes B2 & B8 under application reference 2010/0436.

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 14<sup>th</sup> September 2016 permission was granted for 3 industrial units to the west of the site. To the south of the application site outline permission was granted on 27<sup>th</sup> 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 3. A site-specific Flood Risk Assessment was prepared for the application site by Ardent Consulting Engineers in to support the planning application for consent to implement the industrial development reference 2010/0436.

During the determination of the 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.

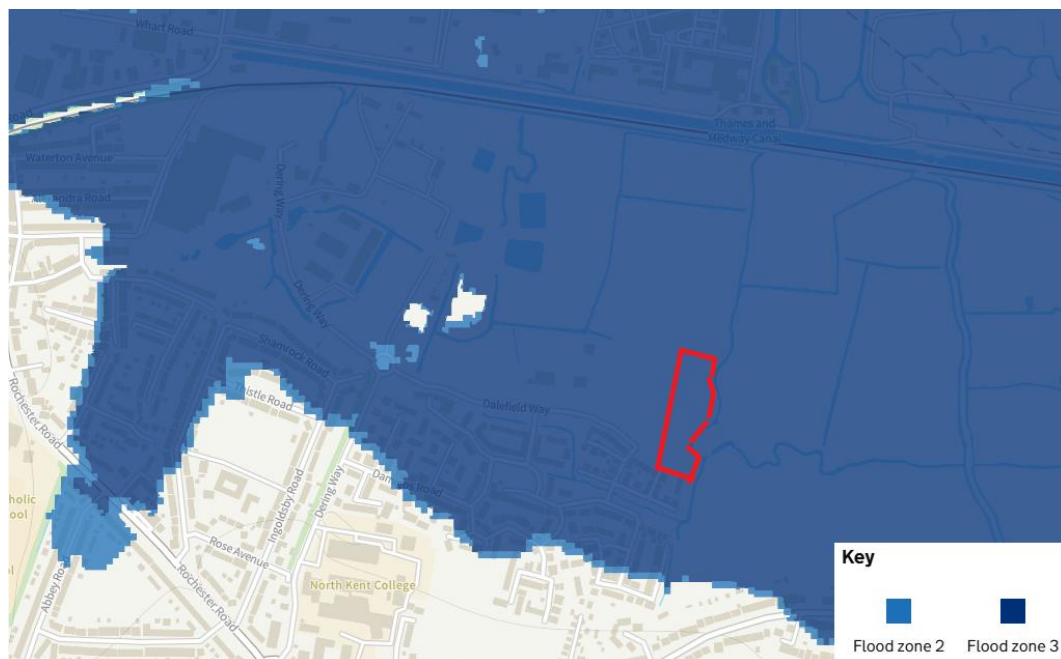
A Flood Risk Addendum was prepared to support the Planning Applications and the Hydraulic Modelling, with the latter having been previously approved by the Environment Agency. At that time the proposals were confirmed as being safe. On receipt of the information from Gravesham BC a joint meeting was 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.

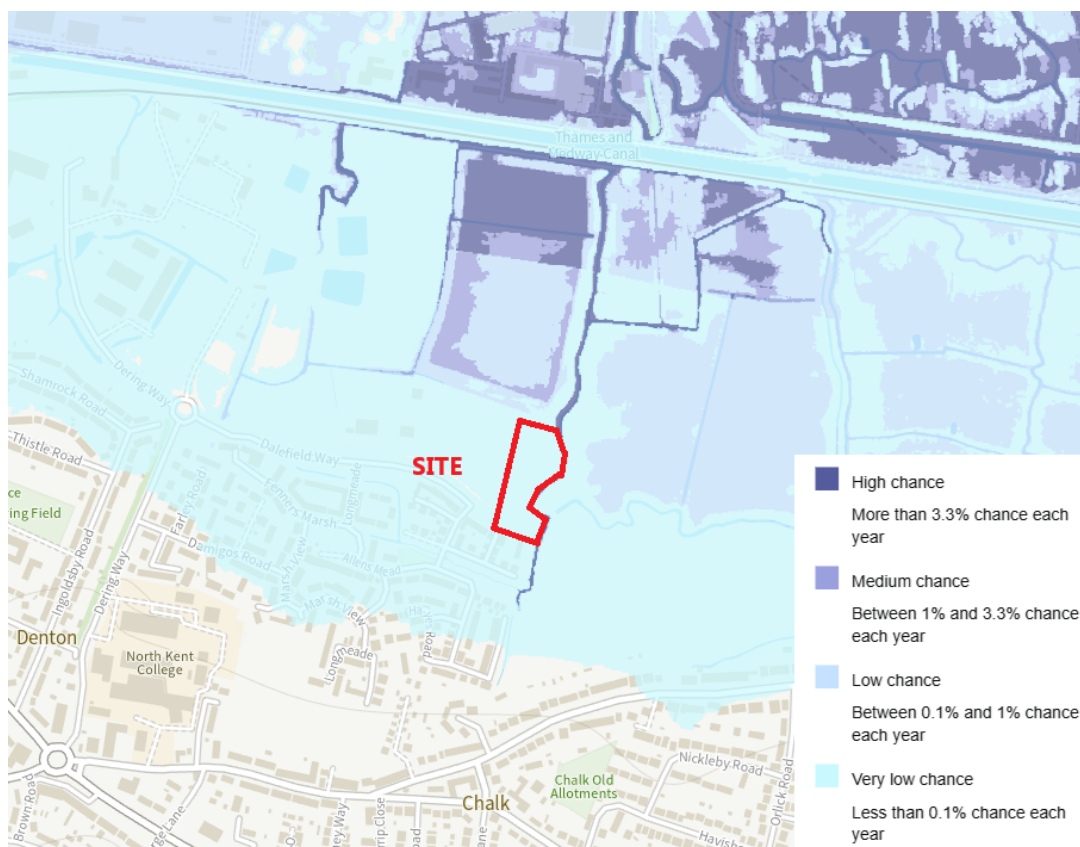
An addendum to the Site-Specific Flood Risk Assessment was prepared by Ardent Consulting Engineers in November 2011, following the receipt of new data from the Environment Agency on the existing flood defence crest heights. The Addendum concluded that the existing flood defence infrastructure and alignment 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 3 – Flood Maps for Planning**



**Figure 4 – Long Term Flood Maps**

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 a pocket 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 the industrial development part of which included the application site. Based on discharge rate of 10l/s (7l/s/ha) the discharge rate was set at 31.1l/s. The application has an area of 9,233m<sup>2</sup> which would have contribute 6.5l/s to the overall discharge from the larger site of 31.1l/s.

## 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 a hardstanding of 7,900m<sup>2</sup> and 1,333m<sup>2</sup> of impermeable road / access. The application site was covered by the 2010 application that covered this site and the neighbouring site so the discharge for the application site has been established, and attenuation of runoff assessed and mitigate for in the wider development proposals.

The application site has a total area of 0.92ha. 1,333m<sup>2</sup> of the site will be tarmac and provide access into the site, the remainder of the site will be replaced with concrete surfaced hardstanding's.

1,333m<sup>2</sup> of the site will be replaced with an impermeable tarmac construction the remainder will be concrete for the storage of materials etc. These areas will be positively drained, and a drainage channel that will be installed down the middle of the hardstanding and the tarmac surfacing sloped to drain to the channel. The existing and proposed permeable and impermeable paved areas are shown on drawing PSK801 & PSK802 included in Appendix C & D.

The previous 2010 application agreed a discharge rate of 7l/s/ha, greenfield rate. For the benefit of this strategy the 7l/s/ha will be used to set the greenfield discharge rate from the application site, the total site area is 0.92ha so this gives a rate of 6.5l/s. This is line with the strategy the rate approved for the larger industrial site.

The 2010 strategy used Cv's 0.75 & 0.84, KCC has requested the calculations are based on Cv's of 1 and 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 2050s epoch for development with a lifetime up to 2060. 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 drainage strategy has therefore been based on the above principles and while attenuation has been provided for the application site in the wider industrial application for robustness this has been ignored for this application. Therefore, the runoff from the application site will be attenuated to achieve the discharge rate of 6.5l/s

To provide the required discharge rate a cellar crate system will be provided under the concrete hardstanding to attenuate the runoff. The crates will discharge to the adjacent drain on the eastern boundary of the site. The runoff from the impermeable surfaces will receive no treatment so a petrol interceptor will be installed before discharging to the drain.

To accommodate a 1 in 100 year storm event plus 20% allowance the crate has been designed at 6m wide x 1m deep and 130m long. A drainage strategy has been prepared for the site and is included in Appendix E as drawing PKS800 rev 02. The full supporting calculations are also included in Appendix F.

## 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 2010 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).

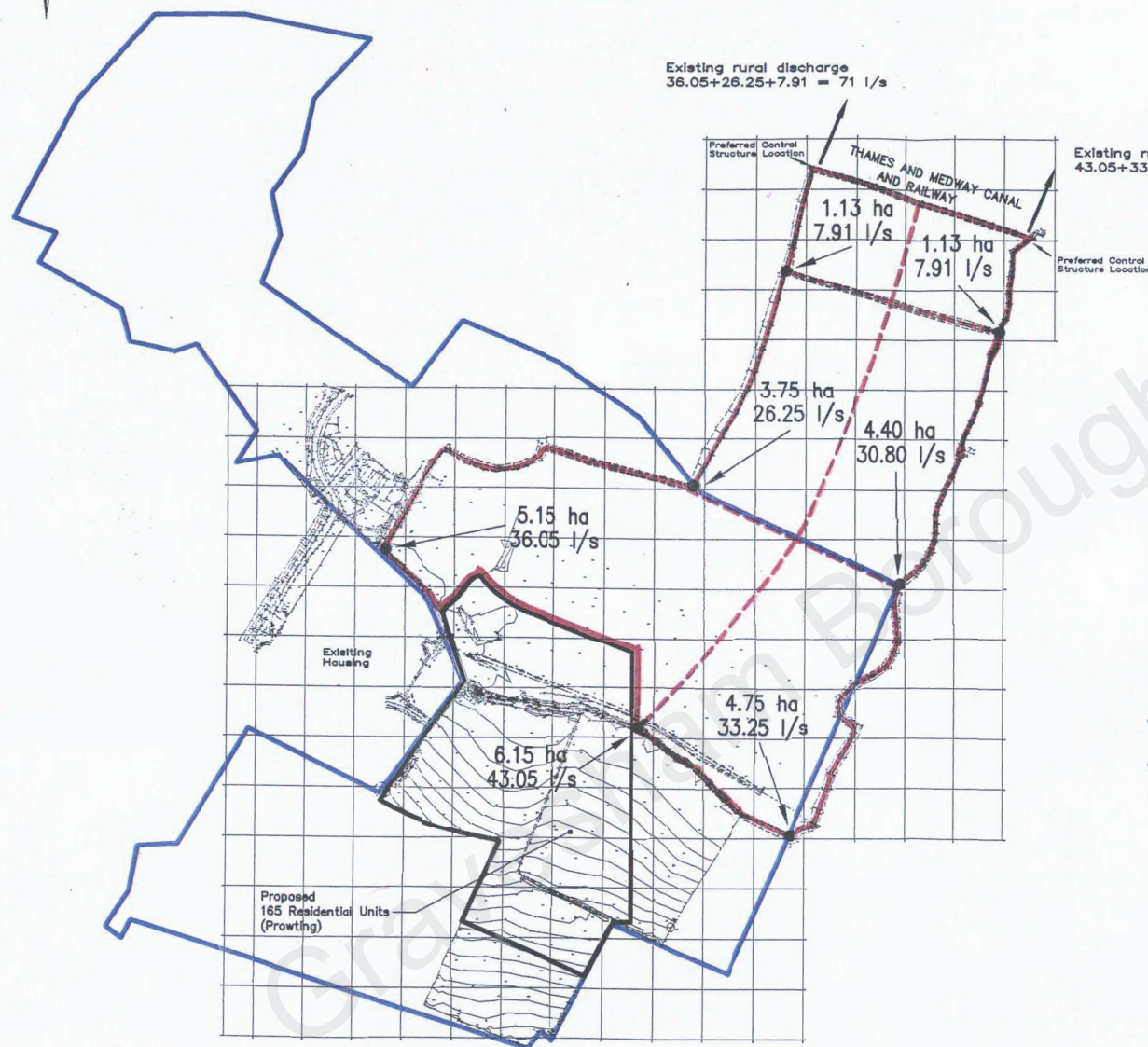
Surface Water run-off from the site will freely discharge into the receiving open channel watercourses and will be restricted to 6.5 litres/sec as set by the overall strategy for the allocated site.

To meet the agreed discharge rate attenuation of the runoff from the impermeable surfacing will be provided in cellar crates below the hardstanding, this will discharge to the adjacent ditch at the greenfield restricted rate via a petrol inceptor.

The introduction of 1,333m<sup>2</sup> of asphalt surfacing and 7,900m<sup>2</sup> of permeable hardstanding 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:

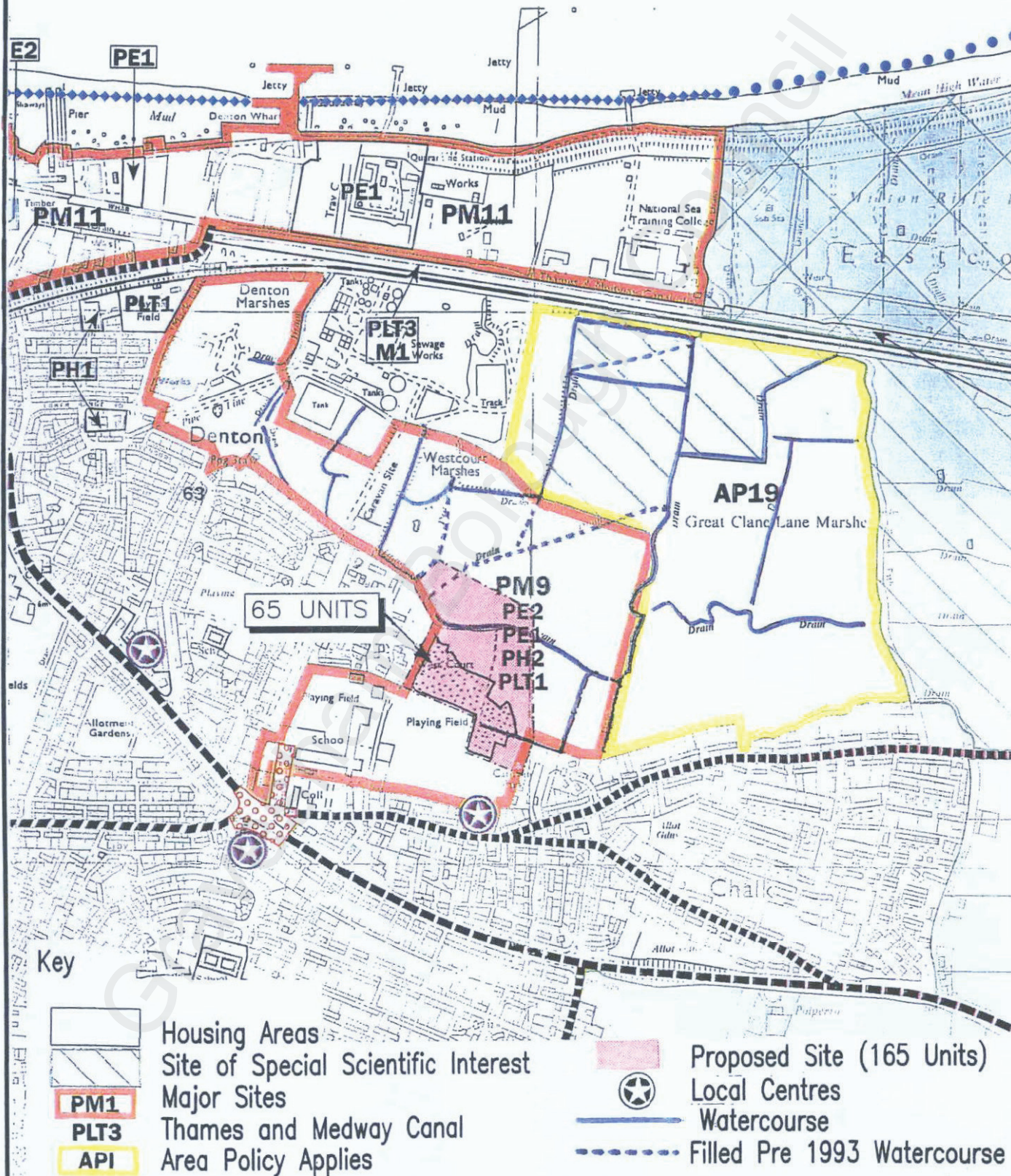
- DRAWING TO BE READ IN CONJUNCTION WITH SUPPORTING CALCULATIONS AND TECHNICAL SUBMISSIONS TO THE ENVIRONMENT AGENCY - FEBRUARY 1999.
- DRAWING TRANSCRIBED FROM GRAVESHAM BOROUGH COUNCIL PROPOSALS MAP 1992 AND SITE SURVEY UNDERTAKEN -
- ALLOWABLE DISCHARGES ARE BASED UPON 7 L/S/ha AS AGREED WITH THE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

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

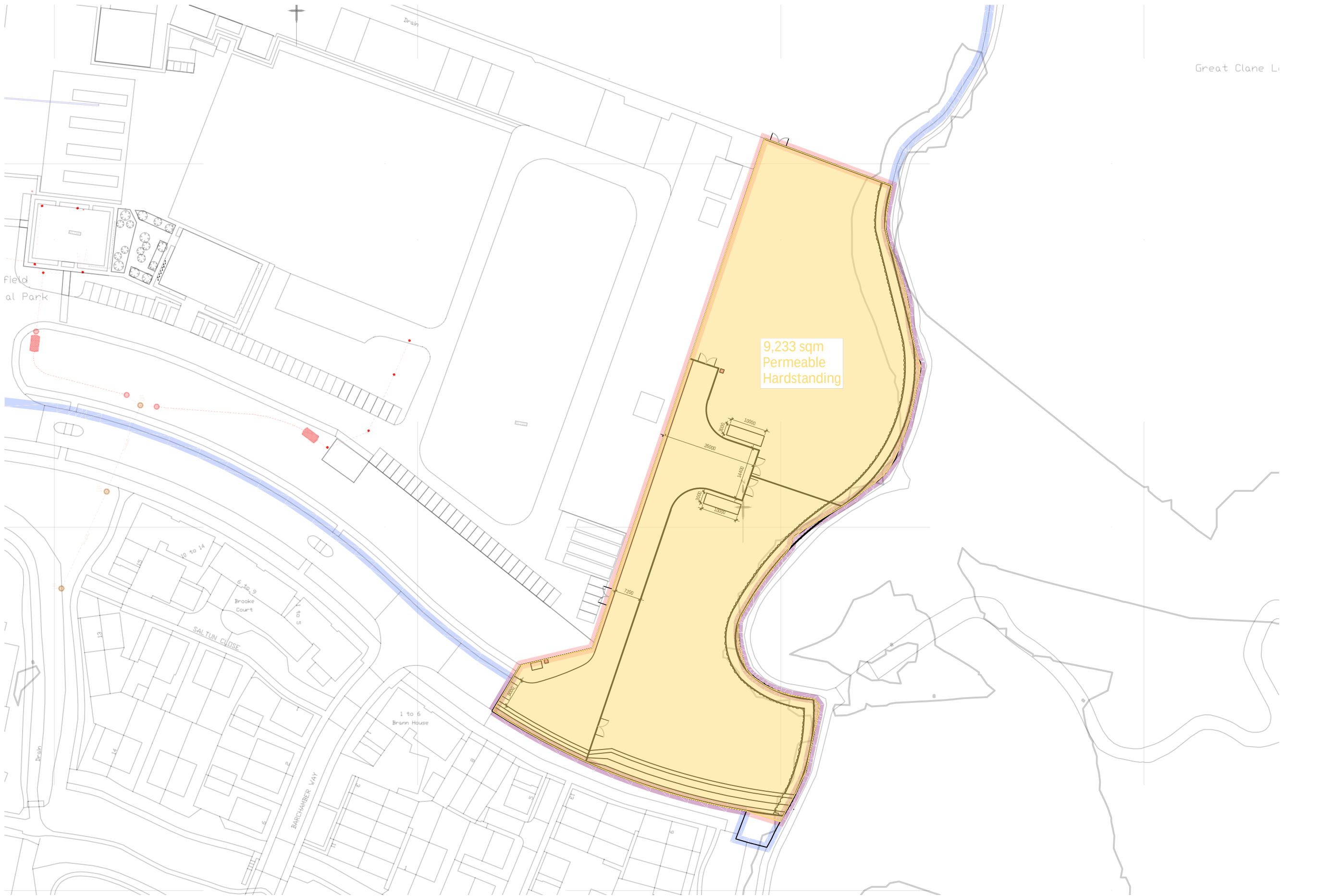
Job Title  
Proposed Development PM9  
Drawing Title  
Watercourse  
Location Plan

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



## Appendix D – Proposed Site Area Plan

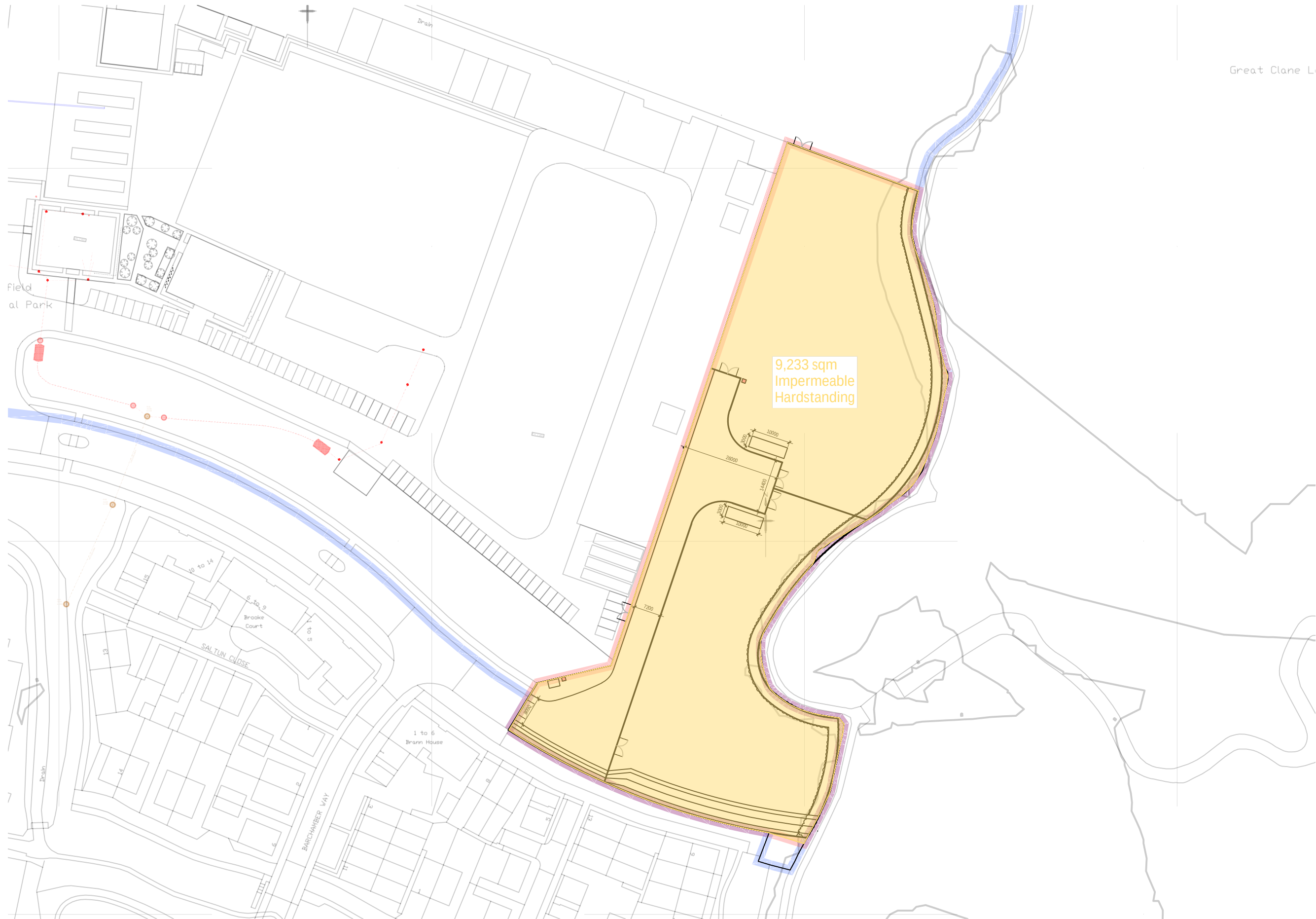




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|       |     |      |             |    |         |                                           |                  |        |
|-------|-----|------|-------------|----|---------|-------------------------------------------|------------------|--------|
| NOTES | REV | DATE | DESCRIPTION | BY | PROJECT | LAND AT DALEFIELD WAY<br>(EAST) GRAVESEND | PROJECT NO 24055 |        |
|       |     |      |             |    |         |                                           | DRG NO PSK801    |        |
|       |     |      |             |    | TITLE   | EXISTING HARDSTANDING AREAS               | DATE OCT 25      | REV 00 |
|       |     |      |             |    |         |                                           | BY GMC           | CHK —  |

## Appendix E – Proposed Drainage Strategy



## Appendix F – Drainage Calculations

## Network Details

### Manhole Schedule

| Manhole | Catchment Area (ha) | Diameter (m) | Type   | CL (m) | IL (m) | Depth To Soffit (m) | Easting (m) | Northing (m) |
|---------|---------------------|--------------|--------|--------|--------|---------------------|-------------|--------------|
| S4      | 0.929               | 1.350        | Type C | 0.000  | -1.800 | 0.800               | 567169.960  | 173437.308   |
| S2      | 0.000               | 1.200        | Type B | 0.000  | -1.800 | 1.650               | 567214.134  | 173559.401   |
| S3      | 0.000               | 1.350        | Type C | 0.000  | -1.605 | 1.455               | 567232.954  | 173564.426   |

### 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       | S4         | -1.800    | S2         | -1.800    | Rect  | 6mx1m         | 129.838    |                | 0.600          | 0.800                  | 0.800                  |
| 1.001       | S2         | -1.800    | S3         | -1.605    | Circ  | 0.15mØ        | 19.480     | 100.0          | 0.600          | 1.650                  | 1.455                  |

## Outfall Details

Outfall Manhole S3 : Free Discharge

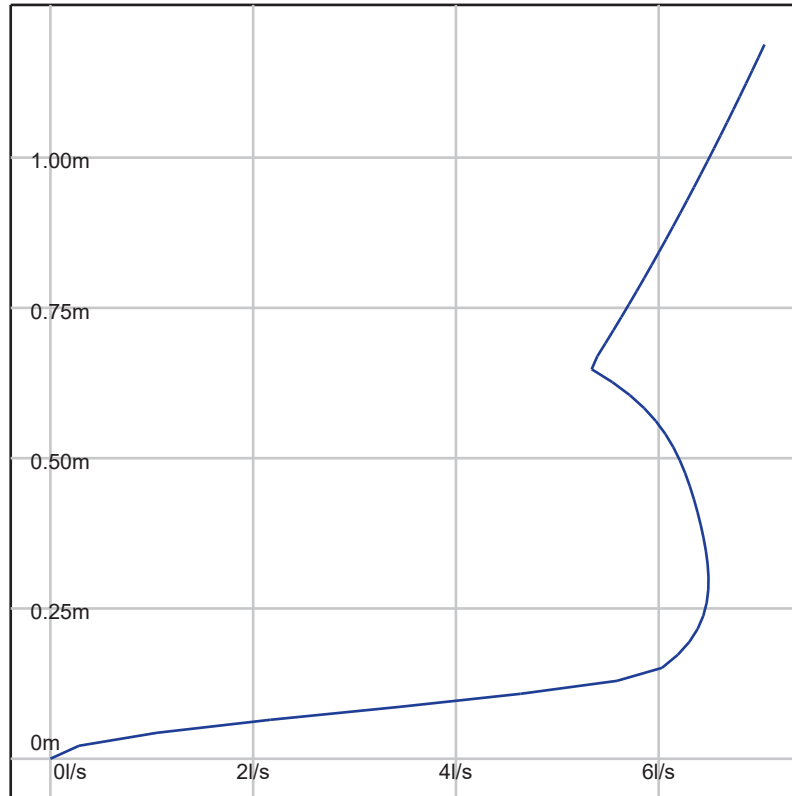
## Flow Control Details

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-0119-6500-1000-6500 | 1.000            | 6.500             | 0.000                  | 0.296       | 6.492         | 0.649       | 5.317         |

## 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<br>(mm/hr) | Runoff<br>Continuity % | Flow<br>Continuity % | Storm                    | Average Intensity<br>(mm/hr) | Runoff<br>Continuity % | Flow<br>Continuity % |
|---------------------|------------------------------|------------------------|----------------------|--------------------------|------------------------------|------------------------|----------------------|
| 1Yr 15Min Winter    | 13.907                       | 0.00                   | 0.00                 | 30Yr+20% 15Min Summer    | 91.817                       | 0.00                   | -0.24                |
| 1Yr 15Min Summer    | 13.907                       | 0.00                   | -0.15                | 30Yr+20% 15Min Winter    | 91.817                       | 0.00                   | -0.14                |
| 1Yr 30Min Winter    | 9.003                        | 0.00                   | 0.00                 | 30Yr+20% 30Min Summer    | 59.608                       | 0.00                   | -0.12                |
| 1Yr 30Min Summer    | 9.003                        | 0.00                   | 0.00                 | 30Yr+20% 30Min Winter    | 59.608                       | 0.00                   | -0.04                |
| 1Yr 60Min Winter    | 5.561                        | 0.00                   | -0.15                | 30Yr+20% 60Min Summer    | 36.866                       | 0.00                   | -0.07                |
| 1Yr 60Min Summer    | 5.561                        | 0.00                   | 0.00                 | 30Yr+20% 60Min Winter    | 36.866                       | 0.00                   | -0.01                |
| 1Yr 120Min Summer   | 4.426                        | 0.00                   | 0.00                 | 30Yr+20% 120Min Summer   | 22.376                       | 0.00                   | -0.03                |
| 1Yr 120Min Winter   | 4.426                        | 0.00                   | 0.00                 | 30Yr+20% 120Min Winter   | 22.376                       | 0.00                   | -0.05                |
| 1Yr 180Min Winter   | 3.771                        | 0.00                   | 0.00                 | 30Yr+20% 180Min Summer   | 16.610                       | 0.00                   | -0.01                |
| 1Yr 180Min Summer   | 3.771                        | 0.00                   | -0.21                | 30Yr+20% 180Min Winter   | 16.610                       | 0.00                   | -0.02                |
| 1Yr 240Min Summer   | 3.144                        | 0.00                   | -0.10                | 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                   | -0.01                |
| 1Yr 360Min Summer   | 2.447                        | 0.00                   | -0.03                | 30Yr+20% 360Min Summer   | 9.856                        | 0.00                   | 0.00                 |
| 1Yr 360Min Winter   | 2.447                        | 0.00                   | 0.02                 | 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                   | -0.03                |
| 1Yr 480Min Winter   | 2.029                        | 0.00                   | 0.02                 | 30Yr+20% 480Min Winter   | 7.935                        | 0.00                   | 0.00                 |
| 1Yr 600Min Summer   | 1.727                        | 0.00                   | -0.08                | 30Yr+20% 600Min Summer   | 6.702                        | 0.00                   | -0.02                |
| 1Yr 600Min Winter   | 1.727                        | 0.00                   | 0.47                 | 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                   | -0.01                |
| 1Yr 720Min Winter   | 1.502                        | 0.00                   | 0.03                 | 30Yr+20% 720Min Winter   | 5.835                        | 0.00                   | 0.00                 |
| 1Yr 960Min Summer   | 1.210                        | 0.00                   | 0.02                 | 30Yr+20% 960Min Summer   | 4.698                        | 0.00                   | -0.01                |
| 1Yr 960Min Winter   | 1.210                        | 0.00                   | 0.02                 | 30Yr+20% 960Min Winter   | 4.698                        | 0.00                   | 0.00                 |
| 1Yr 1440Min Winter  | 0.892                        | 0.00                   | 0.02                 | 30Yr+20% 1440Min Summer  | 3.461                        | 0.00                   | 0.00                 |
| 1Yr 1440Min Summer  | 0.892                        | 0.00                   | 0.02                 | 30Yr+20% 1440Min Winter  | 3.461                        | 0.00                   | 0.00                 |
| 1Yr 2160Min Summer  | 0.657                        | 0.00                   | 0.01                 | 30Yr+20% 2160Min Summer  | 2.543                        | 0.00                   | 0.00                 |
| 1Yr 2160Min Winter  | 0.657                        | 0.00                   | 0.02                 | 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                   | 0.29                 | 30Yr+20% 4320Min Summer  | 1.484                        | 0.00                   | 0.02                 |
| 1Yr 4320Min Winter  | 0.401                        | 0.00                   | 0.32                 | 30Yr+20% 4320Min Winter  | 1.484                        | 0.00                   | 0.03                 |
| 1Yr 5760Min Summer  | 0.334                        | 0.00                   | 0.72                 | 30Yr+20% 5760Min Summer  | 1.191                        | 0.00                   | 0.13                 |
| 1Yr 5760Min Winter  | 0.334                        | 0.00                   | 0.74                 | 30Yr+20% 5760Min Winter  | 1.191                        | 0.00                   | 0.14                 |
| 1Yr 7200Min Summer  | 0.293                        | 0.00                   | 0.97                 | 30Yr+20% 7200Min Summer  | 1.014                        | 0.00                   | 0.25                 |
| 1Yr 7200Min Winter  | 0.293                        | 0.00                   | 0.98                 | 30Yr+20% 7200Min Winter  | 1.014                        | 0.00                   | 0.24                 |
| 1Yr 8640Min Summer  | 0.265                        | 0.00                   | 1.05                 | 30Yr+20% 8640Min Summer  | 0.897                        | 0.00                   | 0.28                 |
| 1Yr 8640Min Winter  | 0.265                        | 0.00                   | 1.04                 | 30Yr+20% 8640Min Winter  | 0.897                        | 0.00                   | 0.29                 |
| 1Yr 10080Min Summer | 0.245                        | 0.00                   | 0.89                 | 30Yr+20% 10080Min Summer | 0.814                        | 0.00                   | 0.28                 |
| 1Yr 10080Min Winter | 0.245                        | 0.00                   | 0.87                 | 30Yr+20% 10080Min Winter | 0.814                        | 0.00                   | 0.28                 |
| 10Yr 15Min Summer   | 58.140                       | 0.00                   | -0.22                | 100Yr 15Min Summer       | 98.007                       | 0.00                   | -0.24                |
| 10Yr 15Min Winter   | 58.140                       | 0.00                   | -0.12                | 100Yr 15Min Winter       | 98.007                       | 0.00                   | -0.14                |
| 10Yr 30Min Summer   | 37.385                       | 0.00                   | -0.10                | 100Yr 30Min Summer       | 64.152                       | 0.00                   | -0.13                |
| 10Yr 30Min Winter   | 37.385                       | 0.00                   | 0.00                 | 100Yr 30Min Winter       | 64.152                       | 0.00                   | -0.04                |
| 10Yr 60Min Summer   | 23.009                       | 0.00                   | -0.05                | 100Yr 60Min Summer       | 39.969                       | 0.00                   | -0.07                |
| 10Yr 60Min Winter   | 23.009                       | 0.00                   | 0.00                 | 100Yr 60Min Winter       | 39.969                       | 0.00                   | -0.01                |
| 10Yr 120Min Summer  | 14.366                       | 0.00                   | -0.01                | 100Yr 120Min Summer      | 24.020                       | 0.00                   | -0.03                |
| 10Yr 120Min Winter  | 14.366                       | 0.00                   | -0.04                | 100Yr 120Min Winter      | 24.020                       | 0.00                   | -0.05                |
| 10Yr 180Min Summer  | 10.807                       | 0.00                   | 0.00                 | 100Yr 180Min Summer      | 17.819                       | 0.00                   | -0.01                |
| 10Yr 180Min Winter  | 10.807                       | 0.00                   | -0.01                | 100Yr 180Min Winter      | 17.819                       | 0.00                   | -0.02                |
| 10Yr 240Min Summer  | 8.689                        | 0.00                   | 0.00                 | 100Yr 240Min Summer      | 14.457                       | 0.00                   | -0.01                |
| 10Yr 240Min Winter  | 8.689                        | 0.00                   | 0.00                 | 100Yr 240Min Winter      | 14.457                       | 0.00                   | -0.01                |
| 10Yr 360Min Summer  | 6.397                        | 0.00                   | -0.05                | 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                   | -0.03                | 100Yr 480Min Summer      | 8.829                        | 0.00                   | -0.03                |
| 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                   | -0.01                | 100Yr 600Min Summer      | 7.555                        | 0.00                   | -0.02                |

## Simulated Rainfall Events

| Storm                | Average Intensity<br>(mm/hr) | Runoff<br>Continuity % | Flow<br>Continuity % | Storm                     | Average Intensity<br>(mm/hr) | Runoff<br>Continuity % | Flow<br>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                   | -0.01                |
| 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                   | -0.01                |
| 10Yr 960Min Winter   | 2.978                        | 0.00                   | -0.01                | 100Yr 960Min Winter       | 5.430                        | 0.00                   | 0.00                 |
| 10Yr 1440Min Summer  | 2.171                        | 0.00                   | -0.02                | 100Yr 1440Min Summer      | 4.033                        | 0.00                   | 0.00                 |
| 10Yr 1440Min Winter  | 2.171                        | 0.00                   | -0.01                | 100Yr 1440Min Winter      | 4.033                        | 0.00                   | 0.00                 |
| 10Yr 2160Min Summer  | 1.588                        | 0.00                   | -0.02                | 100Yr 2160Min Summer      | 2.951                        | 0.00                   | 0.00                 |
| 10Yr 2160Min Winter  | 1.588                        | 0.00                   | 0.01                 | 100Yr 2160Min Winter      | 2.951                        | 0.00                   | 0.00                 |
| 10Yr 2880Min Summer  | 1.274                        | 0.00                   | -0.01                | 100Yr 2880Min Summer      | 2.336                        | 0.00                   | 0.00                 |
| 10Yr 2880Min Winter  | 1.274                        | 0.00                   | 0.01                 | 100Yr 2880Min Winter      | 2.336                        | 0.00                   | 0.00                 |
| 10Yr 4320Min Summer  | 0.947                        | 0.00                   | 0.08                 | 100Yr 4320Min Summer      | 1.661                        | 0.00                   | 0.01                 |
| 10Yr 4320Min Winter  | 0.947                        | 0.00                   | 0.09                 | 100Yr 4320Min Winter      | 1.661                        | 0.00                   | 0.02                 |
| 10Yr 5760Min Summer  | 0.776                        | 0.00                   | 0.24                 | 100Yr 5760Min Summer      | 1.298                        | 0.00                   | 0.11                 |
| 10Yr 5760Min Winter  | 0.776                        | 0.00                   | 0.25                 | 100Yr 5760Min Winter      | 1.298                        | 0.00                   | 0.12                 |
| 10Yr 7200Min Summer  | 0.671                        | 0.00                   | 0.39                 | 100Yr 7200Min Summer      | 1.080                        | 0.00                   | 0.23                 |
| 10Yr 7200Min Winter  | 0.671                        | 0.00                   | 0.41                 | 100Yr 7200Min Winter      | 1.080                        | 0.00                   | 0.23                 |
| 10Yr 8640Min Summer  | 0.601                        | 0.00                   | 0.43                 | 100Yr 8640Min Summer      | 0.936                        | 0.00                   | 0.26                 |
| 10Yr 8640Min Winter  | 0.601                        | 0.00                   | 0.45                 | 100Yr 8640Min Winter      | 0.936                        | 0.00                   | 0.27                 |
| 10Yr 10080Min Winter | 0.550                        | 0.00                   | 0.41                 | 100Yr 10080Min Summer     | 0.835                        | 0.00                   | 0.27                 |
| 10Yr 10080Min Summer | 0.550                        | 0.00                   | 0.41                 | 100Yr 10080Min Winter     | 0.835                        | 0.00                   | 0.27                 |
| 30Yr 15Min Summer    | 76.514                       | 0.00                   | -0.23                | 100Yr+20% 15Min Summer    | 117.609                      | 0.00                   | -0.13                |
| 30Yr 15Min Winter    | 76.514                       | 0.00                   | -0.13                | 100Yr+20% 15Min Winter    | 117.609                      | 0.00                   | -0.15                |
| 30Yr 30Min Summer    | 49.673                       | 0.00                   | -0.11                | 100Yr+20% 30Min Summer    | 76.982                       | 0.00                   | -0.13                |
| 30Yr 30Min Winter    | 49.673                       | 0.00                   | -0.03                | 100Yr+20% 30Min Winter    | 76.982                       | 0.00                   | -0.05                |
| 30Yr 60Min Summer    | 30.722                       | 0.00                   | -0.06                | 100Yr+20% 60Min Summer    | 47.962                       | 0.00                   | -0.07                |
| 30Yr 60Min Winter    | 30.722                       | 0.00                   | 0.00                 | 100Yr+20% 60Min Winter    | 47.962                       | 0.00                   | -0.01                |
| 30Yr 120Min Summer   | 18.646                       | 0.00                   | -0.02                | 100Yr+20% 120Min Summer   | 28.824                       | 0.00                   | -0.03                |
| 30Yr 120Min Winter   | 18.646                       | 0.00                   | -0.04                | 100Yr+20% 120Min Winter   | 28.824                       | 0.00                   | 0.00                 |
| 30Yr 180Min Summer   | 13.842                       | 0.00                   | -0.01                | 100Yr+20% 180Min Summer   | 21.383                       | 0.00                   | -0.01                |
| 30Yr 180Min Winter   | 13.842                       | 0.00                   | -0.02                | 100Yr+20% 180Min Winter   | 21.383                       | 0.00                   | -0.02                |
| 30Yr 240Min Summer   | 11.154                       | 0.00                   | 0.00                 | 100Yr+20% 240Min Summer   | 17.348                       | 0.00                   | -0.01                |
| 30Yr 240Min Winter   | 11.154                       | 0.00                   | -0.01                | 100Yr+20% 240Min Winter   | 17.348                       | 0.00                   | -0.01                |
| 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                   | -0.03                | 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                   | -0.02                | 100Yr+20% 600Min Summer   | 9.067                        | 0.00                   | -0.02                |
| 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                   | -0.01                | 100Yr+20% 720Min Summer   | 7.981                        | 0.00                   | -0.01                |
| 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                   | -0.01                |
| 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                   | 0.04                 | 100Yr+20% 4320Min Summer  | 1.993                        | 0.00                   | 0.00                 |
| 30Yr 4320Min Winter  | 1.237                        | 0.00                   | 0.04                 | 100Yr+20% 4320Min Winter  | 1.993                        | 0.00                   | 0.00                 |
| 30Yr 5760Min Summer  | 0.992                        | 0.00                   | 0.17                 | 100Yr+20% 5760Min Summer  | 1.558                        | 0.00                   | 0.08                 |
| 30Yr 5760Min Winter  | 0.992                        | 0.00                   | 0.18                 | 100Yr+20% 5760Min Winter  | 1.558                        | 0.00                   | 0.09                 |
| 30Yr 7200Min Summer  | 0.845                        | 0.00                   | 0.30                 | 100Yr+20% 7200Min Summer  | 1.296                        | 0.00                   | 0.19                 |
| 30Yr 7200Min Winter  | 0.845                        | 0.00                   | 0.31                 | 100Yr+20% 7200Min Winter  | 1.296                        | 0.00                   | 0.19                 |
| 30Yr 8640Min Summer  | 0.748                        | 0.00                   | 0.33                 | 100Yr+20% 8640Min Summer  | 1.124                        | 0.00                   | 0.22                 |
| 30Yr 8640Min Winter  | 0.748                        | 0.00                   | 0.36                 | 100Yr+20% 8640Min Winter  | 1.124                        | 0.00                   | 0.22                 |
| 30Yr 10080Min Summer | 0.678                        | 0.00                   | 0.33                 | 100Yr+20% 10080Min Winter | 1.002                        | 0.00                   | 0.22                 |
| 30Yr 10080Min Winter | 0.678                        | 0.00                   | 0.33                 | 100Yr+20% 10080Min Summer | 1.002                        | 0.00                   | 0.23                 |

## 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  |
|---------|------------------|-------------|-----------|-----------|--------------|------------|---------|
| S4      | 10080 min Summer | 5683        | -1.520    | 0.280     | 1.458        |            | OK      |
| S2      | 10080 min Summer | 5685        | -1.520    | 0.280     | 1.450        |            | OK      |
| S3      | 10080 min Summer | 5685        | -1.576    | 0.029     | 1.458        |            | 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    | 10080 min Summer | 5683        | S4         | S2         | 0.280          | 0.009              | 1.612          | 0.000           | Surcharged |
| 1.001    | 10080 min Summer | 5685        | S2         | S3         | 0.089          | 0.133              | 1.458          | 0.082           | 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  |
|---------|-----------------|-------------|-----------|-----------|--------------|------------|---------|
| S4      | 2160 min Summer | 1326        | -1.368    | 0.432     | 5.659        |            | OK      |
| S2      | 2160 min Summer | 1327        | -1.368    | 0.432     | 5.659        |            | OK      |
| S3      | 2160 min Summer | 1335        | -1.547    | 0.058     | 5.716        |            | 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 | 1327        | S4         | S2         | 0.432          | 0.024              | 9.589          | 0.000           | Surcharged |
| 1.001    | 2160 min Summer | 1335        | S2         | S3         | 0.105          | 0.437              | 5.716          | 0.322           | 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  |
|---------|-----------------|-------------|-----------|-----------|--------------|------------|---------|
| S4      | 1440 min Summer | 952         | -1.238    | 0.562     | 6.473        |            | OK      |
| S2      | 1440 min Summer | 952         | -1.238    | 0.562     | 6.473        |            | OK      |
| S3      | 1440 min Summer | 952         | -1.543    | 0.062     | 6.461        |            | 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    | 1440 min Summer | 952         | S4         | S2         | 0.562          | 0.033              | 17.071         | 0.000           | Surcharged |
| 1.001    | 1440 min Summer | 952         | S2         | S3         | 0.106          | 0.483              | 6.461          | 0.364           | 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  |
|---------|-----------------|-------------|-----------|-----------|--------------|------------|---------|
| S4      | 1440 min Summer | 987         | -1.115    | 0.685     | 6.435        |            | OK      |
| S2      | 1440 min Summer | 988         | -1.115    | 0.685     | 6.426        |            | OK      |
| S3      | 960 min Summer  | 1008        | -1.543    | 0.062     | 6.491        |            | 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    | 1440 min Summer | 987         | S4         | S2         | 0.685          | 0.036              | 20.589         | 0.000           | Surcharged |
| 1.001    | 960 min Summer  | 1008        | S2         | S3         | 0.106          | 0.485              | 6.491          | 0.366           | 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  |
|---------|-----------------|-------------|-----------|-----------|--------------|------------|---------|
| S4      | 1440 min Summer | 1039        | -0.984    | 0.816     | 6.155        |            | OK      |
| S2      | 1440 min Summer | 1038        | -0.984    | 0.816     | 6.142        |            | OK      |
| S3      | 480 min Winter  | 669         | -1.543    | 0.062     | 6.491        |            | 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    | 1440 min Summer | 1038        | S4         | S2         | 0.816          | 0.039              | 23.632         | 0.000           | Surcharged |
| 1.001    | 480 min Winter  | 669         | S2         | S3         | 0.106          | 0.485              | 6.491          | 0.366           | 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     |
|---------|-----------------|-------------|-----------|-----------|--------------|------------|------------|
| S4      | 1440 min Summer | 1163        | -0.778    | 1.022     | 5.590        |            | OK         |
| S2      | 1440 min Summer | 1162        | -0.778    | 1.022     | 5.588        |            | Surcharged |
| S3      | 5760 min Summer | 4249        | -1.543    | 0.062     | 6.491        |            | 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 | 1380        | S4         | S2         | 1.000          | 0.036              | 21.146         | 0.000           | Surcharged |
| 1.001    | 5760 min Summer | 4249        | S2         | S3         | 0.106          | 0.485              | 6.491          | 0.366           | OK         |