Flood Risk Assessments and Sustainable Drainage Strategy For the Proposed Development of 60 Dwellings on Land Southeast of 208 Coates Road, Coates

Contents

Appendices

1889 – Rev A – FRA – DS – May 2017

MTC Engineering (Cambridge) Ltd.
Company Reg no. 8494749 Registered in England & Wales, VAT Reg no. 168244003
Registered Office: Ground Floor, 24 High Street, Whittlesford, Cambridgeshire, CB22 4LT
T: +44 (0)1223 837270 F: +44 (0)1223 835648 E: office@mtcengineering.co.uk
Directors: M. J. Brindley J. T. Crawley C. S. Brindley
www.mtcengineering.co.uk

Flood Risk Assessment and
Sustainable Drainage Strategy
For the Proposed Development of 60 Dwellings on
Land Southeast of 208 Coates Road, Coates

1 Introduction

1.1 MTC Engineering (Cambridge) Limited has been asked to provide a Flood Risk Assessment and Sustainable Drainage Strategy in relation to the proposed development of 60 residential dwellings on behalf of Swann Edwards Architecture Limited.

1.2 This Flood Risk Assessment is based on the following information:-

1.3 Site Survey provided by Ratcliff Land & Engineering Surveys Ltd.

1.4 Site Layout Provided by Swann Edwards Architecture limited;

1.5 Environment Agency Flooding Information

1.6 Cambridgeshire County Council Surface Water Guidance;

1.7 British Geological Survey Mapping.

1.8 The comments and opinions contained in this report including any conclusions are based on the information available to MTC Engineering (Cambridge) Ltd. during our investigations. The conclusions drawn could therefore differ if the information is found to be inaccurate, incomplete or misleading. MTC Engineering (Cambridge) Ltd. accept no liability should this prove to be the case, nor if additional information exists or becomes available with respect to this site.

1.9 MTC Engineering (Cambridge) Ltd. makes no representation whatsoever concerning the legal significance of its findings or any other matters referred to in the following report. Except as otherwise requested by the client, MTC Engineering (Cambridge) Ltd. are not obliged and disclaim any obligation to update the report for events taking place after the Assessment was undertaken.

1.10 This report is a Sustainable Drainage Strategy relating to flooding and drainage issues associated with the proposed development. The information presented and conclusions drawn are based on statistical data and are for guidance purposes only. This report provides no guarantee against flooding of the study site or elsewhere, nor as to the absolute accuracy of water levels, flow rates and associated probabilities quoted.

2 Site Description

2.1 The site lies on the southern side of Coates Road (A605), Coates and occupies an area of approximately 2.7Ha. A site location plan is provided in Appendix 1.

2.2 To the north the site is bound by existing residential development fronting Coates Road running in a northeasterly direction, then further residential development then open agricultural land.

2.3 To the south the site is bound by open agricultural land, then a drain running in a southeasterly direction, to join a network of drains running through open agricultural land further south.

2.4 The west of the site is bound by an area of trees and shrubs then residential development fronting Coates Road, then open agricultural fields.

2.5 To the east the site is bound by agricultural land then then residential development forming Coates Village.

2.6 The majority of the site is greenfield, however occupies two buildings and concrete hard standing area forming an access to the rear of 206 and 208 Coates Road at the most north western corner of the site.

2.7 The site is at approximately 4.6 metres above Ordnance Datum (AOD) falling in a south easterly direction to levels of approximately 4.3m AOD.

2.8 There are no surface water features in the vicinity of the site.

2.9 British Geological Survey Mapping indicates that the bedrock geology underlying the site is the Oxford Clay Formation, with superficial deposits of sand and gravel.

2.10 The geology is generally of a reasonably permeability, however infiltration testing has yet to be carried out to determine infiltration rates at the site. This will be carried out in

accordance with CIRIA report 156 once conditional planning permission has been granted and the full detailed design is carried out.

3 Sources of Potential Flood Risk

3.1 In accordance with The National Planning Policy Framework all forms of flood risk need to be considered in relation to any development.

3.2 The first form of flood risk to be considered in respect of The National Planning Policy Framework if fluvial flooding.

3.3 The Environment Agency Indicative Flood Map for Planning (Appendix 2) shows the sites lies completely in Flood Zone 1, thus at low risk of fluvial flooding (less than 1 in 1000), with no land at a greater risk of flooding in close proximity of the site.

3.4 The overall fluvial flood risk to the site is considered low.

3.5 The second source of flood risk to be considered in accordance with The National Planning Policy Framework is flooding from the sea.

3.6 The site is located a significant distance in land from the sea and at levels in excess of 4.5m AOD it is not considered to be at any significant risk of flooding from the sea.

3.7 The overall risk of flooding from the sea is therefore considered low.

3.8 The third form of flood risk to be considered in respect of The National Planning Policy Framework is flooding from land.

3.9 Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can quickly run off land and result in local flooding. In developed areas, this flood water can be polluted with domestic sewage with foul sewer surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro level can influence or exacerbate this. Overland flow paths need to be taken into account in development to minimise the risk of flooding from overland flow.

3.10 Land in the vicinity of the site is generally flat and is largely open agricultural land where significant flows are unlikely to develop, whilst land to the south and east is lower than the site itself thus overland flows would not come onto the site from these directions.

3.11 Any flows coming south or east towards the site would simply be picked up by Coates Road and channeled in a southeasterly direction along adjacent roads whilst any flows from the west would be picked up by the network of drains to the south of the site without having any significant impact upon the site, as illustrated on the Environment Agency Surface Water Flood Map.

3.12 The fourth form of flood risk to be considered in accordance with The National Planning Policy Framework is flooding from rising groundwater.

3.13 Groundwater flooding occurs when water levels in the ground rise above surface elevations. It is most likely to occur in low lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as chalk or sandstone, or may be localised sands and river gravels in valley bottoms underlain by less permeable rocks. Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land.

3.14 British Geological Survey Mapping indicates that the underlying geology of the site is the Oxford Clay Formation with superficial deposits of sand and gravel.

3.15 The underlying clay geology would not have a water table present, though the overlying sand and gravel may have ground water present. However there is a significant area of lower lying land to the south of the site, and it is likely that any outflow in groundwater would either result in the development of spring lines in these lower lying areas or direct outflow to the network of drainage features such as ditches before surface ground levels were reached.

3.16 The over risk of the site flooding due to rising ground water levels is considered to be low.

3.17 The fifth form of flood risk to be considered in accordance with the National Planning Policy Framework is the risk of flooding from blocked, overloaded, or burst sewers and water mains.

3.18 Should a sewer or water main block, burst or become overloaded on Coates Road the road is at a lower level than kerb levels and as such it is anticipated flows would be channeled along Coates Road without having any impact upon the site.

3.19 The last form of flood risk to be considered in accordance with the National Planning Policy Framework is flooding from reservoirs, canals or other artificial sources.

There are no reservoirs, canals or other artificial structures in the vicinity of the site that are considered to provide any significant risk of flooding to the site.

4 The Proposed Development and Drainage Strategy

4.1 The proposal involves the development of 60 residential dwellings with associated access and parking areas off Coates Road, Coates as indicated on the site layout provided in (Appendix 3).

4.2 As detailed in Section 3, the site is at a low risk of flooding by any means, thus it is not considered that either setting of minimum floor levels on flood related grounds or the specification of flood resistant or resilient construction measures is required.

4.3 General good practice should be however followed with finished external levels designed to assure flow paths are available between buildings with finished floor levels set sufficiently above adjacent ground levels in order that water will not pond in the vicinity of access points and enter the building under any circumstances.

4.4 The drainage areas based on the current layout are shown in the impermeable area plan provided in Appendix 4 and are as follows;

- Dwelling Roof Area: 5720m^2
- Private Drive/ Parking Area: 2850m^2
- Adoptable Highway Access Area: 5240m^2

4.5 To deal with surface water runoff from these areas the Sustainable Drainage Strategy has been developed in compliance with current relevant local and national guidance.

4.6 Proposed Point of Discharge and Rates

3.5.1 In line with the surface water drainage discharge hierarchy the preferable option for discharge of surface water involves discharge into the ground (infiltration). The superficial sand and gravel is likely to be sufficiently permeable that infiltration can be used as a means of drainage.

3.5.2 Infiltration testing in line with CIRIA Report 156 will be carried out once conditional planning approval has been granted to accurately establish infiltration rates at the site upon which the final detailed drainage design will be based on. However for the indicative design, infiltration rates will be based on 10^{-5} m/s which is the lowest likely rate for either sand or gravel indicated by CIRIA Project Report 21.

3.6 SuDS Systems Proposed at Development

3.6.1 Basins and ponds are a preferred SuDS feature as they are both a flood and pollution reduction measure and also provide a landscape/wildlife benefit. Therefore drainage from the proposed adoptable highway will be constructed to Cambridgeshire County Council specification or similar approved and will drain via road gullies and drainage pipes discharging to an infiltration basin.

3.6.2 Permeable paving is a SuDS technique that is appropriate to use at most developments, including the proposed development, and provides both a flood reduction benefit due to the attenuation provided in the base and a pollution reduction benefit due to the filtration of water as it passes through the permeable surfacing.

3.6.3 Permeable paving will therefore be used on all private driveway and parking areas occupying a total area of approximately 2850m^2. The roof areas of the proposed dwellings (5720m^2) will be drained directly to the base on the permeable paving.

3.7 **Proposed Infiltration Attenuation Volumes**.

3.7.1 Based upon the lowest estimated infiltration rate of 10^{-5} m/s for underlying sand and gravel indicated by CIRIA Project Report 21, Micro Drainage calculations (Appendix 6) indicate that 370m^3 is required to sufficiently attenuate discharge from all roof, and private driveways/parking areas during a 1 in 100 year plus 40% climate change rainfall event whilst infiltration takes place. Assuming a base thickness of 450mm and void ratio of 30% the permeable paving will provide 384m^3 of attenuation, which exceeds what is required.

3.7.2 Based upon the same infiltration rate the Micro Drainage calculations (Appendix 7) indicate that a volume of 291m^3 is required to provide sufficient attenuation for the proposed adoptable highway during a 1 in 100 year plus 40% climate change event whilst infiltration takes place. The infiltration basin proposed on site will provide 340m^3 of attenuation assuming a depth of 1m and side slopes of 1:3 which is more than sufficient.

3.8 **SuDS Treatment Stages**

3.8.1 Surface water from all parking/private access areas is to be filtered through permeable paving, this provides a first stage of treatment by filtration through the permeable surfacing which will remove pollutants such as hydrocarbons.

3.8.2 A second treatment stage will be provided to discharge from all trafficked areas by filtration through the membrane (such as Terram) in which the storage beneath the permeably paved areas will be wrapped, removing further pollutants from discharge and ensuring that surface water from these areas is suitably treated in line with requirements prior to discharge. Discharge from roof areas will also be filtered through this membrane on entry to the attenuation system.

3.8.3 Under SuDS Guidance clean discharge such as that from roofs only requires a single treatment phase prior to discharge, whilst discharge from lightly trafficked areas such

as the proposed parking bays requires two treatment phases.

3.8.4 The proposed adoptable highway will be treated through traditional systems such as trapped gullies which will be provided in line with Local Highway Authority Requirements prior to discharge to the pond which will provide an area in which settlement and absorption can take place prior to infiltration.

3.8.5 All areas associated with the proposed development will therefore receive adequate treatment prior to discharge in line with SuDS Guidance as detailed above.

3.8.6 This Sustainable Drainage Strategy and the calculations provided clearly demonstrate that Sustainable Drainage Systems can be used to successfully drain the proposed development and treat surface water prior to discharge in line with applicable SuDs guidance.

3.9 **Maintenance of SuDS Systems**

3.9.1 Surface water drainage systems for the adoptable highway will be located either in the highway itself or adjacent public open space, and will be adopted by either Cambridge County Council Highways or the Local Water Authority as appropriate.

3.9.2 Post development with acceptation to the adoptable highway the drainage systems at the site will be the owner's responsibility to maintain.

3.9.3 The owner should ensure that the gullies are clear of debris, such as leaves, through routine maintenance.

3.9.4 Removal of silt from the systems which if allowed to develop would reduce the effectiveness of the system. Silt traps will be incorporated into the pipework at the inlet to the block paving sub–base storage and infiltration basin to reduce the risk of clogging from sediments.

3.9.5 CCTV inspection at every inspection point after every major storm event at regular intervals. The system will be accessible through a reachable manhole which will enable easy removal of blockages.

3.9.6 Regular mowing should take place around the infiltration basin and is required along maintenance access routes and in the main storage area.

3.9.7 Adequate access will also be required to assure regular inspections and maintenance.

OPERATION & MAINTENANCE ACTIVITY	SUDS COMPONENT		
REGULAR MAINTENANCE	**INFILTRAITON BASIN**	**POROUS PAVING**	**INSPECTION CHAMBERS / MANHOLES**
INSPECTION	MAYBE REQUIRED	MAYBE REQUIRED	MAYBE REQUIRED
LITTER AND DEBRIS REMOVAL	REQUIRED	MAYBE REQUIRED	MAYBE REQUIRED
GRASS CUTTING	REQUIRED	REQUIRED	
WEED & INVASIVE PLANT CONTROL	REQUIRED	REQUIRED	
SHRUB MANAGEMENT	MAYBE REQUIRED	REQUIRED	
OCCASIONAL MAINTENANCE			
SEDIMENT MANAGEMENT	REQUIRED	MAYBE REQUIRED	MAYBE REQUIRED
VEGETATION MANAGEMENT	REQUIRED		
VACUUM SWEEPING & BRUSHING		MAYBE REQUIRED	MAYBE REQUIRED
REMIEDIAL MAINTENANCE			
STRUCTURE REHABILITATION/REPAIR	REQUIRED	REQUIRED	MAYBE REQUIRED
INFILTRATION SURFACE RECONDITIONING	REQUIRED	REQUIRED	
REPAIR INLETS	REQUIRED		REQURIED
RELEVEL UNEVEN SURFACES	REQUIRED		
REPAIR EROSION	REQUIRED		

3.9.8 The detailed drainage design will only be undertaken at the detailed design phase once conditional planning approval has been granted, however this Sustainable Drainage Strategy and the calculations provided clearly demonstrate that Sustainable Drainage Systems can be used at the proposed development to successfully restrict discharge rates in line with the requirements of Cambridgeshire County Council and the Lead Local Flood Authority.

3.9.9 It is therefore appropriate to apply a surface water drainage condition to any planning approval granted requiring submission and approval of the detailed surface water drainage design at the conditional discharge stage.

4 Conclusion

4.5 The proposal involves the development of the 60 residential dwellings off Coates Road, Coates as indicated on the site layout provided in Appendix 3.

4.6 The area site is approximately 2.7Ha with the proposed impermeable area approximately 1.38Ha.

4.7 The site lies in Flood Zone 1 on the Environment Agency Flood Map and as detailed in Section 3 is considered to be at low risk of flooding by any menas. No specific flood resistant or resilient construction methods are required. Good Practice will however be followed when setting floor levels relative the external levels to ensure that ponding of water in the vicinity of access points will not occur under any circumstances.

4.8 In line with The National Planning Policy Framework the residential development is considered a ‘more vulnerable’ development. This type of development is appropriate in Flood Zone 1 without the need to apply the Exception Test, whilst in Flood Zone 1 the Sequential Test is automatically passed.

4.9 The site has a superficial layer of sand and gravel and likely to be sufficiently permeable so infiltration can take place. Infiltration testing will be carried out in accordance with CIRIA 154 once conditional planning permission is granted.

4.10 Micro Drainage calculations based upon a conservative estimate of the infiltration rate for the underlying geology indicate an attenuation system of 661m^3 will successfully drain a 1 in 100 year plus 40% climate change event whilst infiltration takes place.

4.11 Full details provided in this report demonstrate that the site can be drained in line with requirements.

4.12 Adequate pollution treatment will be provided to all surface water drainage prior to discharge, firstly through filtration via the permeable paving and secondly via filtration

through a membrane such as Terram in which the infiltration/attenuation blankets will be wrapped.

4.13 The adoptable highway will be treated in line with Local Highway Authority guidelines.

4.14 A detailed maintenance plan will be provided for all drainage systems as part of the detailed design phase.

4.15 The Sustainable Drainage Strategy provided successfully demonstrates an available and workable solution for managing surface water in accordance with applicable SuDS guidance, and it is therefore appropriate to apply a surface water drainage condition to any planning approval granted requiring the final detailed drainage design to be undertaken once conditional planning approval has been granted.

4.16 This Sustainable Drainage Strategy is fully in line with current Local and National Policy and there are no drainage related grounds on which to object to the proposed development.

APPENDIX 1

SITE LOCATION

North Arrow

N
W E
S

REV	DATE	DESCRIPTION/REASON FOR ISSUE	APPR

MTC ENGINEERING
MTC Engineering (Cambridge) Ltd.
Ground Floor, 24 High Street
Whittlesford, Cambridgeshire, CB22 4LT
Tel (01223) 837270, fax (01223) 835648
E-mail office@mtcengineering.co.uk

TITLE

COATES ROAD, COATES CAMBRIDGESHIRE SITE LOCATION

ORIG M.B	DATE 20.04.2017
CHKD	SCALE N.T.S
APPR	DRAWING NO 1889-04 REV -

APPENDIX 2

ENVIRONMENT AGENCY FLOOD MAP

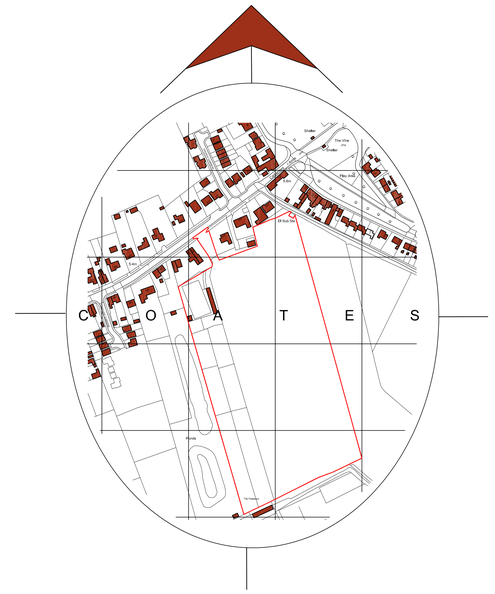
ENVIRONMENT AGENCY
FLOOD MAP FOR PLANNING
COATES ROAD, COATES

APPENDIX 3

PROPOSED DEVELOPMENT LAYOUT

General Notes
1. This drawing shall not be scaled, figured dimensions only to be used.
2. All dimensions are shown in 'mm' unless otherwise stated.
3. The contractor, sub-contractors and suppliers must verify all dimensions on site prior to the commencement of any work.
4. This drawing is to be read in conjunction with all relevant engineers and specialist sub-contractors drawings and specifications.
5. Any discrepancies are to be brought to the designers attention.

Site Plan
Scale: 1:500
0 5 10 15 20
metres



Location Plan
Scale: 1:2500
0 20 40 60 80
metres

House Type Schedule

Plot Number	Beds	Garage	Parking	Unit Type	Dwelling Type
1	3	1	1	Bungalow	Detached
2	3	1	2	Bungalow	Detached
3	3	1	2	Bungalow	Detached
4	3	1	2	Bungalow	Detached
5	3	1	2	Bungalow	Detached
6	3	1	2	Bungalow	Detached
7	2	1	2	Bungalow	Detached
8	2	1	2	Bungalow	Detached
9	2	1	2	Bungalow	Detached
10	2	1	2	Bungalow	Detached
11	3	1	2	Chalet Bung	Detached
12	3	1	2	Chalet Bung	Detached
13	3	1	2	House	Semi-Detached
14	3	1	2	House	Semi-Detached
15	3	1	2	House	Semi-Detached
16	3	1	2	House	Semi-Detached
17	4	1	2	House	Semi-Detached
18	4	1	2	House	Semi-Detached
19	3	1	2	House	Detached
20	3	1	2	House	Detached
21	2	0	2	House	Terrace
22	3	0	2	House	Terrace
23	3	0	2	House	Terrace
24	4	2	2	House	Detached
25	3	1	2	House	Detached
26	3	1	2	House	Detached
27	3	1	1	Chalet Bung	Detached
28	4	1	2	House	Detached
29	3	0	2	House	Semi-Detached
30	3	0	2	House	Semi-Detached
31	2	0	2	House	Semi-Detached
32	2	0	2	House	Semi-Detached
33	3	0	2	House	Terrace
34	3	0	2	House	Terrace
35	2	0	2	House	Terrace
36	2	0	2	House	Terrace
37	3	0	2	House	Terrace
38	3	0	2	House	Terrace
39	3	1	2	House	Detached
40	3	1	2	House	Detached
41	2	0	2	House	Semi-Detached
42	2	0	2	House	Semi-Detached
43	3	0	2	House	Semi-Detached
44	3	1	2	House	Semi-Detached
45	3	1	2	House	Semi-Detached
46	3	1	2	House	Semi-Detached
47	3	1	2	House	Semi-Detached
48	3	0	2	House	Semi-Detached
49	3	0	2	House	Terrace
50	3	0	2	House	Terrace
51	2	0	2	House	Terrace
52	2	0	2	House	Terrace
53	3	0	2	House	Terrace
54	3	0	2	House	Terrace
55	2	0	2	House	Semi-Detached
56	2	0	2	House	Semi-Detached
57	2	0	2	House	Semi-Detached
58	2	0	2	House	Semi-Detached
59	2	0	2	House	Semi-Detached
60	2	0	2	House	Semi-Detached
61	3	1	2	House	Detached
62	3	1	2	House	Detached
63	3	0	2	House	Terrace
64	3	0	2	House	Terrace
65	2	0	2	House	Terrace
66	2	0	2	House	Terrace
67	3	0	2	House	Terrace
68	3	0	2	House	Terrace
69	3	0	2	House	Terrace
70	3	0	2	House	Terrace
71	2	0	2	House	Terrace
72	2	0	2	House	Terrace
73	3	0	2	House	Terrace
74	3	0	2	House	Terrace
75	3	0	2	House	Semi-Detached
76	3	0	2	House	Semi-Detached
77	3	1	1	House	Detached
78	3	1	1	House	Detached
79	3	2	2	House	Detached

SITE PLAN KEY

- Indicates proposed dwellings
- Indicates new adoptable road and footpath entrance
- Indicates existing neighbouring dwellings taken form OS map
- Indicates proposed adoptable road and footpath
- Indicates proposed trees
- Indicates proposed parking spaces

Revisions

A	March 2016	Site Revised for Informal Application

Status
FOR APPROVAL

SWANN EDWARDS
ARCHITECTURE
Swann Edwards Architecture Limited, Elveden House, Gull Road, Guyhirn, Wisbech, Cambs, PE13 4ER
t 01945 450694 e info@swannedwards.co.uk w www.swannedwards.co.uk

Job Title
Proposed Residential Development Land North East of 208 Coates Road, Coates, for Clients of Swann Edwards

Drawing Title
Informal Planning Application Site and Location Plan

Date: December 2015
Scale: As Shown
Sheet. Size: A0
Job No.: SE-526
Dwg. No.: 01
Drawn By: G.E.
Revison: A

APPENDIX 4

IMPERMEABLE AREA PLAN

Play Area

5.6m

5.4m

COATES ROAD

FIELDSIDE

New Site Access

Footpath link to Fieldside

El Sub Sta

Public Open Space

Public Open Space

Development approved under Reference F/YR11/0775/F

LAKESIDE DR

North Arrow

N

W E

S

ADOPTABLE HIGHWAY AREA: 5240m²

PRIVATE DRIVEWAY / PARKING AREA: 2850m²

DWELLING ROOF AREA: 5720m²

REV	DATE	DESCRIPTION/REASON FOR ISSUE	APPR

MTC ENGINEERING

MTC Engineering (Cambridge) Ltd.
Ground Floor, 24 High Street
Whittlesford, Cambridgeshire, CB22 4LT
Tel (01223) 837270, fax (01223) 835648
E-mail office@mtcengineering.co.uk

TITLE

COATES ROAD, COATES CAMBRIDGESHIRE IMPERMEABLE AREAS

ORIG	DATE
S.E.C	19.04.2017
CHKD	SCALE 1:500@A1
APPR	DRAWING NO 1889-02 REV -

APPENDIX 5

INDICATIVE DRAINAGE LAYOUT

North Arrow

N
W E
S

- Permeable Paving Serving Private Road/ Parking Areas
- Surface Water Drainage from Roof Areas
- Surface Water Drainage from Adoptable Highway
- Area of Adoptable Highway Dishcharging to Infiltration Basin
- Storm Inspection Chamber (Depth <0.6m [1 side connection])
- Storm Inspection Chamber (Depth <1.2m [2 side connections])
- Storm BR manhole PCC Ring (1.2-1.5m)

REV	DATE	DESCRIPTION/REASON FOR ISSUE	APPR

MTC ENGINEERING
MTC Engineering (Cambridge) Ltd.
Ground Floor, 24 High Street
Whittlesford, Cambridgeshire, CB22 4LT
Tel (01223) 837270, fax (01223) 835648
E-mail office@mtcengineering.co.uk

TITLE

COATES ROAD, COATES CAMBRIDGESHIRE INDICATIVE DRAINAGE LAYOUT

ORIG S.E.C	DATE 19.04.2017
CHKD	SCALE 1:500@A1
APPR	DRAWING NO 1889-03 REV -

APPENDIX 6

MICRO DRAIANGE CALCULATIONS: PERMEABLE PAVING SYSTEM

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 221 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	4.377	0.227	14.3	193.9	Flood Risk
30 min Summer	4.440	0.290	14.3	247.7	Flood Risk
60 min Summer	4.491	0.341	14.3	291.9	Flood Risk
120 min Summer	4.521	0.371	14.3	316.9	Flood Risk
180 min Summer	4.519	0.369	14.3	315.7	Flood Risk
240 min Summer	4.511	0.361	14.3	308.5	Flood Risk
360 min Summer	4.490	0.340	14.3	290.4	Flood Risk
480 min Summer	4.467	0.317	14.3	271.4	Flood Risk
600 min Summer	4.446	0.296	14.3	253.3	Flood Risk
720 min Summer	4.426	0.276	14.3	236.0	Flood Risk
960 min Summer	4.388	0.238	14.3	203.4	Flood Risk
1440 min Summer	4.322	0.172	14.3	147.3	Flood Risk
2160 min Summer	4.252	0.102	14.3	86.9	O K
2880 min Summer	4.211	0.061	14.3	52.3	O K
4320 min Summer	4.191	0.041	11.6	35.0	O K
5760 min Summer	4.183	0.033	9.3	27.8	O K
7200 min Summer	4.177	0.027	7.8	23.1	O K
8640 min Summer	4.173	0.023	6.6	19.9	O K
10080 min Summer	4.171	0.021	5.9	17.5	O K
15 min Winter	4.407	0.257	14.3	219.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	136.090	0.0	18
30 min Summer	87.658	0.0	33
60 min Summer	53.779	0.0	62
120 min Summer	31.948	0.0	120
180 min Summer	23.295	0.0	172
240 min Summer	18.534	0.0	200
360 min Summer	13.343	0.0	260
480 min Summer	10.542	0.0	328
600 min Summer	8.788	0.0	394
720 min Summer	7.571	0.0	462
960 min Summer	5.981	0.0	596
1440 min Summer	4.284	0.0	848
2160 min Summer	3.065	0.0	1188
2880 min Summer	2.415	0.0	1504
4320 min Summer	1.724	0.0	2204
5760 min Summer	1.357	0.0	2936
7200 min Summer	1.126	0.0	3672
8640 min Summer	0.967	0.0	4400
10080 min Summer	0.850	0.0	5136
15 min Winter	136.090	0.0	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	4.479	0.329	14.3	280.9	Flood Risk
60 min Winter	4.539	0.389	14.3	332.6	Flood Risk
120 min Winter	4.577	0.427	14.3	365.3	Flood Risk
180 min Winter	4.581	0.431	14.3	368.5	Flood Risk
240 min Winter	4.571	0.421	14.3	360.2	Flood Risk
360 min Winter	4.542	0.392	14.3	335.5	Flood Risk
480 min Winter	4.512	0.362	14.3	309.6	Flood Risk
600 min Winter	4.482	0.332	14.3	283.5	Flood Risk
720 min Winter	4.451	0.301	14.3	257.7	Flood Risk
960 min Winter	4.394	0.244	14.3	208.5	Flood Risk
1440 min Winter	4.297	0.147	14.3	125.4	O K
2160 min Winter	4.207	0.057	14.3	48.9	O K
2880 min Winter	4.192	0.042	12.0	35.9	O K
4320 min Winter	4.180	0.030	8.6	25.7	O K
5760 min Winter	4.174	0.024	6.8	20.1	O K
7200 min Winter	4.170	0.020	5.6	16.7	O K
8640 min Winter	4.167	0.017	4.8	14.3	O K
10080 min Winter	4.165	0.015	4.2	12.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	87.658	0.0	32
60 min Winter	53.779	0.0	62
120 min Winter	31.948	0.0	118
180 min Winter	23.295	0.0	174
240 min Winter	18.534	0.0	226
360 min Winter	13.343	0.0	280
480 min Winter	10.542	0.0	356
600 min Winter	8.788	0.0	430
720 min Winter	7.571	0.0	504
960 min Winter	5.981	0.0	642
1440 min Winter	4.284	0.0	892
2160 min Winter	3.065	0.0	1168
2880 min Winter	2.415	0.0	1488
4320 min Winter	1.724	0.0	2200
5760 min Winter	1.357	0.0	2888
7200 min Winter	1.126	0.0	3656
8640 min Winter	0.967	0.0	4408
10080 min Winter	0.850	0.0	5000

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.450	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.857

Time (mins) From:	To:	Area (ha)
0	4	0.857

Model Details

Storage is Online Cover Level (m) 4.600

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.03600	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	285.0
Max Percolation (l/s)	791.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	4.150	Cap Volume Depth (m)	0.000

APPENDIX 7

MICRO DRAINAGE CALCULATIONS: INFILTRATION BASIN SYSTEM

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 696 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	3.848	0.248	3.1	131.3	O K
30 min Summer	3.911	0.311	3.3	167.5	O K
60 min Summer	3.970	0.370	3.4	201.7	O K
120 min Summer	4.020	0.420	3.6	231.4	O K
180 min Summer	4.042	0.442	3.6	244.8	O K
240 min Summer	4.052	0.452	3.7	251.2	O K
360 min Summer	4.057	0.457	3.7	254.1	O K
480 min Summer	4.052	0.452	3.7	250.9	O K
600 min Summer	4.044	0.444	3.6	246.3	O K
720 min Summer	4.037	0.437	3.6	241.8	O K
960 min Summer	4.022	0.422	3.6	232.9	O K
1440 min Summer	3.993	0.393	3.5	215.6	O K
2160 min Summer	3.954	0.354	3.4	192.1	O K
2880 min Summer	3.918	0.318	3.3	171.1	O K
4320 min Summer	3.855	0.255	3.1	135.4	O K
5760 min Summer	3.802	0.202	3.0	106.1	O K
7200 min Summer	3.759	0.159	2.9	82.3	O K
8640 min Summer	3.723	0.123	2.8	63.4	O K
10080 min Summer	3.695	0.095	2.7	48.5	O K
15 min Winter	3.876	0.276	3.2	147.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	136.090	0.0	19
30 min Summer	87.658	0.0	34
60 min Summer	53.779	0.0	64
120 min Summer	31.948	0.0	122
180 min Summer	23.295	0.0	182
240 min Summer	18.534	0.0	242
360 min Summer	13.343	0.0	360
480 min Summer	10.542	0.0	480
600 min Summer	8.788	0.0	534
720 min Summer	7.571	0.0	590
960 min Summer	5.981	0.0	712
1440 min Summer	4.284	0.0	982
2160 min Summer	3.065	0.0	1388
2880 min Summer	2.415	0.0	1792
4320 min Summer	1.724	0.0	2592
5760 min Summer	1.357	0.0	3344
7200 min Summer	1.126	0.0	4040
8640 min Summer	0.967	0.0	4752
10080 min Summer	0.850	0.0	5440
15 min Winter	136.090	0.0	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	3.947	0.347	3.4	188.1	O K
60 min Winter	4.012	0.412	3.6	226.9	O K
120 min Winter	4.068	0.468	3.7	261.2	O K
180 min Winter	4.094	0.494	3.8	277.2	O K
240 min Winter	4.107	0.507	3.8	285.5	O K
360 min Winter	4.116	0.516	3.8	291.0	O K
480 min Winter	4.114	0.514	3.8	289.7	O K
600 min Winter	4.108	0.508	3.8	285.7	O K
720 min Winter	4.098	0.498	3.8	279.9	O K
960 min Winter	4.080	0.480	3.7	268.5	O K
1440 min Winter	4.044	0.444	3.6	246.2	O K
2160 min Winter	3.989	0.389	3.5	212.9	O K
2880 min Winter	3.937	0.337	3.4	182.5	O K
4320 min Winter	3.847	0.247	3.1	131.0	O K
5760 min Winter	3.773	0.173	2.9	90.3	O K
7200 min Winter	3.715	0.115	2.8	58.9	O K
8640 min Winter	3.671	0.071	2.7	36.3	O K
10080 min Winter	3.650	0.050	2.6	25.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	87.658	0.0	33
60 min Winter	53.779	0.0	62
120 min Winter	31.948	0.0	120
180 min Winter	23.295	0.0	180
240 min Winter	18.534	0.0	238
360 min Winter	13.343	0.0	352
480 min Winter	10.542	0.0	462
600 min Winter	8.788	0.0	570
720 min Winter	7.571	0.0	670
960 min Winter	5.981	0.0	754
1440 min Winter	4.284	0.0	1066
2160 min Winter	3.065	0.0	1512
2880 min Winter	2.415	0.0	1932
4320 min Winter	1.724	0.0	2764
5760 min Winter	1.357	0.0	3512
7200 min Winter	1.126	0.0	4176
8640 min Winter	0.967	0.0	4760
10080 min Winter	0.850	0.0	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.450	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.524

Time (mins) From:	To:	Area (ha)
0	4	0.524

Model Details

Storage is Online Cover Level (m) 4.600

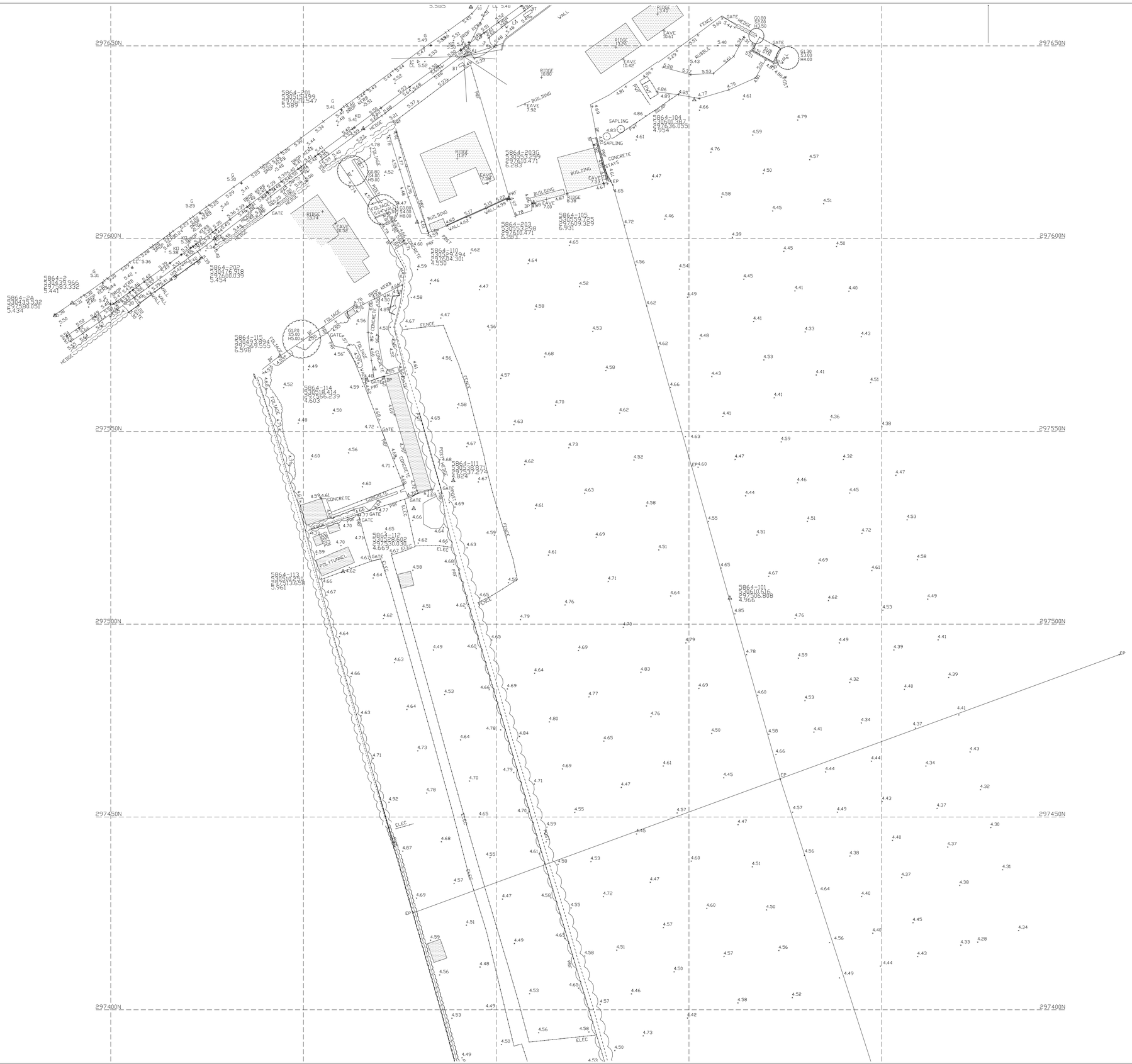
Infiltration Basin Structure

Invert Level (m) 3.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.03600 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.03600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	500.0	1.400	888.3	2.800	1387.5	4.200	1997.5
0.200	548.7	1.600	952.9	3.000	1467.9	4.400	2093.7
0.400	599.6	1.800	1019.6	3.200	1550.5	4.600	2192.2
0.600	652.9	2.000	1088.7	3.400	1635.4	4.800	2292.9
0.800	708.3	2.200	1160.0	3.600	1722.5	5.000	2395.9
1.000	766.1	2.400	1233.6	3.800	1811.9		
1.200	826.1	2.600	1309.4	4.000	1903.6		

APPENDIX 7

SITE SURVEY



North Arrow

N
W E
S

REV	DATE	DESCRIPTION/REASON FOR ISSUE	APPR

MTC ENGINEERING

MTC Engineering (Cambridge) Ltd.
Ground Floor, 24 High Street
Whittlesford, Cambridgeshire, CB22 4LT
Tel (01223) 837270, fax (01223) 835648
E-mail office@mtcengineering.co.uk

TITLE

COATES ROAD, COATES CAMBRIDGESHIRE TOPOGRAPHICAL SURVEY

ORIG	DATE
M.B	0.04.2017
CHKD	SCALE 1:500@A1
APPR	DRAWING NO 1889-01 REV -