SCP
Transportation Planning : Infrastructure Design

Hydraulic Modelling Report

Crabtree Lane, Burscough
Ormskirk

Burscough Parish Council

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1.0 INTRODUCTION

1.1 SCP have been commissioned by Burscough Parish Council, as an independent industry professional, to undertake a hydraulic modelling assessment of the operation of the drainage provision within a set catchment area, within Burscough, and give our impartial view of how the system operates.

1.2 In delivering this assessment, base data has been gathered, to inform that assessment process, through obtaining local sewer records within the set catchment area. In addition to this, a site walkover has been delivered to understand the topography of the set area, and confirm that what is currently on site, aligns with maps and records.

1.3 Using the gathered data, this information has been used model the existing drainage provision within the catchment area with rainfall data, to understand how the network operates at peak periods of rainfall.

1.4 Using the collected data, and the output from the drainage model, this information has been interpreted, and used to form the basis of this report. This report gives an impartial assessment as to how the existing drainage provision / network within the set catchment currently operates, and at locations of flooding, what is perceived to be the cause of the flooding.

1.5 To support the report, a number of layout drawings, and outputted report from the drainage model, have been appended to the rear of this report, to aid with the understanding of the assessment, and support the text.

2.0 DESIGN PRINCIPLES

Modelling methodology

2.1 The catchment area included in this Hydrological and Hydraulic Assessment extends from the residential development south of Liverpool Road South (A59) and to the north of the railway line crossing through Crab tree Lane. to its final location and extents of surveyed area at Marsh Moss Lane. The network could not be accessed further, due to landownership. The drainage within the area is mainly via ditches with some public sewers providing connectivity between the ditches, which also drain the housing estates.

2.2 The model of the existing network has been completed using Microdrainage, the industry standard drainage software developed by XPSolutions.

2.3 The assumptions and parameters included in the model have been detailed below.

Sources of information

2.4 The information used to build the Microdrainage model is listed below, along with the source:

- **OS mapping information and Lidar Data**: covering the extents of the catchment area;
- **Existing Drainage Network.** Information obtained from United Utilities (UU) sewer records with additional detail including, pipe sizes and materials, cover levels and invert levels where available;
- **Site Walkover Survey and Visual Inspection:** Photographs taken during the Site visit on 18th January 2017.

Catchment Analysis

2.5 The drainage ditch directions and routes were determined from the combination of the OS Maps and the information gathered during the site walkover. Where there appeared to be conflicting information, the site visit photographs and data were considered to be more accurate as it has been witnessed on site that some of the existing ditches are no longer present and do not form part of the network.

2.6 Figures 4-1, 4-2 and 4-3 below, show the route and dimensions of the ditches as observed on site.

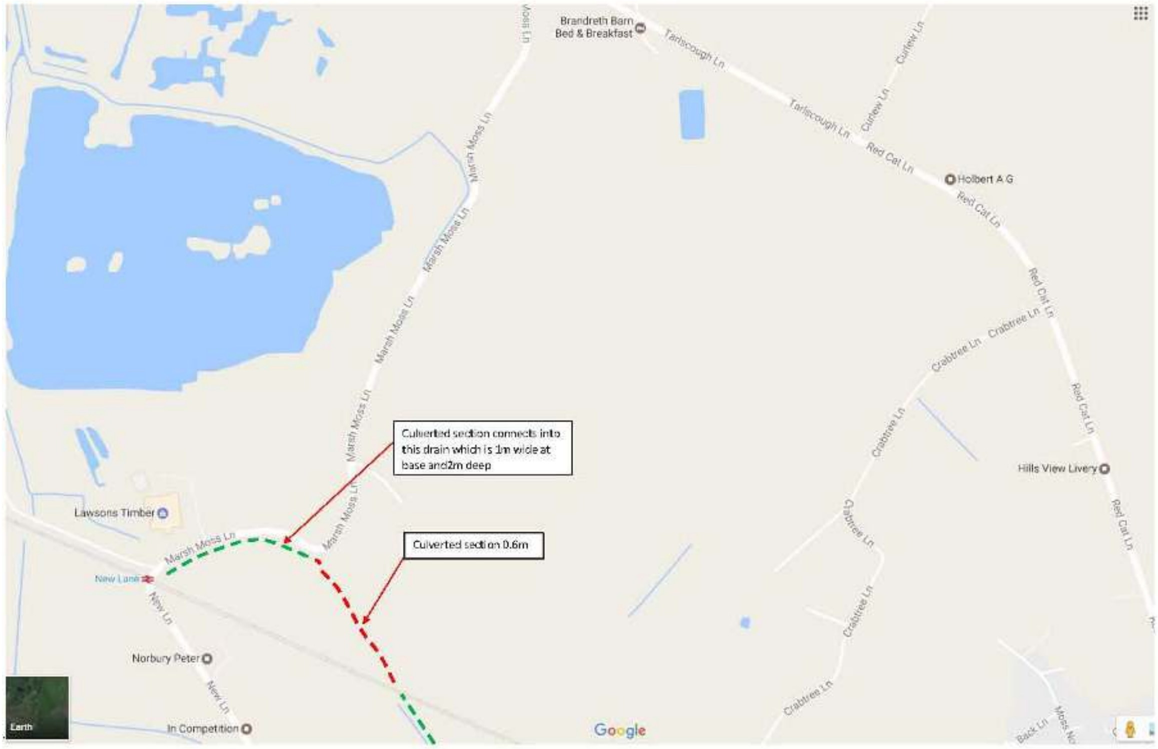


Figure 2-1: Site walkover details north of rail line

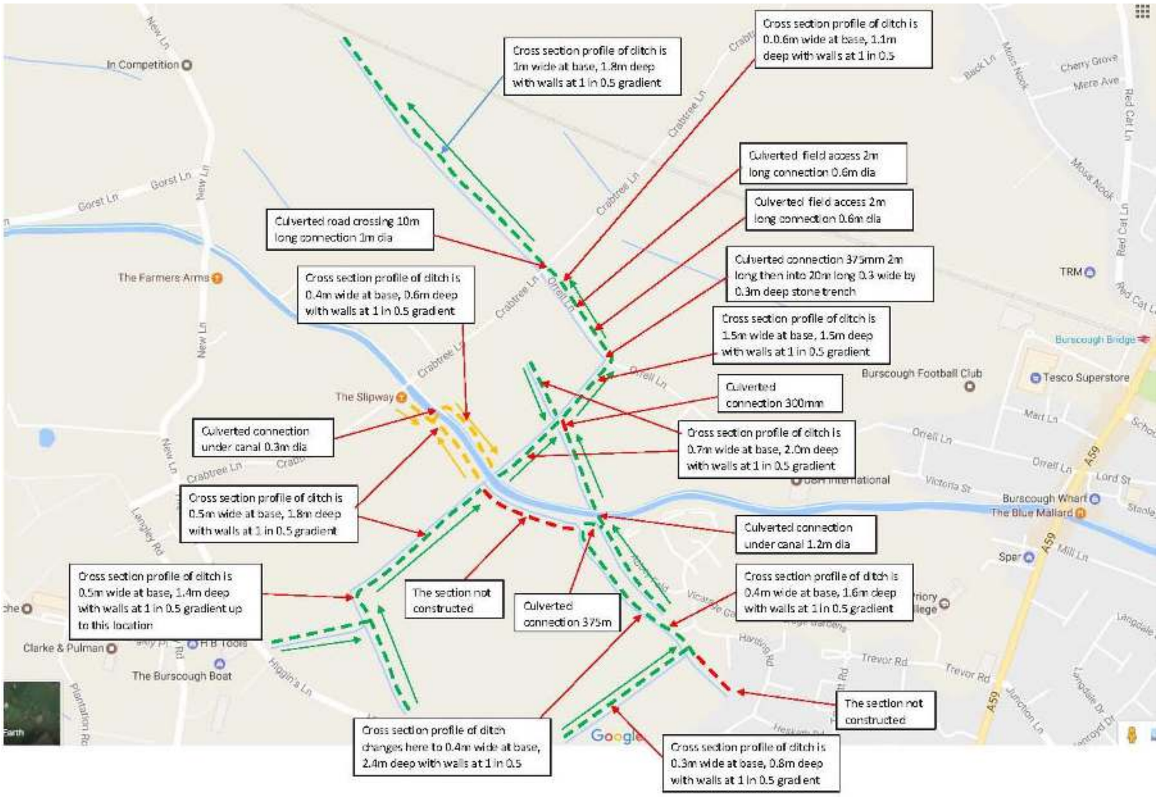


Figure 2-2: Site walkover details south of rail line and north of Higgins Lan

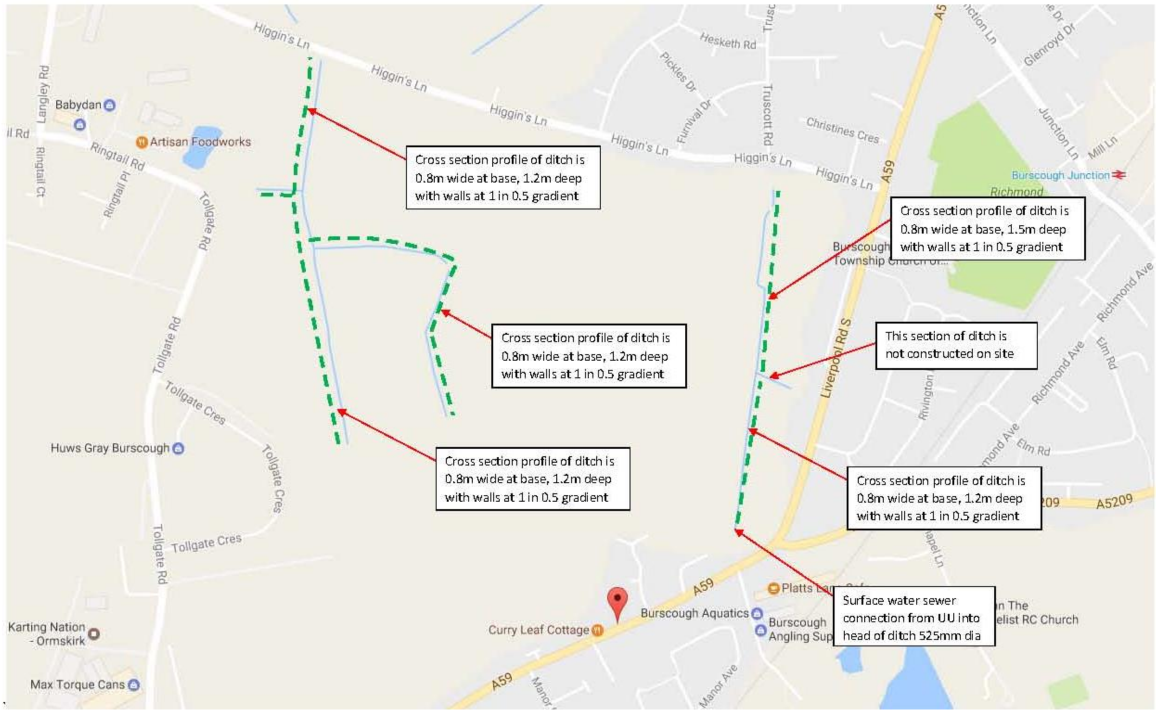


Figure 2-3: Site walkover details south of Higgins Lane

2.7 The complete layout modelled is shown on SCP drawings 16548-0500-0021, 16548-0500-002 and 16548-0500-003 included as Appendix B. The drawings give further details to the drainage networks including details of ownership for areas and apparatus of the drainage network (i.e. Land owner of United Utilities).

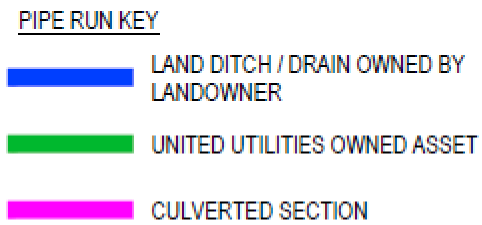


Image 1: Drainage Identification Key on Drawings

2.8 In addition to this, drawing 16548-0500-004 included in Appendix A, details the catchment areas taken by each drain run which has been used in developing the drainage model, which considers overland flow, as well as flow taken from the adjacent housing development, which outfalls into the ditch network as different locations.

2.9 The existing public sewers have been mapped out and located as accurately as possible from the information available. Invert levels are assumed to be a minimum of 1.2m below ground where no information is available from the United Utilities (UU) data. The cover levels are assumed to be at ground levels obtained from the LIDAR data (ground profile information). The UU data is included in Appendix C.

2.10 To estimate the flows through the network at each location and cumulatively, the catchment areas draining into the ditches and pipes were determined. This was based on the existing topographical information to understand the levels and gradients of the land, and the UU drainage plans.

2.11 Using the LIDAR data, a ground profile was generated to understand the direction of overland flows from the Greenfield areas within the catchment. It is considered as standard practice, that in greenfield areas, 95% of rainfall will soak into the ground resulting in 5% runoff outfalling into the nearest outfall location, and in this instance, these are the drainage ditches located within the fields. This was used to determine the areas draining into the various ditches and to calculate the flow rates within the drainage model.

2.12 The urbanised catchment areas (housing estates and roads) were defined based on the UU surface water drainage network (UU data contained in Appendix C) with their points of connection into the ditches. These urbanised catchment areas contribute a higher runoff rate into the drainage network, on the basis that in the areas of hard standing or roof areas, only 5% will soak into the surrounding ground, with 95% of the rainfall captured on the hard areas, running off into drainage network. From review of the layout of the housing estates, the split on areas of hard standing and green field is assumed to be 50% for each, which is worst case, to account for open spaces and gardens within the developments.

2.13 Using the defined catchment areas assessed above, further consideration is required as to the time it takes for a drop of water, landing on a hard surface, and travelling into the drainage network, or in this case the ditch network, which is termed as “The time of entry” (T_e). With this consideration, the T_e of the flows from the urbanised areas are assumed to be greater than 5 minutes given the large catchments, and the possible long pipe runs from the developments into their outfall at the ditches. To account for this, T_e is assumed 15 minutes.

Microdrainage Modelling

2.14 Using the assessment design criteria detailed above, the drainage network was modelled and tested against different critical storms using the standard catchment rainfall profiles from the Flood Studies Report (FSR) within the Microdrainage Software. A critical storm is considered as a level of rainfall intensity, and the greater the year of the return period, the higher the intensity of the storm.

2.15 The return periods tested for the simulation were the following:

- 1 in 30 years
- 1 in 100 years plus 30% cc

2.16 The effects of climate change (cc) were considered in the model through a 30% increase in the peak rainfall for the 1 in 100 year return period.

2.17 For each return period tested, the following storm durations have been simulated, to assess against the length that a storm would release rainfall into the drainage network: 15min; 30min; 60min; 1 hour; 2 hours; 6 hours; 12hours; 24 hours; 48 hours and 72 hours (3 days).

2.18 To account for this additional storage a MADD factor is used. It is generally assumed that additional storage is available within a drainage system through small pipes which facilitate connection from gully into the system etc., which would normally not form part of the modelled system. These available storage volumes are generally greater within drainage systems serving larger areas. This available storage is estimated as MADD Factor which achieves * 10 m^3 per hectare. The MADD factor reasonably specified for most drainage design is in the range of 2 to 5 depending on the size and conditions of the drainage network.

2.19 To make allowance for additional peripheral storage from un-modelled sections of existing network, the MADD factor of 5 has been used for this assessment.

2.20 Through carrying out the site walkover, it was noted that some of the existing ditches are overgrown and unmaintained. With this consideration, and to achieve an improved understanding of how the system operates, two scenarios have been modelled as part of the assessment. The first scenario assumes that the drainage ditches are uniform and free from vegetation within the ditches (well maintained). The second considers the ditches overgrown with vegetation along the banks and within the bed of the ditches (unmaintained).

3.0 SIMULATION RESULTS AND ANALYSIS

3.1 In completion of the drainage modelling based on the methodology detailed above, this has enabled us to assessed areas of the network where the modelling details flooding and what this level of flooding in terms of volume. The table below highlights locations of flooding during the critical storm events and flood volumes, using the scenarios of maintained and unmaintained systems.

3.2 To enable an understanding of where the locations detailed in the table below, are located within the modelled drainage network, each pipe/ditch run has a number, which are detailed on drawings 16548-0500-0021, 16548-0500-002 and 16548-0500-003. Using the pipe number, the location of the flooding is at the beginning of the drain length where it meets the previous numbered run.

3.3 The Manhole column in the table refers to both Manholes and Junction in the model. Where UU manhole numbers are available, these have been used in the model for a greater degree of understanding these on site and against sewer records. All other manhole numbers have been assigned accordingly. The full modelling results can be found in Appendix D.

Table 3-1: Summary of Results – unmaintained ditches/drained runs

US/MH Name	US/CL (m)	Pipe Number	Event	Water Level (m)	Flooded Volume (m³)	Status	Type	Ownership
102	22.700	1.002	120 min 100 year(w) +30%	22.765	65.502	Flood	Ditch	Landowner
9512	21.831	1.003	120 min 100 year(w) +30%	22.731	900.308	Flood	Pipe	United Utilities
104	21.486	1.004	360 min 100 year(w) +30%	22.315	829.242	Flood	Pipe	United Utilities
9508	21.428	1.005	360 min 100 year(w) +30%	22.271	842.939	Flood	Pipe	United Utilities
7	21.200	2.000	120 min 100 year(w) +30%	23.518	2317.915	Flood	Pipe	United Utilities
9507	21.432	1.006	360 min 100 year(w) +30%	22.239	807.171	Flood	Pipe	United Utilities
8609	21.028	1.007	360 min 100 year(w) +30%	21.117	88.919	Flood	Pipe	United Utilities
13	19.100	3.000	120 min 100 year(w) +30%	22.058	2958.365	Flood	Pipe	United Utilities
12	19.153	1.011	30 min 100 year(w) +30%	19.876	722.589	Flood	Pipe	United Utilities
17	17.200	4.000	30 min 100 year(w) +30%	17.359	159.034	Flood	Pipe	United Utilities
108	15.700	1.015	1440 min 100 year(w) +30%	15.827	126.600	Flood	Ditch	Landowner
109	15.000	1.016	1440 min 100 year(w) +30%	15.809	809.057	Flood	Ditch	Landowner
110	14.050	1.017	1440 min 100 year(w) +30%	15.788	1738.342	Flood	Ditch	Landowner
113	15.118	5.002	1440 min 100 year(w) +30%	15.752	633.730	Flood	Ditch	Landowner
114	14.656	5.003	1440 min 100 year(w) +30%	15.752	1095.753	Flood	Ditch	Landowner
115	14.400	5.004	1440 min 100 year(w) +30%	15.752	1351.765	Flood	Ditch	Landowner
116	14.700	5.005	1440 min 100 year(w) +30%	15.752	1051.771	Flood	Pipe	Landowner

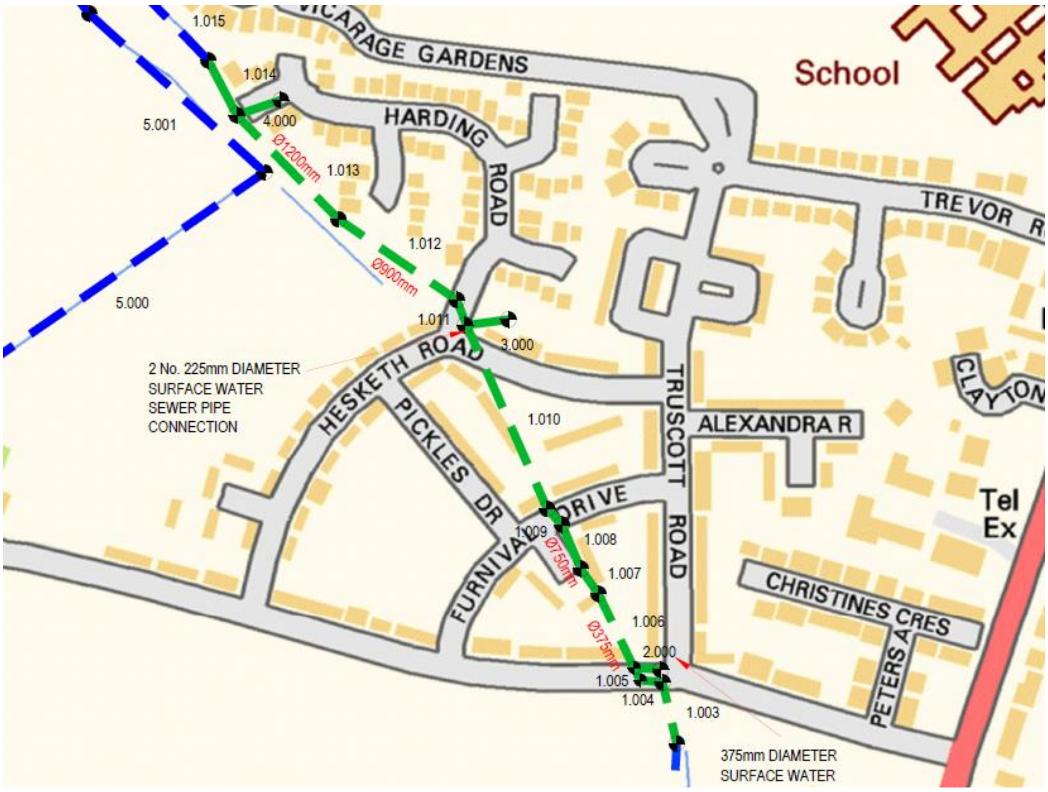
19	16.300	6.000	30 min 100 year(w) +30%	16.556	256.431	Flood	Pipe	United Utilities
117	14.200	1.018	1440 min 100 year(w) +30%	15.774	1573.684	Flood	Pipe	Landowner
118	13.300	1.019	1440 min 100 year(w) +30%	15.769	2469.216	Flood	Ditch	Landowner
119	12.150	1.020	1440 min 100 year(w) +30%	15.757	3607.376	Flood	Pipe	Landowner
142	14.500	7.013	2880 min 100 year(w) +30%	15.450	950.205	Flood	Ditch	Landowner
143	14.900	7.014	2880 min 100 year(w) +30%	15.442	542.410	Flood	Ditch	Landowner
144	11.900	12.000	2880 min 100 year(w) +30%	15.442	3542.411	Flood	Ditch	Landowner
145	11.950	1.021	2880 min 100 year(w) +30%	15.442	3492.424	Flood	Ditch	Landowner
146	11.100	1.022	2880 min 100 year(w) +30%	15.435	4334.819	Flood	Pipe	Landowner
57	10.200	1.025	2880 min 100 year(w) +30%	9.994	0	Flood Risk	Pipe	Landowner

Table 3-2: Summary of Critical Results – Well maintained ditches/drained runs

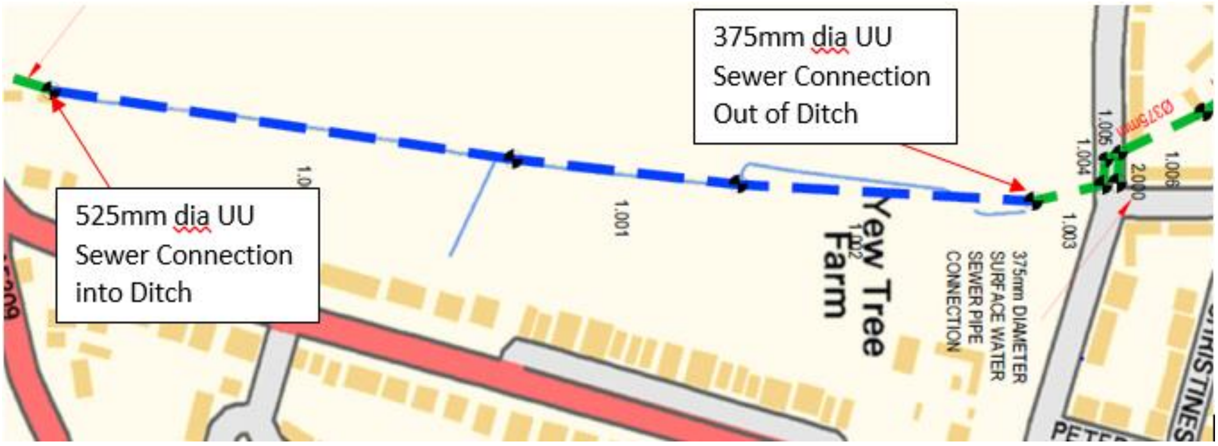
US/MH Name	US/CL (m)	Pipe Number	Event	Water Level (m)	Flooded Volume (m³)	Status	Type	Ownership
102	22.700	1.002	60 min 100 year(w) +30%	22.765	65.309	Flood	Ditch	Landowner
9512	21.831	1.003	60 min 100 year(w) +30%	22.751	920.385	Flood	Pipe	United Utilities
104	21.486	1.004	360 min 100 year(w) +30%	22.312	826.100	Flood	Pipe	United Utilities
9508	21.428	1.005	360 min 100 year(w) +30%	22.271	842.792	Flood	Pipe	United Utilities
7	21.200	2.000	120 min 100 year(w) +30%	23.545	2344.664	Flood	Pipe	United Utilities
9507	21.432	1.006	360 min 100 year(w) +30%	22.242	810.460	Flood	Pipe	United Utilities
8609	21.028	1.007	360 min 100 year(w) +30%	21.119	90.768	Flood	Pipe	United Utilities
13	19.100	3.000	120 min 100 year(w) +30%	22.060	2959.738	Flood	Pipe	United Utilities
12	19.153	1.011	30 min 100 year(w) +30%	19.879	725.827	Flood	Pipe	United Utilities
17	17.200	4.000	30 min 100 year(w) +30%	17.354	154.064	Flood	Pipe	United Utilities
108	15.700	1.015	720 min 100 year(w) +30%	15.184	0	Ok	Ditch	Landowner
109	15.000	1.016	720 min 100 year(w) +30%	15.171	171.373	Flood	Ditch	Landowner
110	14.050	1.017	720 min 100 year(w) +30%	15.156	1106.354	Flood	Ditch	Landowner
113	15.118	5.002	720 min 100 year(w) +30%	15.124	5.881	Flood	Ditch	Landowner
114	14.656	5.003	720 min 100 year(w) +30%	15.124	467.955	Flood	Ditch	Landowner
115	14.400	5.004	720 min 100 year(w) +30%	15.124	724.053	Flood	Ditch	Landowner
116	14.700	5.005	720 min 100 year(w) +30%	15.124	424.354	Flood	Pipe	Landowner

19	16.300	6.000	30 min 100 year(w) +30%	16.554	254.123	Flood	Pipe	United Utilities
117	14.200	1.018	720 min 100 year(w) +30%	15.145	945.223	Flood	Pipe	Landowner
118	13.300	1.019	720 min 100 year(w) +30%	15.136	1836.014	Flood	Ditch	Landowner
119	12.150	1.020	720 min 100 year(w) +30%	15.126	2975.927	Flood	Pipe	Landowner
142	14.500	7.013	120 min 100 year(w) +30%	14.237	0	Flood Risk	Ditch	Landowner
143	14.900	7.014	120 min 100 year(w) +30%	13.103	0	Ok	Ditch	Landowner
144	11.900	12.000	1440 min 100 year(w) +30%	12.812	911.966	Flood	Ditch	Landowner
145	11.950	1.021	1440 min 100 year(w) +30%	12.812	861.975	Flood	Ditch	Landowner
146	11.100	1.022	1440 min 100 year(w) +30%	12.800	1699.698	flood	Pipe	Landowner
57	10.200	1.025	1440 min 100 year(w) +30%	10.370	169.865	flood	Pipe	Landowner

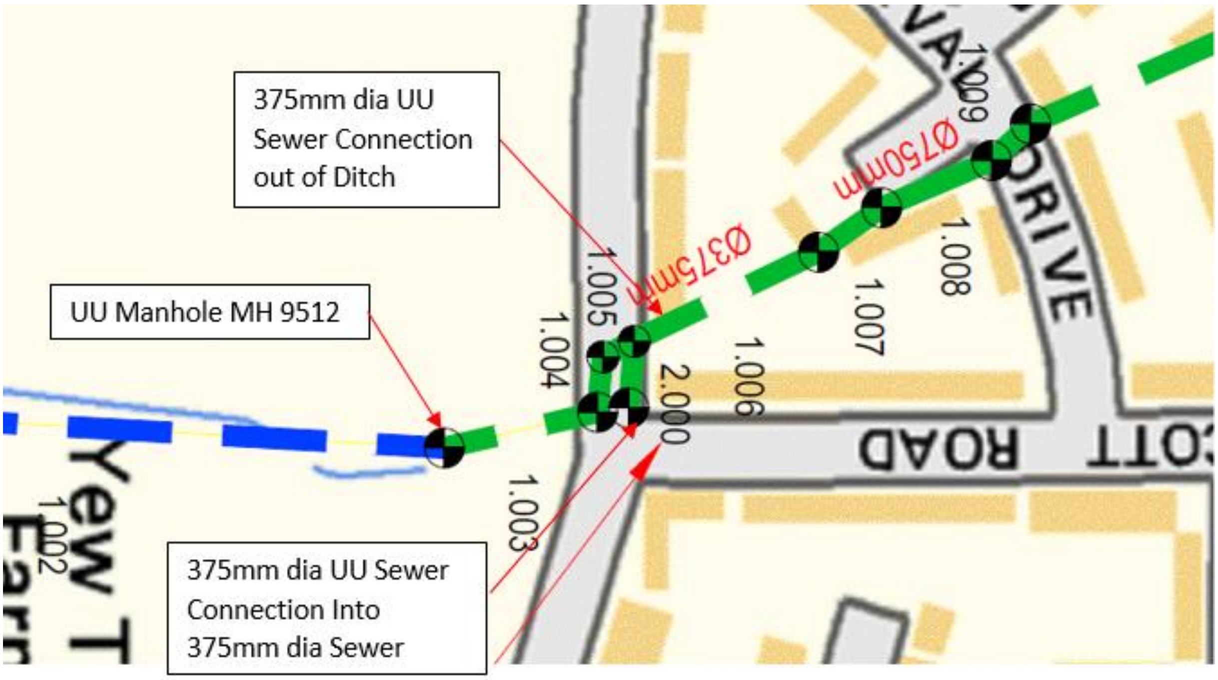
3.4 The model highlights a number of constraints within the system. The existing UU sewers are represented in the model as pipes 1.003 to 1.014 as shown in the image below with the connections from the residential development also highlighted.



3.5 The existing UU data identifies a 575mm diameter pipe connecting into the ditch run 1.000 which then discharges into run 1.003, a 375mm pipe. This suggests possible lack of capacity within the system downstream of run 1.003 if the 575mm pipe flows full bore.



3.6 In addition, drain run 2.000, another 375mm diameter pipe discharges into the system just upstream of pipe 1.006 which remains a 375mm pipe, indicating the likelihood for flooding due to lack of capacity.

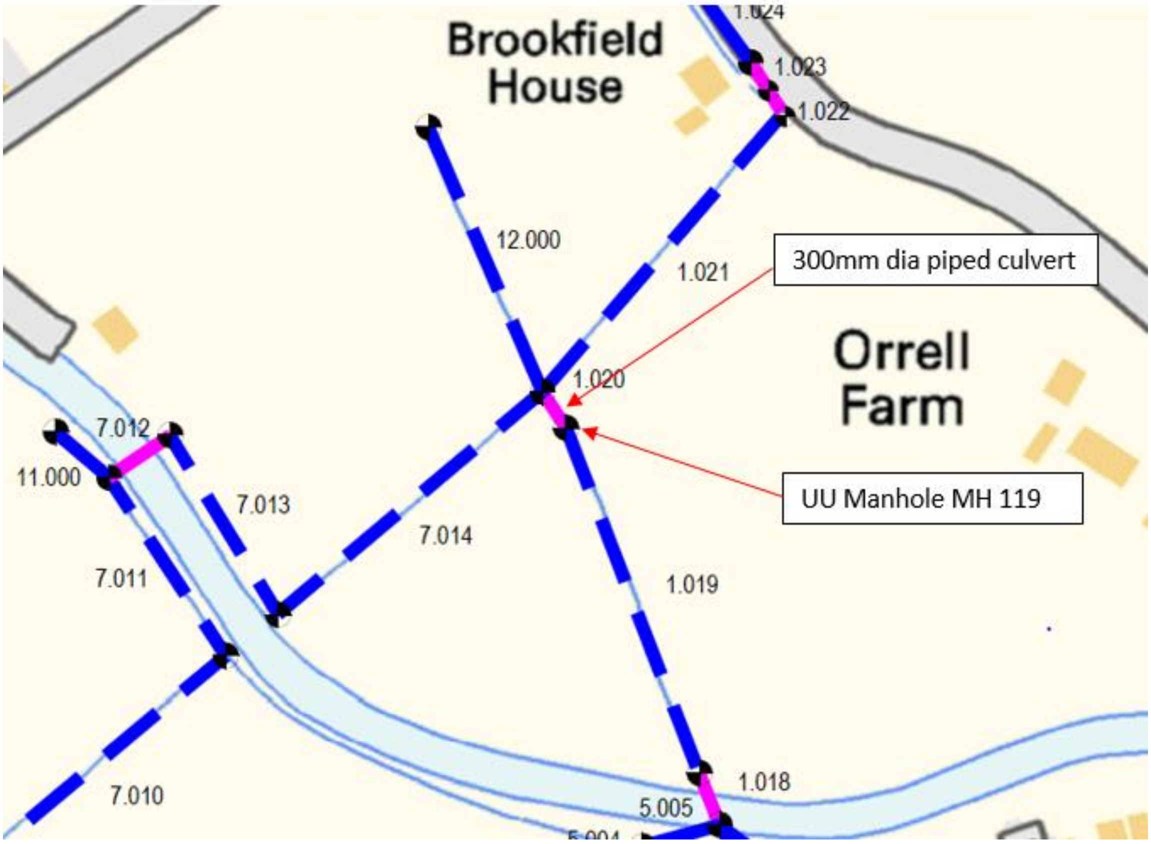


3.7 There is significant flooding at MH 9512 (UU manhole) which is the outfall of the ditches into UU sewers. The modelling results show flood volumes of over 380m^3 during a 30 year rainfall event. These volumes are greatly increased during the 1 in 100year

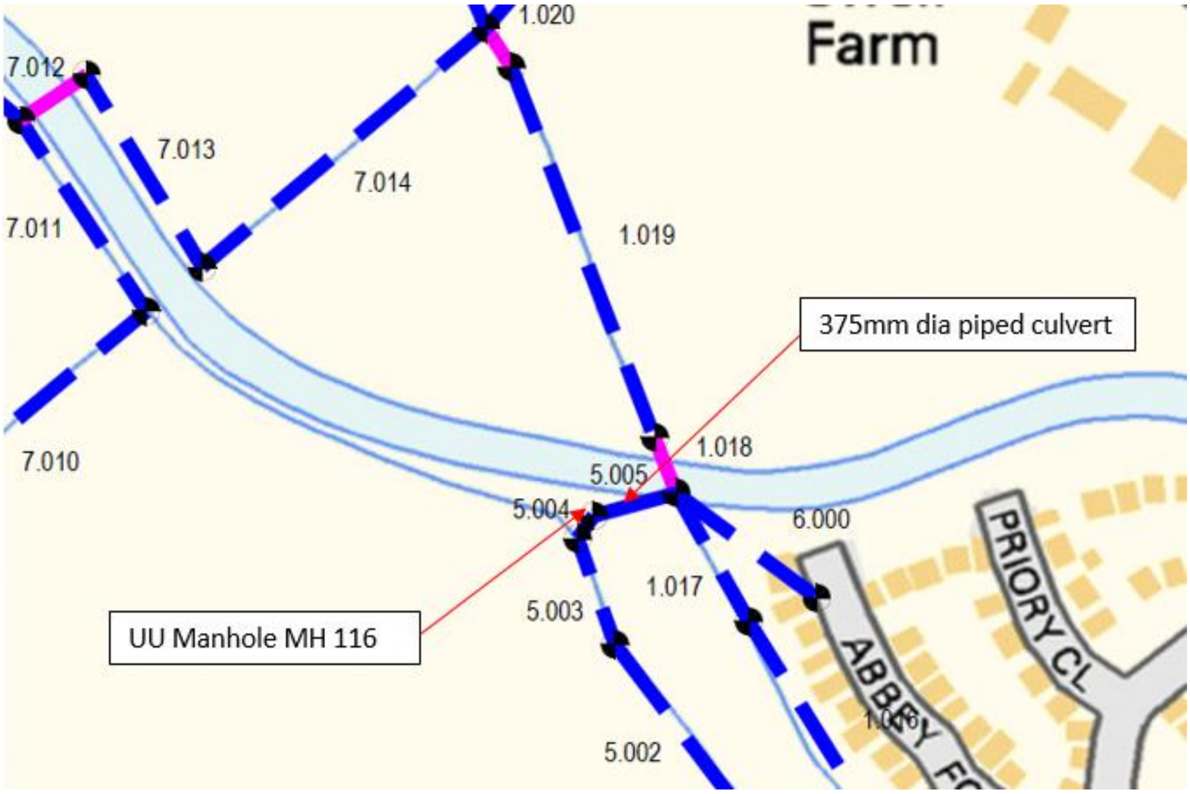
+30%cc events to over 900 m^3. The flooding at this location is likely to be as a result of the large ditch area (800mm x 1500mm for pipe runs 1.000 to 1.002) capturing the runoff from the adjacent field, and the inflow from a 525mm dia pipe from the housing estate south of the ditch, which outfalls out of the ditch through a 375mm dia pipe.

3.8 The rest of the UU system appears to be inundated resulting in flooding all through the system. Significant volumes of flooding occur mainly at the connections points of the drainage from the residential developments. It is worth noting that the connection details and drainage areas have been assumed for modelling purposed and may not truly reflect the existing UU drainage system. However, given the size of the ditches and the catchment area flowing into the system, it is likely that the system will be overwhelmed.

3.9 Further downstream of the system at MH 119 and pipe run 1.020, in the 1 in 100 year event, the water levels rise to over 3.0m above the existing ground levels resulting in over 3600 m^3 of flooding. This is largely attributed to the 2m deep ditch discharging into a 300mm pipe culvert, which connects the ditches together to enable them to operate as a network.



3.10 A similar situation is observed at MH116 (location of run 5.005) which is a 375mm diameter culvert receiving flows from a 400mmx2400mm ditch. The water levels in during a 100 year event +cc are over 1.0m above the existing ground levels with flood volumes of over 1000m^3.



4.0 SUMMARY

4.1 Through collection of data from records, and from site, has enabled a drainage network model to be created, and an assessment to be carried out to understand how the drainage network operates in period of high rainfall.

4.2 As can be seen from the model, and captured in the text above, it is noted that there are constraints within the existing network in different forms. One of these constraints can be seen in locations where high inflow rates from formalised drainage pipes connect into ditches which have smaller outfall pipes out of the ditch, thereby a lower capacity to convey water through the network.

4.3 In other areas of the pipe drainage network, it is considered in locations where 2 drain runs merge of the same pipe size, the capacity of the sewer in this location is not capable of taking the flow within the system, as this potentially doubles the flow for that pipe, whilst retaining the original capacity, and thereby is creating flooding.

4.4 It was noted whilst walking the drainage routes, that a number of the ditches are overgrown, and may benefit from maintenance of these ditches, although the modelling results showed only slight improvements through this operation.

APPENDIX A: CATCHMENT AREAS

APPENDIX B: MODELLING LAYOUT

APPENDIX C: UNITED UTILITIES SEWER MAPS

APPENDIX D: MICRODRAINAGE REPORT