Hydraulic Modelling Report
To Establish the Impact upon Fluvial Flood Storage
In a 1 in 100 Year Plus 35% climate Change Event
Of the Proposed Inland Waterways Marina
At Glebe Farm, Claydon, Banbury, OX17 1TD
From the Adjacent Watercourse

Contents

2420 – Model Report – Rev C August 2020

Appendices

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1 Introduction

1.1 MTC Engineering (Cambridge) Limited has been asked to prepare a hydraulic model of a section of the watercourse running in a southeasterly direction in the vicinity of Boddington Road and just north of Oxford Canal, on behalf of W.A Adams Partnership in relation to the proposed formation of an inland waterways marina.

1.2 During a recent Planning Application (reference 18/00904/F), all Environment Agency objections to the proposed marina were overcome with the exception of determining whether or not the proposed development would have an adverse impact upon the flood plain by the embankments required occupying flood storage volume in a 1 in 100 year plus climate change event, thus triggering a requirement for compensatory flood storage to be provided at the site. A copy of the final Environment Agency letter in relation to Planning Application 18/00904/F is provided in Appendix 2.

1.3 The Environment Agency Flood Map indicates that the site lies in Flood Zones 1, 2 and 3, however is not based upon detailed hydraulic modelling and topographic survey. A HEC-RAS 5.0.7 hydraulic model of the watercourse has therefore been created in order to determine the predicted water levels during a 1 in 100 year fluvial flood event with a 35% allowance for climate change, and determine whether any of the works proposed by the development fall within this flood plain and if so what the impact would be.

1.4 The hydraulic model created is based upon the following information:

- Topographical survey by Essential Construction Services Limited (8th November 2019);
- Cross Sections of the Watercourse by Construction Services Limited and MTC Engineering (Cambridge) Limited;
- Flood Estimation Handbook data.
- REFH Flow Data
- Values of Roughness Coefficient *n* (Chow,1959)
- Ordnance Survey Mapping
- Requirements for Completing Computer River Modelling for Flood Risk Assessments – Guidance for Developers- Version 7

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

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

1.7 This report is a Hydraulic Modelling Report related to the HEC-RAS model created to estimate likely water levels at the site during various return period fluvial flood events. The information presented and conclusions drawn are based on statistical data and are for guidance purposes only. This report provides no guarantee as to the absolute accuracy of water levels, flow rates, and associated probabilities quoted.

2 Site Description

2.1 The site is located on the eastern side of Boddington Road, to the north of Oxford Canal, and is currently occupied by agricultural land.

2.2 The site is surrounded to the north and east by a mixture of open agricultural land and grass paddocks, with Boddington Road running in a northerly direction along the western boundary, past which is further agricultural land and sparse agricultural buildings.

2.3 The Oxford Canal runs in a southeasterly direction along the southwestern boundary of the site, with this then separated from the eastern part of the sites southern boundary by a small area of agricultural land.

2.4 The watercourse that is subject of this modelling runs in a southeasterly direction through grassland to the west then beneath Boddington Road just upstream of the site before continuing to flow along the sites northern boundary then away from the site in a southeasterly direction.

2.5 Structures across the watercourse in the vicinity of the site include a 1.5m diameter culvert which extends for approximately 30m and flows beneath Boddington Road just upstream of the site, and a second short 1.5m diameter culvert which runs beneath the field access between the adjacent fields either side of the watercourse in the northeastern corner of the site.

2.6 The watercourse is predominantly straight, but with one sharper bend at the northeastern corner of the site. There is a paddock along the northern bank and dense trees and shrubbery along the southern bank upstream of Boddington Road. A small area of dense trees and shrubbery is present along either side of the watercourse just downstream of Boddington Road, with this petering out to grass paddock and agricultural fields which run along the remainder of the northern and southern banks in the vicinity of the site.

2.7 The catchment of the watercourse upstream of the site is a rural catchment made up of agricultural fields with very limited built development draining to the watercourse.

2.8 The watercourse flows along a shallow valley which falls in a southeasterly direction, with ground to the north, south and west of the site tending to fall towards the watercourse.

2.9 British Geological Survey Mapping shows the site to be underlain by the Charmouth Mudstone Formation, with no superficial geology present.

3 Hydraulic Model Geometry

3.1 For the purposes of determining flood levels at the site it was considered appropriate to create a hydraulic model running from the upstream side of Boddington Road (cross section 1.547) to approximately 300m downstream of the site (cross section 0.000).

3.2 Essential Construction Services undertook topographic survey work to allow the construction of the hydraulic model, with the survey having been carried out on the 8th November 2019. This includes survey of land to the north of the watercourse, the site itself, and the section of watercourse running upstream and parallel to the site (including bed and bank levels, and relevant structures such as the 1500mm culvert beneath Boddington Road and 1500mm culvert at the sites northeastern corner).

3.3 Some of the land upstream of the site to the south of the watercourse is not owned by the applicant thus was unable to be surveyed due constraints imposed by the third party land owner. Similarly, land to the south of the watercourse directly downstream of the site is owned by a third party and consequently meant survey works of the downstream watercourse and land to the south were unable to be completed.

3.4 Cross sections have been drawn through the section of watercourse that was able to be surveyed with cross sections generally every 100 or so metres, and with additional sections located where relevant such as at the start and end of the two 1500mm culverts.

3.5 To ensure that the areas unable to be surveyed could be accurately modelled LIDAR data was obtained for the site and overlain onto the topographical site survey. A copy of the Topographical survey and LIDAR data is provided in Appendix 3. The data was then used to interpret the profile of land on the right hand side of the watercourse for upstream cross sections (1.547, 1.492, 1.402, 1.372 and 1.342).

3.6 In order to model the downstream section of watercourse that was unable to be surveyed, it was assumed that the longitudinal gradient and profile of the watercourse would continue to be similar to that surveyed immediately upstream.

3.7 This is considered a reasonable assumption to make, firstly, as that the gradient of the watercourse that has been surveyed remains relatively linear, thus it is not anticipated that there would be any significant variation in gradient. Secondly, a site walkover carried out on 12th February 2020 confirmed that the geometry of the downstream section of watercourse did not vary greatly from that upstream, with relevant photos showing this provided in Appendix 4.

3.8 The approximate route of the watercourse was drawn onto the survey to 300 metres downstream and the watercourse bed and bank profile then calculated based upon the average profile of the two most downstream cross sections surveyed. Bed and bank levels where then calculated based upon the continuation of the average longitudinal gradient for the upstream watercourse.

3.9 Cross sections where then drawn every 50m or so (cross sections 0.25, 0.2, 0.15, 0.1, 0.05 and 0.0) based upon survey data on land to the north and the assumed profile and levels of the watercourse. As survey data is not available for land on the right hand side of the watercourse LIDAR data was instead used to interpret the profile of land on this side of the watercourse.

3.10 The location of each cross section is shown on the topographical/LIDAR survey provided in Appendix 3, with copies of the cross sections themselves proved in Appendix 5.

3.11 Cross section 1.342, which runs to the west of the culvert beneath Boddington Road was copied to provide upstream and downstream sections immediately either side of the culvert (at sections 1.341 and 1.312) with piped invert levels and drain bed levels updated as necessary at each face based upon the survey.

3.12 Cross sections 0.462, which runs to the north of the culvert beneath the field access was copied to provide upstream and downstream sections immediately either side of the culvert (at sections 0.461 and 0.452) with piped invert levels updated as necessary.

3.13 Each cross section was entered into HEC-RAS using the chainage and datum provided on the cross sections. The crossing at the 1500mm culvert beneath Boddington Road was entered using a bridge deck to the height of road profile, whilst the crossing at the 1500mm culvert beneath the field access was entered using a bridge deck to the height of the left and right banks, with the culvert running through these at the surveyed invert levels at the upstream and downstream ends.

3.14 During initial model runs, glass walling occurred at some sections, which required cross sections 1.547, 1.492, 1.402, 1.372, 1.342, 1.304 and 0.00 to be extended on their left hand sides, with LIDAR data used to determine how the profile of land would continue past that has been surveyed.

3.15 Additionally to improve the model stability interpolated cross sections have been provided every 20 metres from cross section 1.547 to cross section 1.402 and from cross section 1.312 to cross section 0.00.

3.16 A Mannings's Number of 0.05 is considered appropriate for a watercourse such as this which tends to be a clean channel with a stoney bed and some undulation creating pools and shoals and was therefore applied to the main channel. The minimum and maximum values indicated for such a water course are 0.045 and 0.06.

3.17 With regards to the flood plain/out of bank flow, the vast majority of the upstream flood plain on the left bank is open paddock, which is likely to have a Manning's Numbers of 0.03 for pasture with no brush and short grass. The upstream flood plains on the right bank is largely made up of dense trees and shrubbery, which is likely to have a Manning's Number of 0.07 for an area of medium to dense brush in winter.

3.18 For a short distance downstream of Boddington Road (cross sections 1.312, 1.304, 1.192 and 1.112) the flood plain on both the left and right bank is largely made up on dense trees and shrubbery and as such a Manning's Number of 0.07 would also apply.

3.19 The dense trees and shrubbery then tends to decrease with open paddock and agricultural land forming the remainder of the left and right bank respectively, and would likely have a Manning's Number of 0.03 for pasture with no brush and short grass, and cultivated areas with no crop (Chow, 1959). Photos of the watercourse and floodplain are provided in Appendix 4.

3.20 Sensitivity testing has been carried out for Manning's Numbers as detailed in Section 5, and it has been determined that the model is not overly sensitive to Manning's Numbers thus variations on the above would not have a significant impact upon the results detailed in Section 7, and the Mannings Numbers detailed above are considered suitable for use in the model.

3.21 Finally, levees were added to high points on either bank of the sections throughout the model to prevent flooding occurring in lower adjacent areas unless flows actually come over bank levels.

4 Hydraulic Model Flows

4.1 Initially catchment data was obtained from the Wallingford Hydro Solutions Limited FEH Web Service for the downstream end of the section of watercourse modelled (grid reference 446850, 250750).

4.2 This data was firstly used to generate a hydrograph for the 1 in 100 year return period event on the watercourse using ReFH Version 2 software which indicated a peak flow of 24.772 cubic metres per second (cumecs), with a copy of ReFH Flow hydrographs provided in Appendix 6.

4.3 A second 1 in 100 year flow estimate was calculated using the catchment descriptors method, with the results provided in Appendix 7. These ranged between 10.092 cumecs and 16.608cumecs, and averaged to give a flow of 12.389cumecs.

4.4 This was around half the peak of 24.772 cumecs predicted by the Revitalised FSR/FEH method, which was therefore used to provide a 1 in 100 year flow hydrograph used in the hydraulic model to ensure that the most conservative flow estimate was used.

4.5 The 1 in 100 year flows were then entered into the hydraulic model as a flow hydrograph with the downstream boundary conditions used being normal depth of 0.00128 which is based upon the gradient between the two downstream cross sections (0.05 and 0.00).

4.6 There are no gauging stations in the vicinity of the site that could be used to provide calibration to the model. However to ensure the model is operating realistically an inspection of the watercourse was undertaken, with photos provided in Appendix 4. The photos of the watercourse were taken on the 12th February 2020 immediately after Storm Ciara and show that the water level within the watercourse remained significantly below bank levels, thus it is considered realistic that out of bank flow would only occur during very extreme events.

4.7 What's more sensitivity testing has been carried out for flows as detailed in Section 6, and it has been determined that the model is not overly sensitive to flows thus variations in these would not have a significant impact upon the results as detailed in Section 7.

5 Sensitivity Testing of Manning's Numbers

5.1 In the absence of any available data with which to calibrate the model, sensitivity testing on the Manning's Numbers used has been carried out.

5.2 The sensitivity test involved the Manning's Numbers used for the channel and floodplain (Section 3) being adjusted by +/- 20% and the results compared against results given by the model when using the proposed Manning's Numbers to determine whether or not the model is overly sensitive to alterations to Manning's Numbers.

5.3 A copy of results using the proposed Manning's Numbers for the 1 in 100 year flow is provided in Appendix 8. The same flow was then run again with the only alteration being that the Manning's Numbers were increased 20% (Appendix 9) and decreased 20% (Appendix 10). A comparison between the modelled water levels at each section based upon these three scenarios is provided in Table 5.1 on the following page.

5.4 As can be seen from the below results, increasing and decreasing the Manning's number by 20% tends to increase and decrease the waters levels by between 70mm and 100mm throughout the majority of the water course and in the vicinity of the proposed development.

5.5 A slightly higher variation occurs in the vicinity of the culverts, however the level of variation indicated lies within the expected range for a channel such as this and does not indicate that the model is overly sensitive to variation in Manning's Numbers.

5.6 The Manning's Numbers proposed for use in the model are considered suitable for use, and it is not considered that slight variations from true values would have a significant impact upon water levels throughout the model.

River Station	Correct Manning’s Number Water Level	Manning’s Numbers Increased 20%		Manning’s Numbers Decreased 20%	
		Level	Difference	Level	Difference
1.547	113.28	113.26	-0.02	113.59	+0.31
1.492	113.28	113.26	-00.2	113.59	+0.31
1.402	113.27	113.26	-0.01	113.58	+0.31
1.372	113.27	113.26	-0.01	113.58	+0.31
1.342	113.24	113.22	-0.02	113.57	+0.33
1.312	111.35	111.45	+0.1	111.23	-0.12
1.304	111.27	111.38	+0.11	111.14	-0.13
1.192	110.70	110.77	+0.07	110.61	-0.09
1.112	110.40	110.47	+0.07	110.33	-0.07
1.022	110.26	110.32	+0.06	110.19	-0.07
0.922	109.74	109.78	+0.04	109.70	-0.04
0.802	109.44	109.47	+0.03	109.41	-0.03
0.672	109.03	109.06	+0.03	108.88	-0.15
0.502	108.86	108.81	-0.05	108.64	-0.22
0.467	108.85	108.79	-0.06	108.64	-0.21
0.462	108.85	108.78	-0.07	108.62	-0.23
0.452	108.16	108.34	+0.18	108.07	-0.09
0.445	108.33	108.42	+0.09	108.28	-0.05
0.420	108.23	108.30	+0.07	108.15	-0.08
0.395	108.10	108.19	+0.09	108.03	-0.07
0.300	107.90	107.90	0.00	107.81	-0.09
0.250	107.85	107.75	-0.1	107.70	-0.15
0.200	107.84	107.68	-0.16	107.65	-0.19
0.150	107.83	107.63	-0.2	107.64	-0.19
0.100	107.83	107.61	-0.22	107.63	-0.20
0.050	107.41	107.29	-0.12	107.61	+0.20
0.000	106.96	106.89	-0.07	107.00	+0.04

Table 5.1: Manning’s Number Sensitivity Test Results

6 Sensitivity Testing of Flows

6.1 In the absence of any data with which to calibrate the models, further sensitivity testing has been carried out in relation to flow data used in the model.

6.2 This involves running the model with the proposed Mannings Numbers but the 1 in 100 year flow used being increased and decreased by 20%, with copies of the results and unsteady flow data provided in Appendices 11 and 12. Table 6.1 on the following page compares the results of the modelled water levels for the increased and decreased flows at each station against those produced using the proposed 1 in 100 year flow.

6.3 As can be seen from the below results, increasing and decreasing the flows by 20% tends to increase the waters levels by between 10mm and 80mm or decrease the water levels by around 70mm throughout the majority of the water course and the vicinity of the site.

6.4 This falls within the range of variability expected as the higher the water level the wider the cross sectional area of the channel, thus greater flow would usually have less impact upon water levels than the decrease.

6.5 The model is not overly sensitive to flow increases or decreases.

6.6 As the model is not overly sensitive to flow it is considered that the 1 in 100 year flow used is suitable for establishing reasonably accurate 1 in 100 year water levels in the model, and if anything is on the conservative side given that the Revitalised FSR/FEH flow being used are significantly higher than the catchment descriptor calculated flows.

River Station	Correct Flow Water Level	Flow Increased 20%		Flow Decreased 20%	
		Level	Difference	Level	Difference
1.547	113.28	113.29	+0.01	113.26	-0.02
1.492	113.28	113.29	+0.01	113.26	-0.02
1.402	113.27	113.29	+0.02	113.26	-0.01
1.372	113.27	113.29	+0.02	113.26	-0.01
1.342	113.24	113.24	0.00	113.24	0.00
1.312	111.35	111.48	+0.13	111.19	-0.16
1.304	111.27	111.40	+0.13	111.13	-0.14
1.192	110.70	110.78	+0.08	110.62	-0.08
1.112	110.40	110.47	+0.07	110.33	-0.07
1.022	110.26	110.33	+0.07	110.19	-0.07
0.922	109.74	109.78	+0.04	109.70	-0.04
0.802	109.44	109.48	+0.04	109.40	-0.04
0.672	109.03	109.09	+0.06	108.95	-0.08
0.502	108.86	108.93	+0.07	108.80	-0.06
0.467	108.85	108.91	+0.06	108.80	-0.05
0.462	108.85	108.87	+0.02	108.80	-0.05
0.452	108.16	108.33	+0.17	108.15	-0.01
0.445	108.33	108.50	+0.17	108.27	-0.06
0.420	108.23	108.37	+0.14	108.15	-0.08
0.395	108.10	108.23	+0.13	108.05	-0.08
0.300	107.90	107.97	+0.07	107.84	-0.06
0.250	107.85	107.89	+0.04	107.79	-0.06
0.200	107.84	107.86	+0.02	107.78	-0.06
0.150	107.83	107.85	+0.02	107.77	-0.06
0.100	107.83	107.84	+0.01	107.77	-0.06
0.050	107.41	107.44	+0.03	107.31	-0.1
0.000	106.96	107.06	+0.1	106.80	-0.16

Table 6.1: Flow Sensitivity Test Results

7 Hydraulic Model Results

7.1 To determine the extent of flooding pre-development during a 1 in 100 year plus 35% climate change event the 1 in 100 year flow hydrograph was increased by a factor of 35% (higher central climate change allowance anticipated for 2115 in the Thames Region). A copy of the results are provided in Appendix 13, with a summary of the results provided in Table 7.1.

7.2 As can be seen from the cross sections provided in Appendix 13, during a 1 in 100 year plus 35% climate change event the majority of out of bank flow is on the left hand side bank, thus on the opposite side of the watercourse to the site.

7.3 Minimal out of bank flow occurs on the right hand side bank at the upstream end of the site, with ponding tending to remain on the northern side of an embankment which runs adjacent to the watercourse, with exception of an area of ponding in the central northern part of the site (in the vicinity of cross section 1.022) where water levels are marginally higher than the existing embankment, thus causing a limited area of ponding to the south of the embankment as shown on the flood extents plan provided in Appendix 14.

7.4 Downstream of this out of bank flow remains limited to the northern side of the embankment, with the extent of ponding only increasing again on the inside of the bend where the watercourse turns to run through the second culvert at the downstream extent of the site.

7.5 The results indicate that at the upstream end of the site (cross section 1.312 and 1.304) water levels are between 111.57m and 111.48m above Ordnance Datum (AOD) in the 1 in 100 year plus 35% climate change event, falling to 107.87m AOD at the downstream end of the site.

7.6 To determine the extent of flooding post-development during a 1 in 100 year plus 35% climate change event and whether the proposed development would have any adverse impact upon flood storage volumes during such an event the model was run again but with geometry updated to the post development scenario.

In order to consider the post development scenario the model cross sections in the vicinity of the site were updated (1.304, 1,192, 1.112, 1.022, 0.922, 0.802, 0.672, 0.502, 0.467, 0.462, 0.445, 0.420, 0.395 and 0.3) to suit the ground levels associated with the proposed new embankment. A copy of the post development cross sections is provided in Appendix 15.

7.7 Additionally to also ensure the proposed lake has been taken into account, the lake has been modelled as a storage area using the area times depth method. To ensure the storage volume provided by the lake is modelled accurately the surface area of the lake (22650m^2) was entered into the model as the area, whilst the permeant design water level of the lake of 107.87m AOD was entered as the minimum elevation as any flood storage provided by the lake would be above this level.

7.8 As any flow coming out of bank at cross section 0.502, 0.467, 0.462,0.452,0.445,0.42,0.395 and 0.3 could discharge to the lake, the cross sections were modelled with a lateral connection to the lake using a weir/embankment system. The elevation of the weir/embankment has been based upon the ground level directly adjacent to the lake at each cross section, with water would only beginning to flow into the lake when the adjacent ground level is exceeded.

7.9 The model was run again using the post development model cross sections and with the 1 in 100 year flow hydrograph was increased by a factor of 35%. A copy of the post development results are provided in Appendix 16, with a summary of the results with comparison made to the pre-development results provided in Table 7.1 below.

River Station	Pre-Development 1 in 100 year plus 35% Climate Change Water Level	Post Development 1 in 100 year plus 35% Climate Change Water Level	Level Difference in Pre and Post Development Scenario
1.547	113.34	113.34	+-0.00
1.492	113.34	113.34	+-0.00
1.402	113.33	113.34	+0.01
1.372	113.33	113.34	+0.01
1.342	113.28	113.29	+0.01
1.312	111.57	11.57	+-0.00
1.304	111.48	111.48	+-0.00
1.192	110.83	110.81	-0.02
1.112	110.50	110.50	+-0.00
1.022	110.36	110.36	+-0.00
0.922	109.81	109.81	+-0.00
0.802	109.51	109.51	+-0.00
0.672	109.11	109.10	-0.01
0.502	108.93	108.77	-0.16
0.467	108.91	108.76	-0.15
0.462	108.87	108.75	-0.12
0.452	108.33	108.16	-0.17
0.445	108.50	108.39	-0.11
0.420	108.38	108.28	-0.10
0.395	108.23	108.16	-0.07
0.300	107.96	107.94	-0.02
0.250	107.89	107.87	-0.02
0.200	107.86	107.85	-0.01
0.150	107.85	107.84	-0.01
0.100	107.84	107.83	-0.01
0.050	107.44	107.44	+-0.00
0.000	107.06	107.04	-0.02

Table 7.2: Post-Development Model Results –1 in 100 Year Plus 35% C.C

7.10 As can be seen from the cross sections provided in Appendix 16 and flood extent drawing provided in Appendix 16, post development the 1 in 100 year plus 35% climate change event flood extent is almost identical to the pre-development scenario, with the majority of out of bank flow occurring on the left hand side of the bank.

7.11 Out of bank flow on the right hand bank continues to remain mostly on the northern side of the existing embankment, but with limited ponding occurring in the central northern part of the site where water levels are slightly above the existing embankment.

7.12 As can be seen from the plan in Appendix 17, the proposed embankment would remain to the south of any ponded water in the central northern part of the site and thus outside of the 1 in 100 year plus 35% climate change flood extent. The proposed embankment would therefore have no adverse impact upon flood storage at the site.

7.13 The proposed lake in the eastern area of the site is located within the 1 in 100 year plus 35% climate change flood extent, however provides a flood storage benefit as the surface of the lake will be lower than existing ground levels.

7.14 As can be seen by the plan provided in Appendix 17, and results provided in Table 7.2 the lake will reduce water levels at the downstream end of the site, by between 10mm and 170mm in the vicinity of cross sections 0.672 and 0.420.

7.15 This is because any water that would begin to build up and pond on the inside bend where the watercourse turns to run through the second culvert would instead be allowed to build up on the larger area of the proposed lake thus the resultant water level would be lower.

7.16 The proposed lake will therefore not have a detrimental impact on flood storage volumes, but a beneficial impact.

8 Conclusions

8.1 The model has been constructed using reliable cross section data from topographic survey undertaken by Essential Constrction Services Ltd and LIDAR data information.

8.2 A 1D steady state model is considered appropriate in this instance in line with Environment Agency guidance given that there are no complex flow routes in the flood plain or significant areas of flood plain storage.

8.3 Flows were estimated using two different methods, with the worst case ReFH estimation method used to provide the 1 in 100 year flow hydrograph used in the model, with this increased by a factor of 35% to account for climate change.

8.4 Sensitivity testing has been carried out for the Manning's Numbers used in the model. This indicates that whilst there is limited variation in water levels this is within the expected range and the Manning's Numbers used are considered reasonable.

8.5 Sensitivity testing has been carried out for a 20% increase and decrease on the 1 in 100 year flow used in the model. This indicates that whilst there is variation in water levels this is within the expected range and the flows used are considered reasonable.

8.6 The modelled 1 in 100 year plus 35% climate change flood level applicable to the upstream end of the site (cross section 1.312 and 1.304) is between 111.57m and 111.48m AOD, falling to 107.87m AOD at the downstream end of the site.

8.7 Modelling shows that the vast majority of the site subject to development would remain almost entirely dry during a 1 in 100 year plus 35% climate change event. No ground raising works proposed are located within the modelled 1 in 100 year plus 35% climate change flood extent, thus will have no adverse impact upon flood storage at the site in such an event.

8.8 No ground raising will take place in the area shown as at risk of flooding in a 1 in 100 year plus 35% climate change event in the drawings provided in Appendix 14, without obtaining the prior written consent of the Local Planning Authority.

8.9 The only proposed development within the 1 in 100 year plus 35% climate change flood plain is part of the proposed lake, which involves excavation works only with a lake water level of 107.75m AOD proposed.

8.10 The modelled post development scenario shows that the proposed lake would have no detrimental impact to the proposed development, but would in fact provide a flood reduction measure by reducing water levels at the site as is will increase the available flood storage.

8.11 The hydraulic modelling report demonstrates that the proposed development will have no adverse impact upon the flood plain of the watercourse along the northern boundary of the site, thus provides sufficient information to overcome the Environment Agency objection on the grounds detailed in Appendix 2.

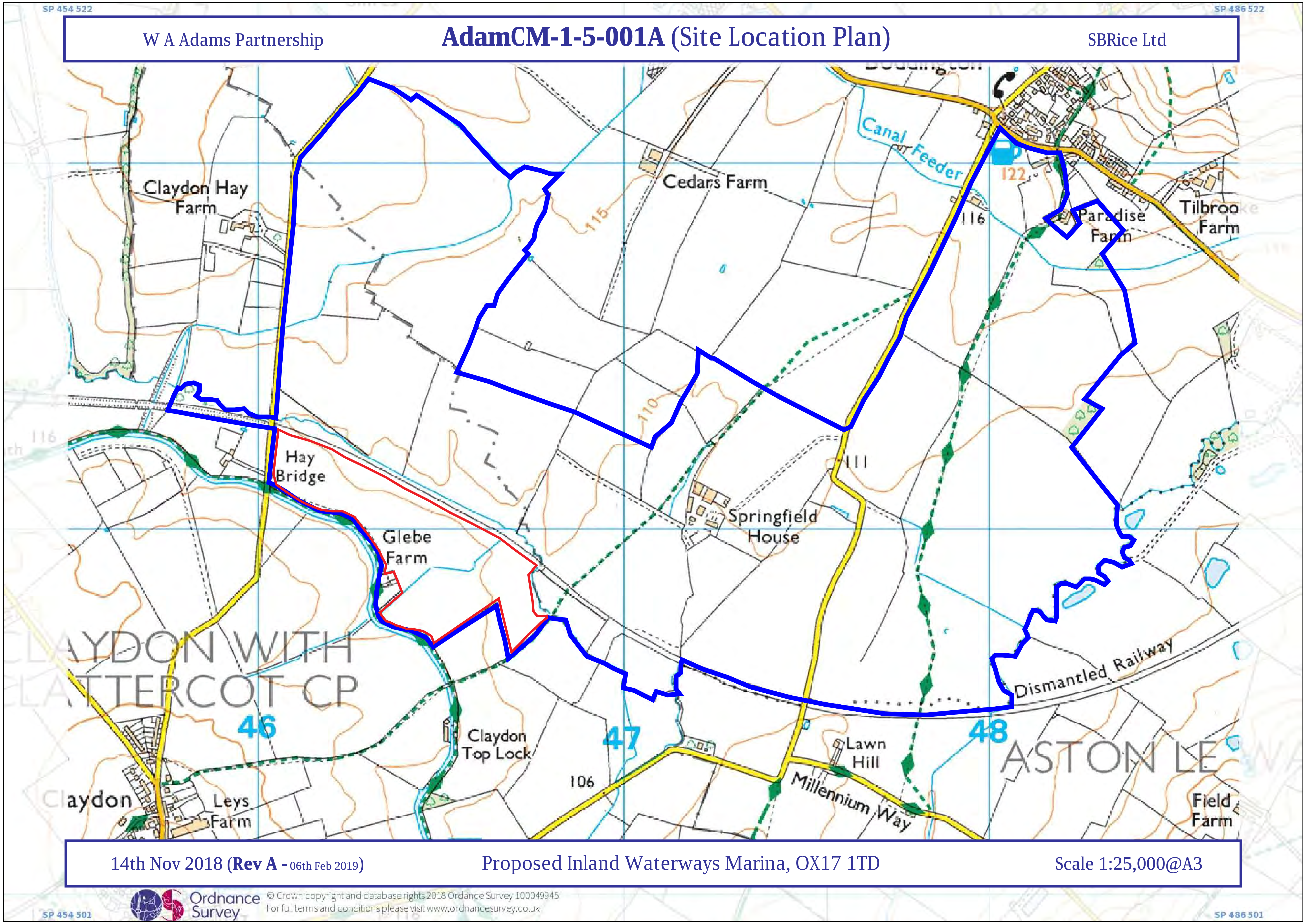
APPENDIX 1

SITE LOCATION PLAN

W A Adams Partnership

AdamCM-1-5-001A (Site Location Plan)

SBRice Ltd



14th Nov 2018 (**Rev A -** 06th Feb 2019)

Proposed Inland Waterways Marina, OX17 1TD

Scale 1:25,000@A3

Ordnance Survey

APPENDIX 2

FINAL ENVIRONMENT AGENCY RESPONSE TO PLANNING APPLICATION 18/00904/F

creating a better place

Environment Agency

Ms Clare O'Hanlon
Cherwell District Council
Planning & Development Services
Bodicote House
White Post Road
Bodicote
Banbury
OX15 4AA

Our ref: WA/2018/125260/03-L01
Your ref: 18/00904/F

Date: 12 September 2019

Dear Ms O'Hanlon

Formation of inland waterways marina with ancillary facilities building, car parking, access and associated landscaping including the construction of a new lake.
Glebe Farm, Claydon, Banbury, OX17 1TD.

Thank you for your consultation on the above planning application.

The site lies with Flood Zones 1, 2 and 3 in accordance with our flood risk mapping. However the Cherwell District Council Strategic Flood Risk Assessment (SFRA) Level 1 update dated May 2017 section 4.3.5.1 states that:

"*Due to the limited extent of detailed modelling of the 5% AEP event in the District, where detailed modelled outlines for the 5% AEP event are unavailable, as a precautionary approach Flood Zone 3a (>=1% AEP) should be used as a proxy for Flood Zone 3b for the purposes of the sites included within this Level 1 SFRA Update.*

There is no modelled flood data available. Therefore according to the Cherwell SFRA this site lies within Flood Zone 3b. Flood Zone 3b is defined as land where water has to flow or be stored in times of flood. In accordance with Table1 'Flood Risk' of the Planning Practice Guidance.

This site has an ordinary watercourse running along the northern boundary. This becomes the main river the Wormleighton Brook towards the south east of the site. There is also a potential presence of protected species for environmental permits within the site, the European Water Vole.

Environment Agency response

Inadequate FRA

Cont/d..

In the absence of an acceptable Flood Risk Assessment (FRA) we **maintain our objection** to the grant of planning permission and recommend refusal on this basis for the following reasons:

Reason

The FRA submitted with this application does not comply with the requirements set out in paragraph 163 of the National Planning Policy Framework or Cherwell Local Plan Policy ESD 6 (Sustainable Flood Risk Management). The submitted FRA does not therefore, provide a suitable basis for assessment to be made of the flood risks arising from the proposed development.

Explanation

We have reviewed the Flood Risk Assessment (EAS, 1319/2019 Rev: B, July 2019) submitted in support of the proposed development. We are pleased that the development has been re-located to Flood Zone 1 although the red line boundary of the site still lies within Flood Zone 3 (therefore 3b as detailed in our letter dated 24 April 2019). A flood risk assessment should explore the existing flood risk to the site and potential increased risk as a result of the proposed development. Mitigation such as floodplain compensation should then be considered if required in order to maintain the floodplain.

As the red line boundary encroaches into Flood Zone 3, a climate change assessment should still be undertaken using an appropriate allowance. As noted, the current Flood Map isn't based on detailed modelling for this area, rather broad scale generalised modelling which is used to indicate potential flood risk for further investigation.

Therefore there is still some uncertainty as to whether the development will impact on the floodplain. Providing more confidence in this by assessing the 1% AEP plus climate change extent is essential given that the base of the earth work's in some locations run exactly along the edge of the mapped Flood Zone (Site Plan, dwg no: A05/020 E, 01/07/2019). As the development has been re-located to an area of lower flood risk, full detailed hydraulic modelling may not be appropriate now but other methods should be used to improve confidence in the FRA's conclusions.

We note that the footpath proposed within the flood zones is to be set an existing ground level and therefore not impact on floodplain storage or impede flood flows (FRA section 4.7).

Overcoming our Objection

The applicant can overcome our objection by submitting an FRA which covers the deficiencies highlighted above and demonstrates that the development will not increase flood risk elsewhere and where possible reduces flood risk overall. If this cannot be achieved we are likely to maintain our objection to the application.

Notes to local planning authority regarding decision

If the Local Authority are minded to grant permission against our recommendation, we request the Local Authority reconsult us for further representation. Please note we may have comments and conditions in other areas of remit following reconsultation.

In accordance with the Planning Practice Guidance (Reference ID: 7-043-20140306), please notify us by email within 2 weeks of a decision being made or application withdrawn. Please provide us with a URL of the decision notice, or an electronic copy of the decision notice or outcome.

Foul drainage and water quality

In the FRA paragraph 6.25 it states that:

“The boats themselves are not part of the planning application, and it is understood that foul waste from narrowboats is usually pumped out to an underground holding tank where it will be periodically emptied via a licenced waste disposal firm.”

If this is the case and the boat users at the marina are not going to be using the private sewage treatment system then we are able to **withdraw our objection** on water quality grounds. However the applicant and local planning authority will need to be aware that an environmental permit will be required for the use of the proposed private sewage treatment system which is for the clubhouse. Please be aware that the permit may not be granted.

The equivalent of 20 houses were proposed to use the private sewage treatment system. In the current submission the numbers of people who would use the facility have been reduced and the applicant has calculated the rate of discharge from the site to Wormleighton Brook as the equivalent of three four bedroom houses which would not need to connect to the public sewer.

The applicant has identified the sewage system they would use and proposed a reed bed before the discharge reaches the brook. It is unclear which Conder SAF system they would install and clarification of this is sought.

The calculations of usage of the facilities in Appendix M for the FRA are based on low numbers (48 people) this is the best case scenario. There must be capacity in the system to deal with peak usage. During the time the applicant has considered March-October, this is a particularly sensitive time for ecology and higher numbers of people may use the facilities at this time leading to variable discharge rates and it must be ensured that the discharge is of a quality that does not impact the environment. Calculations must be undertaken for 50% and 75% usage of the facilities.

Informatives

Environmental permitting regulations (EPR) - main rivers

This development may require an Environmental Permit from the Environment Agency under the terms of the Environmental Permitting (England and Wales) (Amendment) (No. 2) Regulations 2016 for any proposed works or structures, in, under, over or within 8 metres of the top of the bank of designated ‘main rivers’. This was formerly called a Flood Defence Consent. Some activities are also now excluded or exempt. An environmental permit is in addition to and a separate process from obtaining planning permission. Further details and guidance are available on the GOV.UK website: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.

Environmental permit – Foul drainage

The foul drainage associated with this development will require an Environmental Permit under the Environmental Permitting Regulations 2010, from the Environment

Agency, unless an exemption applies. The applicant is advised to contact the Environment Agency on **08708 506 506** for further advice and to discuss the issues likely to be raised. You should be aware that the permit may not be granted. Additional 'Environmental Permitting Guidance' can be accessed via our main website (https://www.gov.uk/government/publications/environmental-permitting-guidance).

Final Comments

Once again, thank you for contacting us. Our comments are based on our available records and the information as submitted to us.

Please quote our reference number in any future correspondence.

If you have any queries please contact me.

Yours sincerely

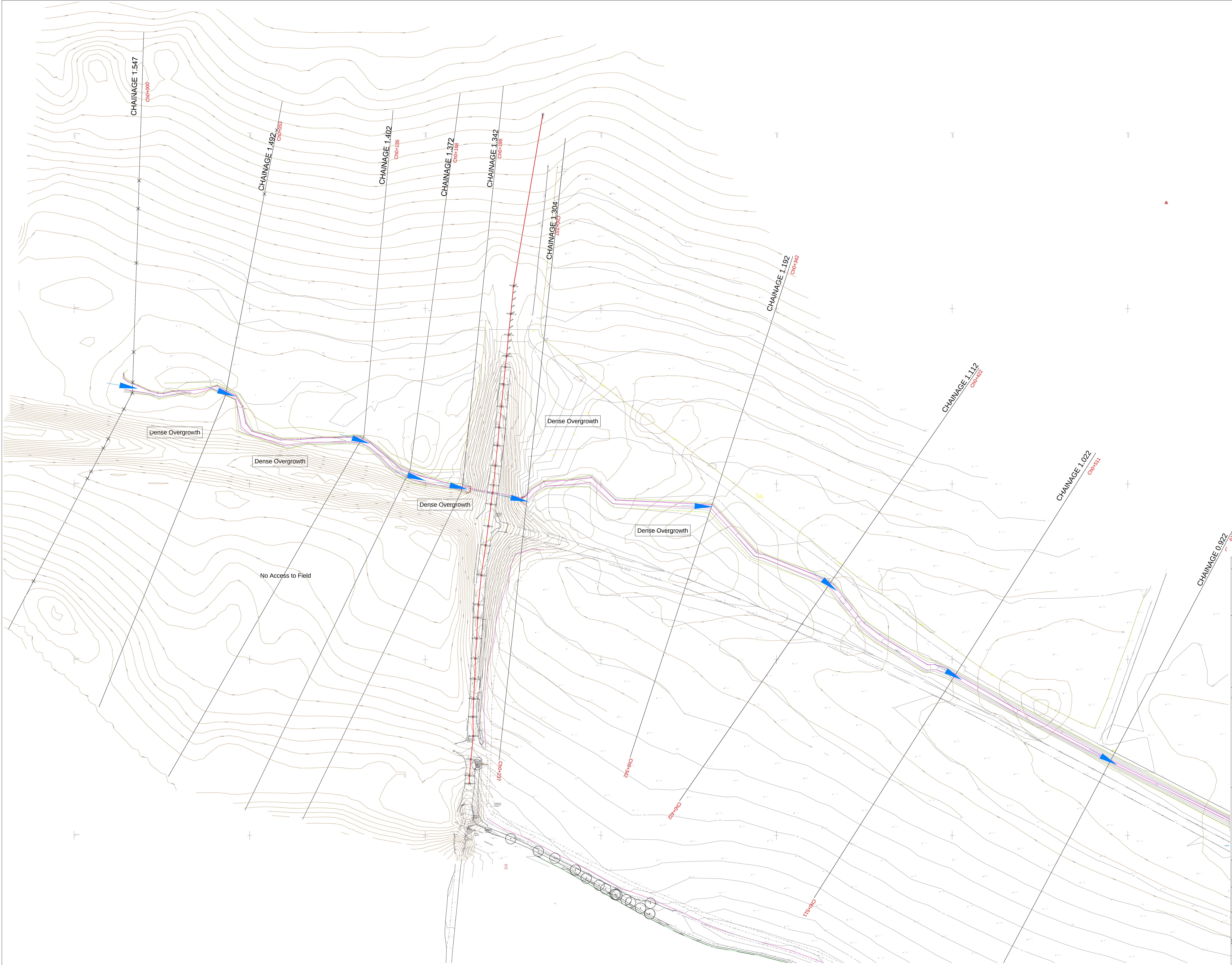
Miss Michelle Kidd
Planning Advisor

Direct dial 02030259712
E-mail planning_THM@environment-agency.gov.uk

cc SBRICE Ltd

APPENDIX 3

TOPOGRAPHIC SITE, WATERCOURSE, AND ROAD SURVEY, LIDAR DATA AND CROSS SECTION LOCATION PLAN



KEY:

Flow Direction

REV	DATE	DESCRIPTION/REASON FOR ISSUE	APPR
B	16.06.2020	UPDATED CROSS SECTIONS	SEC
A	18.02.20	ADDED FLOW DIRECTION & LIDAR DATA	SEC

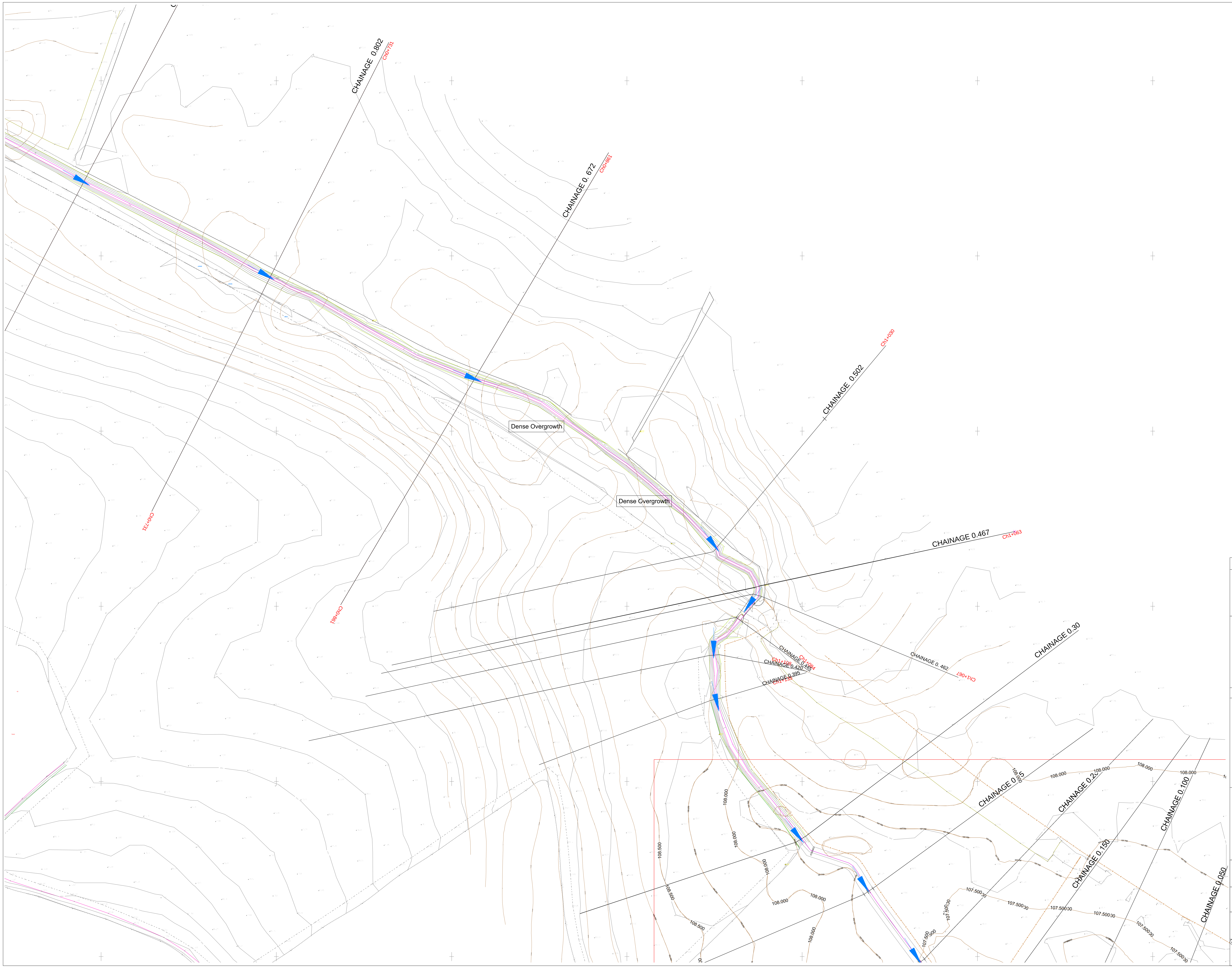
MTC ENGINEERING

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

NEW INLAND MARINA, ON LAND AT GLEBE FARM CLAYDON, BANBURY CROSS SECTION LOCATIONS 1 of 3

ORIG S.E.C
DATE 29.11.2019
CHKD
SCALE 1:1000@A1
APPR
DRAWING NO 2420-02
REV B



KEY:

◄ Flow Direction

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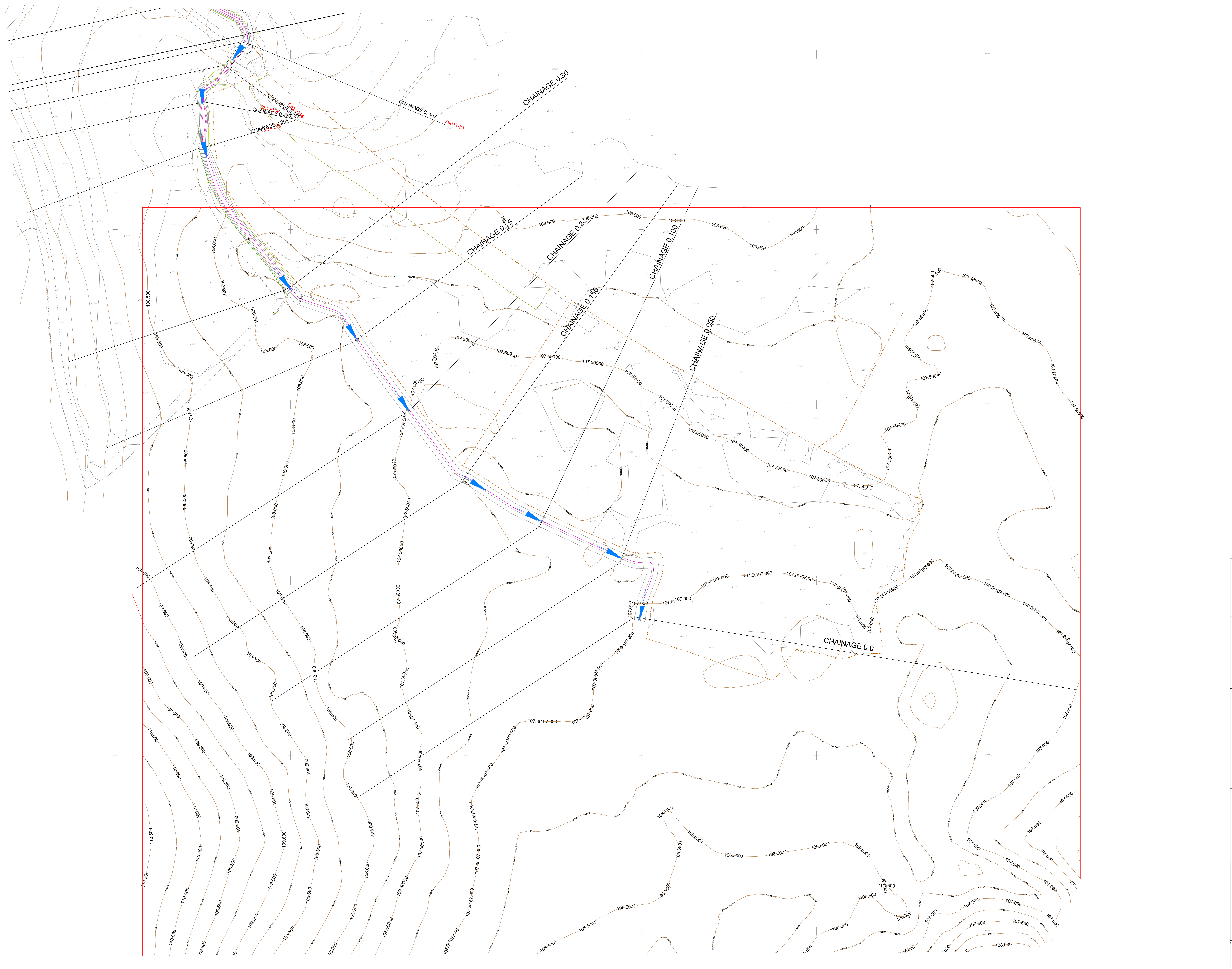
NEW INLAND MARINA,
ON LAND AT GLEBE FARM
CLAYDON, BANBURY
CROSS SECTION LOCATIONS
2 of 3

ORIG S.E.C	DATE 29.11.2019
CHKD	SCALE 1:1000@A1
APPR	DRAWING NO 2420-03 REV B



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ORIG S.E.C	DATE 29.11.2019
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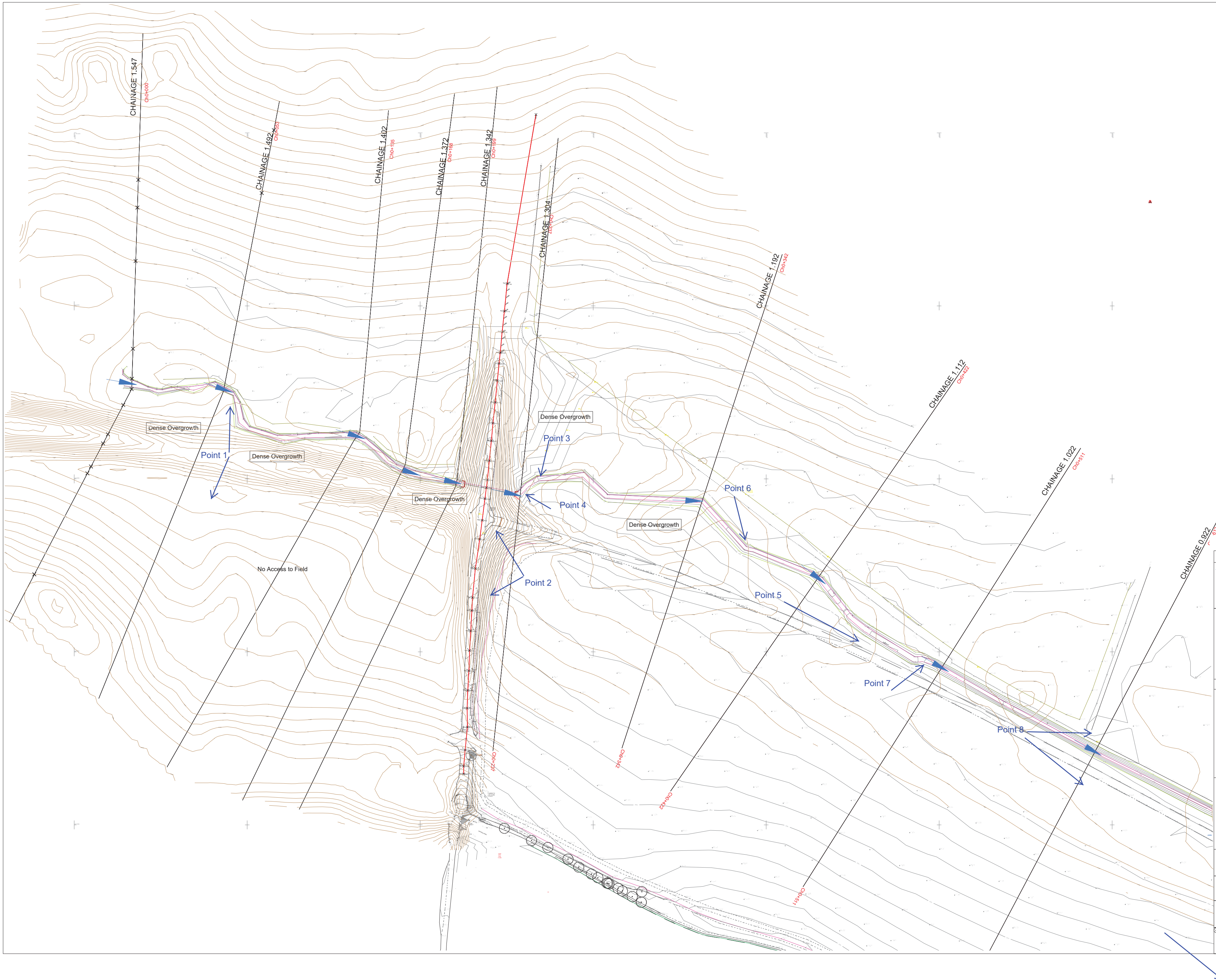
APPR	DRAWING NO 2420-04 REV B



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1 of 3

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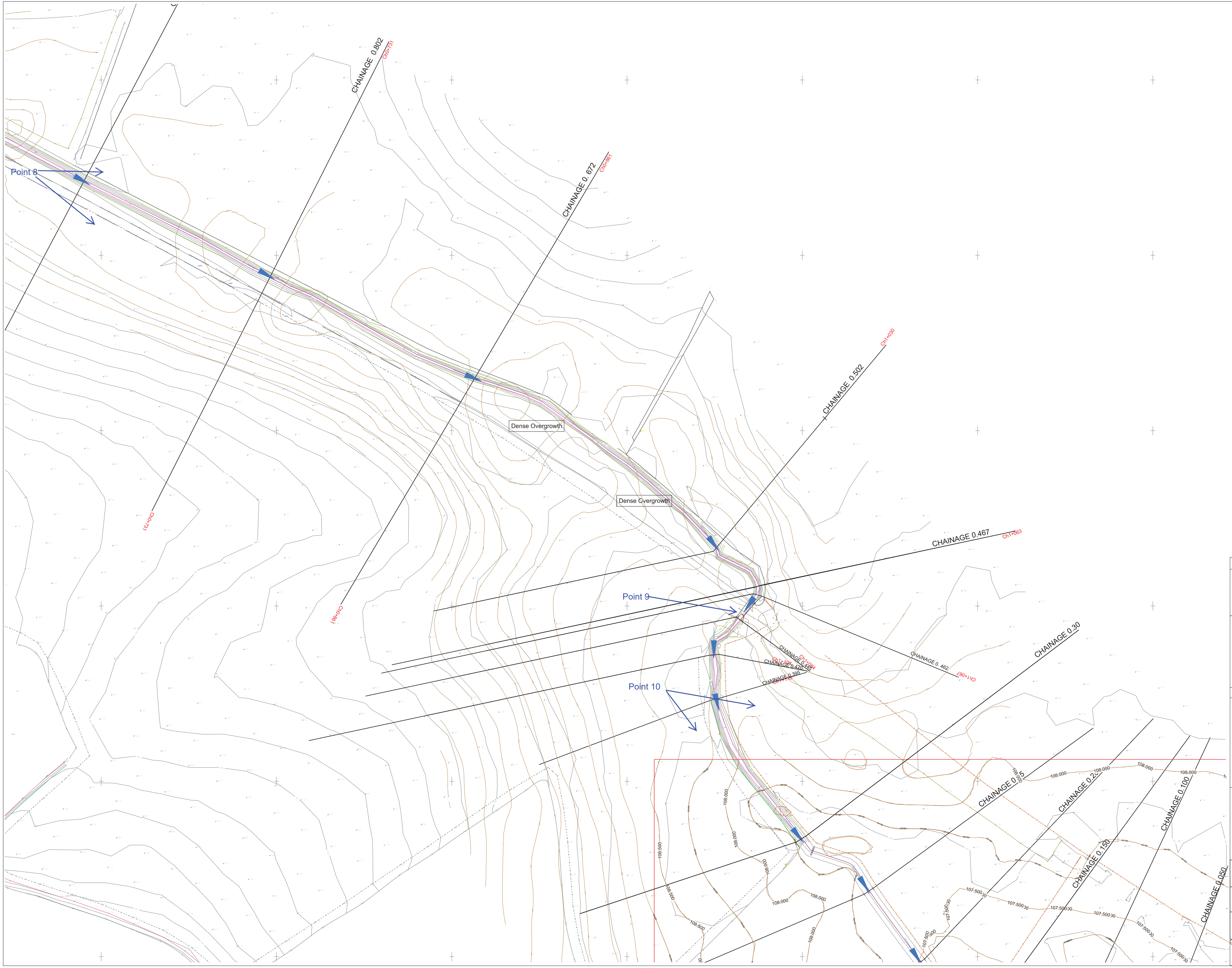
APPR	DRAWING NO 2420-02 REV B



KEY:

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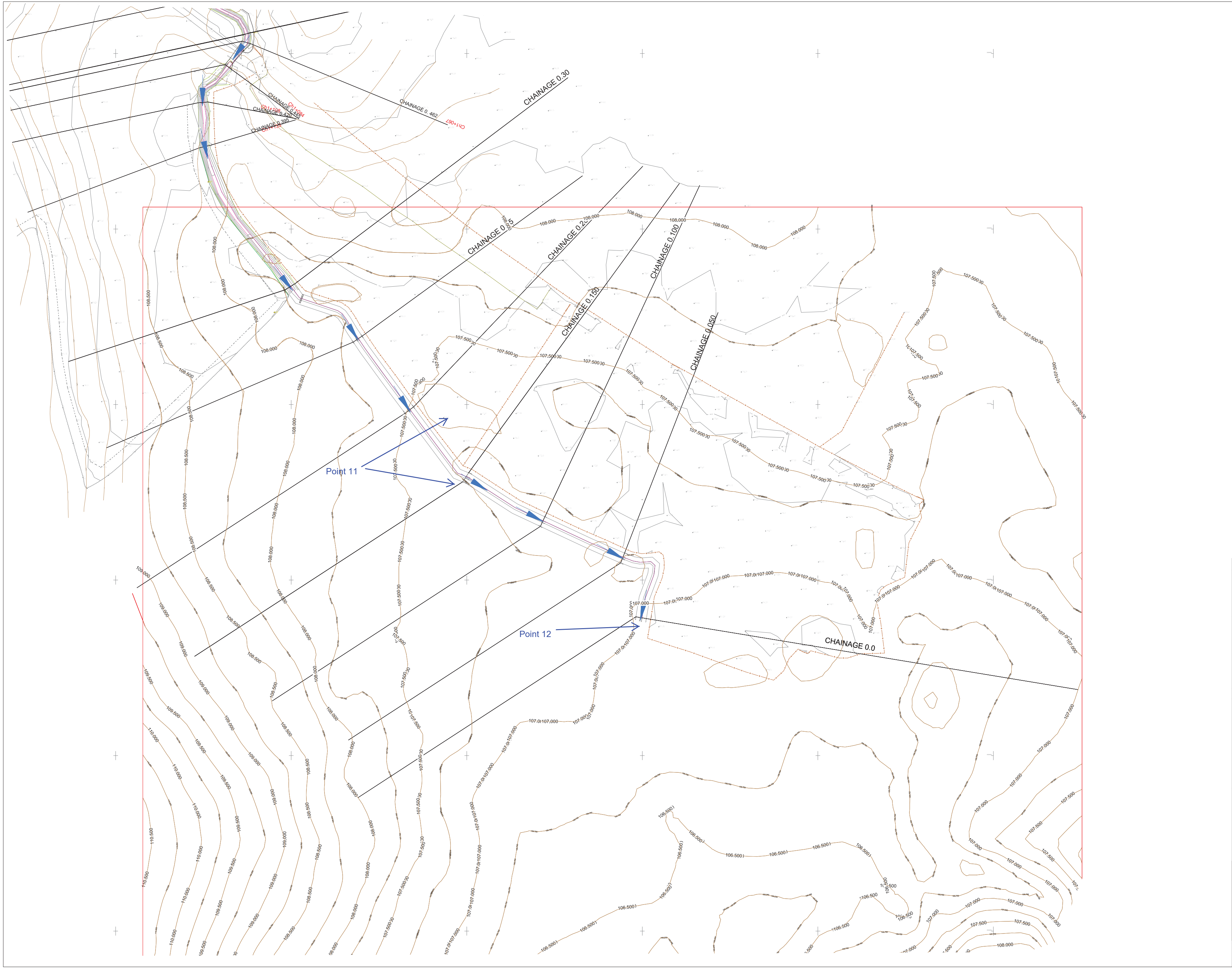
SCALE 1:1000@A1
APPR
DRAWING NO 2420-03
REV B



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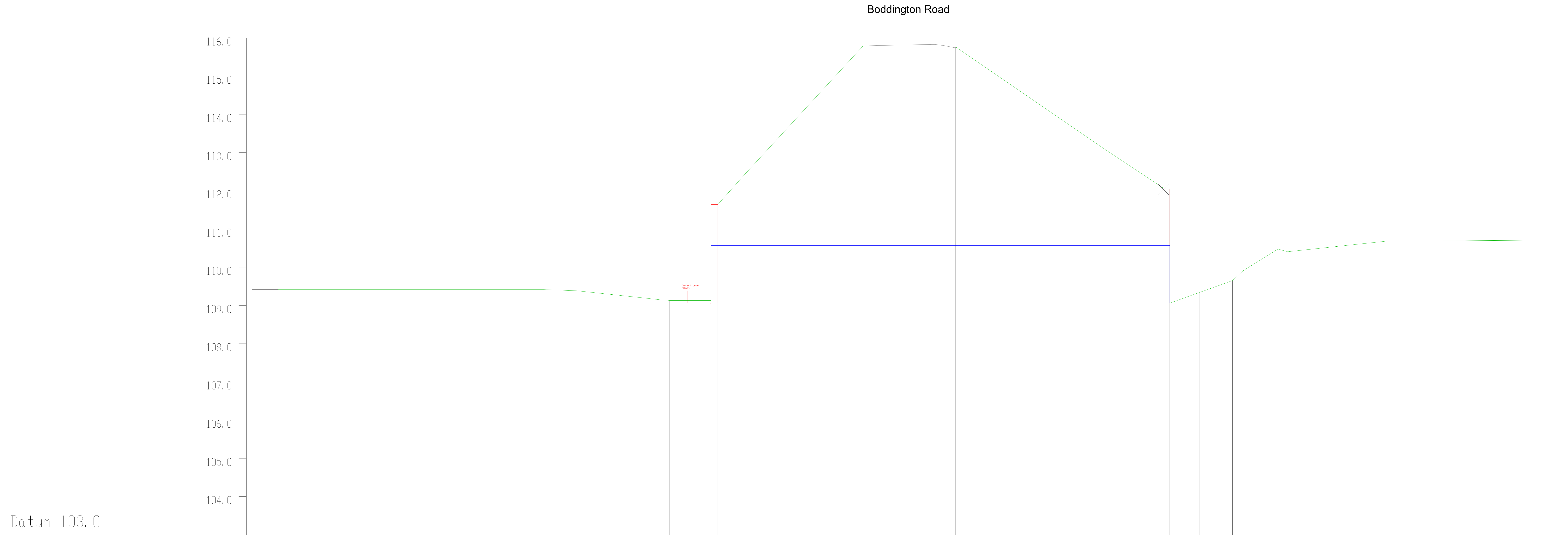
CLAYDON, BANBURY
CROSS SECTION LOCATIONS
3 of 3

ORIG S.E.C
DATE 29.11.2019
CHKD
SCALE 1:1000@A1
APPR
DRAWING NO 2420-04
REV B



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109.414	176.257
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114.540	225.000
113.167	230.000
112.024	234.142
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110.708	259.840

Regular offsets
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180.000
185.000
190.000
195.000
200.000
205.000
210.000
215.000
220.000
225.000
230.000
235.000
240.000
245.000
250.000
255.000
260.000

Notes:

1. The accuracy and content of this drawing are dependent on the surveyed scale and survey specification, care should be taken when working with other plotted scales or from CAD.

Station Co-Ordinates:

Station	Easting	Northing	Level

Survey Control Data:

Datum for Levels:
Bench Mark: Ordnance Survey
Value:
Grid: OSGB36(15)

Rev	Description of revision	Date
B	Amendments made as required	24.11.19
A	Issued to Clients Engineer for Review	19.11.19

essential construction services

Site Name:
Banbury Marina

Surveyed: DC/JR/JG
Drawn: DC/JR/JG
Checked: JR

Title

Flood Risk Survey
Cross Section Through
Boddington Road Culvert

Plotted Scale: 1:500 H
1:200 V
Date: 8th Nov 2019
Sheet Size: A1

Drawing No. Banbury Marina / 010
Revision B

Photo taken from RSK Environment Limited report, showing bed of watercourse on 26th July 2019, show a stoney bed to the watercourse

1. Photos of flood plain and embankment on right hand side of watercourse upstream of Boddington Road and in the vicinity of cross sections 1.547 – 1.342. Flood plain directly adjacent to watercourse consisting of dense trees and shrubbery, unable to access. Photos taken on 12th February 2020.

2. Photos of embankment up to Boddington Road upstream and downstream of the watercourse. Photos taken on 12th February 2020.

3. Photos of flood plain on left and right bank of watercourse directly downstream of Boddington Road. Flood plain primarily consists of dense trees and shrubbery. Photos taken on 12th February 2020.

4. Culvert beneath Boddington Road, standing downstream and looking upstream from right hand side bank. Photos taken on 12th February 2020.

5. Photo shows extent of dense trees and shrubbery running adjacent to right hand side of watercourse, with open agricultural land located to the south of this. Photos taken on 12th Febraury 2020.

6. Photo shows flood plain on left and right hand side of watercourse in the vicinity of cross sections 1.192 and 1.112, showing flood plain to consist of dense trees and shrubbery. Photos taken on 12th February 2020.

7. Photo shows reduction in dense trees and shrubbery with left bank floodplain becoming open paddock in the vicinity of cross section 1.022. Photos taken on 12th February 2020.