Norwich Western Link

Environmental Statement

Chapter 12: Road Drainage and the Water Environment

Appendix 12.2: Flood Risk Assessment

Sub Appendix D: River Wensum Hydrology Verification

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Document Reference: 3.12.02d

Version Number: 00

Date: March 2024

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1 Introduction

1.1.1 This hydrology verification forms an Appendix of the **Flood Risk Assessment** (Document Reference: 3.12.02) and should be read in conjunction with the **River Wensum Hydraulic Modelling Report** (Document Reference: 3.12.02b) and **River Wensum Technical Modelling Log** (Document Reference: 3.12.02c).

1.1.2 Subsequent to Environment Agency review of the submitted hydraulic modelling and associated hydrology for the River Wensum, it has been proposed that a number of checks are undertaken to determine whether the existing hydrological study, undertaken in 2017 by CH2M consulting (Modelling and Forecasting 2015-16 Q2, Wensum Model Report, Version 2.1, CH2M, May 2017), is considered suitable to inform fluvial inflow hydrographs for the River Wensum modelling study. Appendix A of the CH2M report contains the detailed hydrological analysis on which this assessment is based, this data is available on request from the Environment Agency.

1.1.3 The checks have included:

- Derivation of an up to date AMAX series using the 2012 JBA rating to confirm QMED using all available gauge data;
- Comparison of the updated QMED value with that used previously in the CH2M study;
- An ungauged pooling group assessment, noting the pooling group review completed in the CH2M study for consistency, using HiFlows v10 data and WINFAP Version 5; and
- Comparison of updated peak flows, using the latest QMED and growth factors, to the peak flows used within the CH2M study.

2 Updated AMAX Series

2.1.1 The AMAX series for the gauges at both Costessey Mill main weir and the Costessey Mill side channel has been provided by the Environment Agency. The stage values from the side channel have been input into the 2012 JBA rating, provided in **Table 2-1**.

Table 2-1 JBA 2012 Rating at Costessey Mill

Segment	Stage (lower)	Stage (upper)	C	a	b
1	0	0.498	50.133	0.021	2.155
2	0.498	0.505	14.07	0.5	68.266
3	0.505	0.56	13.584	0.547	7.472
4	0.56	0.598	28.563	0.441	10.744
5	0.598	0.9	80.96	-0.586	0.141

2.1.2 **Table 2-2** shows the AMAX series with both flow and stage values at the Costessey Mill side channel.

Table 2-2 AMAX Series data, flows derived using the 2012 JBA Rating.

Time stamp	Stage (m)	Derived using JBA Rating (2012) (Flow m3/s)	Included / excluded from CH2M QMED Calculation	Included / excluded from updated QMED Calculation
01/10/1996 09:00	0.398	7.7	Excluded	Excluded
01/10/1997 09:00	0.649	54.8	Excluded	Excluded
01/10/1998 09:00	0.517	21.6	Excluded	Excluded

Time stamp	Stage (m)	Derived using JBA Rating (2012) (Flow m3/s)	Included / excluded from CH2M QMED Calculation	Included / excluded from updated QMED Calculation
01/10/1999 09:00	0.474	11.0	Included (unknown source for flow value)	Excluded
01/10/2000 09:00	0.601	44.4	Included (unknown source for flow value)	Excluded
01/10/2001 09:00	0.438	9.4	Included (unknown source for flow value)	Excluded
01/10/2002 09:00	0.392	7.5	Included (unknown source for flow value)	Excluded
01/10/2003 09:00	0.623	50.9	Excluded	Excluded
01/10/2004 09:00	0.479	11.3	Included	Included
01/10/2005 09:00	0.451	9.9	Included	Included
01/10/2006 09:00	0.518	21.7	Included	Included
01/10/2007 09:00	0.564	30.1	Included	Included
01/10/2008 09:00	0.526	23.0	Included	Included

Time stamp	Stage (m)	Derived using JBA Rating (2012) (Flow m3/s)	Included / excluded from CH2M QMED Calculation	Included / excluded from updated QMED Calculation
01/10/2009 09:00	0.578	35.0	Included	Included
01/10/2010 09:00	0.494	12.0	Included	Included
01/10/2011 09:00	0.454	10.1	Included	Included
01/10/2012 09:00	0.546	26.4	Included	Included
01/10/2013 09:00	0.524	22.7	Included	Included
01/10/2014 09:00	0.442	9.5	Included	Included
01/10/2015 09:00	0.521	22.2	Not available	Included
01/10/2016 09:00	0.419	8.5	Not available	Included
01/10/2017 09:00	0.547	26.6	Not available	Included
01/10/2018 09:00	0.414	8.3	Not available	Included
01/10/2019 09:00	0.475	11.1	Not available	Included
01/10/2020 09:00	0.567	31.1	Not available	Included

2.1.3 The previous QMED calculation used data from 1999 to 2014. The CH2M study recommends that QMED is derived:

- Using data from 1999 onwards, with the preceding period excluded as the tilting weir structure was not built at that time; and
- Discarding the annual maxima from 2003 as levels were strongly influenced by a blockage of the structure.

2.1.4 The estimated QMED value from the CH2M study is 22.7m3/s. Using flow values calculated using the 2012 JBA rating for the years 1999-2002 and

2004-2020 gives an updated QMED value of 12.0m^3/s, which is significantly lower than the previously estimated value.

2.1.5 The CH2M report states that, “level data between 1996 and 2001 are suspect and therefore have been excluded”. However, it appears that data for these years has been included in the previous estimate. The flow values provided in the CH2M report do not match flow values calculated using the 2012 rating and stage levels provided by the Environment Agency. The provenance of the flow values specified for the years between 1999-2002 in the CH2M report is unknown. As such, the calculated flow values from 1999-2002 have been excluded from the updated QMED calculation. The updated QMED estimate using flow values from 2004-2020 only is 21.7m3/s.

2.1.6 This is a decrease in QMED of 4.4% in comparison to the previous estimate. As this value is relatively small, it indicates that incorporation of the most recent AMAX series data into the QMED estimate does not have a significant impact on QMED values.

3 Growth curve derivation

3.1.1 The CH2M Upper Wensum hydrology report states that the growth curve is based on enhanced single site analysis at 340001 (Yare@Colney) gauge, as the rating at Costessey Mill was judged too unreliable for enhanced single site to be conducted. This approach, using a nearby gauge to derive the growth curve, is considered non-standard. The report states that “inspection of key catchment descriptors show a good match between Colney and Costessey Mill, and hence transfer of the growth curve is defendable”. The catchment descriptors appear generally similar, however some parameters are quite different. For example, the catchment size at Costessey Mill is 570.9km2, and at the Colney gauge it is 231.8km2. The differences in the catchment descriptors may introduce uncertainty in the derivation of the pooling group and the use of the Yare@Colney in an enhanced single site analysis. The

Flood Frequency Curves derived by CH2M during their hydrology study have been appended to this document for reference.

3.1.2 To provide a comprehensive assessment of the growth curve at Costessey Mill, three pooling groups have been derived:

- The default pooling group for Costessey Mill provided by WINFAP5;
- The reviewed pooling group based upon the reviewed ungauged pooling group stated in the CH2M report;
- Enhanced single site analysis for the Yare@Colney, based upon the pooling group stated in the CH2M report;

3.1.3 **Table 3-1** shows the different growth factors in comparison to the final growth factors used in the CH2M assessment.

Table 3-1 Updated growth factors and previously derived growth factors

Return period	Growth factor (Default PG)	Growth factor (Reviewed PG)	Growth factor (ESS@Yare)	CH2M Growth Factors
2	1.00	1.00	1.00	1.00
5	1.37	1.36	1.45	1.47
10	1.63	1.62	1.75	1.78
20	1.92	1.89	2.06	2.10
25	2.02	1.99	2.17	2.21
30	2.10	2.07	2.25	2.29
50	2.35	2.30	2.50	2.55
75	2.56	2.49	2.71	2.76
100	2.72	2.64	2.86	2.92

Return period	Growth factor (Default PG)	Growth factor (Reviewed PG)	Growth factor (ESS@Yare)	CH2M Growth Factors
200	3.14	3.02	3.25	3.32
500	3.79	3.61	3.82	3.91
1000	4.37	4.12	4.30	4.40

3.1.4 The updated derived growth factors and QMED value of 21.7m^3/s have been used to calculate updated peak flow values, which are given in **Table 3-2**. The previous peak flow values have also been given for comparison.

Table 3-2 Updated peak flows and previous peak flows.

Return period	Peak flows m^3/s (Default PG)	Peak flows m^3/s (Reviewed PG)	Peak flows m^3/s (ESS@Yare)	CH2M Peak flows
2	21.70	21.70	21.70	22.70
5	29.69	29.60	31.47	33.30
10	35.46	35.20	38.04	40.40
20	41.66	41.10	44.75	47.60
25	43.79	43.12	46.98	50.00
30	45.57	44.81	48.85	52.00
50	50.91	49.80	54.23	57.80
75	55.51	54.05	58.72	62.80
100	58.98	57.24	62.06	66.20
200	68.14	65.60	70.55	75.30

Return period	Peak flows m^3/s (Default PG)	Peak flows m^3/s (Reviewed PG)	Peak flows m^3/s (ESS@Yare)	CH2M Peak flows
500	82.29	78.29	82.98	88.60
1000	94.76	89.34	93.40	99.70

3.1.5 Using the enhanced single site analysis, the derived peak flows using the updated QMED value are largely similar to those produced previously. The average difference in peak flow value is -5.98%. This can be mainly attributed to the difference in QMED value as the growth factor values for the updated and previously used enhanced single site analysis are very similar.

3.1.6 The aim of this study was to recreate the analysis undertaken previously, incorporating the available gauge data for the years subsequent to the previous CH2M study. A review of the method, including the non-standard use of enhanced single site analysis at the Yare@Colney, was not proposed and it is assumed that this methodology has been previously approved by the Environment Agency.

3.1.7 Therefore, to determine the impacts of incorporating the latest data on peak flow values the enhanced single site analysis has been used for comparison. The updated peak flows are generally a minor reduction in flow value in comparison to the previously derived ones but this is not considered significant. As these higher flows form the basis of the inflows to the River Wensum model, it is considered that their use would provide a marginally more conservative estimate of flood risk in the study area. Therefore, the original flows have been retained for further use within the Norwich Western Link road project.