Fluvial Hydraulic Modelling Report

1. Basic Model Information

Model Name:	A14 Oxholme Drain	
Primary Watercourses / Water Bodies	Oxholme Drain	
Designation	Non-main river	
Model ID	The following table presents information regarding the Existing and Scheme Model Scenario ID	
Model Scenario ID	**Scenario**	**Return Period**
A14_OXD_BL_020_002.DAT	Existing Model	1 in 25 years (4% AEP)
A14_OXD_BL_100_002.DAT		1 in 100 years (1% AEP)
A14_OXD_BL_100CC_002.DAT		1 in 100 years + 20% (1%+CC AEP)
A14_OXD_BL_020_002_Design.DAT	Scheme Model	1 in 25 years (4% AEP)
A14_OXD_BL_100_002_Design.DAT		1 in 100 years (1% AEP)
A14_OXD_BL_100CC_002_Design.DAT		1 in 100 years + 20% (1%+CC AEP)

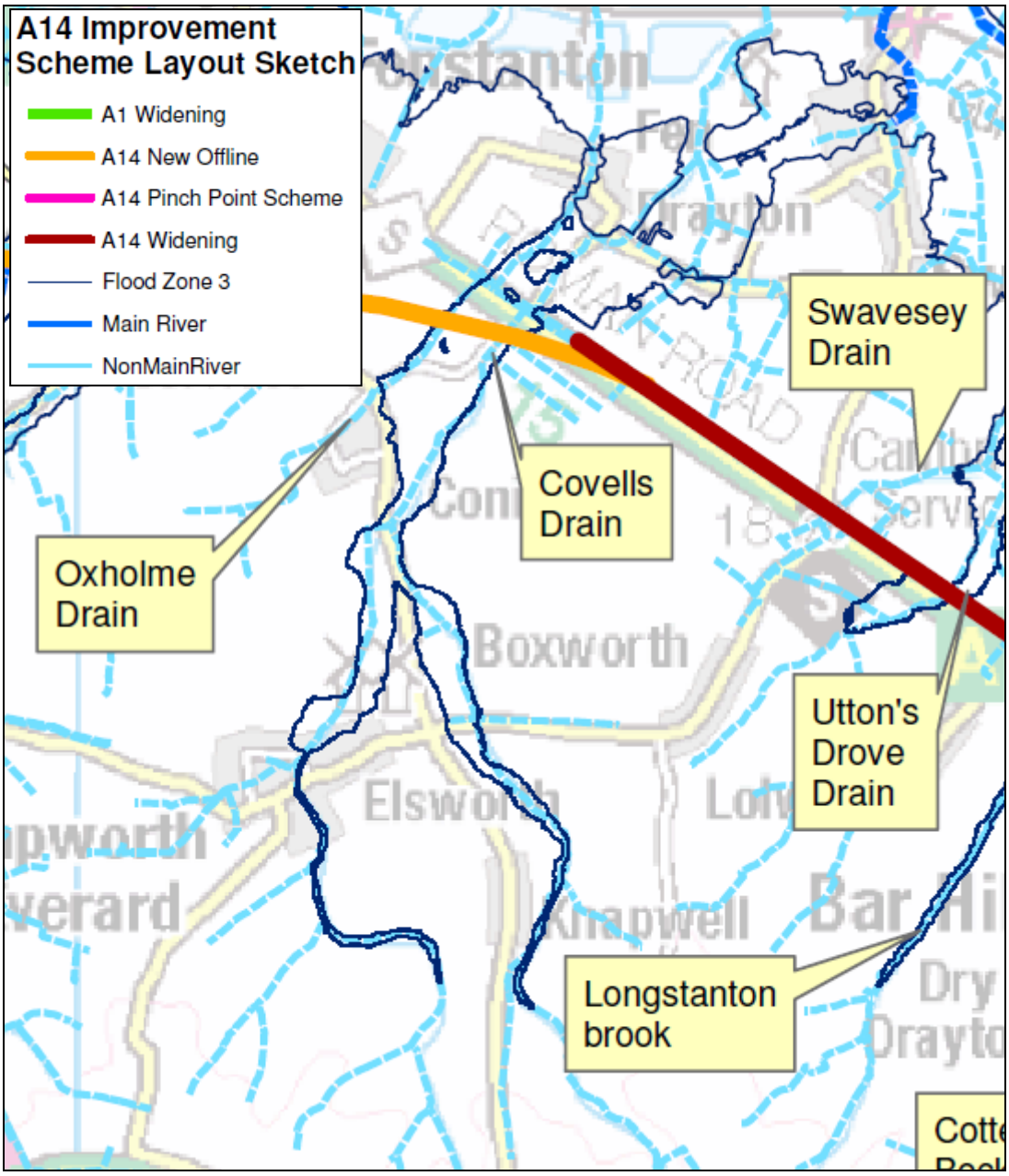
2. Survey Data and Base Mapping

2.1 Base Mapping:	1 to 10,000 Scale Raster Reference: TL3060
2.2 DTM for 2D Model domain:	N/A 1D Model
2.3 River channel/Structures survey	All survey data have been retained as in existing. Number of cross-sections included in this model: 47

3. Hydraulic Model Construction and Schematisation

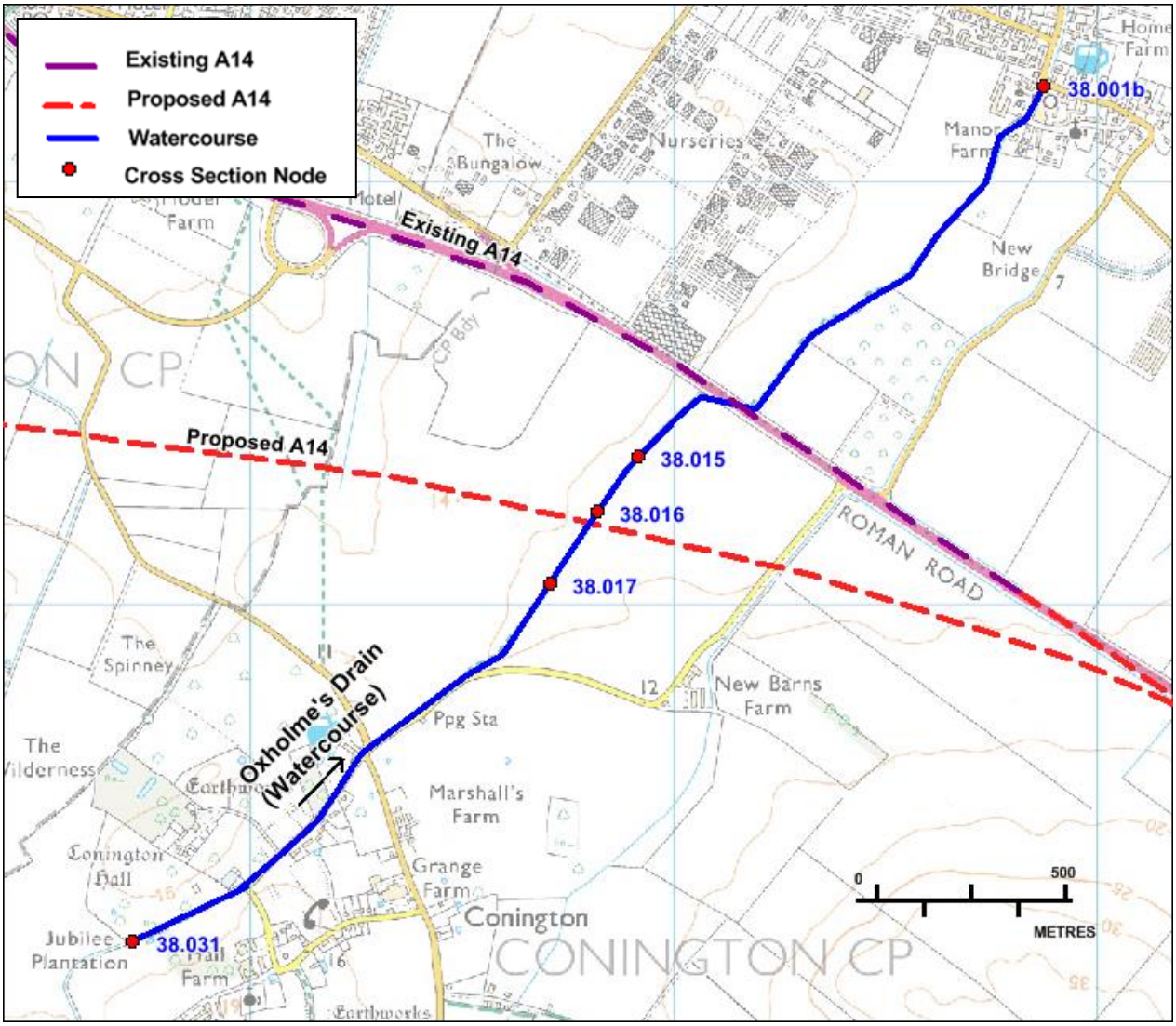
3.1 Software:	**1D domain:**	ISIS Version 3.7.0.233 (32 bit - Single Precision)
	2D domain(s):	N/A
3.2 Baseline model:	Atkins 2009 ISIS 1D Model	
3.3 Model area / extent:	The areal extent of the model and model schematisation in the proximity of the new A14 figures are presented in the following figures	

Areal Extent of Oxholme's Drain



Baseline model schematisation including upstream and downstream model nodes

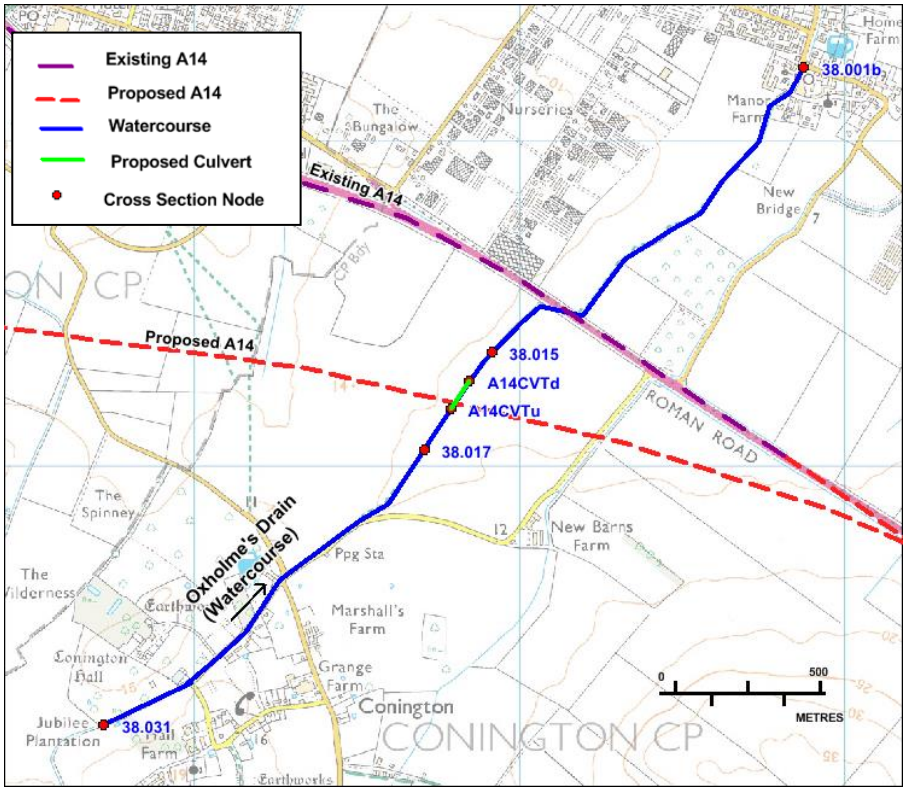
Distance in between cross sections nodes have been approximated based on ISIS 1D model distances. The location of all nodes is approximate. The image below shows only key nodes and not all the nodes present in the ISIS model.

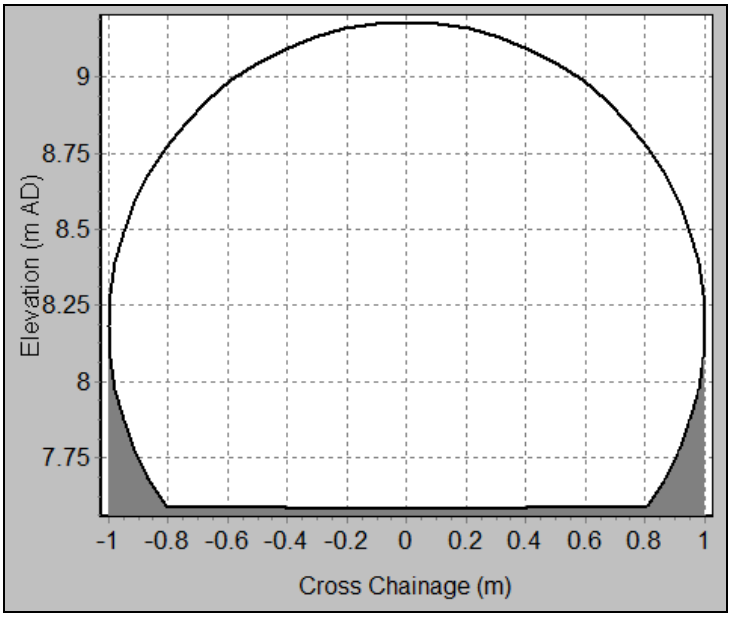


3.4 Model reaches:	The following model reaches as shown on the maps referred above have been defined in the model:	
Watercourse name	**Upstream model node**	**Downstream model node**
Oxholme's Drain	38.031	38.001b
Total model length (km):	3.121	
3.5 Model structures:	N/A	
3.6 Floodplain schematisation	Floodplain areas have been modelled using a 1D approach in the ISIS model using extended cross sections.	
3.7 Model Boundaries - Inflows	Hydrological flow hydrographs are input into the model as point inflows at locations indicated in the table below:	
(a) Existing Model	Peak inflows (m^3/s) are summarised in the table below for the existing model.	
Input Node in the	**Annual Exceedance Probability**	

Hydraulic Model	4%	1%	1% + CC
38.031	0.895	1.281	1.569
3.8 Model Boundaries – Downstream Conditions	Downstream boundary conditions adopted in the model are as follows:		
	The downstream boundary is set as the 50% AEP peak water level on the River Great Ouse at the Oxholme Drain's confluence with the Ouse. This boundary was chosen due to the difference in critical duration on the two watercourses. The outflows at the downstream end of the model extent are modelled using a head-time boundary type with a constant stage of 5.0 m AD. This boundary condition was applied at node 38.001b.		

4. Scheme Model Build

4.1 Scenario Definition	Inclusion of a 98m circular culvert of 2m diameter across new A14 alignment.
ISIS 1D Model	
4.2 Model Extent of the Affected area	**Scheme model schematisation including upstream and downstream model nodes** Distance in between cross sections nodes have been approximated based on ISIS 1D model distances. The location of all nodes is approximate. The image below shows only key nodes and not all the nodes present in the ISIS model. 
4.3 Modelling approach for the new structures	Proposed culvert is located 450m approximately from existing A14. In the ISIS model proposed culvert is located between cross sections 38.017 and 38.015. Cross section A14CVTu has been created and located 155m downstream of cross section 38.017 where the proposed culvert starts. Proposed culvert spans from cross section A14CVTu to cross section A14CVTd, which is a copy of cross section 38.016 and located 112m from cross section 38.015. The bed level for both A14CVTu and A14CVtd was adjusted to retain the channel gradient.
4.4 Model Units added/removed	Proposed culvert was modelled using the following units: Culvert Inlet Unit = A14CVTu Symmetrical Conduit Unit (x2) = A14c1u and A14c1d Culvert Outlet Unit = A14c1d Introduced Cross section Unit = A14CVu (155m downstream of cross section 38.017)

	Removed Cross section Unit = 38.016 (Culvert is being modelled as a single conduit, this cross section was located in between of A14CVTu upstream and A14CVTd downstream)
4.5 Culvert Inverts	Proposed culvert is buried 0.4m (20% of the culvert diameter). The effect of having a circular conduit buried 0.4m has been reproduced by using a symmetrical conduit unit instead of a circular conduit unit. This is shown in the following figure:  Upstream Bed Level: = 7.581(As upstream open section level) Downstream Bed Level = 7.386 (As upstream open section level) Culvert Inlet Control Data = Conduit Type A used Culvert Outlet Loss Coefficient = 1.0
4.6 Hydraulic Roughness of proposed units	Roughness coefficients based on design specifications. Bed roughness Colebrook-White Friction = 0.3 (For natural channel) Wall/Soffit roughness Colebrook-White Friction = 0.00015 (For smooth concrete)
4.7 Design Detail Sources	Culvert dimensions *Proposed A14_Structures on Watercourses.xlsx* Road outline used to calculate approximate distance between proposed culvert ad current A14 alignment *A14-JAC-ZZ-00-M2-C-00001.dwg*

5. Hydraulic Model Outputs

5.1 Model Simulations

The model outputs were processed to extract maximum stage values at key locations for the 4%, 1% and 1% + CC AEP.

a) Existing Model

Maximum Stage values for the Existing Model are provided in the table below at key locations

Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
Upstream model node	38.031	12.234	12.341	12.398
152m u/s of proposed A14	38.017	8.94	9.122	9.221
u/s of proposed A14	A14CVTu	8.646	8.822	8.917
d/s of proposed A14	38.015	8.215	8.397	8.499
Downstream model node	38.001b	5.000	5.000	5.000

b) Scheme Model

Maximum Stage values for the Scheme Model are provided in the table below at key locations

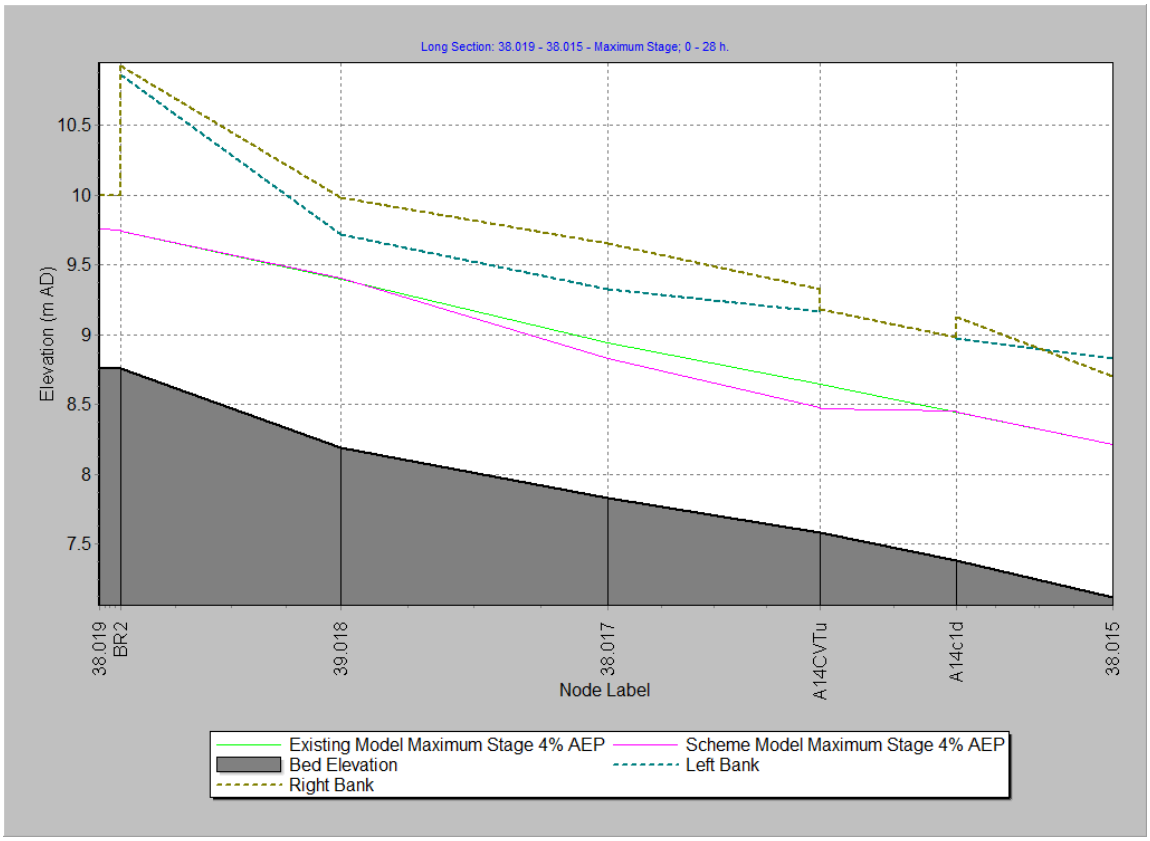
Location	Model node	Peak Water level (mAOD)		
		4%	1%	1% + CC
Upstream model node	38.031	12.234	12.341	12.398
152m u/s of proposed A14	38.017	8.834	9.003	9.206
u/s of proposed A14	A14CVTu	8.477	8.651	8.859
d/s of proposed A14	38.015	8.215	8.397	8.499
Downstream model node	38.001b	5.000	5.000	5.000

Effect of proposed Structures

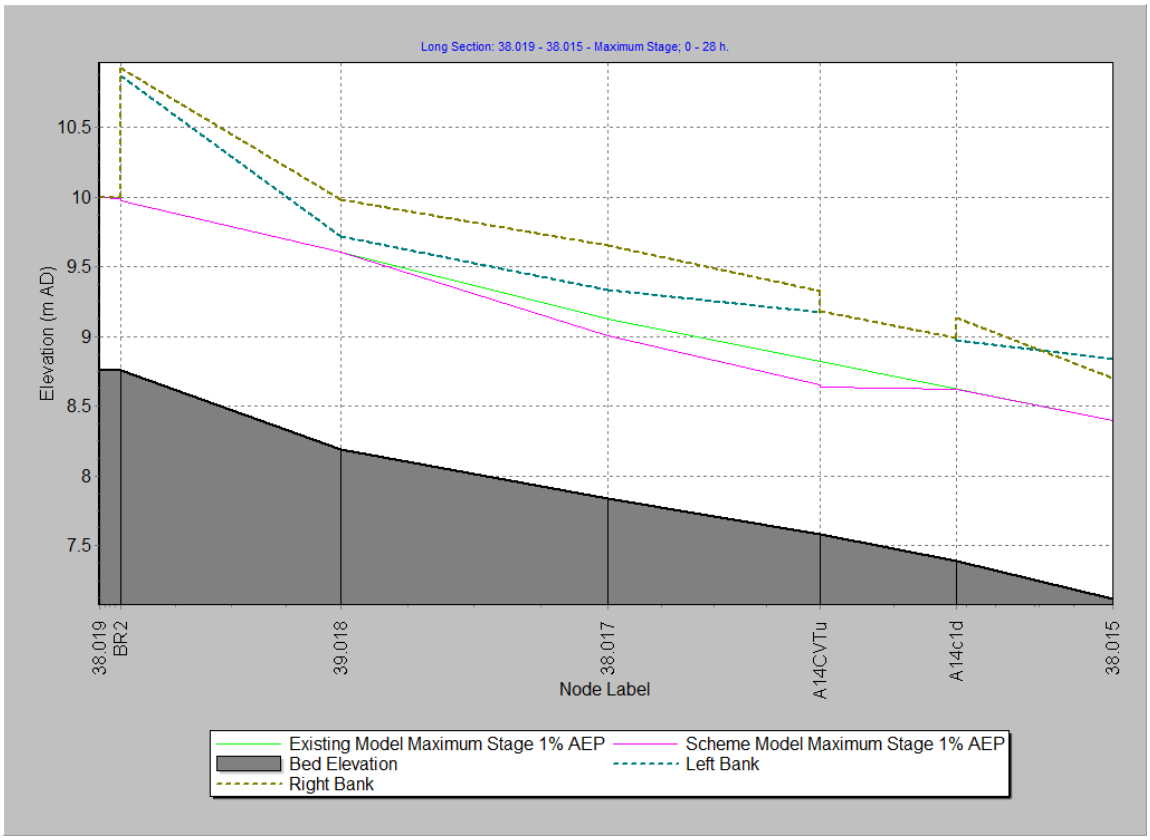
The results show a reduction in maximum stage upstream of the proposed culvert in all scenarios.

The following figures present a comparison between maximum stage for the Existing and Scheme Models for the 4%, 1% and 1% + CC AEP.

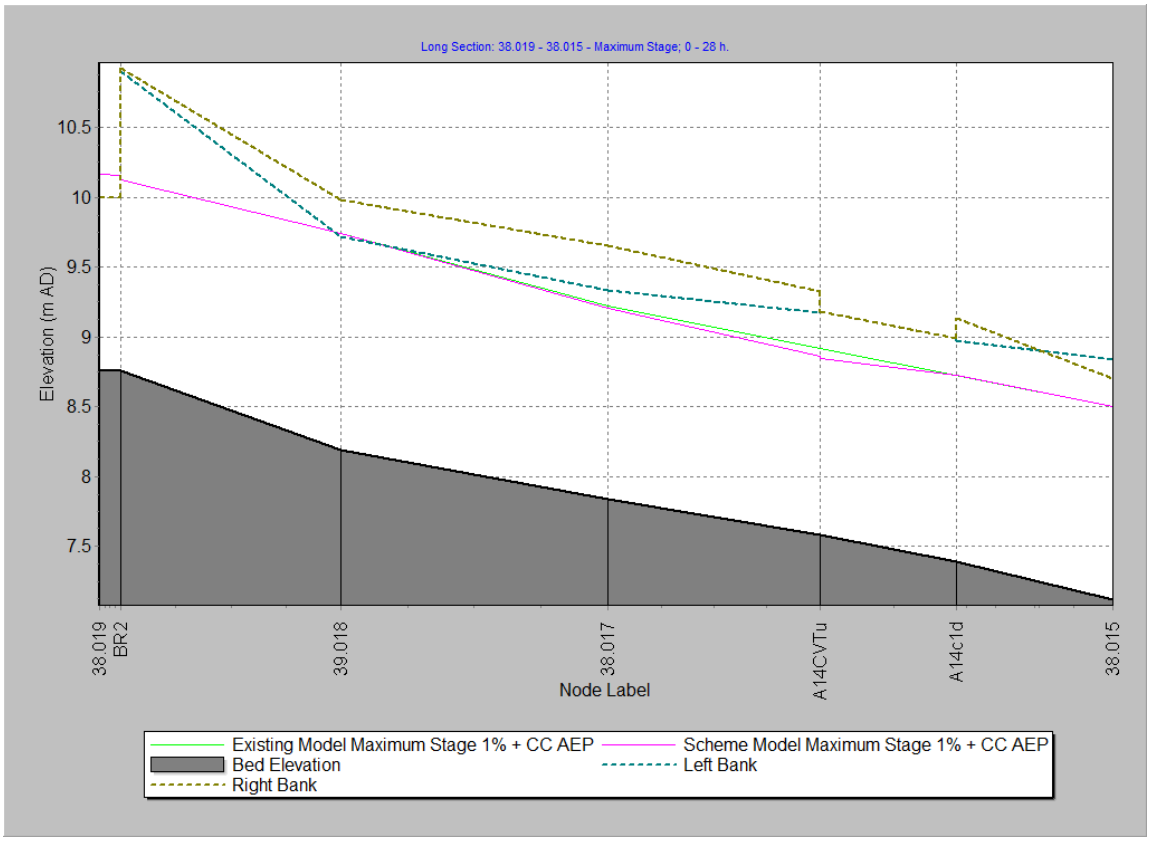
Maximum Stage Upstream and Downstream of proposed culvert – 4% AEP



Maximum Stage Upstream and Downstream of proposed culvert – 1% AEP



Maximum Stage Upstream and Downstream of proposed culvert – 1%+CC AEP



6. Key model assumption and limitations

- The supplied hydraulic models were assumed to be fit for purpose and no detailed review was undertaken for the purpose of Flood Risk Assessment of the A14 scheme.
- No cross section geo-referencing/schematics were provided with the model. The location of the proposed culvert was calculated based on design drawings for the proposed A14 alignment. The distance between the proposed A14 and existing A14 has been approximated was on drawings
- In the baseline model, significant glass walling was identified in some locations. Any amendments to model to eliminate glass walling were beyond the scope of this comparative study.
- Slight instabilities were seen in the simulations but values remain within reasonable limits
- Cross section A14CVTu and A14CVTd have been copied from cross section 38.016 with lowered bed levels to retain existing channel gradient. At these locations there is no survey or LiDAR data available at this time
- Culvert inlet design was assumed to feature headwall with square edges
- No calibration or sensitivity testing simulations were carried out as part of this hydraulic modelling exercise