Geomorphological Assessment of the proposed Cherry Holme island restoration project on the River Trent at the Catton Hall & Barton Quarry estates

Final Report

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Draft Version 1.0		Nick Mott
Draft Version 2.0		Nick Mott
Final Version 1.0	Modification made to Q95 ford depth	Nick Mott

Contract

This report describes work commissioned by Staffordshire Wildlife Trust, by email dated 22/12/2014. The Staffordshire Wildlife Trust's representative for the contract was Nick Mott. Matthew Hemsworth and Seb Bentley of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

Catton Hall Estate

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1 Introduction

1.1 Background to the Study

JBA Consulting was commissioned by the Staffordshire Wildlife Trust in February 2012 to undertake a geomorphological audit and options appraisal for the proposed restoration of a section of the River Trent at Catton Hall Estate. The principle aims of the 2012 study were driven by Water Framework Directive Measures, seeking opportunities to improve the hydromorphological and ecological status of this reach of the River Trent. The outcomes of this work were recommendations for future suitable restoration works. To date some works have been carried out by the Staffordshire Wildlife Trust.

1.2 Purpose

In 2015, with funding from Natural England's Innovation Project, JBA Consulting was commissioned by the Staffordshire Wildlife Trust to investigate the impact of the proposed reconnection of a palaeo-channel at Cherry Holme, adjacent to Catton Hall. Currently, the palaeo-channel has been excavated by Staffordshire Wildlife Trust, but it is not yet connected to the Trent at its upstream point, and is therefore acting as a backwater zone. The purpose of this study is to investigate the water level impact of full palaeo-channel reconnection along with the installation of a ford crossing at the palaeo-channel intake.

1.3 Approach

A brief field based audit of the palaeo-channel was undertaken on the 30th January 2015, investigating the palaeo-channel reconnection proposals supplied by Staffordshire Wildlife Trust. Following the audit hydraulic modelling was undertaken, using the Environment Agency hydraulic model, to gain a better understanding of the impact of flood levels within the River Trent.

1.4 Existing Water Framework Directive Status

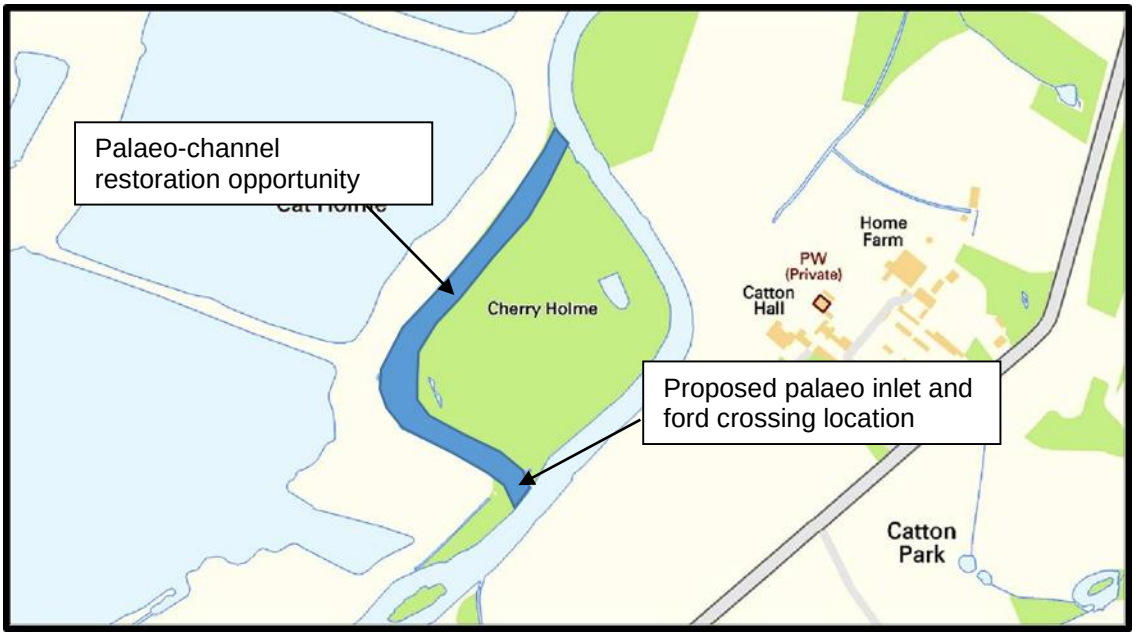
The River Trent local to the study reach is designated as a Heavily Modified Waterbody. At present, the Water Framework Directive (WFD) defines the overall river status as Poor Potential, but with a target of reaching Good Ecological Potential by 2027. An opportunity exists to improve the morphological and ecological status/potential by restoring the reach of the Trent at Catton Hall.

2 Palaeo Reconnection Proposal

2.1 Overview

The area labelled Cherry Holme, adjacent to Catton Hall Estate over the left bank, was once an island and OS Maps show the previous route of the palaeo-channel, which was abandoned between 1955-1964 (Figure 2-1). Historical records show that there was also a weir structure spanning half of the channel at the entrance to the palaeo-channel where it branched off from the current main channel. An opportunity was identified (JBA, 2012) to reconnect the palaeo-channel through excavation, in order to improve the hydromorphic diversity across the meander and also relieve some of the erosion pressure on the right bank at Catton Hall Estate.

Figure 2-1: Palaeo - channel at Cherry Holme



Since 2012, Staffordshire Wildlife Trust have excavated the palaeo-channel at Cherry Holme, however, it is not yet connected to the River Trent at its upstream point. Along with the reconnection of the palaeo-channel a ford is also required for access to the island. It is proposed that this is located downstream of the palaeo-channel inlet. The purpose of this study is to determine the impact of the palaeo reconnection and ford installation on adjacent flood levels.

2.2 Site visit appraisal

The River Trent channel adjacent to Cherry Holme has been over deepened (a legacy of the dredging previously undertaken along this reach and incision that is a result of the disconnected floodplain). This may have contributed to the palaeo-channel's demise during the 1950's. A significant area of erosion is actively occurring along the right bank of the Trent downstream of the proposed palaeo-channel inlet point (Figure 2-2). This is leading to bank instability and erosion into the floodplain as the Trent attempts to naturally migrate. The reconnection of the palaeo-channel and installation of the ford crossing may act to reduce the erosional pressure along the right bank.

Figure 2-2: Active bank erosion on the right bank of the Trent adjacent to Cherry Holme

The palaeo-channel has been excavated by Staffordshire Wildlife Trust and is currently only connected to the Trent at its downstream point. As a result water levels within the channel vary as the Trent rises and falls due to water being able to back up into the palaeo-channel, therefore acting as a backwater zone.

The dimensions of the palaeo-channel which has been reinstated by the Staffordshire Wildlife Trust remain close to its original shape and course (based on historic mapping) By excavating the old palaeo-channel Staffordshire Wildlife Trust have removed silt and regraded banks. Several islands have been maintained within the palaeo-channel, which will act to vary flow and provide backwater areas following the proposed reconnection. The following figures (Figure 2-3 to Figure 2-6) illustrate the existing state of the palaeo-channel during January 2015.

Figure 2-3: Excavated and regraded palaeo-channel

Figure 2-4: Excavated and regraded palaeo-channel

Figure 2-5: Palaeo-channel outlet into Trent

Figure 2-6: Proposed palaeo-channel inlet location

3 Hydraulic Modelling

3.1 Overview

Two 1D segmented hydraulic model (ISIS) of the River Trent have been created. One has been used to represent the proposed new Palaeo reconnection and ford. The optimum bed levels for the new channel and river crossing have been identified. The second hydraulic model has been used to represent the baseline conditions (i.e. without the Palaeo-channel and ford in place).

The following assumptions have been made:

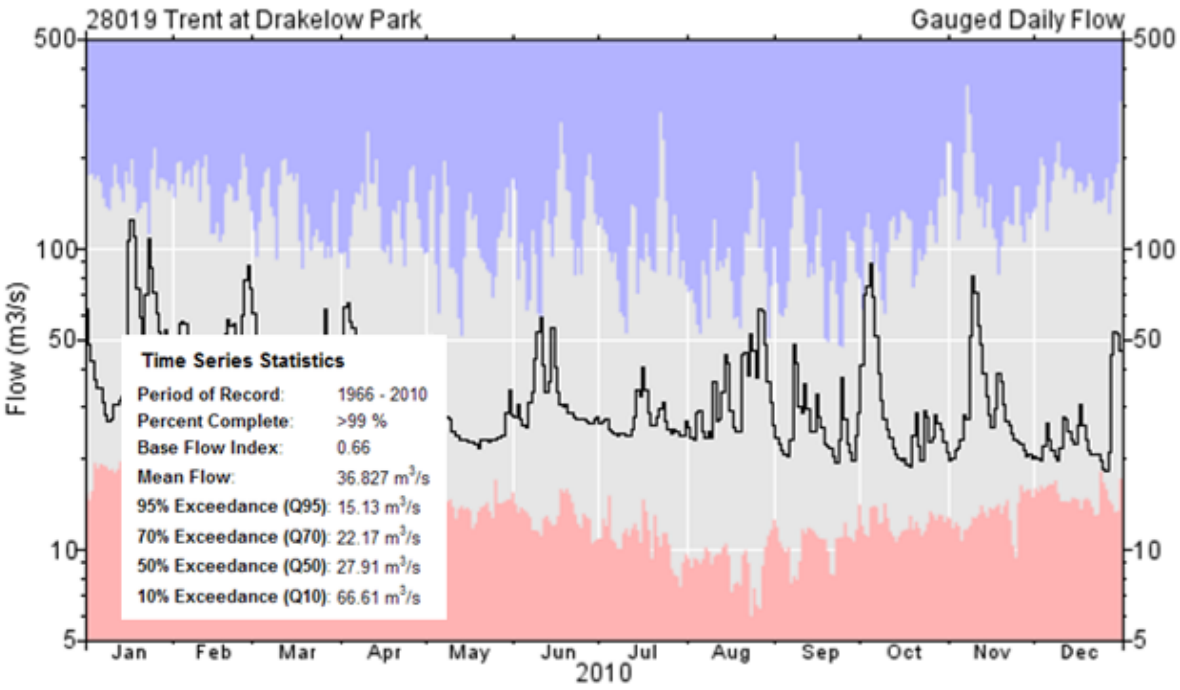
- Levels of up to 30cm will be maintained over the ford allowing off road vehicles to cross
- The Trent will remain the main route of conveyance

Analysis of the hydraulic model results has also been undertaken to assess the sensitivity of the channel to deposition and erosion through the analysis of critical shear and velocities. An assessment has also been undertaken to assess the impact upon the right bank of the main channel adjacent to the hall. The final modelling results have been used to assess the impact of the re-connection on flood risk. The following section details the hydraulic modelling methodology, outcomes and recommendations.

3.2 Simulated flows

The flow regime for the River Trent through the Catton Estate is approximated by the data from the Environment Agency gauge station at Drakelow Park (Figure 3-1). Hydraulic conditions were simulated for the Q95 flow and also the 1 in 2 year and 1 in 100 year flood events.

Figure 3-1: Summary of hydrology for the River Trent at Drakelow Park



3.3 Palaeo-channel and ford representation

1D hydraulic modelling (ISIS) was used to assess the impact of the palaeo-channel reconnection and ford proposed for the River Trent through Catton Estate. The model works on a cross-section basis to calculate water surface profiles for steady, gradually varied flow in open channels. The model was constructed using sections from the Environment Agency ISIS model for this reach of the River Trent, infilling with additional sections (for both the Trent and Palaeo-channel) provided by the Staffordshire Wildlife Trust for this project. The configuration of cross-sections, is shown in Figure 3-2.

Figure 3-2: Cross Section Locations

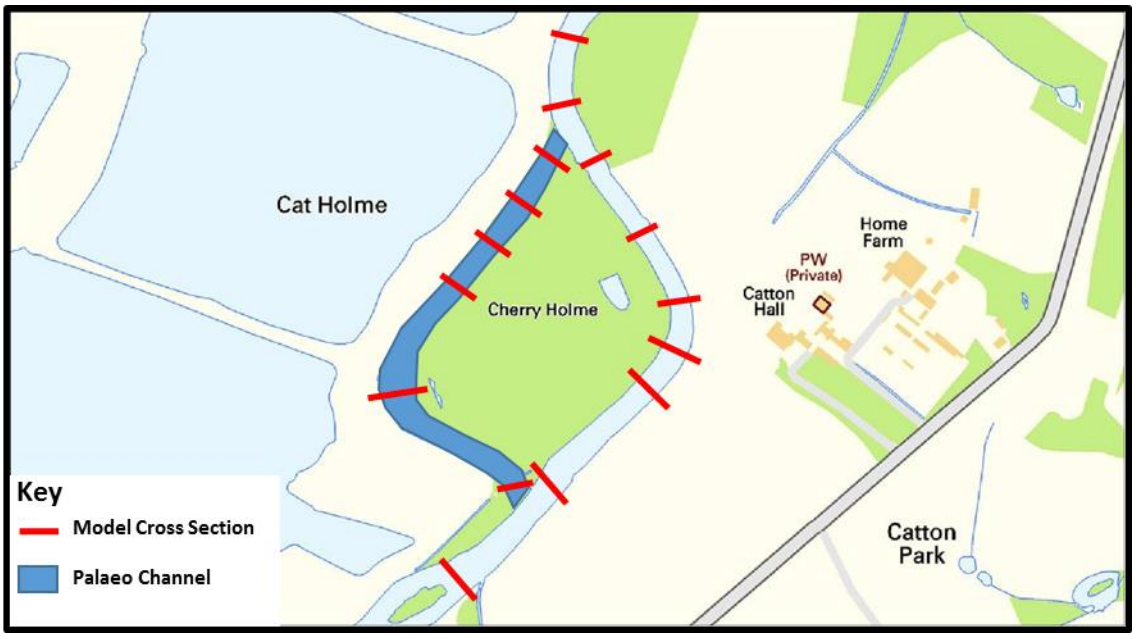
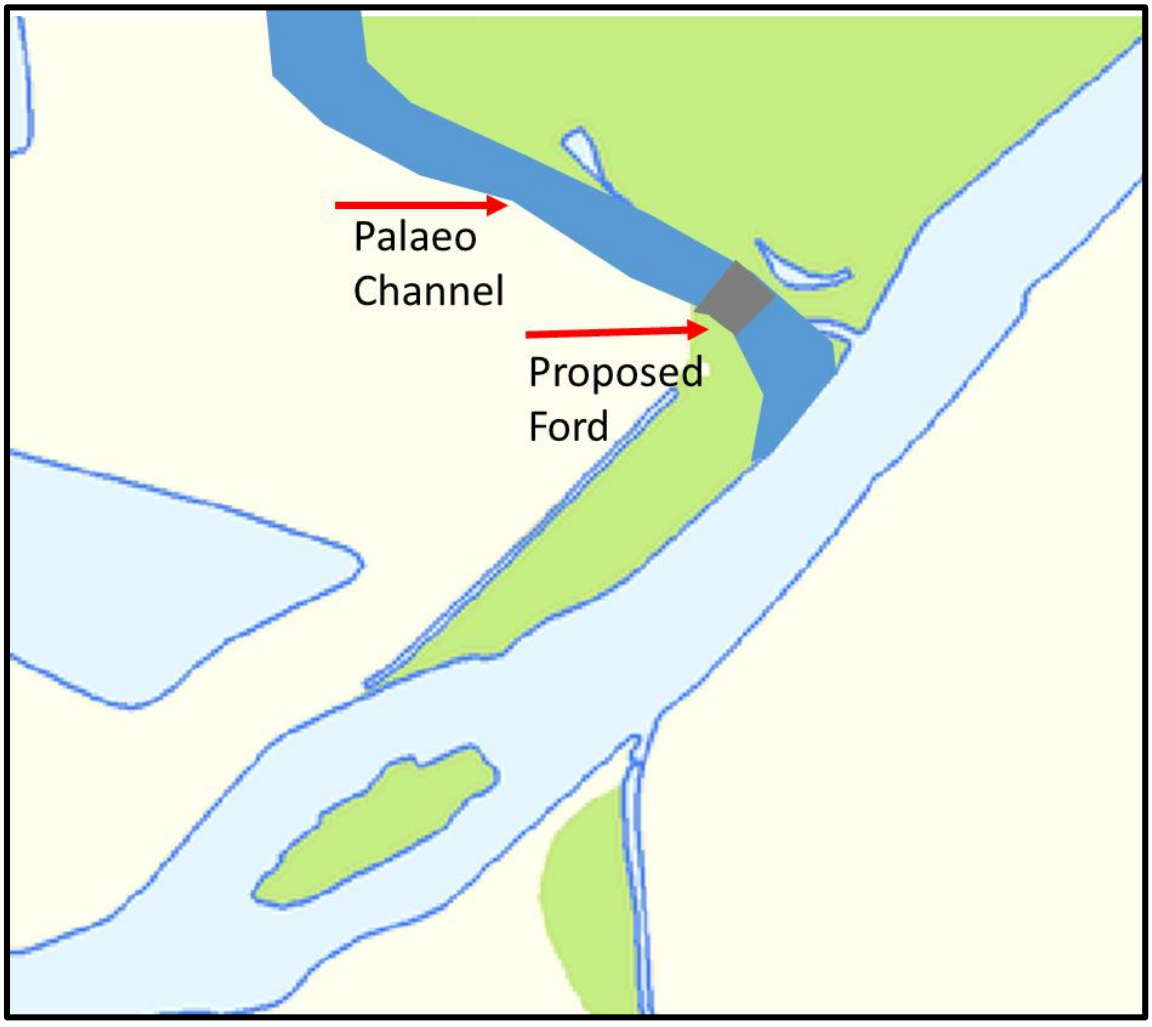


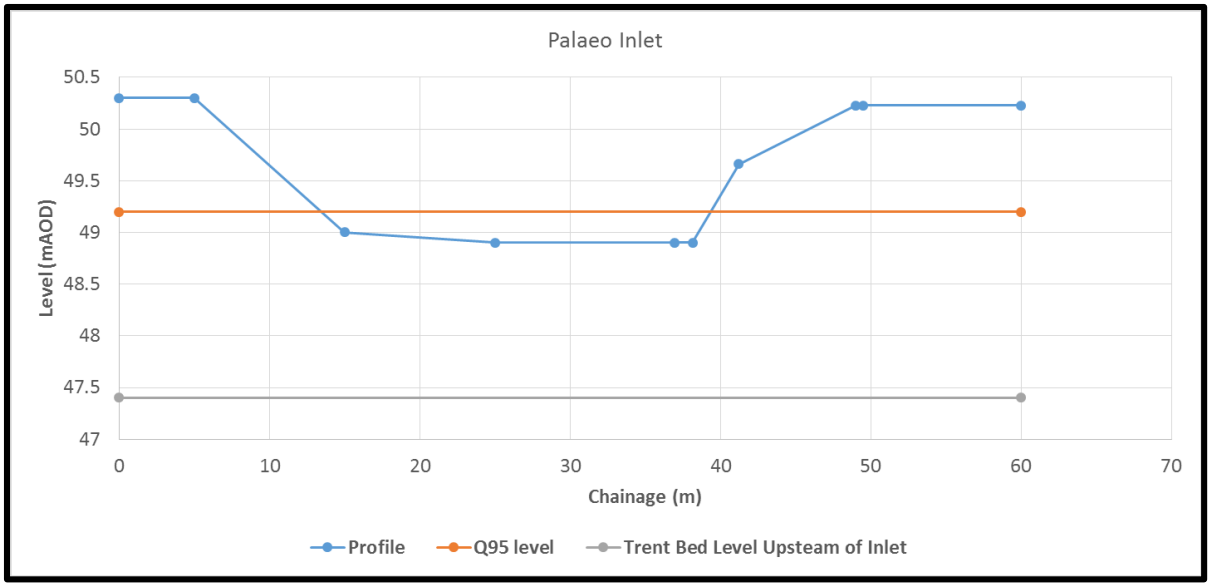
Figure 3-3: Palaeo-channel Reconnection and Ford Location



A comparison of the bed levels in the vicinity of the palaeo-channel inlet has been undertaken in order to set an appropriate invert level for the palaeo-channel inlet. The in-channel Q95 water level, which is representative of normal low flow within the Trent was used to set these levels. Figure 3-3 outlines the proposed ford location and palaeo-channel inlet.

Consideration also had to be given to the proposed ford height. The client's requirements for the ford height were that, during low flow conditions (i.e. Q95), depths were not to be greater than 30cm. The modelled levels are summarised in Figure 3-4.

Figure 3-4: Palaeo-channel Inlet



3.4 Impact on up and downstream water levels

A comparison has been made on the up and downstream water levels with and without the ford and palaeo-channel in place.

Figure 3-5: Q95 (low flow) up and downstream water level impact

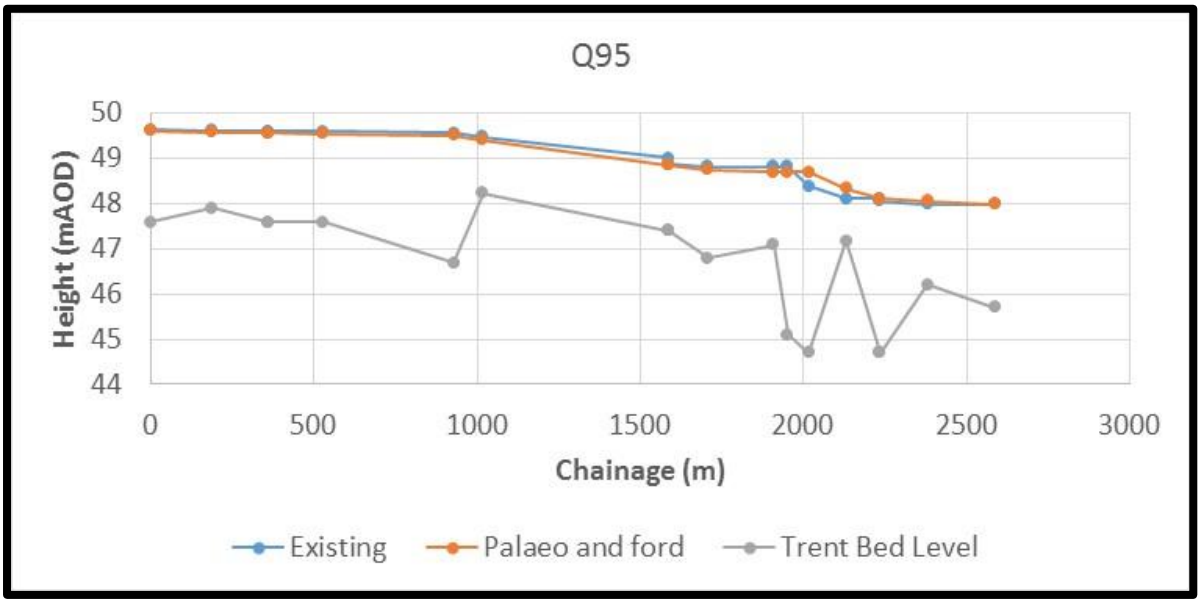


Figure 3-5 shows the existing Q95 water level and the Q95 water level with the palaeo and Ford in place along the Trent for the area shown in Figure 3-2. A slight decrease in water level is noted upstream of the palaeo-channel inlet, whilst a slight increase in water level is noted immediately downstream of the palaeo-channel outlet.

Figure 3-6: 1 in 2 year flood up and downstream water level impact

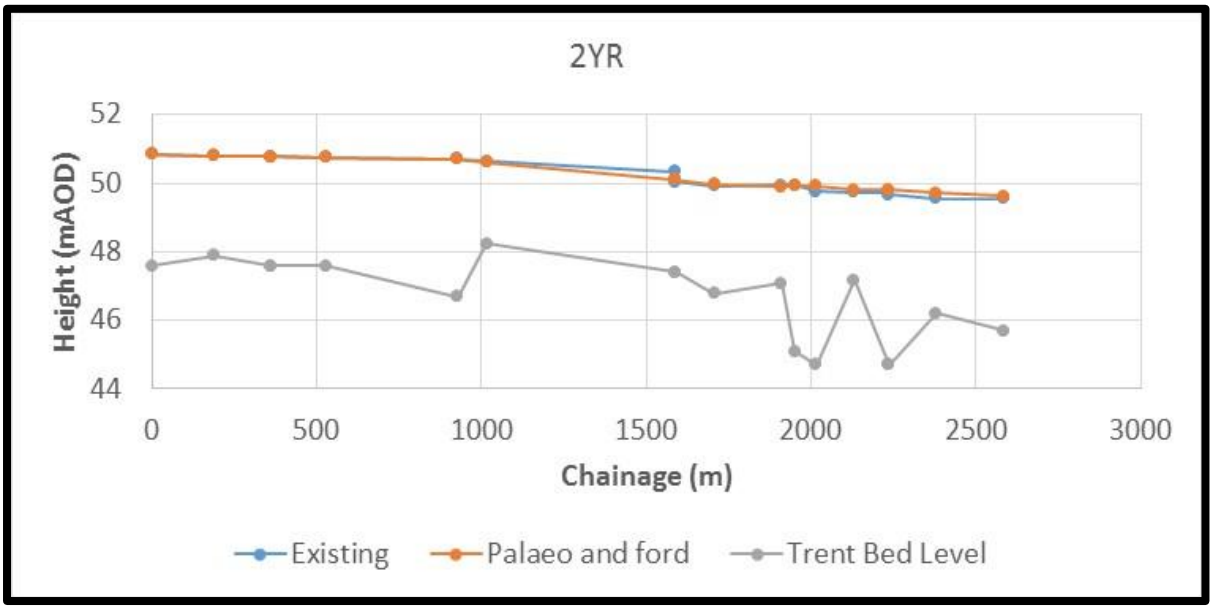


Figure 3-6 shows the existing 1 in 2 year water level and the 1 in 2 year water level with the palaeo and Ford in place along the Trent for the area shown in Figure 3-2. Upstream water levels were found to be reduced. A minor increase in water level at the confluence point (80mm) was noted, however this soon reverted back to the existing level downstream of the confluence point.

Figure 3-7: 1 in 100 year flood up and downstream water level impact

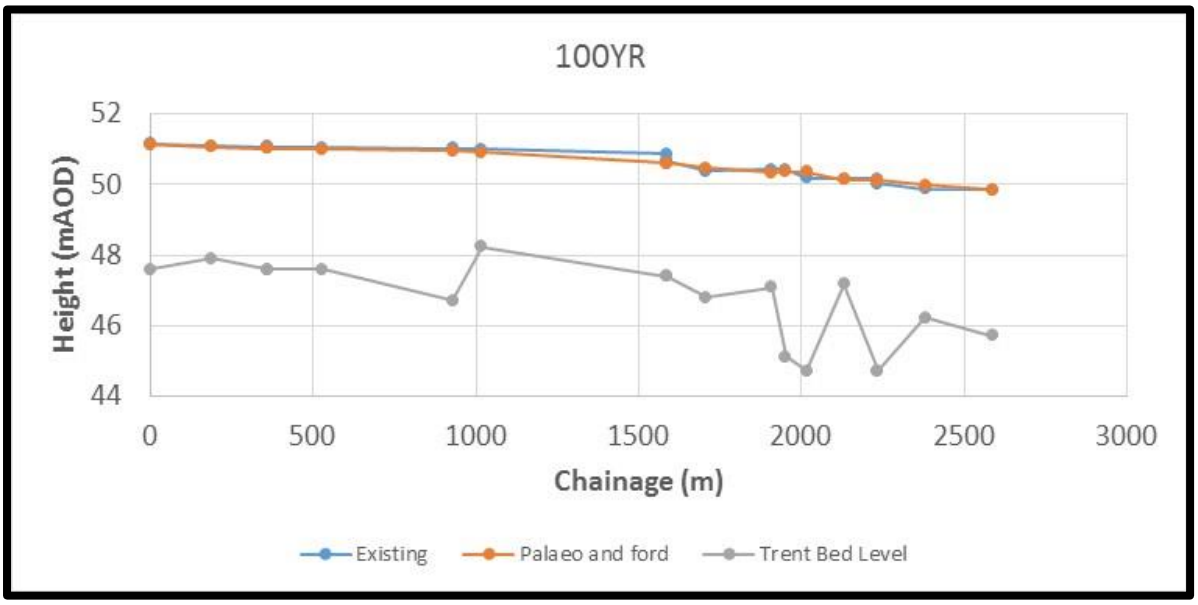


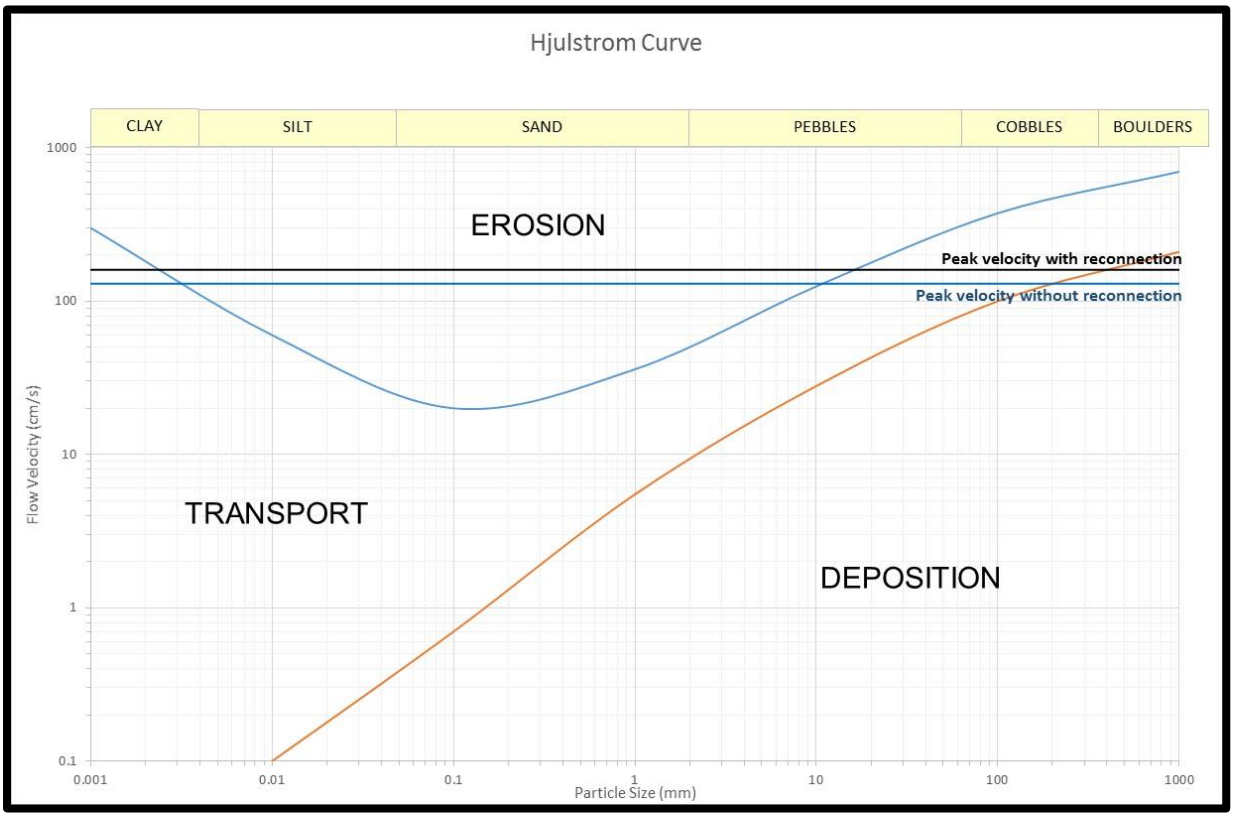
Figure 3-7 show shows the existing 1 in 100 year water level and the 1 in 100 year water level with the palaeo and Ford in place along the Trent for the area shown in Figure 3-2. Minor upstream reductions in water level were noted. A minor increase in water level at the confluence point (10mm) was noted, however this soon reverted back to the existing level downstream of the confluence point.

3.5 Change in hydraulic conditions

A review of in channel velocity using the Hjulstrom Curve has been carried out on both the Trent and the palaeo-channel to determine impacts on channel stability as a result of the palaeo reconnection and Ford placement. Currently, the palaeo-channel is dominated by fine sediment, whilst the main Trent channel is dominated by clean gravels and sands.

As the palaeo-channel is currently not connected to the River Trent the water within the channel can be treated a backwater area. With and without the palaeo-channel connected to the main River Trent potential erosive velocities were noted at the inlet. Possible mitigation options could be to introduce some short term bank protection measures around the ford and inlet. Nevertheless, it is expected that most erosion will continue on the right bank of the Trent (although this could be slightly reduced downstream of the inlet as a result of the reconnection).

Figure 3-8: Velocity at the proposed ford



4 Conclusion

4.1 Key points

- Two hydraulic models have been created to investigate the impact of the palaeo-channel reconnection and ford placement.
    - Model 1 - Existing conditions.
    - Model 2 - With palaeo-channel reconnection and ford in situ.
- The ford height has been set at 30cm lower than the low flow in-channel level to allow vehicular access
- The palaeo-channel inlet has been set 1.5m higher than the Trent bed level (Trent bend level obtained from EA hydraulic model)
- With the ford and palaeo-channel reconnection in situ during low flow (Q95) conditions, the local area changes in water level are minimal. No out of bank flooding occurs.
- With the ford and palaeo-channel reconnection in situ during the 1 in 2 year flood event, water levels increase locally by up to 80mm. Outside of the local area changes in water level are minimal. Some localised out of bank flooding has been noted.
- With the ford and palaeo-channel reconnection in situ during the 1 in 100 year flood event, water levels increase locally by up to 10mm. Outside of the local area changes in water level are minimal. Some localised out of bank flooding has been noted
- Within the River Trent slight reductions in velocities were noted between the inlet and outlet of the palaeo-channel. With reconnection increased velocities were found to occur, as expected in the palaeo-channel, especially at the inlet due to the flow split (it is expected that erosion would only occur during flood conditions and most of the erosion would occur on the opposite outer bend bank).
- Measures may need to be taken to protect banks or widen the palaeo-channel inlet.

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