Technical Note

PROJECT:	Whitecross Farm	PROJECT REF:	EVY0927
Subject	Response to EA letter	Revision	B

Authored	PHA		12/04/2023
Reviewed	JRY		13/04/2023
Authorised	JRY		18/04/2023

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Introduction and overview

Further to the recent flood risk modelling information provided to support the planning application for Whitecross Farm mineral extraction, the Environment Agency (EA) have written requesting additional information to be provided with respect to the hydraulic modelling (email from Sarah Warris-Simmons to Mary Hudson 29 March 2023). This document is intended to supply the requested information. The EA requested that changes applied to the model should be clearly justified and the model files provided.

The EA's letter also contained questions concerning sensitivity testing on the grid size (10m vs 20m) and the use of the latest available LiDAR. The sensitivity tests were addressed in Edenvale Young letter to Mary Hudson (1 March 2023 and in the accompanying spreadsheet). However, the EA has asked for more details and sight of the modelling files to support the statements made in that response. This document is in three parts:

1. Discussion on the changes made to the model and the reasons for those changes,
2. Further details of the grid size and LiDAR sensitivity analyses,

All the model files have now been made available to the EA via online distribution, including those for the sensitivity tests undertaken.

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[1] https://www.openstreetmap.org/copyright

Initial modifications to the EA model.

The modelling for the sand and gravel proposals at the Whitecross Farm site is based on the EA's Abingdon Flood Schemes River Thames model. The incoming model was initially modified to make it suitable for assessing the flood risk at the site. The changes made and their justifications are outlined below. This included modifications to the TUFLOW simulation control files and the model.

The following modifications were made to the simulation control files:

- All "\" in files have been replaced with "/" for use in linux and the command "Use Forward Slash == ON" has been applied.
- The simulation control files (ief and tcf) have been renamed from *v10_Tab_rp100a.ief* to *wcf_v00-A_f100.ief* in accordance with EVY version control and quality assurance practice.
- The results are named in accordance with EVY version control and quality assurance practice (i.e wcf_v00-A_f100)
- Checks and results have been sent to EVY standard folders (which included commenting out the commands for this in the 1D domain block)
- The "LIDAR" folder has been renamed "lidar" to match the file paths in the .tgc
- MB1 (mass balance) has been added as a mapped output for analysis.
- ZUK0 has been replaced with ZUK2 for mapped outputs, which follows the latest DEFRA guidance on hazard mapping.
- The grid output format has been changed from *.asc to *.flt, which is a more efficient file format.
- The following commands have been added to the simulation control files in order to refine outputs:

    o Time Output Cutoff Depths == 0.002,0.1
    o FLT Map Output Data Types == d V h Z0 ZUK2
    o FLT Map Output Interval == 0

It should be noted that the above modifications only affect file handling and reporting. None of the changes affect model performance or the results.

In addition, the following changes were made to the model:

- A single uninitialised z-point elevation at the edge of the active domain was addressed by adding the command "Set zpts == 60" prior to all other zpt commands in the .tgc.
- The grid size was altered from 10m to 20m to improve the mass conservation within the model. The objective of this change was to improve model stability by reducing the mass balance errors. This is discussed in Edenvale Young's letter of the 1 March 2023. Further details of the sensitivity testing are given later in this document.

It should be noted that increasing the cell size to 20m resulted in a change in the position of cells selected to represent the road embankments and cells selected as SX links for conduits under embankments. At some locations the cell selected to be a boundary was the same cell as had been raised by a thick z-line and this was not appropriate for connection with an SX link.

As such, boundary features were moved to the nearest neighbouring cell to ensure connectivity on the floodplain. At Wallingford bridge, which is the closest such case, to the development site, the SX link circles for the 20m grid were moved to ensure that they did not select the same cell as the 2d_zln for the road embankment and the addition of CN lines to connect the pipes layer (unchanged) to the adjusted SX boundaries (see Figure 1 and Figure 2).

These modifications are embedded into Edenvale Young's **model version 6**.

Figure 1: Wallingford Bridge arrangement on the 10m grid, showing zln_check for the raised embankment, 1d_nwk layer with green arrows for the conduits under the embankment, 2d_bc layer with red circles for SX links and corresponding 1d_to_2d_check with red cells
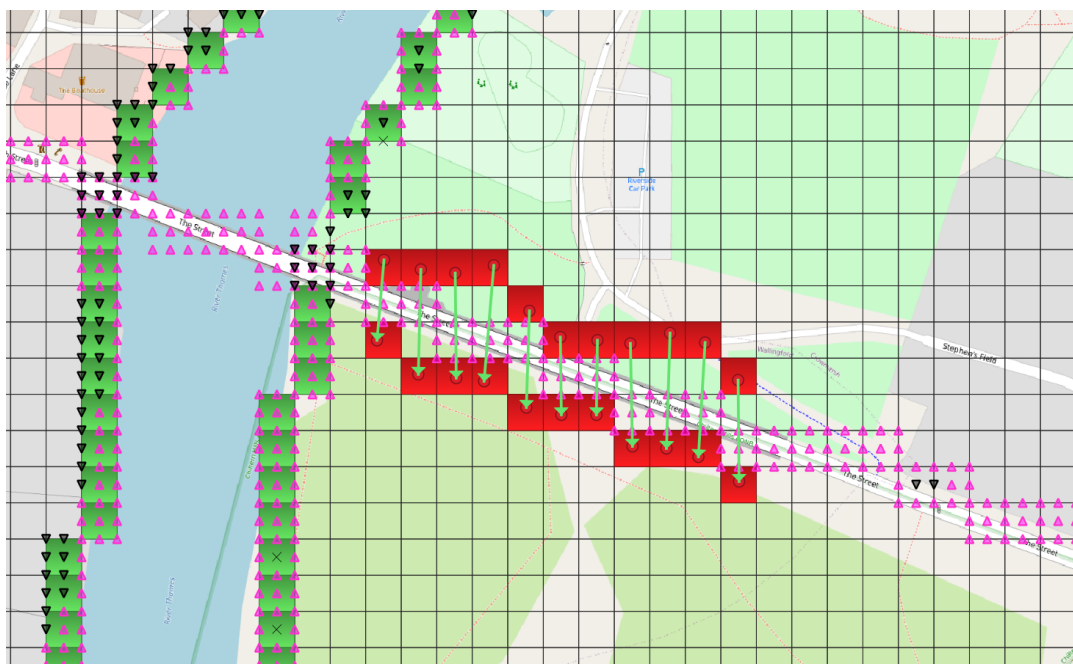
Figure 2 - Wallingford Bridge arrangement on the 20m grid, showing zln_check for the raised embankment, 1d_nwk layer with green arrows for the conduits under the embankment, 2d_bc layer with red circles for SX links and corresponding 1d_to_2d_check with red cells denoting SX links.
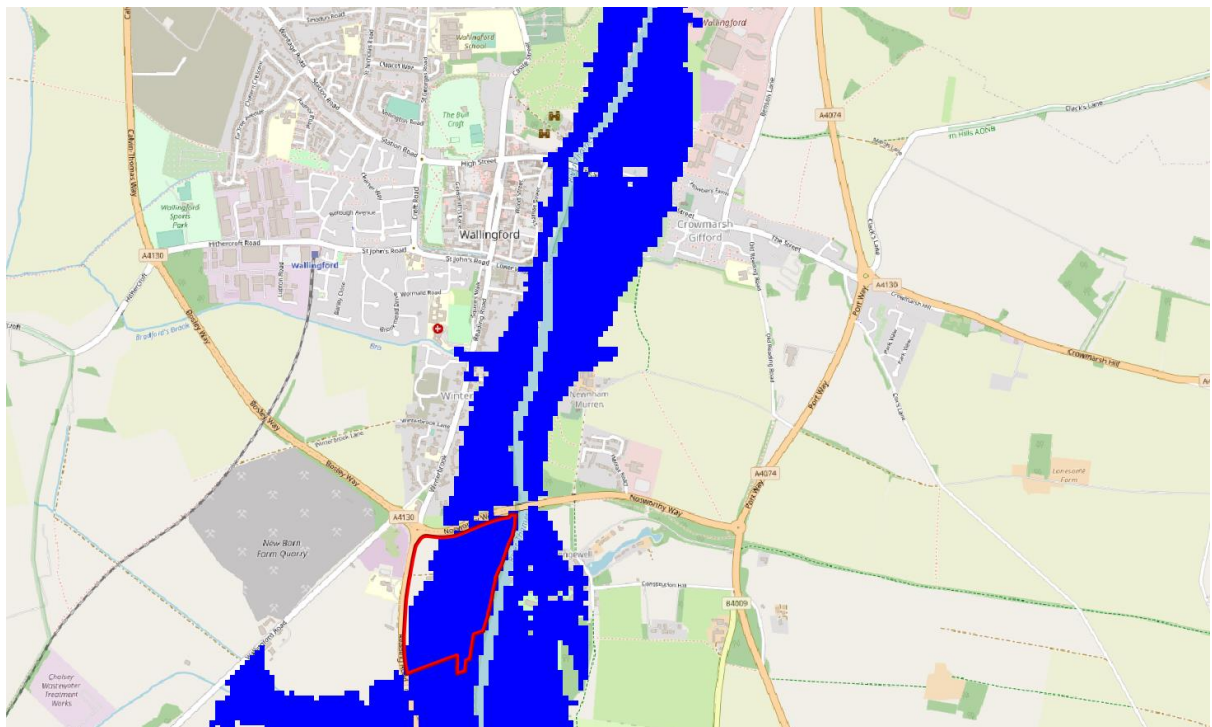
Modifications following the EA's Review

The following changes were made to model version 6 in response the EA's review (i.e the excel spreadsheet accompanying their letter of the 12 January 2023).

a) The .DAT file was reviewed and 'kinks' in the conveyance curves at river sections were removed through the addition of panel markers.

b) The review identified that the latest LiDAR had not been applied to the model; this is discussed later in this document.

c) An ESTRY floodplain conduits near Shillingford (significantly upstream of the site) appeared to have been typo'd with an inlet coefficient of 5.0 - this was corrected to 0.5.

d) The review identified that the grid resolution had been changed from 10m to 20m; this is discussed later in this document.

Please note that items a) to c) relate to issues with the EA's Abingdon Flood Schemes River Thames model and not the modifications made by Edenvale Young (i.e the 10m to 20m grid). However, it is acknowledged that the review findings were legitimate concerns.

Modifications a) to c) have been carried through into Edenvale Young's **model version 7.3** to provide a like-for-like comparisons between the existing baseline scenario and the temporary works during the sand and gravel extraction. Model version 7.3 has been made available to the EA.

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Sensitivity analyses

Grid Resolution Sensitivity

The Abingdon Flood Schemes River Thames model supplied by the EA was based on a 10m resolution. In order to determine whether a 20m grid resolution had a significant impact on the results, a sensitivity analysis was undertaken. Model version 7.4 is a duplicate of Model Version 7.3 (described above) except that the .tgc was adjusted to use a 10m cell size instead of 20m.

Figure 3 and Figure 4 show the outlines of the baseline flood extent with 10 and 20m grid sizes for comparison. The difference between the flood extent for the 10m and 20m grids is minimal. This is unsurprising as both versions of the model have mass balance errors less than 1%. As notded in previous correspondence, a mass balance error of less than 1% is generally accepted by the industry as an indication that a TUFLOW model is healthy.

Whilst both model versions are healthy, the small differences in flood extent are directly attributable to mass balance errors. Mass balance was discussed in detail in Edenvale Young' letter of the 1 March 2023 which demonstrated that the use of a 20m grid was more stable than a 10m grid resulting in smaller mass balance errors. Accordingly, the 20m grid (**model version 7.4)** has been retained as being appropriate in evaluating the difference in flood levels associated with the baseline and excavation scenarios. The full set of model files for Model Version 7.4 of the model have been made available to the EA.
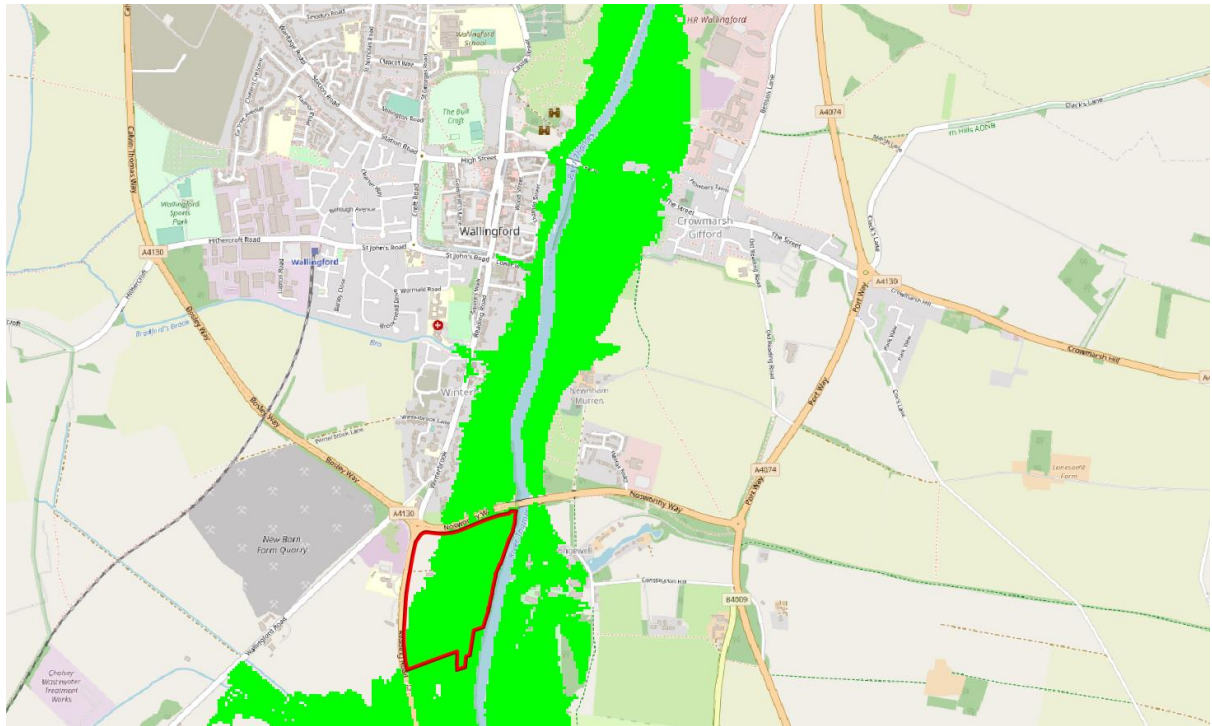

Figure 3: Flood Extent - 100cc12 event using version 7.3 with the 20m grid

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Figure 4: Flood Extent - 100cc12 event using version 7.4 with the 10m grid.

LiDAR Sensitivity

The model supplied by the EA incorporated raster elevations which are assumed to have been derived from an older LiDAR dataset. At the request of the EA a sensitivity analysis was undertaken to compare the results of the incoming model containing the embedded terrain data with the modified model containing new LiDAR. **Model version 7.5** is a duplicate of version 7.3. The .tgc was adjusted to include the latest composite LiDAR dataset (1m dated 2020) which was downloaded in February 2023 from DEFRA portal.

Figure 5 and Figure 6 show the baseline flood extent for comparison. The flood extents are very similar except in the area to the south-west of the site. A road crossing a tributary of the Thames, has been "filtered out" in the Abingdon Flood Schemes River Thames version of the model supplied by the EA. This allows flood water to flow into an area of low-lying land. This is not the case with model version 7.5. Such features are not unexpected when changing LiDAR sets, however they do require some consideration to ensure that a new LiDAR set is handled appropriately.

The use of LiDAR datasets was also discussed in detail in Edenvale Young' letter of the 1 March 2023 which demonstrated that there is very little difference in the application of the old or updated LiDAR in relation to the mass balance error using a 20m grid. Given the broad agreement between the two sets of results it was not considered a beneficial use of time to update the model with new LiDAR. The full set of model files for version 7.5 of the model has been made available to the EA.
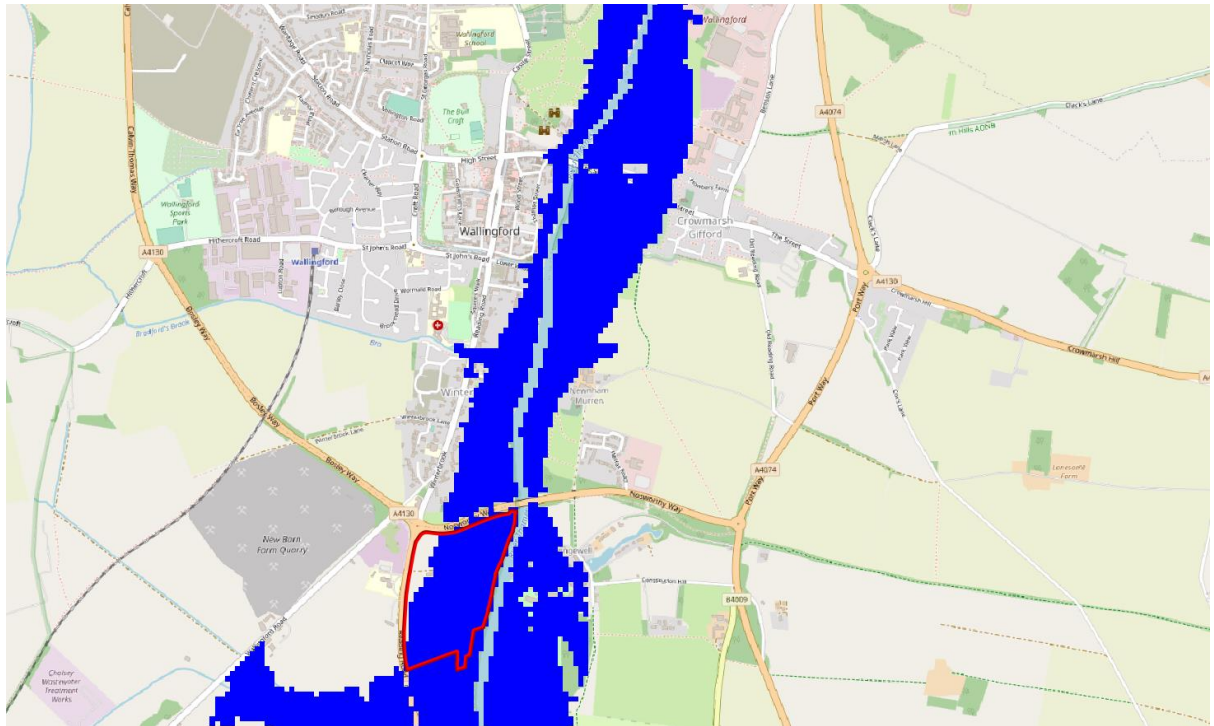
Figure 5: Flood Extent - 100cc12 event using version 7.3 with the raster elevation contained in the supplied EA model
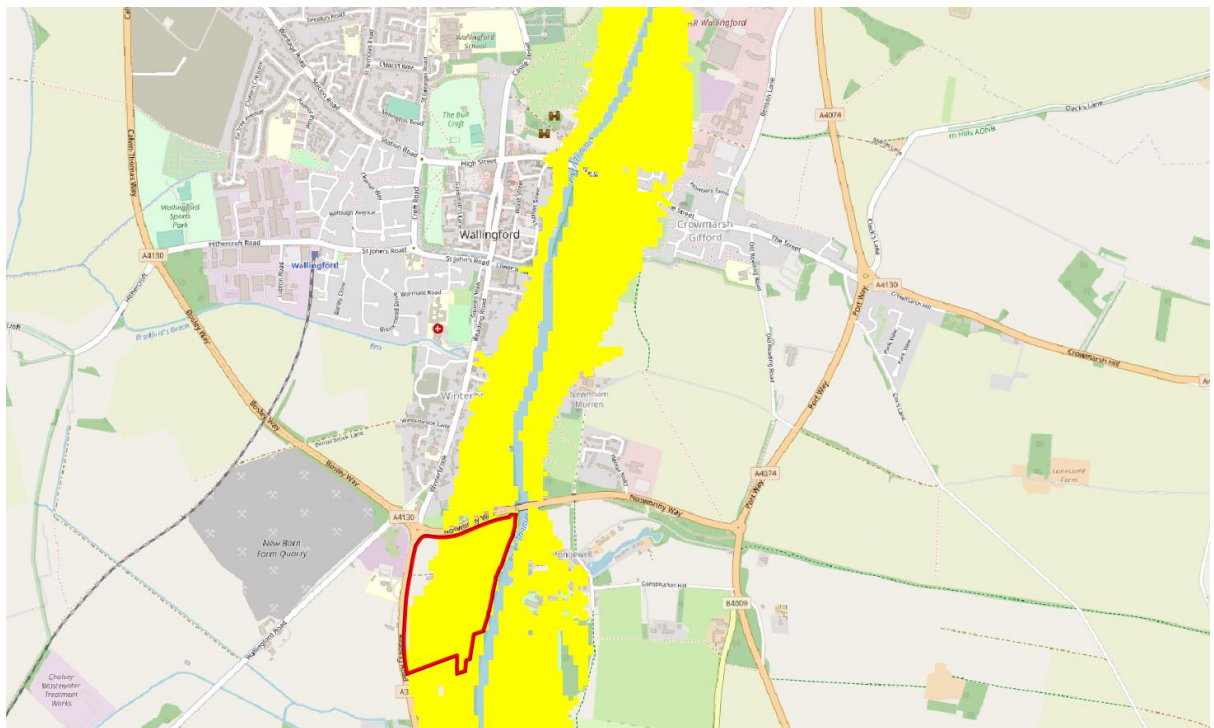

Figure 6: Flood Extent - 100cc12 event using version 7. 5 with the new LiDAR downloaded from the DEFRA portal