



HR Wallingford
Working with water

Elton Reservoir Flood Studies - Phase 2: Impact of Proposed Development

Summary Update Report For Circulation



FWR6309-RT002-R01-00

September 2020

Document information

Document permissions	Confidential - client
Project number	FWR6309
Project name	Elton Reservoir Flood Studies - Phase 2: Impact of Proposed Development
Report title	Summary Update Report For Circulation
Report number	RT002
Release number	R01-00
Report date	September 2020
Client	Canal & River Trust
Client representative	David Brown
Project manager	Matthew Atyeo
Project director	Alex Murphy

Document history

Date	Release	Prepared	Approved	Authorised	Notes
04 Sep 2020	01-00	MSA	MDA	CAG	

Document authorisation

Prepared



Approved



Authorised



© HR Wallingford Ltd

This report has been prepared for HR Wallingford's client and not for any other person. Only our client should rely upon the contents of this report and any methods or results which are contained within it and then only for the purposes for which the report was originally prepared. We accept no liability for any loss or damage suffered by any person who has relied on the contents of this report, other than our client.

This report may contain material or information obtained from other people. We accept no liability for any loss or damage suffered by any person, including our client, as a result of any error or inaccuracy in third party material or information which is included within this report.

To the extent that this report contains information or material which is the output of general research it should not be relied upon by any person, including our client, for a specific purpose. If you are not HR Wallingford's client and you wish to use the information or material in this report for a specific purpose, you should contact us for advice.

Executive Summary

In 2018 as part of a suite of studies to derive the reservoir flood hydrology and dam breach flood impacts, HR Wallingford were commissioned by The Canal & River Trust to undertake a baseline Risk Assessment for Reservoir Safety (RARS) assessment for Elton Reservoir. This assessment was completed to enable the impact of future housing developments on and around the reservoir to be quantified.

In 2020 HR Wallingford have now been commissioned to undertake an update of the 2018 baseline RARS assessment, to quantify the impacts of the specific development plans around the reservoir. The RARS was updated to consider any changes in performance of the reservoir that had become apparent in the intervening period, and to include the future development area as depicted on the 'PEEM3059_Elton_Sketch Matserplan_rev8 LR.pdf' drawing, provided to HR Wallingford by Peel.

The risk assessment follows the UK best practice methodology developed by a team of experts led by HR Wallingford in 2013 and laid out in the established RARS guidance publication¹ which is now industry standard guidance. In carrying out this analysis we have relied on information provided by the Client and personal knowledge of the structure by the most recent Inspecting Engineer.

By utilising a detailed dam breach and flood spreading model on the downstream area (pre and post development) the impacts of the development was ascertained. From the modelling and assessments completed it is estimated that there would be a marginal increase in the Population at Risk (PAR) and Average Social Life Loss (ASLL) should the reservoir breach following the construction of the proposed development.

The dam categorisation is highly likely to be impacted by the construction of the downstream development, this would require that the dam be proven to safely convey a more onerous safety check and design flood conditions than is currently required. The meeting of these more onerous flood conditions could require significant works to the reservoir structure and/ or associated downstream channels.

Potential risk reduction measures have been identified and assigned a high level cost estimate with rudimentary commentary on their suitability. The consideration of specific measures to reduce risks and the assessment of the proportionality of these is beyond the scope of this study.

¹ Guide to risk assessment for reservoir safety management, EA 2013

Contents

Executive Summary

1.	Introduction	1
1.1.	Context to the study	1
2.	Scope of this Report	2
3.	Review of Flood Inundation Modelling and Flood Routing	3
3.1.	Future Development Masterplan	3
3.2.	Impact on Reservoir Catchment	3
3.3.	Impact on Downstream Breach Flood Inundation	3
4.	Review of Risk Assessment for Reservoir Safety (RARS) Study	10
4.1.	Risk identification	10
4.2.	Risk Analysis	10
4.2.1.	Overall Annual Probability of Failure	10
4.2.2.	Consequence Analysis	10
4.3.	Risk Evaluation	10
4.3.1.	Risk Tolerability	10
4.3.2.	Risk Reduction measures	11
4.3.3.	Proportionality	11
4.4.	Conclusions	12

	Appendices	13
--	------------	----

A.	Future Proposal Masterplan – PEEM3059_Elton Sketch Masterplan_rev8 LR.pdf	
----	---	--

Figures

Figure 1.1:	Elton reservoir	1
Figure 3.1:	Master plan of the future development overlaid on the baseline PMF breach flood	4
Figure 3.2:	The breach flood with raised development	5
Figure 3.3:	Areas of the development for the model scenarios	6
Figure 3.4:	Flood depth with the development (area 3b not raised)	7
Figure 3.5:	Difference in flood depth with the development (area 3b not raised) and the baseline	8
Figure 3.6:	Locations of water level results	9

Tables

Table 3.1:	Summary impact of development on reservoir peak inflow	3
Table 3.2:	Results for the development with area 3b not raised	9
Table 4.1:	Potential Risk Reduction Measures	11

1. Introduction

Elton reservoir was built between 1804 and 1808 to supply water to the Manchester Bolton and Bury (MBB) Canal. This canal is now no longer in use, so the reservoir is not now required to provide lockage water, although it does provide a sweetening flow. There are active plans to reopen the canal from Bury to Hall Lane in the next few years which will increase the demands on the reservoir. Details of these plans are available on the Manchester, Bolton and Bury Canal Society website (<http://www.mbbcs.org.uk/index.html>). The location of the reservoir is shown in Figure 1.1.

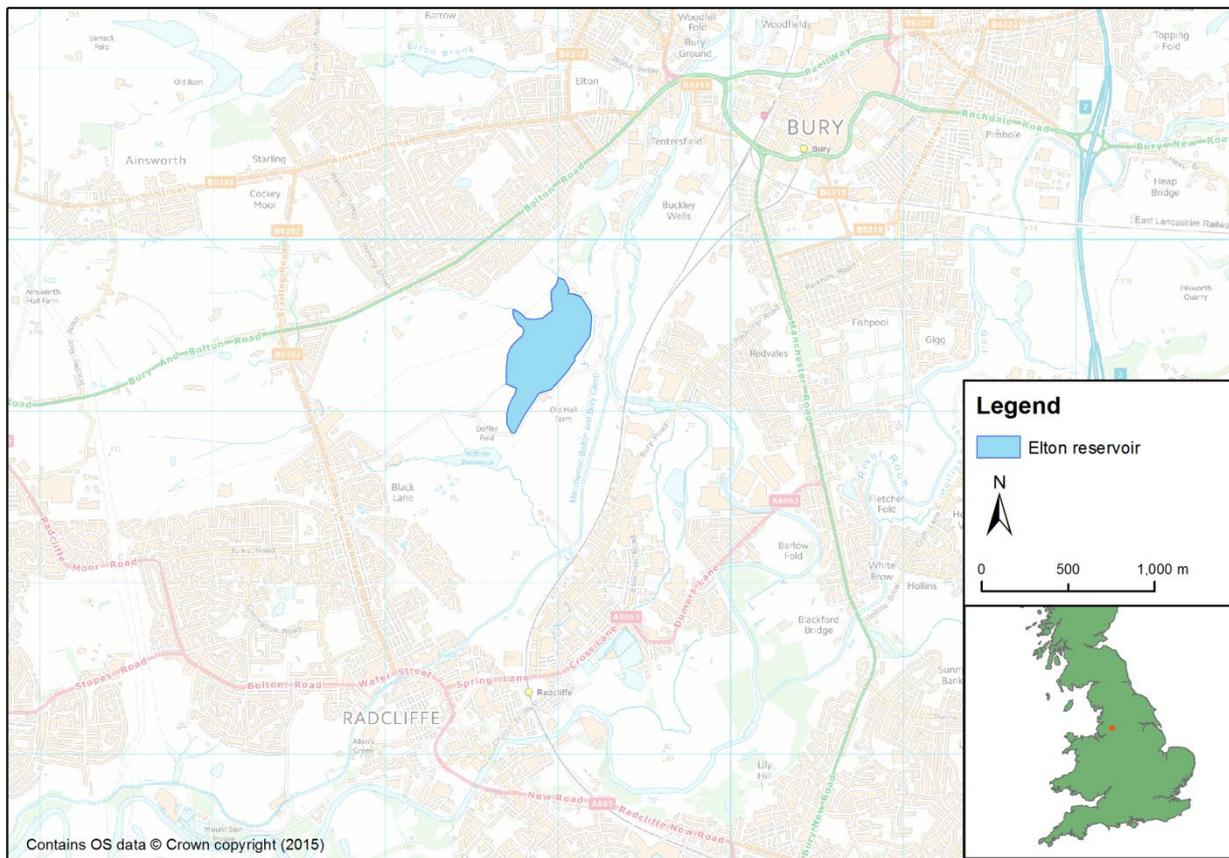


Figure 1.1: Elton reservoir

1.1. Context to the study

Bury Council and the Greater Manchester Combined Authority (GMCA) have allocated the land around Elton Reservoir for housing development in the Draft Greater Manchester Spatial Framework. Peel Group is a major landowner in the area and supports the proposed allocation.

As any future development in this area may have significant effects on the Canal & River Trust’s management of the reservoir, the two parties have agreed to work together to better understand the impacts.

The Canal & River Trust (CRT) has raised issues relating to the risks posed by the reservoir to any new homes built downstream, and the potential effects on the management of Elton Reservoir, in its response to the GMSF consultation. A masterplan to underpin the GMSF allocation needs to be prepared. It is therefore necessary to assess the impact of the reservoir on the proposals, identify where development may be located and what, if any, mitigation measures relating to the reservoir may be needed to facilitate that development. This may be in relation to the reservoir itself, the feeder channels and MBB Canal that the reservoir outfalls to, or the engineering and drainage of adjacent land in order to achieve flood defences/levels.

The Canal & River Trust and Peel agreed that HR Wallingford should undertake a series of baseline studies in 2018 to assess in detail the current situation in order that the effects of the future development on and from the reservoir may be adequately modelled and quantified.

These baseline studies comprise:

- A Flood Study – to assess the inflow hydrology and the design and safety check flood values in accordance with recently revised industry guidance.
- A Dam Breach Study – to assess the speed of a dam breach using a predictive dam breach model, and the likely dam breach inundation extents downstream using a rapid flood spreading model.
- A Risk Assessment for Reservoir Safety (RARS) Study – to establish likely failure modes and to estimate the current probability of failure using the latest industry guidance.

Each of these three studies resulted in a comprehensive report submitted to both the Canal and River Trust and Peel Group in draft, and amended and reissued following any comments received.

In 2020 HR Wallingford were commissioned to undertake an update of the Risk Assessment for Reservoir Safety (RARS) Study to include the effects of the future development.

Peel provided a masterplan outline of the future development that identified areas apportioned to recreational, residential, commercial and environmental purposes.

2. Scope of this Report

This report provides a summary of the flood inundation modelling and the RARS update completed to model quantifiable impacts of the future development on and from the reservoir. The report does not provide details of the Flood Study, Dam Breach Flood Inundation or Risk Assessment for Reservoir Safety (RARS) methodology as this was covered in depth within the baseline study reports issued in 2018.

The flood risk posed by the emergency drawdown of Elton reservoir has not been modelled in this study. This study has looked at the more onerous condition of mitigation measures required to minimise the flood inundation in the event of a breach failure of the reservoir. The emergency drawdown flood risk scenario is assessed and mitigated within the Surface Flood Risk Assessment undertaken by others.

3. Review of Flood Inundation Modelling and Flood Routing

3.1. Future Development Masterplan

The future proposal masterplan (PEEM3059_Elton Sketch Masterplan_rev8 LR.pdf) was issued by Peel to HR Wallingford and is appended to this report for reference.

3.2. Impact on Reservoir Catchment

An update was completed to assess the impact on the flood hydrology that the future development within the reservoir catchment would pose and a precis follows:

The future development could increase the percentage of urban area from 52% to 67% so an extra 15% of the total catchment area. This increases the peak inflow of the PMF by around 25%, however because the area of the reservoir is large compared to the size of the catchment there is very little change in the peak reservoir water level as shown in Table 3.1.

Table 3.1: Summary impact of development on reservoir peak inflow

Description	Baseline 2018	Update 2020
PMF peak inflow	69.1 m3/s	86.8 m3/s
Maximum Stillwater elevation (PMF)	88.29 mAOD	88.39mAOD

Source: HR Wallingford, 2020

The result of this assessment is that the breach modelling runs completed in 2018 do not need to be changed.

3.3. Impact on Downstream Breach Flood Inundation

The master plan of the future development was compared with the 2018 baseline breach flood model results to identify the areas of the development that would be at risk (see Figure 3.1). This shows that the areas of the development between the canal and the rail line would be at significant risk from a breach of the reservoir. The development parcels on the west of the canal would also be at risk. The development residential areas were artificially raised in the model to provide barriers to the flood flow and then the flood inundation model was run. The flood depths with the raised development are shown in Figure 3.2.

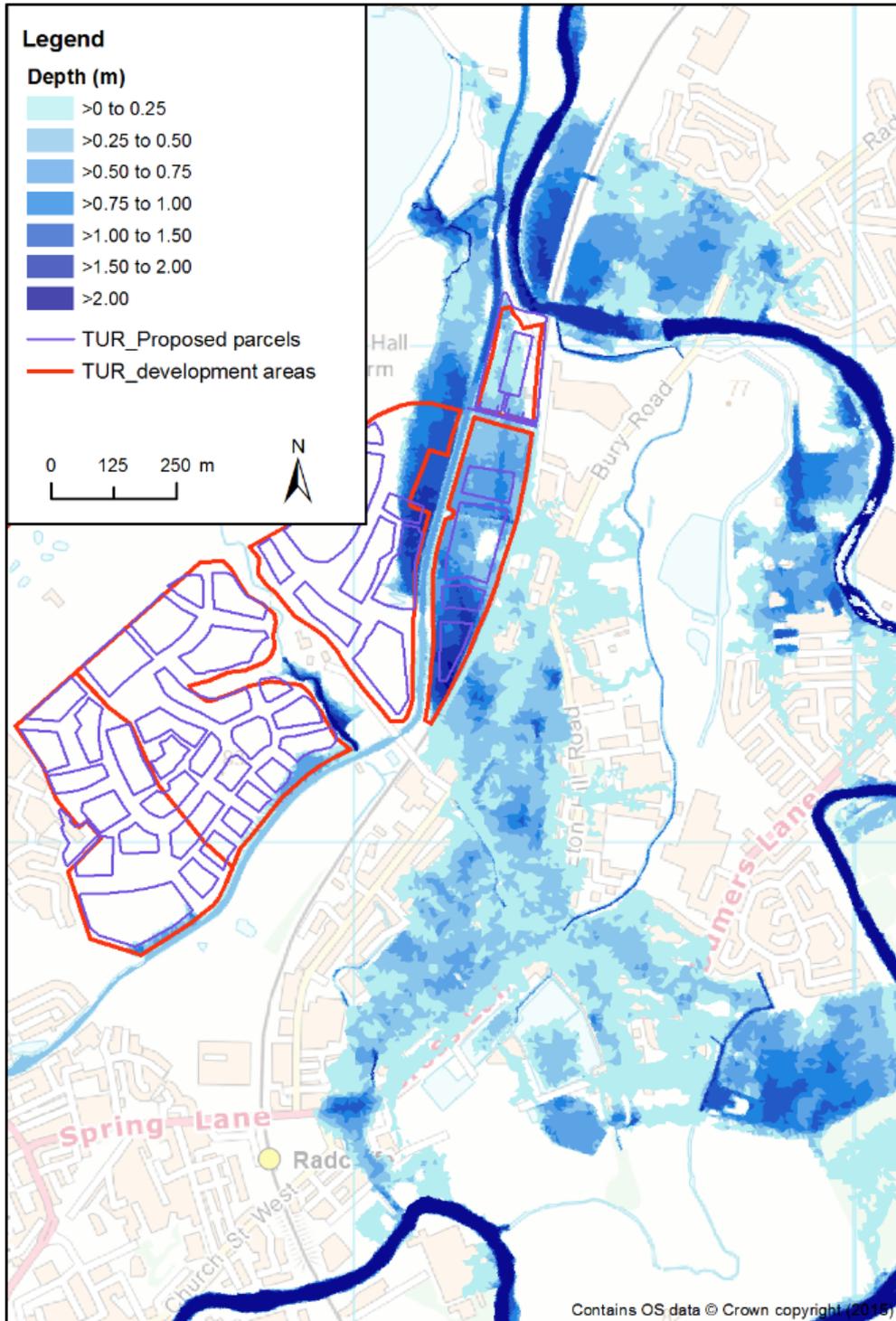


Figure 3.1: Master plan of the future development overlaid on the baseline PMF breach flood

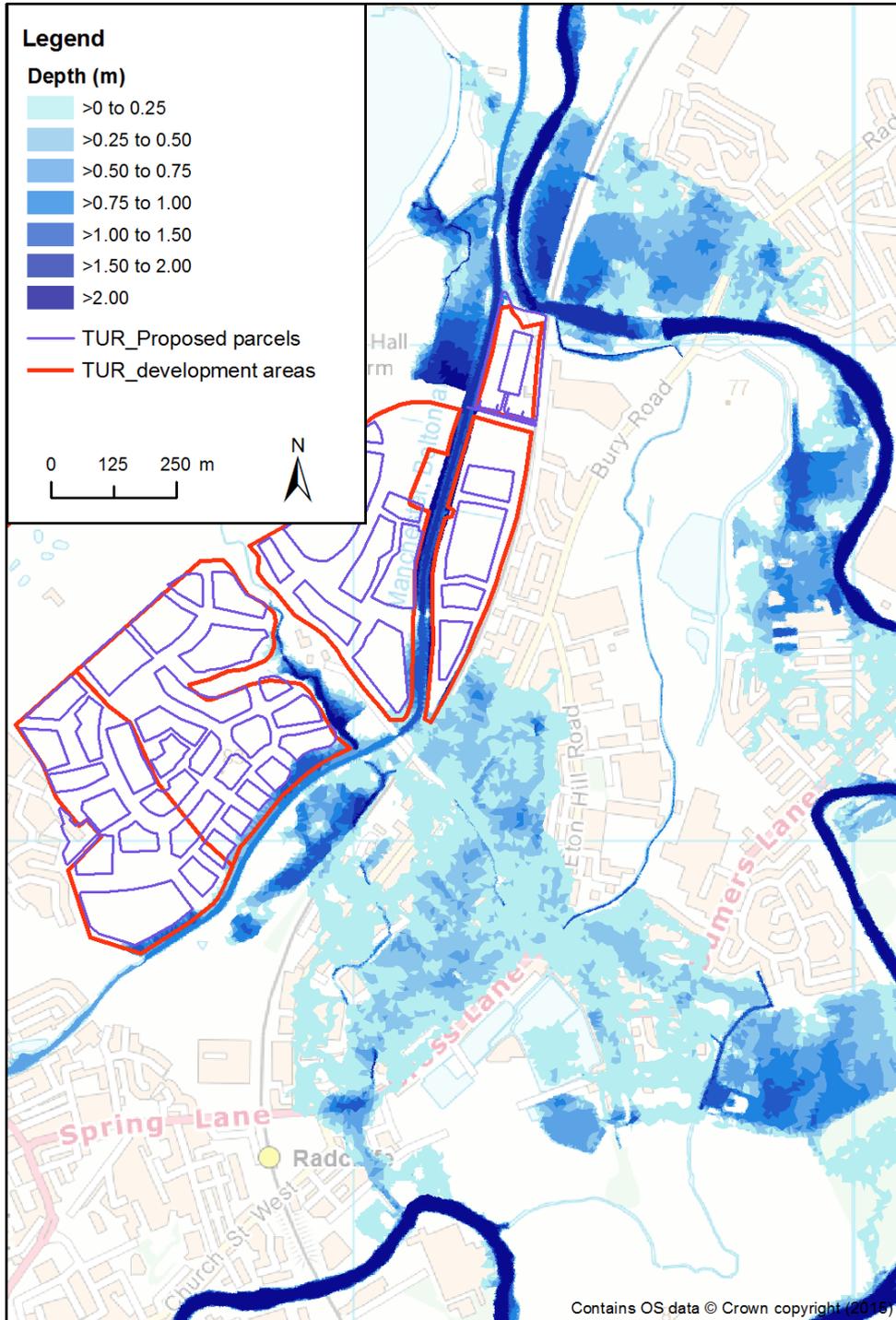


Figure 3.2: The breach flood with raised development

The impacts on the flood limits of the future development were assessed and options considered, and modelled, in an attempt to minimise the impact of the future development on the existing flood inundation limits. The initial options included:

- Increased length of the overflow weir between the canal and the river Irwell;
- A bund at the upstream end of the development to direct flow towards the river Irwell;
- A bund along the canal to create storage between the reservoir and the development.

The model results showed that these options had little impact on the flood flows through the proposed development area. Scenarios were then run with different zones (see Figure 3.3) of the development not developed:

- Area 1 not raised;
- Area 2 not raised;
- Area 3a & 3b not raised;
- Area 3b not raised.

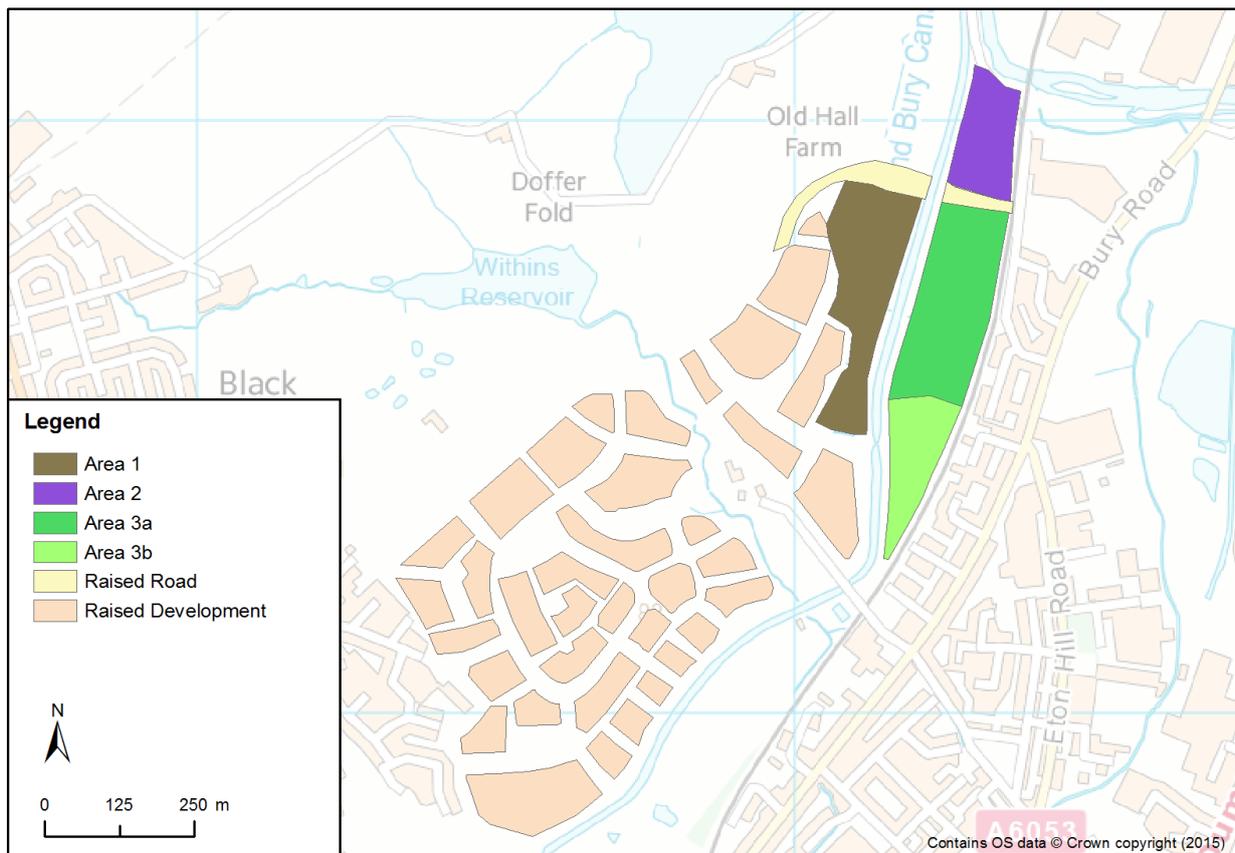


Figure 3.3: Areas of the development for the model scenarios

The flood depths and extent when area 3b is not raised are very similar to those for the existing (baseline) conditions (see Figure 3.4 and Figure 3.5). The elevation at which the areas of the development would need

to be set to prevent flooding in a breach of the reservoir were identified from the model results. These are given in Table 3.2 for the locations shown in Figure 3.6.

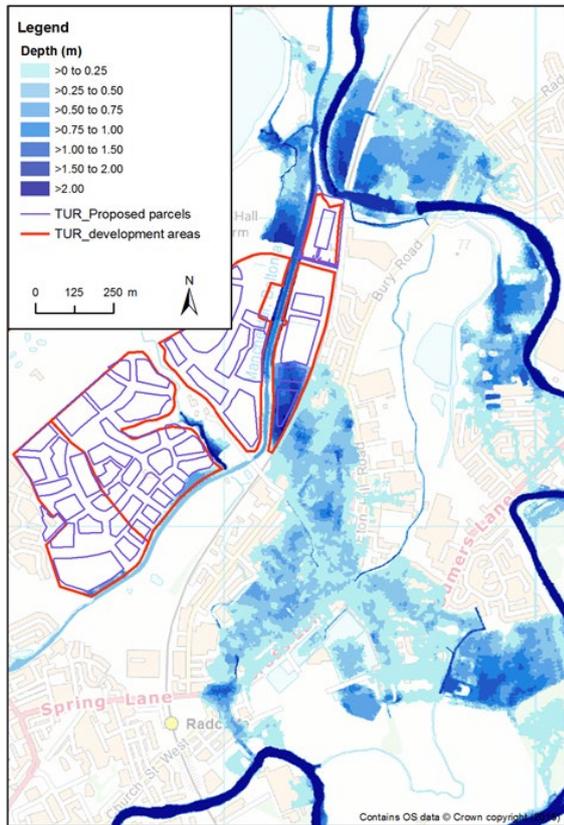


Figure 3.4: Flood depth with the development (area 3b not raised)

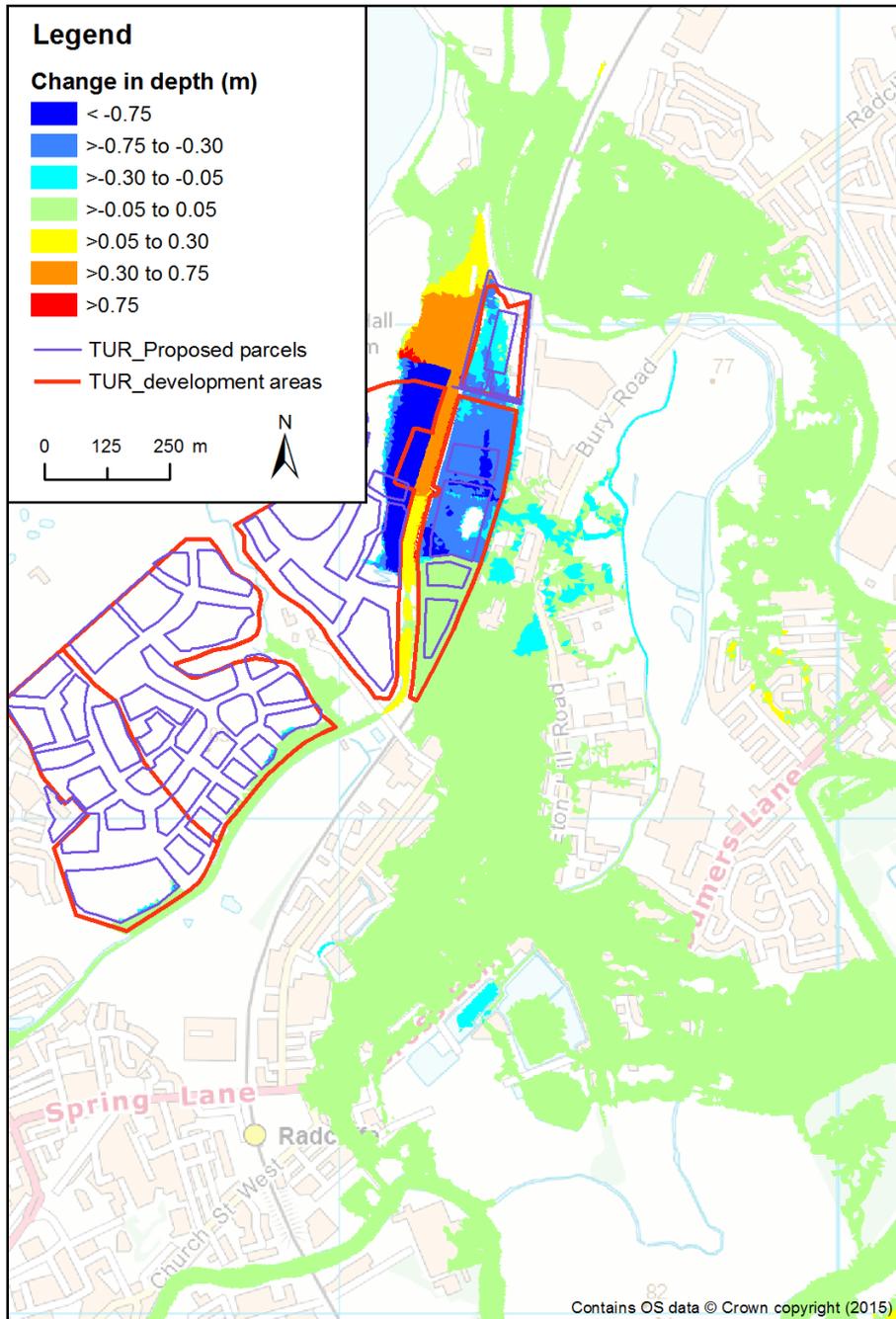


Figure 3.5: Difference in flood depth with the development (area 3b not raised) and the baseline

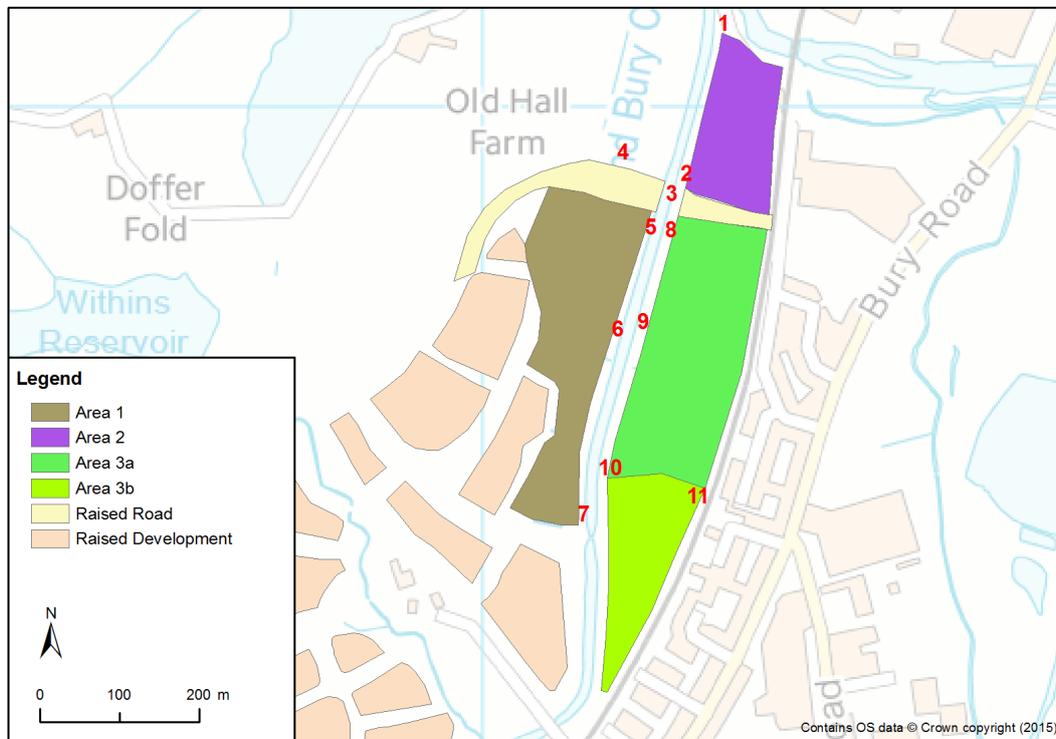


Figure 3.6: Locations of water level results

Table 3.2: Results for the development with area 3b not raised

ID	Location	Water level (m AOD)	Existing ground level (m AOD)	Water depth (m)
1	Area 2 north	77.25	76.58	0.67
2	Area 2 south	77.09	75.40	1.69
3	Road bridge (canal)	77.09	75.70	1.39
4	Road bridge (west)	77.16	75.47	1.69
5	Area 1 north	77.00	75.58	1.42
6	Area 1 mid	76.76	74.99	1.77
7	Area 1 south	76.51	74.91	1.60
8	Area 3a north	77.00	75.09	1.91
9	Area 3a mid	76.76	74.46	2.30
10	Area 3a south west	76.28	74.57	1.71
11	Area 3a south east	74.85	74.2	0.65

Once the changes to the development layout were agreed the RARS study was then updated to include changes on the reservoir site and the future development.

4. Review of Risk Assessment for Reservoir Safety (RARS) Study

Following the derivation of a preferred development layout from the flood inundation modelling update the 2018 baseline RARS study was updated. This update included the addition of the future development and a review of the reservoirs performance using the latest reservoir performance data supplied by CRT. The methodology followed was as detailed within the Elton Reservoir Baseline studies report; Risk Assessment for Reservoir Safety, 2018 with the salient procedures identified below.

The RARS completed for Elton was again a hybrid of Tier 2 and Tier 3, where we had the more detailed hydrology, dam breach and flood inundation study outputs to overwrite the basic Tier 2 assessments.

4.1. Risk identification

The Failure Mode Identification (FMI) was reviewed in relation to the additional sources of data received following the baseline study in 2018. Failure modes considered both credible and significant were then taken forward to the risk analysis stage.

4.2. Risk Analysis

4.2.1. Overall Annual Probability of Failure

As completed during the 2018 baseline study, the identified individual threats which could result in failure of the dam were considered in more detail utilising the RARS methodology.

4.2.2. Consequence Analysis

The inundation area and hazard classification outputs from the (Tier 3) inundation modelling study were used to undertake a consequence analysis in accordance with the standard Tier 2 methodology. The consequences were estimated for the 'no warning' scenario.

The Associated Societal Life Loss (ASLL) and economic damages estimated for Elton Reservoir were plotted on a consequence diagram for UK dams to permit consequence classification.

4.3. Risk Evaluation

4.3.1. Risk Tolerability

The updated risk tolerability classification for the reservoir was assessed by plotting the estimated probability of failure against the estimated consequences of failure (for the case following construction of the future development) on an FN chart. This enables the risk posed to be assigned to one of three zones, Broadly acceptable, As low as reasonably practicable (ALARP) and Unacceptable. Should the dam plot within the ALARP and Unacceptable it is common for the Undertaker to consider works that may reduce the risk to the Broadly acceptable zone.

There are many ways of influencing the risk ranging from physical works, to improved surveillance and early warning systems for populations downstream.

4.3.2. Risk Reduction measures

This RARS update has resulted in an increase of both the Annual Probability of Failure (APF) and the Population at Risk should the reservoir fail following the construction of the future development.

From the assessment completed for the prescribed failures modes, various possible risk reduction measures have been considered, these are presented in Table 4.1 with high level cost estimate and commentary on suitability. The estimated cost bands are:

- Low <£100,000;
- Medium >£100,000 <£1,000,000;
- High >£1,000,000.

Table 4.1: Potential Risk Reduction Measures

Measure Ref	Group of Options (RARS Table 6.2)	Specific Actions	Estimated Cost	Comment
1	Reduce uncertainty in estimation of risk	Further detailed probability of failure investigations	Low	Unlikely to add significant further clarity within a reasonable budget. Already have good information / data on reservoir construction and materials.
2	Improve likelihood of detection	Increase frequency of inspection	Low (but will be ongoing cost)	Reasonable possible intervention.
3	Reduce likelihood of initiation	Remedial grouting – full depth for length of dam	High	Reasonable possible intervention.
4	Reduce likelihood of initiation	Addition of berms along toe of steepest slope	Medium	Due to site restrictions unlikely to be practical option.
5	Reduce likelihood of initiation	Raising of the clay core – along length of dam	Medium	Reasonable possible intervention.
6	Reduce likelihood of initiation	permanent lowering of TWL	Medium	Reasonable possible intervention – however implications for future water resources.

Source: HR Wallingford, 2020

4.3.3. Proportionality

Within Table 4.1 we have included a high level proportionality assessment identifying those mitigation measure deemed to be reasonable possible interventions. Without a detailed, costed specific scheme to assess, it is not possible to comment further on the proportionality of any risk reduction measure at this stage.

If, as a result of the agreed development plans in the future, significant risk reductions measures (such as one of those identified in Table 4.1 or another option) become necessary, the cost of these measures can be estimated and compared with the reduction of risk achieved, therefore allowing a conclusion to be reached on the proportionality of such measures.

4.4. Conclusions

Should the proposed development be constructed downstream of the reservoir it could result in a marginal increase to the Population at Risk (PAR) and the Average Social Life Loss (ASLL) should the reservoir breach.

The construction of the development downstream of the reservoir (even with the proposed development mitigation measures implemented) is highly likely to increase the dam categorisation and, ultimately require that the dam be proven to safely convey a more onerous safety check and design flood scenario during its next periodic inspection.

To meet the more onerous safety check and design flood scenarios could require significant works to the reservoir structure and/ or associated downstream channels.

Appendices

A. Future Proposal Masterplan – PEEM3059_Elton Sketch Masterplan_rev8 LR.pdf



Plans reproduced by permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office. © Crown Copyright and database right [2017]. All rights reserved. Ordnance Survey Licence number [100020449].

Copyright of Turley

This drawing is for illustrative purposes only and should not be used for any construction or estimation purposes. To be scaled for planning application purposes only.

No liability or responsibility is accepted arising from reliance upon the information contained within this drawing.

- Existing trees
- Proposed trees
- Water bodies
- Proposed development
- Hedges - retained and enhanced
- Grassland habitat - species rich - managed for wetland and scrub
- SBI Wetland - managed for species rich grass/sedges/scrub and woodland regeneration and buffers to GC

- Managed Agricultural fields as hay meadows with intensified hedgerow planting and species rich buffers
- Amenity Grassland
- Detention Basins
- E** Local centre 1 - including high street retail and local community centre building
- F** Local centre 2 - with proposed location for new Metro train halt and station, accessed from new bridge, with small retail facilities, and apartments over decked car parking
- J** Local parks - formal, with small play provision

- Proposed Built interventions
- 1** Potential Enhancements to existing sailing club
- 2** Potential enhanced access and leisure area
- 3** Potential beach zone close to Yacht club and public car park (upgraded and linked to path system), with a new Regional Park Interpretation Building
- 4** Potential timber jetty for casual public use and part time mooring
- 5** Cycling Hub building linked to National Cycle route and proposed new Metro rail station
- 6** Potential park ranger station with facilities and extended parking provision
- 7** School locations (1.5 FE) - with playing fields
- 8** Underground water storage
- 9** Potential location for secondary school



Client:
Peel Investments (North) Ltd

Project:
Elton Reservoir

Drawing:
Sketch Masterplan

Project Number:
PEEM3059

Drawing Number: **6101** Scale: **1:5000 @ A1** Status: **Draft**

Revision: Date: **October 2017** Checked By: **ST**

09 (01.03.2019)





HR Wallingford
Working with water



HR Wallingford is an independent engineering and environmental hydraulics organisation. We deliver practical solutions to the complex water-related challenges faced by our international clients. A dynamic research programme underpins all that we do and keeps us at the leading edge. Our unique mix of know-how, assets and facilities includes state of the art physical modelling laboratories, a full range of numerical modelling tools and, above all, enthusiastic people with world-renowned skills and expertise.



FS 516431
EMS 558310
OHS 595357

HR Wallingford, Howbery Park, Wallingford, Oxfordshire OX10 8BA, United Kingdom
tel +44 (0)1491 835381 fax +44 (0)1491 832233 email info@hrwallingford.com
www.hrwallingford.com