



SID 5 Research Project Final Report

● **Note**

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- This form is in Word format and the boxes may be expanded or reduced, as appropriate.

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Project identification

1. Defra Project code
2. Project title
3. Contractor organisation(s)
4. Total Defra project costs (agreed fixed price)
5. Project: start date
end date

6. It is Defra's intention to publish this form.
Please confirm your agreement to do so..... YES NO

(a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.

Defra recognises that in a small minority of cases there may be information, such as intellectual property or commercially confidential data, used in or generated by the research project, which should not be disclosed. In these cases, such information should be detailed in a separate annex (not to be published) so that the SID 5 can be placed in the public domain. Where it is impossible to complete the Final Report without including references to any sensitive or confidential data, the information should be included and section (b) completed. NB: only in exceptional circumstances will Defra expect contractors to give a "No" answer.

In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

Background to R&D project

The aim of this project is to scope methodologies that will allow an assessment to be made of the risk posed by raised reservoirs with a capacity of less than 10,000m³. The methodology will be used for two different purposes.

The first is to inform decisions arising from the Flood and Water Management Act. The Act enables reservoirs of 10,000m³ or larger to be brought within reservoir safety legislation (the Reservoirs Act 1975 only covers reservoirs with a capacity greater than 25,000m³). This project has scoped risk-based methodologies to provide an evidence base for this minimum reservoir volume. This is because the Act contains powers for the 10,000 m³ figure to be adjusted upwards or downwards according to evidence. Evidence as to whether it needs to be adjusted upwards would be derived from the registration and risk-assessment process. However, the Act provides no process by which evidence can be gathered as to whether the figure is too high. For the purpose of determining the appropriate minimum reservoir volume to be included within reservoir safety legislation only the risk to life due to an unplanned escape of water will be considered.

The second use of the outputs is to develop a methodology to satisfy the Environment Agency's obligations with regards to reservoirs under the Flood Risk Regulations 2009. This legislation requires the Environment Agency to determine in relation to each river basin district whether, in its opinion, there is a significant flood risk from the sea, main rivers and reservoirs. For those areas identified as flood risk areas a flood hazard map and flood risk map must then be produced. For reservoirs this process has been started with the National Reservoir Inundation Mapping project (NRIM) which has carried out reservoir inundation mapping for all reservoirs registered under the Reservoirs Act 1975. However, the Environment Agency must assess the flood risk posed by all reservoirs, including those with a capacity of less than 25,000m³.

Results of R&D project

An assessment of the available data sources has shown that individual reservoir parameters (such as dam height and storage volume) are likely to be both costly and time consuming to acquire, and may be of questionable accuracy. In contrast reservoir locations, ground topography and details of flooding receptors

are relatively easy to obtain and are generally of a good quality.

Three methodologies that will allow an assessment to be made of the risk posed by small raised reservoirs have been scoped. These have differing levels of accuracy and anticipated costs:

- High Level Screening – generalised qualitative analysis requiring little input data and producing a comparative consequence score for each reservoir location
- Intermediate – risk assessment based on detailed modelling but with assumptions made regarding reservoir details. 2D modelling carried out for each reservoir location using a set of dam breach hydrographs representing a range of potential reservoir volumes
- Detailed – risk assessment based on detailed 2D modelling and using individual reservoir details to produce a specific breach hydrograph for each location

R&D Outputs and their use

Following testing of the methodologies on a small case study sample the following recommendations have been made:

- The High Level Screening method has been found to be significantly more time-consuming and subjective than anticipated. It delivers outputs that are considerably less useful than the other proposed methodologies, but may be more costly to implement. It is therefore recommended that this methodology is not developed further.
- The Intermediate method uses simple inputs and produces results that can be used to provide an evidence base for the lower limit on reservoir volume for the Flood and Water Management Act. This method cannot produce individual risk assessments for each reservoir as it uses generic breach hydrographs. However, it provides a detailed assessment of the level of risk of each reservoir location
- It is likely to be both time-consuming and costly to obtain the individual reservoir details necessary to carry out the Detailed method. The information cannot be obtained with sufficient accuracy from a desk study so it would be necessary to conduct site visits, or request this information from reservoir undertakers. It is therefore recommended that this methodology is not used on all reservoirs. However, it may be possible to use the results from the Intermediate method to target detailed risk assessments on only those reservoir locations shown to potentially pose significant risk.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:

- the scientific objectives as set out in the contract;
- the extent to which the objectives set out in the contract have been met;
- details of methods used and the results obtained, including statistical analysis (if appropriate);
- a discussion of the results and their reliability;
- the main implications of the findings;
- possible future work; and
- any action resulting from the research (e.g. IP, Knowledge Transfer).

The aim of this project was to develop a methodology that will allow an assessment to be made of the risk posed by raised reservoirs with a capacity of less than 10,000m³. The methodology developed will initially be used for two different purposes.

The first is to inform decisions arising from the Flood and Water Management Act. The Act enables reservoirs of 10,000m³ or larger to be brought within reservoir safety legislation (the Reservoirs Act 1975 only covers reservoirs with a capacity greater than 25,000m³). This project has scoped risk-based methodologies to provide an evidence base for this minimum reservoir volume. This is because the Act contains powers for the 10,000 m³ figure to be adjusted upwards or downwards according to evidence. Evidence as to whether it needs to be adjusted upwards would be derived from the registration and risk-assessment process. However, the Act provides no process by which evidence can be gathered as to whether the figure is too high. For the purpose of determining the appropriate minimum reservoir volume to be included within reservoir safety legislation only the risk to life due to an unplanned escape of water will be considered.

The second use of the outputs is to develop a methodology to satisfy the Environment Agency's obligations with regards to reservoirs under the Flood Risk Regulations 2009. This legislation requires the Environment Agency to determine in relation to each river basin district whether, in its opinion, there is a significant flood risk from the sea, main rivers and reservoirs. For those areas identified as flood risk areas a flood hazard map and flood risk map must then be produced. For reservoirs this process has begun with the National Reservoir Inundation Mapping project (NRIM) which has carried out reservoir inundation mapping for all reservoirs registered under the Reservoirs Act 1975. However, the Environment Agency must assess the flood risk posed by all reservoirs, including those with a capacity under 25,000m³. The Flood Risk Regulations 2009 state that if identified as having a significant flood risk, maps must be produced to include:

- “The number of people living in the area who are likely to be affected in the event of flooding
- The type of economic activity likely to be affected in the event of flooding
- Any industrial activities in the area that may increase the risk of pollution in the event of flooding
- Any relevant protected areas that may be affected in the event of flooding
- Any areas of water subject to specified measures or protection for the purpose of maintaining the water quality that may be affected in the event of flooding, and
- Any other effect on
 - Human health
 - Economic activity
 - The environment (including cultural heritage)”

The project aims have been achieved through the following objectives as set out in the contract:

1. Identify data sources that can be used for the risk assessment and assess for completeness, quality and accessibility (discussed in section 2.2 of FD2640/TR1).
2. Identify information required to assess risk posed by small reservoirs. This includes information on receptors of impacts and information on the hazards posed (discussed in section 2.1 of FD2640/TR1).
3. Develop methodology for risk assessment appropriate to the number of reservoirs that are likely to be assessed and the resources available (discussed in section 3 of FD2640/TR1).
4. Undertake a number of case studies to test and validate the methodology. This will consider a range of different reservoir types and situations (discussed in section 4 of FD2640/TR1).

The above objectives set out in the contract are discussed in Technical Report FD2640/TR1

It is anticipated that there will be a large number of small reservoirs requiring a risk-assessment. Therefore, in formulating the risk assessment methodologies preference has been given to techniques which can be automated and which require minimal user input and judgement. The use of automated methods also improves consistency as it reduces scope for individual user judgement.

Three methodologies with differing levels of accuracy and anticipated costs have been produced. These are:

- High Level Screening – generalised qualitative analysis requiring little input data and producing a comparative consequence score for each reservoir location
- Intermediate – risk assessment based on detailed modelling but with assumptions made regarding reservoir details
- Detailed – risk assessment based on detailed modelling and using specific reservoir details derived from a desk study

Experience gained through undertaking a number of case studies and from the National Reservoir Inundation Mapping (NRIM) project has shown that individual reservoir parameters (dam height, storage volume etc) are likely to be both costly and time consuming to acquire, and may be of questionable accuracy. In contrast reservoir locations, ground topography and details of flooding receptors are relatively easy to obtain and are generally of a good quality.

The High Level Screening method has been shown to be significantly more time-consuming and subjective than anticipated. It delivers outputs that are considerably less useful than the other proposed methodologies but may be more costly to implement. It is therefore recommended that this methodology is not developed further.

The Intermediate method uses simple inputs and produces detailed results that can be used to provide an evidence base for the lower limit on reservoir volume for the Flood and Water Management Act. This method cannot produce individual risk assessments for each reservoir but it provides a detailed assessment of the level of risk of each reservoir location, which may be used to facilitate the risk-based allocation of resources for further study.

The collection of the information necessary in order to carry out specific risk assessments in line with the Detailed method has proved to be difficult. The information cannot be obtained with sufficient accuracy from a desk study so it would be necessary to carry out site visits or request the information from reservoir undertakers. This proved a time consuming and costly operation in the NRIM project, and for this study it would additionally be necessary to establish ownership and obtain contact details for undertakers. This is likely to add an additional cost.

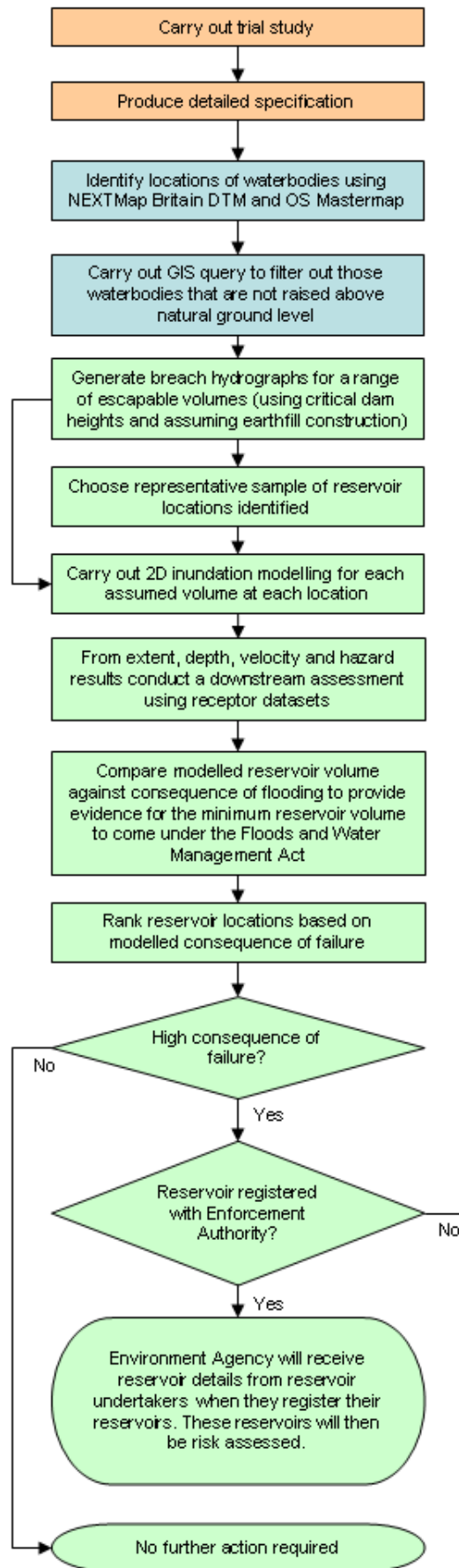
It is recommended that for the purpose of establishing a minimum volume for the Flood and Water Management Act a representative sample of reservoir locations should be identified and the consequences of failure assessed using the Intermediate method. To ensure that the varying topography and land use with England and Wales is properly represented this sample should be geographically dispersed.

It is not known what size a representative sample is likely to be as there is no accurate information available on the number of reservoirs smaller than 25,000m³ in England and Wales. However, Hughes et al, 2004, carried out a GIS-based assessment of the number of waterbodies in Great Britain. This study did not differentiate between natural waterbodies and raised reservoirs, but found a total of 17,941 waterbodies greater than 0.02 ha in area in England and Wales. There are currently approximately 2100 reservoirs registered under the Reservoirs Act 1975, leaving approximately 15,800 natural waterbodies or raised reservoirs smaller than 25,000m³. For the purposes of budgeting if it is then assumed that 1/3 of these waterbodies are raised reservoirs then this gives a figure of approximately 5,000 raised reservoirs. Based upon this figure it has been assumed for the cost estimates that a sample of 1000 reservoirs is likely to be sufficient.

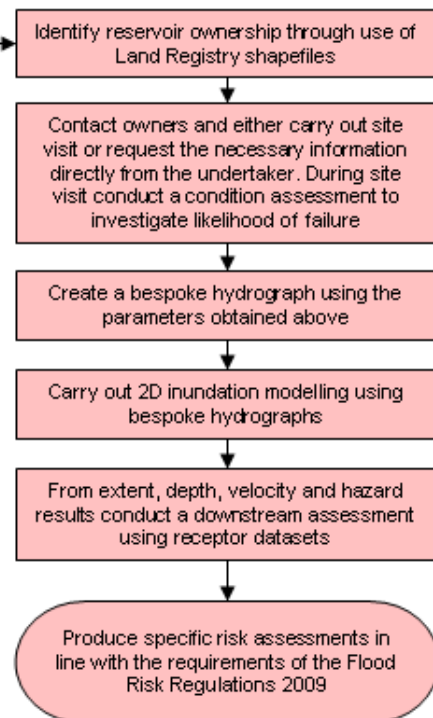
For the purpose of meeting the requirements of the Flood Risk Regulations 2009 it is recommended that the Intermediate method be carried out on all reservoir locations identified. The results from this analysis will show the general level of risk of each reservoir location and will provide a means for the risk-based prioritisation of resources for further study. Ownership may then be established and undertakers contacted for those reservoir locations highlighted through this method as potentially posing a significant risk. It should be noted that for all reservoirs with a capacity of greater than 10,000m³ the Flood and Water Management Act requires reservoir undertakers to register with the Enforcement Authority, and subsequently supply relevant information to them. Assuming that the level of compliance with this aspect of the law is high, it is anticipated that it will only be necessary to establish ownership and contact undertakers where there are reservoirs that are not registered under the Act which have been shown to have a potentially significant consequence of failure. The flow chart below shows the recommended risk assessment methodology.

To develop and test the methodology for risk assessment thoroughly it is recommended that a trial study be carried out. This would involve a more detailed case study analysis of the proposed methodology, followed by production of a detailed specification to ensure consistency.

Intermediate method



Detailed method



References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

This project produced the following R&D outputs:

- **R&D Technical Report FD2640/TR1 Scoping the Risk Assessment Process for Small Reservoirs.** April 2010
- **R&D Technical Summary FD2640/TS Scoping the Risk Assessment Process for Small Reservoirs.** April 2010
- **R&D Project Profile FD2640/PP Scoping the Risk Assessment Process for Small Reservoirs.** April 2010