



South East Strategic Reservoir Option
Preliminary Environmental Information Report

Appendix 19.3 - Information to support assessment of risks

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Contents

1 Introduction 1

1.2 Geological hazards..... 1

1.3 Reservoir safety..... 3

References 9

List of tables

Table 1.1 Indicative outline of operation procedures 6

1 Introduction

- 1.1.1 This document provides additional information to support the Major accidents and disasters assessment in Chapter 19 of the PEI Report.
- 1.1.2 Following the scoping opinion, the Applicant has prepared this appendix to provide further detail to support the assessment of the risk of embankment breach in Chapter 19. It contains information about geological hazards of the Site and relevant legislation and guidance for the construction and operation of reservoirs. It also explains the design aspects and construction, operation, monitoring and emergency planning measures that will be put in place to address the risk of embankment breach.

1.2 Geological hazards

Location and topography

- 1.2.1 The reservoir would be located in the Vale of the White Horse, a broad valley feature to the west of Abingdon. The Site is essentially flat lying with a slight gradient to the north-east.

Geology

- 1.2.2 The reservoir would be predominantly underlain by mudstone of the Ampthill Clay Formation and Kimmeridge Clay Formation (undifferentiated) that are impermeable cover. A thin band of the Lower Greensand Group (sandstone) bisects the south-eastern third of the reservoir, whilst the south-eastern third of the Site is underlain by the Gault Formation clays.
- 1.2.3 Limestone of the Stanford Formation (Corallian Group) lies within draft Order limits. It is not present at the surface in the reservoir area.
- 1.2.4 Information obtained from historical ground investigations suggests that the Corallian Group is at a depth of approximately 35m OD beneath the north-west corner of the embankment. Existing ground levels are in the region of 55m OD, indicating 20m of the Kimmeridge Clay above the Corallian Group. The depth to the Corallian Group increases to the southeast, where it is at approximately 0m OD giving 50m of impermeable clay cover.
- 1.2.5 Geological maps of England can be obtained from the British Geological Survey (BGS). The BGS mapping indicates a variety of superficial deposits across the Site; superficial deposits are unconsolidated sediments such as gravel, sand, silt or clay. Alluvium (unconsolidated material deposited by rivers and streams) is present in the north-west and east associated with river courses, as well as a small area in the centre. Much of the Site is underlain by River Terrace Deposits comprising the Northmoor Sand and Gravel Member, Summertown Radley Sand and Gravel Member and Wolvercote Sand and Gravel Member of the Upper Thames Valley Formation. Head deposits (soils deposited on a slope, by solifluction and gelifluction) are recorded in the centre and south-east of the Site.

Landslide/ mass movements hazard

- 1.2.6 No infilled ground is mapped beneath the embankment (Appendix 10.2 Environmental database search reports). No existing or active landslides are mapped beneath the reservoir site by the BGS.
- 1.2.7 The design will ensure that low strength materials would be removed from beneath the embankment prior to construction. Earthwork slopes will be designed in accordance with relevant standards; consideration will be given to the height of the embankment, the foundation, the permeability and the material from which it is to be constructed. The embankment would be constructed using soil excavated from a borrow pit, which would be placed and compacted in accordance with an earthworks specification, designed to meet recognised standards and requirements set out in section 1.3 below. The predominant source of material would be the Kimmeridge Clay which is low permeability and can be used to provide a stable embankment.

Sinkhole hazard

- 1.2.8 Solution sinkholes are associated with the removal of a soluble rock, such as chalk, gypsum or limestone; the manifestation of sinkholes can be exacerbated by human influences, such as broken pipes, modified drainage or diverted surface water (BGS, 2025). No related dissolution features are recorded on BGS 1:50,000 Series Sheet 253. A BGS memoir was not available for Sheet 253, which covers the area where the reservoir is to be located. However, a memoir is available for Sheet 237 (Thame), which includes similar geology to Sheet 253. The memoir did not refer to large scale dissolution features in the Corallian Group.
- 1.2.9 Environmental database search reports (Section 19 in Appendix 10.2 of the PEI Report), shows that for the Site there are no natural cavities, mining cavities, reported recent incidents, historical incidents or any records related to the national karst databased associated with the Site.
- 1.2.10 The area has a well-developed dendritic drainage system of rivers and streams with various isolated water bodies of ponds, lakes and local reservoirs. Stream sinks (also known as sinkholes) where surface streams disappear underground into bedrock are not recorded. Stream sinks, if present, would usually be anticipated along the line where impermeable rocks overlie potentially soluble rocks. This interface is present to the northwest of the Site; no stream sinks are associated with it.
- 1.2.11 No features associated with sinkholes have been observed at surface during the previous historical site walkovers.
- 1.2.12 Some dissolution was recorded in boreholes advanced into the limestone of the Corallian Group during previous phases of ground investigation, with features locally over 100mm in diameter, that were sometimes infilled with stiff grey clay.
- 1.2.13 The risk of sinkholes developing related to soluble rocks is negligible and need not be considered further in the context of the embankment dam and associated infrastructure. Likewise, there is no likelihood of large-scale ground surface settlement that could cause an increased risk of flooding.

1.3 Reservoir safety

- 1.3.1 The UK boasts a strong track record in reservoir safety, supported by a long tradition of dam construction. Many reservoirs still in use today were built over 200 years ago and continue to be maintained under modern safety standards. This success is due to the multilayered approach to managing risk around reservoir safety known as the Reservoir Risk Hierarchy.
- 1.3.2 In the UK, reservoir safety is sustained through a combination of regulatory frameworks, design, construction, regular inspections, ongoing maintenance and emergency readiness measures. These elements work together to ensure that reservoirs are operated in a secure and controlled manner.

Legislation

- 1.3.3 In England and Wales, any work related to the construction, operation, alteration or modification of large reservoirs such as SESRO must align with the Reservoirs Act 1975 (the Act), as modified by the Water Act 2003 and the Flood and Water Management Act 2010. The Act provides a comprehensive legal framework for ensuring reservoir safety. Adherence to the Act guides all stages of design, construction, operation, and maintenance regime by:
- Defining four roles for engineers under the Act: Construction Engineer, Supervising Engineer, Qualified Civil Engineer, and Inspecting Engineer.
 - Providing a framework of panels under which engineers must qualify to carry out one of the roles under the Act.
 - Ensuring that all engineers on the panels are examined and appointed as qualified by the Secretary of State for Environment, Food and Rural Affairs (Defra) in consultation with the Institution of Civil Engineers.
 - Ensuring that new reservoirs are designed, built, and initially monitored by a Construction Engineer.
 - Ensuring that existing reservoirs are at all times under the supervision of a Panel engineer and are regularly monitored to ensure ongoing safety performance.
 - Independent inspections completed by a Panel engineer who can recommend safety actions to be completed within a set timeframe, which the undertaker must comply with/perform.
 - Ensuring that an emergency on site plan is prepared for all large reservoirs that is informed by inundation modelling before the reservoir is filled. Using this modelling, the Environment Agency publishes flood extent maps for emergency planning purposes for all regulated reservoirs.
 - In England, empowering the Environment Agency to enforce compliance and penalise reservoir owners who breach legal requirements.
- 1.3.4 The Act is reviewed and enhanced from time to time. There is currently a programme for reform planned by Defra.

Guidance

- 1.3.5 The Reservoirs Act 1975 is supported by secondary legislation in the form of Statutory Instruments that define many of the matters described in the Act.

- 1.3.6 There is also supplementary guidance for managing specific technical aspects of reservoir design and operation, such as managing floods, seismic risk and drawdown capacity. There is a continuous programme of research and development projects around reservoir safety which results in new and updated guidance implemented by the sector. Examples of industry guidance includes:
- 2023 – CIRIA C813 – Siphons in dams – design, installation, operation, management and testing.
 - 2020 - CIRIA C789 – Pipework, Valves and associated equipment in dams. A guide to operation maintenance, condition assessment and rehabilitation.
 - 2007 – CIRIA – The Rock Manual. Relates to the rock armour protection of the upstream slope of the dam.
 - 2017 – DEFRA/EA – Guide to drawdown capacity for reservoir safety and emergency planning. Relates to the emergency drawdown capacity through the outlet tunnel pipework.
 - 2015 – ICE – Floods and Reservoir Safety 4th Edition. Relates to the dam crest level to limit wave overtopping.
 - 2013 – EA – Risk Designation Guidance
 - 2011 – DEFRA/EA – Modes of failure and Monitoring and measuring techniques
 - 2011 – DEFRA/EA - Lessons learnt from historical Dam Incidents
 - 1995 – ICOLD - Bulletin 95 – Embankment Dams Granular Filters and Drains
- 1.3.7 The Project will conform to legislation, industry best practice and guidance in design, construction and operation as set out below.

Design

- 1.3.8 Reservoirs, particularly those classified as high consequence under the Reservoirs Act 1975 (as amended)¹, are designed with a primary objective of mitigating catastrophic risk. This is achieved through design principles and comprehensive risk assessments, underpinned by international best practice and national legislation (as outlined above).
- 1.3.9 In the UK, the design and construction of new reservoirs must be supervised by an appointed Construction Engineer, as required under the Reservoirs Act 1975. To hold this role, an engineer must be highly experienced and appointed to the appropriate Panel of reservoir engineers, reflecting one of the highest thresholds of competence in UK civil engineering. These appointments are made by the Secretary of State (via DEFRA), based on recommendations from the Institution of Civil Engineers' Reservoirs Committee.
- 1.3.10 The design has been reviewed and developed under the supervision of an All Reservoir Panel Engineer. A Construction Engineer has been appointed to oversee the design development, site trials, and eventual construction.
- 1.3.11 In line with both international best practice and UK guidance, the Project also benefits from independent oversight by a Reservoir Advisory Panel. This board of experts reviews key aspects of the Project design, construction planning, and safety strategies and includes members who provide continuity from earlier stages of the Project.

¹ A high consequence reservoir is a large, raised reservoir, where, in the event of an uncontrolled release of water, there is a risk to human life and a number of legal duties will apply

- 1.3.12 The Project design incorporates multiple levels of resilience. Key features include:
- It is a non-impounding design which means that, unlike dams which are constructed to impound natural watercourses, it is not at risk from extreme floods.
 - Modern and robust design with a wide embankment.
 - Controlled access to prevent accidental or deliberate damage, the dam crest is designed to be robust and protected against uncontrolled vehicular access.
 - Wave erosion protection: The internal face of the embankment would be able to withstand erosion caused by wind driven waves, including those generated during extreme weather events.
 - Overfilling prevention system: Like many other Thames Water reservoirs, the Project would include a comprehensive control system to prevent overfilling.
 - Emergency drawdown capacity: the Project is designed with the ability to lower the water level at a rate of 1 metre per day, which is the maximum drawdown rate recommended in UK guidance. This provision ensures that, in the event of structural issues, the reservoir level can be reduced promptly to reduce pressure on the embankment.
 - Monitoring and surveillance: A comprehensive automated system would be installed throughout the dam structure to detect movement, leakage, or other anomalies. These alerts would interface with Thames Water's existing reservoir safety management systems. Monitoring would also be undertaken via surveillance, which is included in Table 1.1 below.
- 1.3.13 Across the sector, both in the UK and internationally, there is a strong emphasis on continuous improvement based on research and development. Bodies such as the British Dam Society, ICOLD, ICE Reservoir Committee, and the Panel Engineers Committee play vital roles in shaping guidance, disseminating lessons learned, reviewing the qualifications of key professionals, and influencing updates to legislation and standards. Their involvement ensures that projects like SESRO benefit from the most current advances in reservoir safety.

Construction

- 1.3.14 As outlined above, in accordance with the Reservoirs Act 1975, no reservoir should be constructed without the appointment of a Construction Engineer. Furthermore, in line with recommendations set out in the Coxon Report (1986), a panel of independent specialists is established to review and provide expert advice on the design and construction of all major new dam projects. This ensure that the Project is subject to external review and best practice guidance.
- 1.3.15 To ensure safety throughout the construction phase, the following measures are to be considered:
- Use of trial embankment and clay compaction trials.
 - Use of modern specialist plant, materials, testing and manufacturing (including precast or off site fabrication) to significantly improve quality control.
 - Deployment of GPS controlled compaction plant to improve consistency.
 - Increased use of high-quality precast components.
 - Establishment of on site testing laboratories.

- Installation of monitoring equipment including piezometers and inclinometers to monitor impacts of construction.
- Use of drone surveys and other modern surveying techniques to increase precision and efficiency.

Operation, monitoring and review

- 1.3.16 Thames Water operates 59 reservoirs under the Reservoirs Act 1975 and applies the same rigorous standards to the Project. The reservoir would be continuously monitored and maintained to ensure long-term safety and compliance.
- 1.3.17 Since the SESRO reservoir would be a high-risk reservoir (Dam Category A), it will require a Reservoir Safety Management Plan (RSMP). This will set out what surveillance, monitoring, and maintenance is required, including frequency, and how it will be operated. The on-site emergency plan will be appended with a record of all surveillance, operational and maintenance activities together with associated data and will be kept up to date.

Table 1.1 Indicative outline of operation procedures

Monitoring frequency	Item	By whom
Daily	Visual confirmation of reservoir level and comparison with level sensors.	Reservoir Operator
Twice weekly or other as specified for an individual reservoir	Customer Operations team	Customer Operations team
Weekly (detail exact day if necessary)	Water level, Detailed bespoke monitoring regimes, Leakage flow measurements at v-notch	Customer Operations team
Twice per calendar year (minimum)	S12 Reservoir inspection (1 No S12 inspection report annually)	Supervising engineer
12 months	Crest level	Survey contractor
Maximum 10 yearly	S10 Reservoir Inspection	Inspecting Engineer

- 1.3.18 Thames Water has robust and well-established systems for surveillance and maintenance, which will be applied for the Project. Key operational monitoring includes:
- Ground movement (level surveys).
 - Pore water pressure (piezometers).
 - Drainage flows (V-notch weirs).
 - Water levels and weather data.
- 1.3.19 Reservoir operators will gather data to track performance and regular on site inspections by trained engineers, as outlined in Table 1.1. Routine maintenance will cover embankments, drawdown systems, and site infrastructure (roads, signage, fencing, etc.) ensuring continued successful operation. Thames Water has extensive experience and an excellent track record of undertaking such work for its reservoirs.

- 1.3.20 A Supervising Engineer will be appointed throughout operation to monitor performance, raise safety concerns, and advise on improvements. An annual statement on reservoir condition will be submitted to Thames Water and the Environment Agency.
- 1.3.21 A Section 10 inspection will be carried out by an Inspecting Engineer at least once every 10 years, and any safety measures they recommend must be implemented within a defined timescale and are monitored by the Environment Agency. These inspections provide a detailed assessment of the reservoir's condition and performance.
- 1.3.22 Throughout reservoir operation, further performance reviews and assessments will be undertaken to support safety. They may include (depending on requests by Inspecting Engineer):
- Stability analysis using modern analytical techniques to assess the integrity of embankments and slopes is important.
 - Inundation mapping to understand flooding extent in the unlikely event of dam failure, which would be used to inform updated emergency planning (see below).
 - Risk Assessment for the Reservoir Safety Risk Assessment to ensure quantification of risks is up to date based on current reservoir operation.
- 1.3.23 The Operation and Maintenance (O&M) Manual will be scheduled during the final stages of the dam construction phase, which allows the manual to be ready as the dam approaches completion and commissioning. It will be based on the Flood and Water Management Act 2010, Reservoir Act 1975 and Health and Safety Executive (HSE) guidelines.
- 1.3.24 Thames Water will ensure the Project is operated safely through robust continuous monitoring, regular inspections and ongoing maintenance supported by external independent and highly qualified engineers, in accordance with and pursuant to a tried and tested legislative framework. This approach reflects a commitment to the Project's long-term safety, compliance, and resilience.

Emergency planning

- 1.3.25 While the risk of breach is extremely low due to the Project's robust design and full bunding, preparedness measures are in place to ensure public safety.
- 1.3.26 An emergency on-site plan according to Environment Agency guidance (2021) will be developed during the design and construction phase of the Project, before filling the reservoir. The on-site emergency plan will include emergency response protocols, escalation procedures, emergency drawdown measures and on-site plan determining the access routes and the location of equipment controls. It will ensure the right people can prevent, control and respond to any threat from the reservoir that could endanger life or property. On-site plans refer to emptying the reservoir in an emergency or undertaking temporary repairs and facilitating this through the associated procedure which is certified every 5 years by a reservoir Supervising Engineer.
- 1.3.27 For the Project, from observed flows at Sutton Courtenay gauging station and Culham lock², the median flow in the River Thames is 17m³/s and with the addition of emergency

² Gauging station flows at Sutton Courtenay can be found at <https://nrfa.ceh.ac.uk/data/station/meanflow/39046>. Observed water level records upstream of Culham lock can be found at: <https://environment.data.gov.uk/hydrology/station/255a860c-247c-4f7d-a38a-01f22c27a149>

drawdown flow then the total flow is still below river capacity (110m³/s is the flow at which Thames weir gates are open, “bankfull” is slightly higher). With normal or low flows in the River Thames, the emergency drawdown flow would be fully contained in the river without flooding. If reservoir drawdown is required, it may not need to discharge at maximum capacity (for example to lower the water levels to examine a minor irregularity in the inner embankment face).

- 1.3.28 Modelling of embankment breach will be undertaken prior to filling the reservoir to inform the on-site emergency plan which is needed to obtain a ‘preliminary certificate’ under the Reservoirs Act 1975 (as amended by the Flood and Water Management Act).
- 1.3.29 The on-site emergency plan would work in conjunction with off-site emergency plans. Off-site plans are coordinated by the Local Resilience Forum (LRF) involving reservoir operators. Guidance and templates (Defra, 2021) set out considerations such as flood risk, coordination of a response, vulnerable communities, infrastructure and recovery. The guidance also refers to data protection for sharing of reservoir flood mapping outlined in the National Protocol for the Handling, Transmission and Storage of Reservoir Inundation (Flood) Maps for England and Wales (UK Reservoir Safety Group, 2018). This data is used for both on-site and off-site plans.
- 1.3.30 The EA has developed the Reservoir Flood Mapping (RFM) Specification (which is not published publicly) for assessment of reservoir failure impact and publishes reservoir inundation maps for all existing reservoirs in the UK based on this approach. It is noted that the inundation mapping analysis does not inform the design of the reservoir embankment itself, which will be designed in accordance with international best practice. Furthermore, the Reservoirs Act 1975 does not require these plans to be developed during the design phase.

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