

Canal & River Trust
Toddbrook Reservoir
Spillway Options Report Update

P11742-ARP-YL-001-001-RP-Z-0028

P3 | 17 March 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 277087

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ARUP

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1 Introduction

1.1 Purpose of this report

This report has been prepared as an update to the ‘Toddbrook Spillway Options Report’, published on the Canal & River Trust (the Trust) website on 6 November 2020. The Options Report ([which can be accessed here](#)) outlined the work done to review options for the spillway repair works required at Toddbrook dam to address damage to the auxiliary spillway following the incident that occurred on 1st August 2019. It explained the process taken to identify, evaluate and select a shortlist of sites for the spillway works. It concluded with the selection of a shortlist of two options to be taken forward for further investigation and review.

The objective of this report is to provide an update to the Spillway Options Report which concluded with the selection of two shortlisted spillway options. These were presented for public consultation in September 2020. This report describes the investigation work that has been completed by Arup since then, explains the process of selecting the preferred option and describes the subsequent technical development of the scheme.

The Trust has also published a corresponding non-technical summary on its dedicated project web page (<https://canalrivertrust.org.uk/restoring-toddbrook-reservoir>). The non-technical summary explains the key features of the confirmed spillway scheme and how these were informed by a range of factors, including consultation feedback and technical constraints. The non-technical summary is a recommended starting point for understanding the refined spillway scheme.

Appendix A provides some background information about dams and reservoirs and helps to explain some of the terms used in this report. Appendix B includes plans and sketches of the proposed scheme.

1.2 Project team

The key roles and responsibilities of the organisations forming the Toddbrook Reservoir project team are:

Canal & River Trust - reservoir owner and operator

Arup - Civil engineering consultant appointed by the Trust to carry out design work

Kier - Civil engineering contractor appointed by the Trust to carry out construction work

Mott McDonald – providing a Qualified Civil Engineer appointed by the Trust – responsible under the Reservoirs Act for inspecting the reservoir and overseeing the design and construction of the repair works

2 Investigations and design development of shortlisted Spillway Options A and B

Further technical work has been undertaken since September 2020 to investigate the shortlisted options, develop the designs and compare the options. This work is summarised within this section. For reference, the two shortlisted options, as presented at the public consultation in September 2020, and in the Spillway Options Report are:

- **Option A - new bathtub spillway at the left-hand end of the dam with spillway channel passing through the dam and the park; and**
- **Option B - new side channel spillway at right-hand end of the dam, with spillway channel through the Memorial Park woodland.**

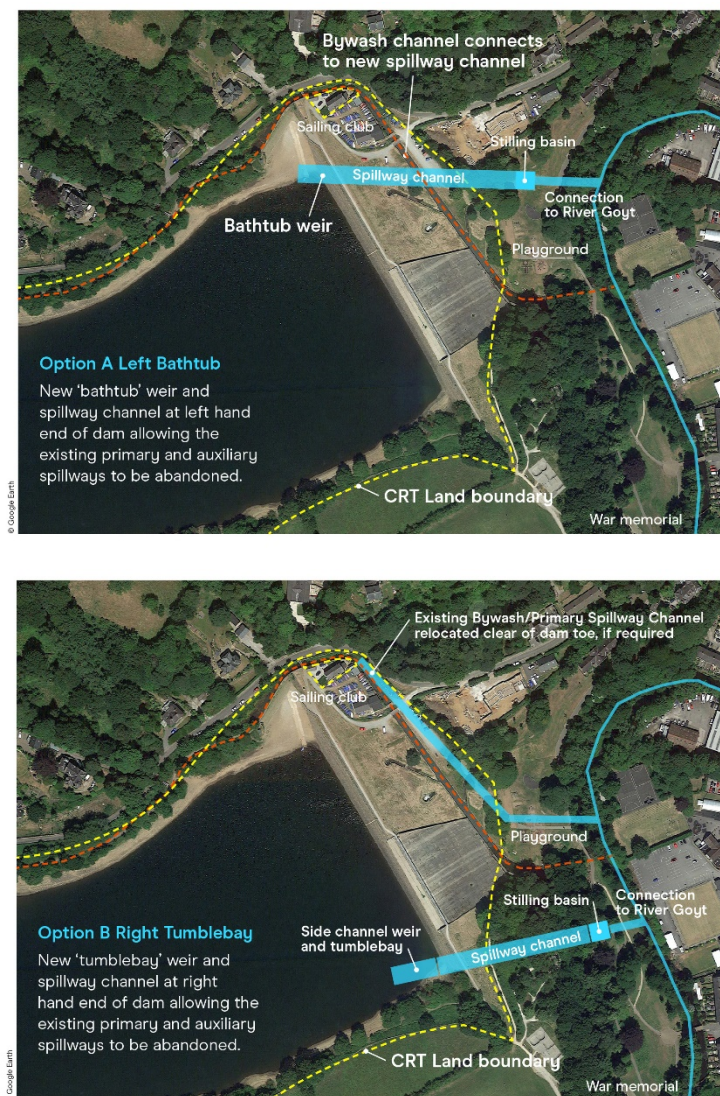


Figure 1 – Shortlisted Options A and B

2.1 Physical constraints

Further review of the physical constraints was undertaken using a detailed topographical survey. This mapped out in more detail above ground buildings and infrastructure plus surface features that were used to confirm locations of known underground assets such as the canal feeders and mine drainage workings. The alignment of the options was subsequently refined where possible to avoid these physical constraints. This involved adding two slight bends to the alignment of Option A to ensure there would be sufficient room to construct the spillway whilst avoiding the constraints.

2.2 Hydraulic design

The hydraulic designs of the two options were developed to better understand the key dimensions of the spillways such as weir length, channel widths, depths and profiles. The refinement of Option A to include bends in the spillway chute as described above was one reason that the hydraulic design of Option B was considered to be more straightforward, although neither option was ruled out on grounds of hydraulic design.

2.3 Health and safety

The designs were developed to take further account of health and safety considerations, to identify hazards and try to avoid, reduce or control risks arising during construction and the lifetime of the structures. This included reviewing how safe access could be provided to the structures for inspection and maintenance. The gradient of the Option A spillway was less steep than Option B, making this access easier to provide.

2.4 Flood risk

An initial review of the impact of the spillway discharge positions to the River Goyt on the risk of flooding for Options A and B was undertaken. This was based on information obtained from the Environment Agency. As the discharge position of the Option A spillway is downstream of the existing spillway discharge position, the flood risk should not increase. However, the initial assessment indicated that for Option B flood levels in the River Goyt could increase as a result of the spillway discharge position being upstream of the existing position.

2.5 Ground Investigations

Further ground investigations were carried out to gain more information about the ground conditions, focusing on the areas where spillway Options A and B were proposed. The information gathered from these investigations was reviewed alongside historical information to develop draft ground models, to gain an understanding of ground conditions, constraints and risks. Key risks identified included the management of groundwater during construction and the effects of this on third party assets, particularly for Option A. The alignment of Option A would also have involved construction across the natural slope of the ground and

potential uneven loading of the ground that would need to be managed. Option B presented risks associated with the steepness and stability of the ground during construction and historical landslips in the area.

2.6 Ecology and Biodiversity

A Preliminary Ecological Appraisal, including a Phase 1 habitat survey, and a suite of bat surveys were undertaken to better understand the ecological constraints associated with the two options. The results will be used to inform appropriate mitigation measures as part of the proposed scheme. Option B would require a significant loss of trees to allow construction. As noted in the Options Report the reservoir is designated as a Site of Special Scientific Interest (SSSI) due to the presence of a rare moss species and permission will be required for either option from Natural England for works within this area.

3 Public Consultation

Public consultation on the two shortlisted spillway options was undertaken in September 2020. The feedback received through consultation has been analysed and considered alongside the technical assessments described in this report.

Consultation feedback indicated a preference for Option A on balance. However, a range of comments and opportunities relating to both options were submitted. These have been considered through ongoing design development, including how best to mitigate potential impacts and further explore identified opportunities.

A summary of the consultation feedback received is presented in ‘Restoring Toddbrook Reservoir – Consultation Summary Note’.

A further explanation of how feedback has informed design development is provided in a non-technical summary of the new spillway option.

Both of these documents are publicly available on the Trust’s dedicated project web page (<https://canalrivertrust.org.uk/restoring-toddbrook-reservoir>).

4 Review of Spillway Options A and B

Once the further investigations and development of Options A and B had been completed, the project team reviewed the technical work carried out by Arup alongside the public consultation feedback and work done by the Trust and Kier. The project team evaluated the two options to establish the proposed scheme to be taken forward.

A summary of the key benefits and constraints identified for Options A and B is provided in Table 1.

	Option A	Option B
Key Benefits	<ul style="list-style-type: none"> • Less Flood risk - as the discharge from the spillway to the River Goyt is in a similar location. • Health & Safety – spillway gradient less steep than Option B means easier to provide access to inspect and maintain. • Landscape and visual – possibility to connect into existing bywash to provide a flow of water in the channel reduces the visual impact. • Public consultation - Option A generally preferred over Option B. Option A has less impact on Memorial Park Woodland and pump track and considered to have greater opportunity to mitigate feedback concerns than Option B. 	<ul style="list-style-type: none"> • Hydraulics – the straight alignment of the channel allows for a more straightforward hydraulic design • Physical constraints – less constraints than Option A, avoids impacts on the sailing club
Key Constraints	<ul style="list-style-type: none"> • Physical constraints – the proposed alignment is influenced by the position of the sailing club buildings, canal feeders and mine drainage workings which adversely impacts on the hydraulic design of the structures. • Geotechnical risks – groundwater to be managed during construction plus associated risks, potential uneven loading of the ground to be managed. • Topography – the proposed alignment involves construction across the natural slope of the ground which increases geotechnical and construction risks 	<ul style="list-style-type: none"> • Topography – proposed alignment is on steep ground increasing geotechnical and construction risks. • Flood risk – initial assessment indicates increase in flood risk – any mitigation could involve works in the river. • Geotechnical risks – groundwater to be managed during construction, stability of excavations during construction and historical landslip • Environmental / Public consultation – significant loss of trees required to allow construction of Option B • Landscape and visual – new spillway would not always have a flow of water within it so less opportunities to mitigate visual impacts.

Table 1: Key benefits and constraints of Options A and B

Consideration of the investigations and design development work supported the optioneering process that had been followed, but highlighted that further work was required to develop a scheme that considers appropriate mitigations and opportunities. Following review of the key constraints and benefits of the two options as outlined in Table 1, Option A was considered to be more favourable than Option B and therefore taken forward for further development.

5 Further development of Option A

As noted in Section 5, further work was required to develop the proposed scheme based on Option A. Arup therefore undertook further design refinement with the aim of mitigating the effects of the key constraints identified in Table 1.

In order to mitigate the geotechnical, physical and hydraulic constraints identified, it was necessary to review the alignment of Option A. Detailed consideration of mitigating these multiple factors brought the current position of the sailing club into question, re-positioning it being the only way of optimising the design in several respects. As a result, after careful thought, it was concluded that the sailing club would need to be relocated, with the Trust committed to re-providing the affected facilities as part of the project.

This decision allowed the alignment to be reviewed, as described further in Section 6, key benefits of a revised alignment being:

- it allows the channel to cross perpendicular to the dam, optimising the design in terms of dam safety.
- it increases the distance from nearby properties compared to the original Option A presented at public consultation.
- it follows the slope of the natural ground which reduces the geotechnical and construction risks and means it is possible to situate the proposed spillway more within the existing landscape to mitigate visual impact.
- downstream of the spillway a channel will run through the park area to discharge flows to the river, a benefit of which could be the opportunity to integrate the spillway and downstream channel within a re-landscaped park.

The revised alignment allowed improvements to be made to the hydraulic design, key aspects are:

- The revised position of the channel through the dam potentially affected the efficiency of the proposed bathtub type weir and so the use of a side channel weir is now proposed, discharging into a tumble bay (see Figure 2 for details). This arrangement has the advantage that the bywash channel can be connected into the tumble bay so that water will typically flow continuously down the new spillway. The existing bywash channel can be infilled (noting that a connection to Brookfield Pond is to be maintained).
- The depth of the channel through the dam has been increased to improve hydraulic characteristics of the flow, and as well as making the channel

more perpendicular to the dam it has been possible to narrow the channel. The bend in the channel has been refined to reduce the risk of adverse flow conditions. Opportunities to reduce the height of the walls required in the stilling basin at the downstream end of the channel by flaring the width of the spillway channel have been explored.

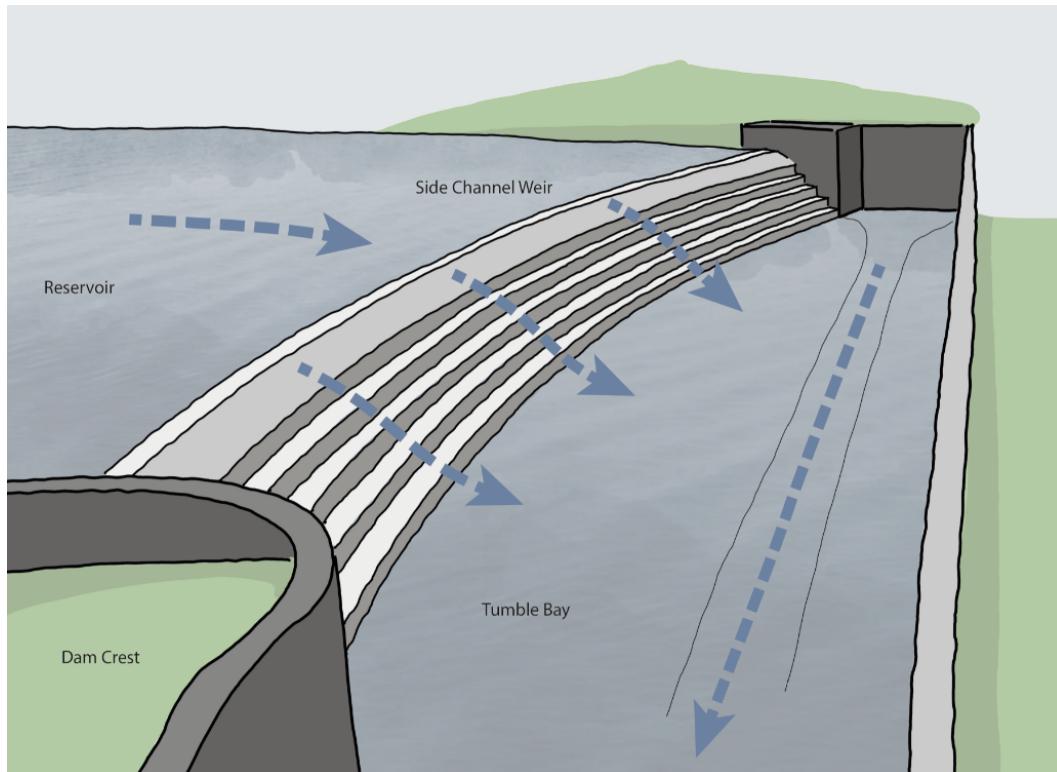


Figure 2 – Diagram of side channel weir and tumble bay

6 Summary of Proposed Scheme

6.1 Scheme description

The proposed scheme is illustrated on both the scheme sketch plan and general arrangement plan included in Appendix B. These show the construction of a new spillway on the left hand side of the dam to transfer flood flows from the reservoir to the River Goyt. Water will flow over a side channel weir into a tumble bay structure located within the reservoir basin at the north end of the dam. This connects to a spillway chute that crosses through the dam and turns the flow of water towards the river. A stilling basin area is used to reduce the energy of the water before it discharges into a channel that travels through the park area to connect with the River Goyt.

The existing sailing club buildings and slipway will need to be relocated to construct the proposed spillway; the Trust is committed to providing these relocated facilities through engagement with the sailing club.

The stilling basin is designed to be partly hidden within the existing hillside and the channel through the park will be integrated into the landscape. There are

opportunities for the channel area to be an interactive and usable public space. The design will consider the health and safety risks associated with the flowing water in the channel in the park area. The channel will impact on the existing play area, which will be relocated within the park area. As described in Section 6.3 below, the Trust is committed to working with key stakeholders in developing an appropriate design.

The bywash around the north of the reservoir will discharge into the tumble bay at the top of the new channel. This will result in a continuous flow of water in the spillway and will allow the existing primary spillway and part of the bywash channel to be decommissioned and infilled. The supply to Brookfield Pond will be maintained by installing new pipes.

The existing auxiliary spillway will be decommissioned, the dam crest height increased, and the area grassed over.

In addition there will be other improvements to the dam infrastructure including the installation of valves on the reservoir outlet pipes and modifications to the clay core inside the dam.

Two sketches have been developed to illustrate views of the scheme when it is completed, these are included in Appendix B as well as being included as figures below. Figure 3 shows the likely view from the dam looking towards the new spillway when the reservoir is overflowing the weir, so that the northern wall of the tumble bay would be visible.



Figure 3 – view looking north-east from the dam towards the new weir and tumble bay structure

Figure 4 illustrates how the stilling basin and channel in the park may look, when viewed from the park area. This includes some of the measures that could be used to integrate the spillway structures into the surrounding landscape.



Figure 4 – view looking east from the park towards the existing dam and new spillway structure

6.2 Benefits and opportunities

The key benefits and opportunities for the proposed scheme when compared to the two shortlisted Options A and B presented at public consultation are:

- refinements have been made to the hydraulic design of the spillway which improves the way flood flows are passed over the dam towards the River Goyt.
- the construction risks due to ground conditions have been reduced by moving the spillway further away from some nearby properties and avoiding constructing on uneven ground.
- there are more opportunities for landscaping and community enhancement as the alignment of this option follows the existing topography more closely and provides opportunities to integrate the structures into the park and play area to minimise visual and amenity impact.
- the bywash channel can discharge into the spillway to typically maintain a flow of water in the spillway, which reduces the visual impact of the channel and provides opportunities for an interactive water feature in the park, noting that the design will need to consider the health and safety risks of flowing water within the park area.
- the scheme avoids significant tree felling that would have been required to construct Option B, as well as wider potential impacts to the southern area of the park.

6.3 Scheme Development

Development of the designs for the scheme will continue over the coming months, to produce outline designs and then detailed designs for construction. The following matters will be addressed as part of that development:

- impact on Sailing club – the Trust is committed to providing equivalent facilities for the sailing club. Further work and engagement with Toddbrook Sailing Club will be undertaken to identify the most suitable location for the affected buildings and slipway.
- impact on Memorial Park and play area – the Trust is committed to working with key stakeholders and the community to minimise the impact of the project on the park and play area and to work to identify landscape and community benefit opportunities to be incorporated into the design. The sketch plan and views provided are indicative concept plans which illustrate the type of measures that could be used to mitigate the visual impacts of the project and provide enhancement to the landscape.
- ground conditions and temporary works – the works will involve deep excavations through the dam and significant temporary works to allow construction and careful phasing of the work to maintain the flood protection measures and manage spoil arising from the works.

Appendix A

Dams and Reservoirs

A1 Dams and Reservoirs

A **dam** is a structure built across a stream or river to confine and control the flow of water. Dams vary in size and construction from small earth embankments to high massive concrete structures. A **reservoir** is the water stored behind a dam for uses including water supply, irrigation, flood storage and hydropower. Sometimes, the term **reservoir** is used to describe both the water, dam and associated structures.

Spillways are structures that either form part of a dam or are found just beside one. They are used, when a reservoir is full, to pass flood water safely and in a controlled way over, around or through a dam. At the top of the spillway is a **weir** which controls the level at which the water starts to flow down the spillway. Some common types of spillways are described below. Further information and photographs can be found on the British Dam Society website:

<https://britishdams.org/about-dams/dam-information/spillways-and-outlets/>

Side channel spillways are used mainly with embankment dams. They are located just upstream and to the side of the dam. The water flows over the side channel weir into a tumble bay. Then it flows down a chute and towards the river downstream of the dam.



Figure A - 1: Example of a side channel spillway

A **bathtub spillway** is a structure that protrudes into the reservoir in the shape of a bath. The water flows over the top of the bathtub into the centre and then down a chute and towards the river downstream of the dam.

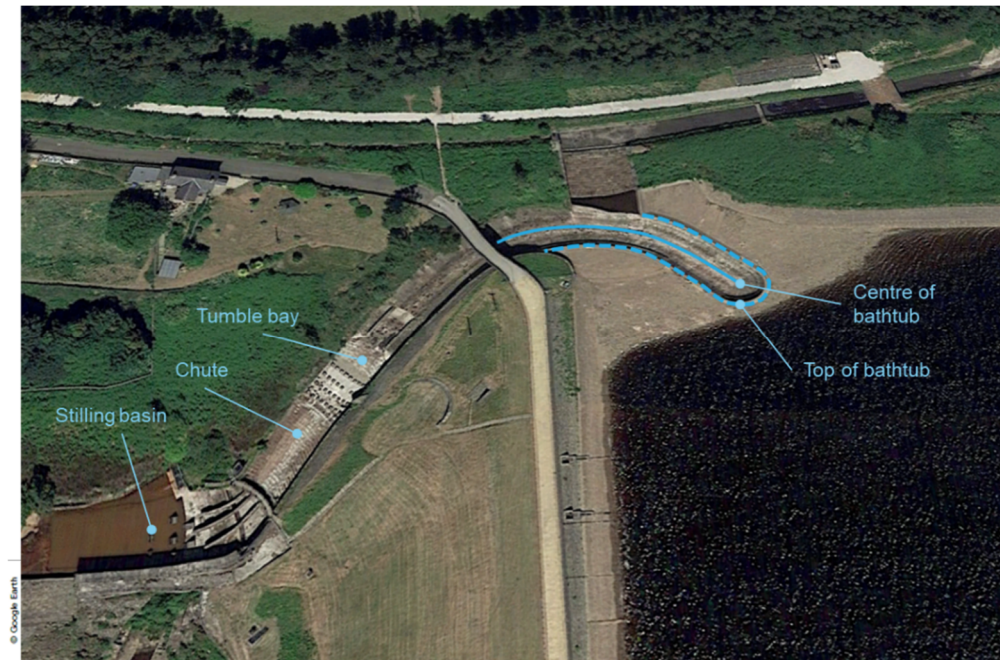


Figure A - 2: Example of a bathtub spillway

Most spillways have a **stilling basin** at the downstream end. This structure removes the energy from the water before it is discharged into the river downstream.

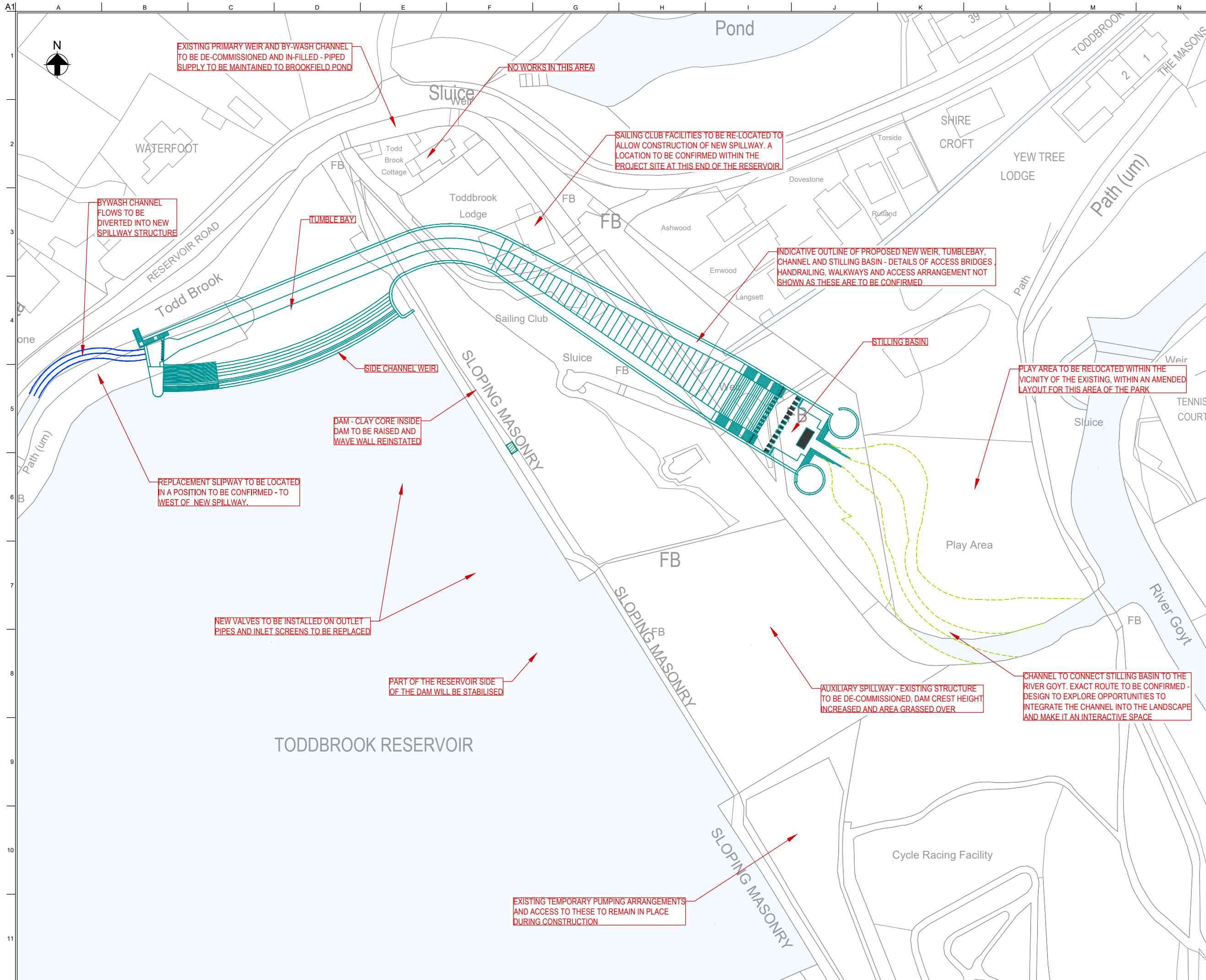
Some dams have more than one spillway. The **primary spillway** will be lower than the other spillways and water will overflow over this first. Other **auxiliary spillways** may be present at a higher level and so will not operate as frequently.

Other **outlets** may be built under, through or around the dam, to release water from the reservoir for different uses.

A **bywash channel** allows some of the flows that could enter the reservoir to be diverted around the reservoir and discharged into the river downstream, maintaining flow in the river.

Appendix B

Toddbrook Spillway Scheme Plans and Sketches



EXISTING PRIMARY WEIR AND BY-WASH CHANNEL TO BE DE-COMMISSIONED AND IN-FILLED - PIPED SUPPLY TO BE MAINTAINED TO BROOKFIELD POND

NO WORKS IN THIS AREA

SAILING CLUB FACILITIES TO BE RE-LOCATED TO ALLOW CONSTRUCTION OF NEW SPILLWAY. A LOCATION TO BE CONFIRMED WITHIN THE PROJECT SITE AT THIS END OF THE RESERVOIR.

BYWASH CHANNEL FLOWS TO BE DIVERTED INTO NEW SPILLWAY STRUCTURE

TUMBLE BAY

INDICATIVE OUTLINE OF PROPOSED NEW WEIR, TUMBLEBAY, CHANNEL AND STILLING BASIN - DETAILS OF ACCESS BRIDGES, HANDRAILING, WALKWAYS AND ACCESS ARRANGEMENT NOT SHOWN AS THESE ARE TO BE CONFIRMED

SIDE CHANNEL WEIR

STILLING BASIN

PLAY AREA TO BE RELOCATED WITHIN THE VICINITY OF THE EXISTING, WITHIN AN AMENDED LAYOUT FOR THIS AREA OF THE PARK

REPLACEMENT SLIPWAY TO BE LOCATED IN A POSITION TO BE CONFIRMED - TO WEST OF NEW SPILLWAY.

DAM - CLAY CORE INSIDE DAM TO BE RAISED AND WAVE WALL REINSTATED

NEW VALVES TO BE INSTALLED ON OUTLET PIPES AND INLET SCREENS TO BE REPLACED

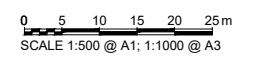
PART OF THE RESERVOIR SIDE OF THE DAM WILL BE STABILISED

AUXILIARY SPILLWAY - EXISTING STRUCTURE TO BE DE-COMMISSIONED, DAM CREST HEIGHT INCREASED AND AREA GRASSED OVER

CHANNEL TO CONNECT STILLING BASIN TO THE RIVER GOYT. EXACT ROUTE TO BE CONFIRMED - DESIGN TO EXPLORE OPPORTUNITIES TO INTEGRATE THE CHANNEL INTO THE LANDSCAPE AND MAKE IT AN INTERACTIVE SPACE

EXISTING TEMPORARY PUMPING ARRANGEMENTS AND ACCESS TO THESE TO REMAIN IN PLACE DURING CONSTRUCTION

GENERAL NOTES:
 1. REFER TO SCHEME SKETCH P11742-ARP-YL-001-001-SK-AL-015 FOR FURTHER DETAILS



Rev	Date	By	Chkd	Appd

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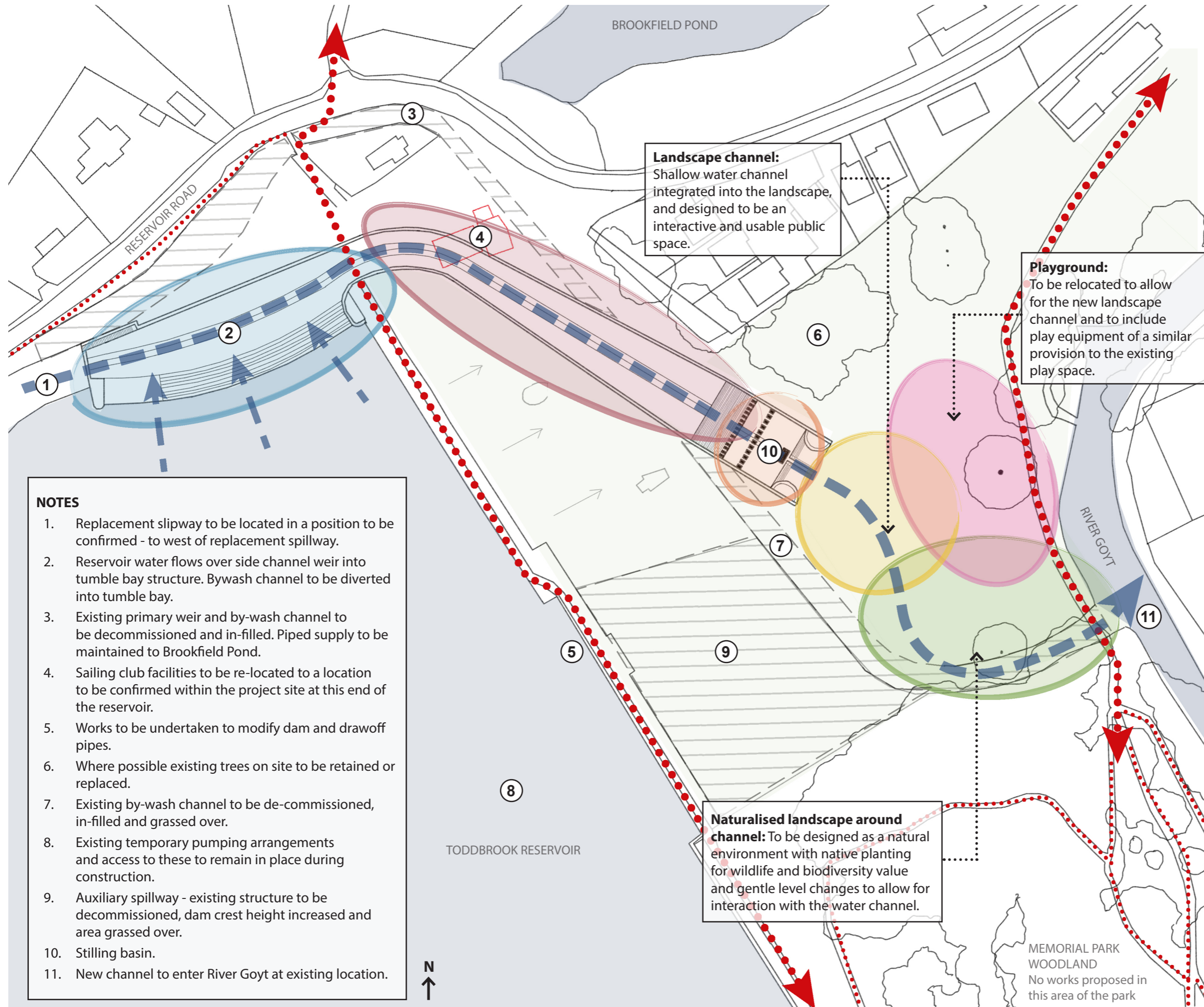


Project Title
TODDBROOK RESERVOIR

Drawing Title
SCHEME GENERAL ARRANGEMENT PLAN

Scale at A1	1:500
Role	CIVIL
Suitability	S2 - FOR INFORMATION
Arup Job No	277087-00
Rev	P2
Name	P11742-ARP-YL-001-001-DR-Z-018










Toddbrook Spillway Scheme Sketch



Landscape channel:
Shallow water channel integrated into the landscape, and designed to be an interactive and usable public space.

Playground:
To be relocated to allow for the new landscape channel and to include play equipment of a similar provision to the existing play space.

Naturalised landscape around channel: To be designed as a natural environment with native planting for wildlife and biodiversity value and gentle level changes to allow for interaction with the water channel.

- KEY**
-  Spillway weir
 -  Spillway channel
 -  Stilling basin
 -  Landscape channel
 -  Playground
 -  Naturalised landscape channel
 -  Public Right of Way (PRoW)
 -  Water movement
 -  Existing structures to be removed

- NOTES**
1. Replacement slipway to be located in a position to be confirmed - to west of replacement spillway.
 2. Reservoir water flows over side channel weir into tumble bay structure. Bywash channel to be diverted into tumble bay.
 3. Existing primary weir and by-wash channel to be decommissioned and in-filled. Piped supply to be maintained to Brookfield Pond.
 4. Sailing club facilities to be re-located to a location to be confirmed within the project site at this end of the reservoir.
 5. Works to be undertaken to modify dam and drawoff pipes.
 6. Where possible existing trees on site to be retained or replaced.
 7. Existing by-wash channel to be de-commissioned, in-filled and grassed over.
 8. Existing temporary pumping arrangements and access to these to remain in place during construction.
 9. Auxiliary spillway - existing structure to be decommissioned, dam crest height increased and area grassed over.
 10. Stilling basin.
 11. New channel to enter River Goyt at existing location.

DRAWING TITLE:
Toddbrook Spillway Scheme Sketch

DRAWING NO:
P11742-ARP-YL-001-001-SK-AL-015-S2-P5

DATE:
17/03/2021

MEMORIAL PARK WOODLAND
No works proposed in this area of the park

This document takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.



DRAWING TITLE:
Toddbrook Spillway Sketch View - From dam towards weir
DRAWING NO:
P11742-ARP-YL-001-001-SK-AL-016-S2-P3
DATE:
17/03/21

Artists impression, indicative concept proposals only

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Artists impression, indicative concept proposals only

DRAWING TITLE:
Toddbrook Spillway Sketch View - From park towards spillway
DRAWING NO:
P11742-ARP-YL-001-001-SK-AL-017-S2-P2
DATE:
17/03/21

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