Clydach Reservoir

Discontinuance Study

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Executive summary

(1) Arcadis Consulting UK Limited ('Arcadis') was commissioned by Dŵr Cymru Welsh Water ('DCWW') in March 2022 to assess the feasibility of discontinuance of Clydach reservoir as an alternative to undertaking remedial works to the valves and pipework. This report presents a summary of the information reviewed and gathered throughout the project, the options considered, and the constraints identified.

(2) The study was carried out in three stages:

Stage 1. Data gathering
Stage 2. Concept design development
Stage 3. Outline design development

(3) A total of five options were considered in Stage 2 of this project. A sustainability & optioneering (S&O) workshop was held on 24th August 2022 where three options were short-listed to be taken forward for outline design development:

Option 1. Retain (projected reservoir volume ~ 50,000 cubic metres)
Option 3B. Dam modification (projected reservoir volume ~ 5,000 cubic metres)
Option 4. Dam removal (projected reservoir volume = 0 cubic metres)

(4) A risk & value (R&V) workshop was held on 1st November 2022. The 'identified solution' was Option 1 due to considerably lower capital expenditure. However, the 'preferred solution' was Option 3B. This is based on reduced residual risk, lower carbon impact, greater opportunity for biodiversity and lower operational expenditure. The preferred solution of Option 3B is to be put forward to the Asset Investment Group in 2023.

1 Project background

1.1 Problem statement

(5) Clydach reservoir is an impounding reservoir situated on the outskirts of the St. Gwyno Forestry national park in Wales. It was constructed around 1892 for municipal water supply purposes and is believed to have fed water to the larger, non-impounding reservoir, Perthcelyn. It is no longer used for supply but is normally maintained full for amenity purposes.[1]

(6) A survey undertaken by Mott MacDonald in 2017 identified several issues related to the valves and pipework within the reservoir. The cost of the capital remedial works was estimated at approximately £1.5 million.[2] If progressed, these works would require investment in the current asset management plan (AMP) cycle, i.e. before December 2025.

(7) Arcadis Consulting UK Limited ('Arcadis') was commissioned by Dŵr Cymru Welsh Water ('DCWW') in March 2022 to assess the feasibility of discontinuance of Clydach reservoir as an alternative to the remedial works to the valves and pipework. If progressed, these works would require investment in the next AMP cycle, i.e. 2025-2030.

1.2 Purpose of this report

(8) This report presents a summary of the information reviewed and gathered throughout the project, the options considered, and the constraints identified. This report will be used to inform the selection of an option to be progressed to detailed design.

1.3 Methodology

(9) This study has been carried out in three stages, as described in Figure 1-1.

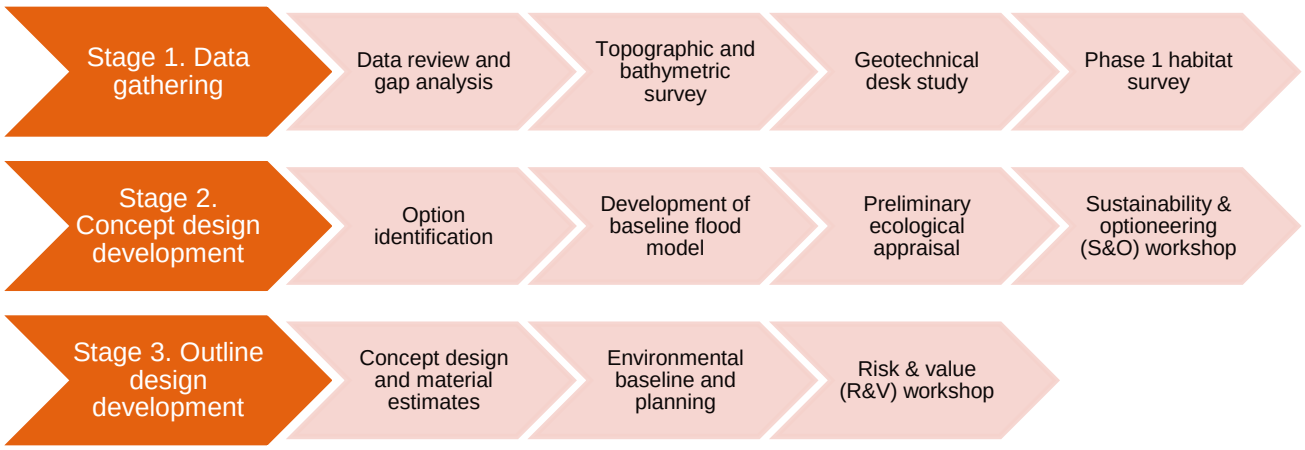

Figure 1-1. Project methodology

[1] *Report on a Statutory Inspection under Section 10(2) of the Reservoirs act 1975.* Arup, 2017.
[2] Estimate provided by Morgan Sindall during Risk & Value workshop held on 1st November 2022.

1.4 Success criteria

(10) If discontinuance is selected as the preferred option, it is DCWW's wish to be absolved of all future maintenance liabilities and for the reservoir to be transferred to the non-operational assets department. This will require the retained volume and storage capacity of the reservoir to be reduced to as low as reasonably practicable.

(11) An alternative solution would be to sell the site for a nominal fee to the local outdoor activity group in Daerwynno.

1.5 Assumptions and limitations

(12) Where information has been unavailable or insufficient to progress with option development, assumptions have been made and these are stated throughout. These assumptions are subject to change during the detailed design phase when further information is gathered through surveys and investigations.

(13) This report has been prepared in accordance with the terms and conditions of the appointment. Arcadis cannot accept any responsibility for any use of or reliance on the contents of this report by any third party. The copyright of this document shall remain the property of Arcadis.

(14) This report has relied on data from several sources which are referenced in footnotes and which Arcadis believes to be trustworthy. However, Arcadis is unable to guarantee the accuracy of information provided by others.

(15) The report is based on information available at the time of writing. Additional information may become available in the future which may have a bearing on the conclusions of this report and for which Arcadis cannot be responsible.

(16) Arcadis does not accept liability for any use of the information presented in this report unless it is signed by the author, checker and approver and marked as final.

2 Site background

2.1 Location and access

(17) The position of Clydach reservoir is shown in Figure 2-1.

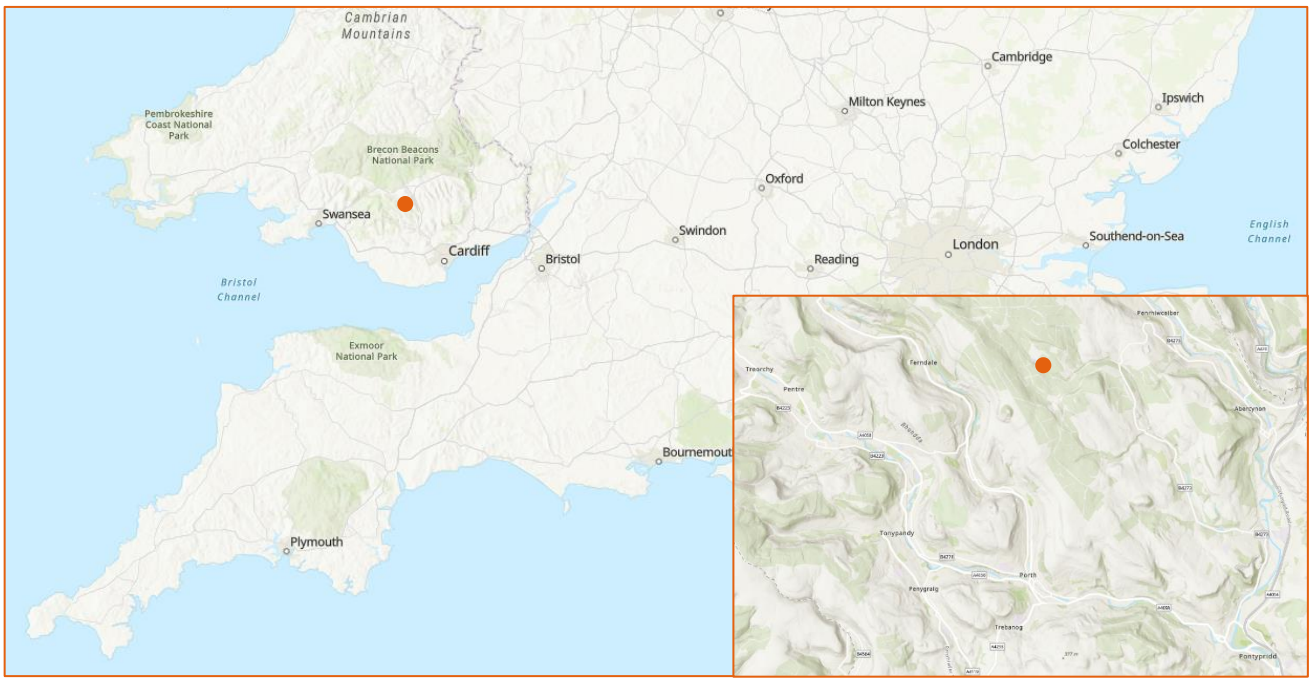

Figure 2-1. Location plan showing position of Clydach reservoir

(18) Access to the reservoir is available via two routes, both accessed from the public highway at the location shown in Figure 2-2.

- Access to the left abutment is via a narrow private road off the public highway, approximately 1.2 kilometres long.
- Access to the right abutment is via a forestry track, approximately 1.4 kilometres long.

(19) There is a large Forestry Commission Wales parking area around 2.8 kilometres from the site (ST 03270 95826) called Llanwynno. This is open and used by the public. There is some space to park alongside the reservoir.[3]

(20) Figure 2-3 shows the location of two premises along the access routes, the Daerwynno Outdoor Activity Centre and Pistyll Goleu farm. DCWW have reported difficulties with the owner of Pistyll Goleu farm when using this access route.

[3] *Dam Safety Asset Survey Report – 20170127 – Clydach.* Capital Delivery Alliance, 2017.

Figure 2-2. Access point from the public highway (Google Maps, 2022)

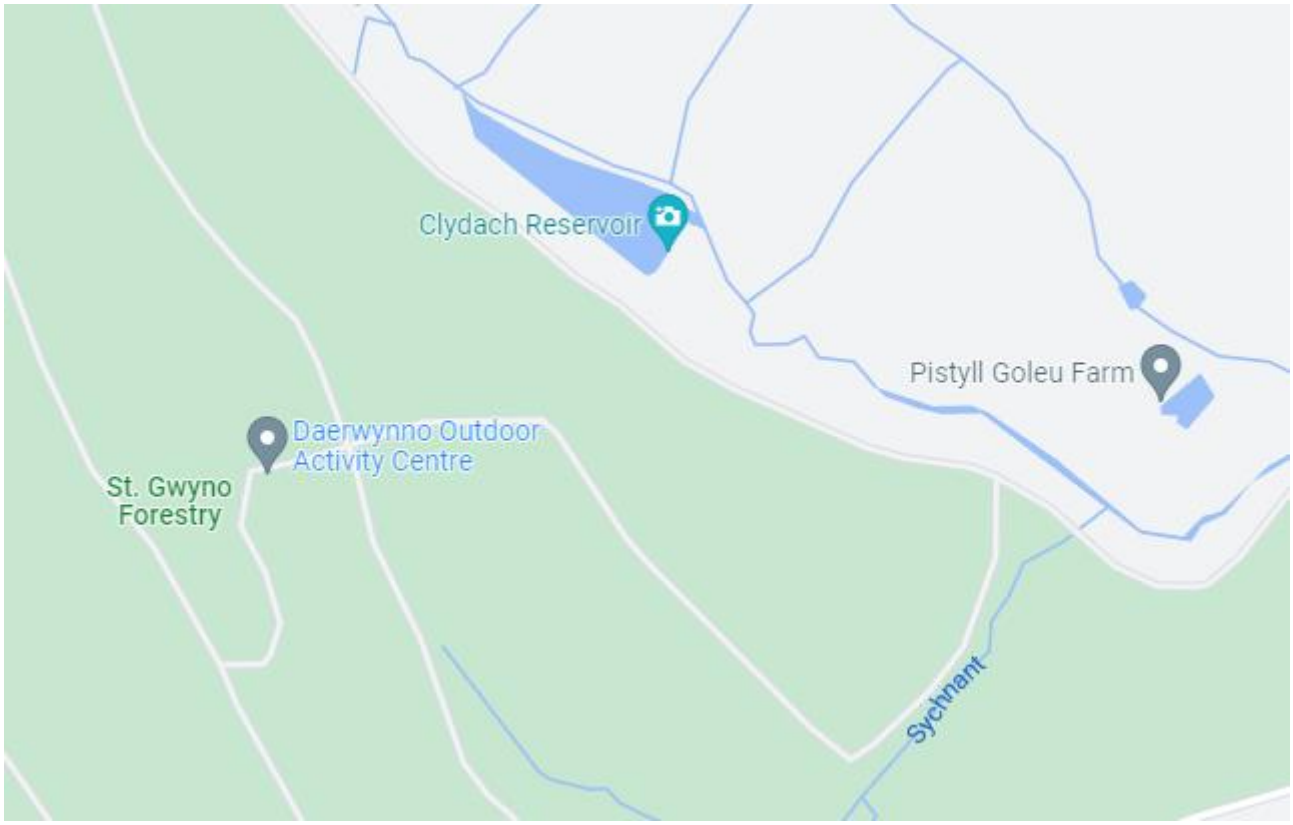

Figure 2-3. Map showing neighbouring properties to Clydach reservoir (Google Maps, 2022)

2.2 Structural details

(21) Clydach reservoir is an impounding reservoir retained by an embankment dam across the Nant Clydach, a tributary of the Afon Taf. The reservoir inlet structure has a fine steel mesh protecting the two 375-millimetre (15-inch) inlet valves. Inflows from much of the direct catchment are routinely diverted around the reservoir via the by-wash.[4] The by-wash follows the left perimeter of the reservoir and discharges into the Nant Clydach downstream of the embankment toe. Downstream the reservoir features an overflow weir and spillway channel on the left abutment, and a 'dry well' valve tower off the southern shoreline upstream of the right abutment of the dam.[4]

(22) Key parameters which have been used during option development are summarised in Table 2-1.

Table 2-1. Parameters used for option development

Parameter	Value
Grid reference	ST 028 966
Capacity	55,840 cubic metres
Top water level	284.074 metres above Ordnance Datum
Surface area	1.4 hectares
Dam category	Category A
Dam construction	Earth fill with puddle clay core
Dam height	10.2 metres
Crest width	6 metres
Upstream face slope	1 in 3
Downstream face slope	1 in 2.5

2.3 Operation and maintenance

(23) DCWW is responsible for the safety of Clydach reservoir as the Reservoir Undertaker under the Reservoirs Act 1975. This constitutes:

- Twice-weekly visits and recording of water levels by DCWW operatives.
- Annual Safety Inspections, carried out by a Supervising Engineer under Section 12 of the Act.
- Ten-yearly Safety Inspections, carried out by an Inspecting Engineer under Section 10 of the Act.

(24) DCWW has advised that the current maintenance regime for the reservoir is as follows:[5]

- Scour valves and dam safety critical valves are tested every 6 months.
- Ground maintenance contractors visit the site approximately twice a year to cut the grass, remove vegetation growth on the upstream face and fell any trees overhanging the by-wash and spillway.

[4] *Report on a Statutory Inspection under Section 10(2) of the Reservoirs act 1975.* Arup, 2017.
[5] Email conversation with Edward Pritchard, Dam Safety Assistant Engineer at DCWW, on 28th March 2022.

- Levelling of the crest of the dam embankment once a year.
- Pest control contractors visit the site quarterly.

(25) According to DCWW, the reservoir was most recently drawn down in 2019 due to an issue with the scour valve. Figure 2-4 and Figure 2-5 show the reservoir when full and empty, respectively.

Figure 2-4. Clydach reservoir, full (Google Earth, 2001)

Figure 2-5. Clydach reservoir, empty (Google Earth, 2018)

3 Constraints

3.1 Reservoirs Act 1975

(26) Under the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010, ('the Act') all large, raised reservoirs in Wales are subject to regulation by the enforcement authority, Natural Resources Wales ('NRW').

Definition of a large, raised reservoir (England and Wales)

1) In this Act "large, raised reservoir" means—
   a. a large, raised structure designed or used for collecting and storing water, and
   b. a large, raised lake or other area capable of storing water which was created or enlarged by artificial means.
2) A structure or area is "raised" if it is capable of holding water above the natural level of any part of the surrounding land.
3) A raised structure or area is "large" if it is capable of holding 25,000 cubic metres of water (in England) or 10,000 cubic metres of water (in Wales) above the natural level of any part of the surrounding land.

(27) Discontinuance is the removal of a reservoir from the ambit of the Act by reducing its capacity to less than 10,000 cubic metres (in Wales). Discontinuance works are only permitted if designed or approved and supervised by a Qualified Civil Engineer (QCE).[6] Under Section 13(2) of the Act, once discontinuance works are complete, a certificate shall be issued to the owner and the enforcement authority. At this point, the reservoir can be removed from the register.[7]

(28) The following is a list of actions required to obtain certification for the discontinuance under Section 13(2) of the Act.

a) Produce a detailed design for the discontinuance and gain approval from the QCE.
b) Construct the discontinuance works under the supervision of the QCE.
c) Provide evidence to the QCE that the stored volume in the reservoir is below 10,000 cubic metres.
d) Demonstrate to the QCE that the modified structure is stable and capable of passing the required flood events.

(29) Following discontinuance, a reservoir will no longer be subject to regulation by the Act. However, the reservoir owner will retain strict liability for the residual asset, and this does not preclude the asset from ongoing maintenance or inspection.

(30) Mr James Penman, All Reservoirs Panel Engineer (ARPE), has been appointed as QCE by DCWW and consulted as part of this study. Mr Penman has advised that for discontinuance works which retain a residual volume of 10,000 cubic metres, this should be designed to be stable in the 1,000-year event, with a safety check on the 10,000-year event, and sufficiently wide to avoid any substantial flood rise during the design event.

[6] *Reservoirs Act 1975 (as amended by the Flood and Water Management Act 2010).* 1975. HM Government.
[7] *Discontinuance of Small Reservoirs.* 2012. J. R. Claydon.

3.2 Flooding

(31) The reservoir discharges into the Nant Clydach, which follows the route shown in Figure 3-1 toward the village of Ynysybwl, about 4.5 kilometres downstream of the reservoir. Approximately 3.5 kilometres further downstream the Nant Clydach joins the Afon Taf and flows toward the town of Pontypridd.

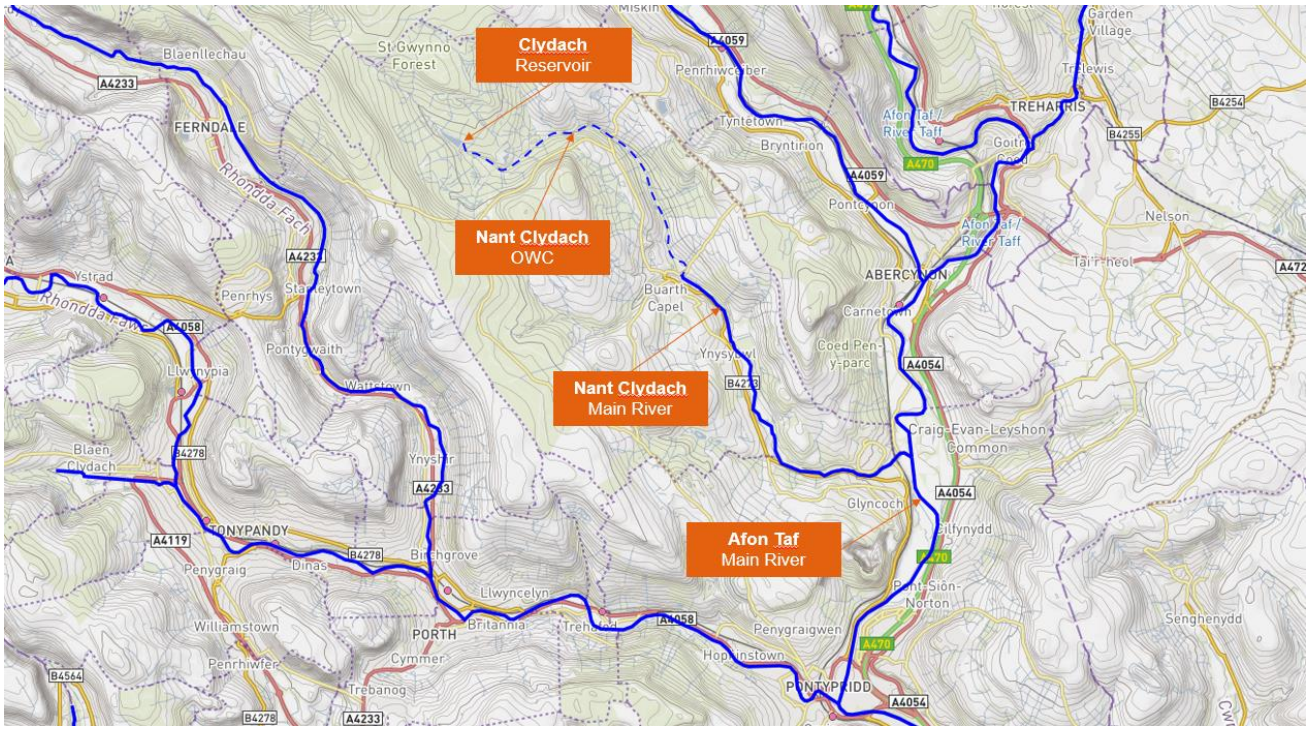

Figure 3-1. Clydach reservoir and downstream watercourses

(32) NRW has been consulted as part of this study and provided the following comment:

> *"An FCA* [Flood Consequence Assessment] *will be required to demonstrate that the removal/discontinuance of the existing reservoir does not increase flooding elsewhere and, in this case more importantly downstream within Ynysybwl itself (see plan below)* [Figure 3-2]. *There are known issues of flooding from the Nant Clydach (main river) and the tributaries in the area of Ynysybwl and there is likely to be a 'perception' by local residents of increased flooding associated with the removal/discontinuance of the reservoir. This is the reason why robust evidence will be required to support this proposal which can be used if challenged."*

(33) DCWW reports that the reservoir is typically held at maximum capacity for amenity purposes. This means that the reservoir in its current arrangement is providing little to no flood attenuation benefit. However, in light of the issues of flooding in the area of Ynysybwl, NRW has stipulated that any discontinuance scheme must have a positive or neutral impact on downstream flood risk.

(34) A flood consequence assessment (FCA) of the short-listed options was commissioned as part of this project. At the time of writing this assessment is still in progress and is expected to be delivered in early 2023.

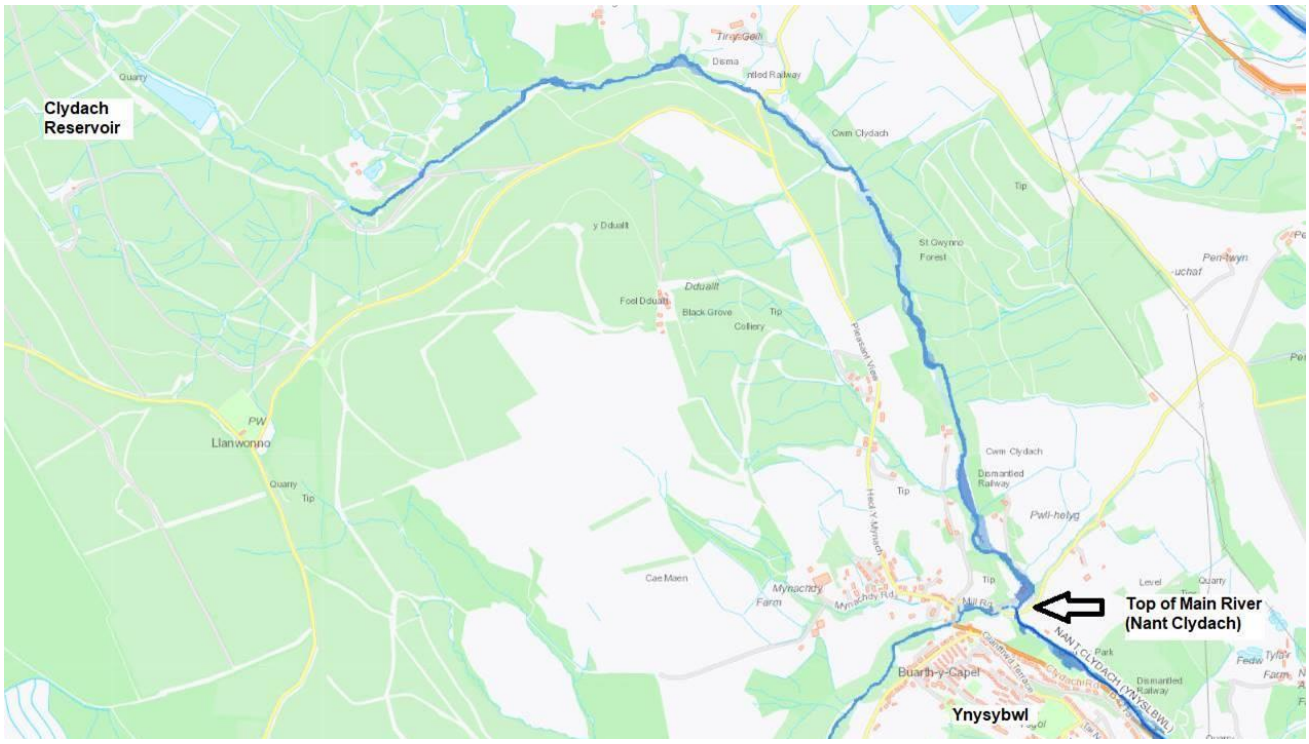

Figure 3-2. Extract from flood map provided by Natural Resources Wales

3.3 Geotechnical

(35) A Phase 1 geotechnical and geo-environmental desk study was undertaken as part of this project and is attached in Appendix C. The study comprises the following items:

- Review of site information, including local geology, hydrogeology, hydrology and environment.
- Preparation of a Preliminary Conceptual Site Model.
- Preliminary geotechnical assessment of potential engineering hazards and constraints concerning the proposed changes.
- Recommendations for ground investigation (GI).

(36) Several potential geotechnical hazards and constraints were identified through this study and are summarised in Table 3-1. It was concluded that there is insufficient data to provide a suitable basis for the works associated with discontinuance.

Table 3-1. Summary of geotechnical hazards and constraints

Ref	Constraint
1	The presence, extent and composition of the Made Ground are unknown.
2	The extent and composition of the superficial deposits and bedrock underlying the site are unknown/to be confirmed.
3	The height of the dam, its composition and its core thickness are unknown/to be confirmed.
4	The available information on the strength, density, compressibility, and contamination level of the materials forming and underlying the site and groundwater levels is very limited.

(37) No intrusive GI has been undertaken at this stage. The recommendations presented in the desk study should be used to inform the design of GI works which would be required as part of the detailed design of any discontinuance works.

3.4 Environmental

(38) A CAF317 enabling checklist was completed by Mott MacDonald in May 2022 and provided to Arcadis. This has been reviewed and updated throughout the project and is attached in Appendix D. Key constraints identified in the CAF317 relating to the discontinuance options are as follows:

- There is a hydrological connection between the site and an SSSI.
- The site is within Flood Zone 3 on the new Flood Map for Planning.
- The works are near an ordinary watercourse.

(39) The CAF317 enabling checklist recommended that a Phase 1 habitat survey be undertaken at the earliest possible stage. This survey and the subsequent Preliminary Ecological Appraisal (PEA) were undertaken by Arcadis in August 2022. Outputs are attached in Appendix E and Appendix F, respectively.

(40) An environmental baseline and planning desktop study was undertaken in October 2022 to assess the environmental constraints and opportunities for the two options short-listed at the S&O workshop, in addition to the baseline 'retain' option. The study assessed the short-listed options against the following criteria:

- Air quality.
- Biodiversity.
- Cultural heritage.
- Water environment.
- Landscape and visual.
- Geology and soils.
- Noise and vibration.
- Population and human health.
- Climate.
- Material assets and waste.
- Major accidents and disasters.

(41) The full study report, including an environmental constraints plan, is attached in Appendix G.

(42) If discontinuance of the reservoir is progressed, the next steps will be to seek an Environmental Impact Assessment (EIA) screening opinion and pre-application planning advice from the Rhondda Cynon Taf planning department. Estimated programme durations are 2-3 weeks for EIA screening, followed by 3-5 weeks for preparation of a scoping report if an EIA is determined to be required. If required, delivery of the EIA will be dictated by the time of year and survey requirements.

3.5 Permits

Flood risk activity permit

(43) The reservoir is approximately 4 kilometres from the main river section of the Nant Clydach, therefore it is not expected that a Flood Risk Activity Permit (FRAP) would be required for any discontinuance works.

Ordinary watercourse consent

(44) The Nant Clydach is an ordinary watercourse immediately downstream of the dam. Any permanent works which would constitute an alteration to the watercourse (e.g. adjustment or removal of the spillway or any works to the downstream outlet channel) would require Ordinary Watercourse Consent (OWC). Any temporary works required to complete the works may also require consent; this is dependent on the contractor's chosen methodology.

Impoundment and discharge license

(45) DCWW has not provided details of any impoundment or discharge licenses held for the reservoir; due to the date of its construction, it is unlikely that any are held. The enforcement authority will require that licenses are obtained for the current reservoir arrangement, and subsequently amended or revoked to reflect any discontinuance works.

Planning permission

(46) Discontinuance of the reservoir would constitute a significant change to the area and is therefore highly likely to require a full planning application. The local planning authority for the area is Rhondda Cynon Taf County Borough Council. The Council is required to make a decision on an application within 8 weeks; this can be fast-tracked to 28 days via payment of an £86 additional charge.

Water framework directive

(47) A water framework directive (WFD) compliance assessment is required for any works which:

- Modify the shape or size of a watercourse.
- Increase or decrease flow.
- Remove or introduce sediment and/or vegetation.
- Introduce artificial materials to a watercourse.

(48) A WFD compliance assessment should be undertaken as part of any application for an environmental permit (e.g. impoundment or discharge) or as part of an EIA during the planning application. The process is described in Figure 3-3. The estimated programme duration for screening and scoping is 6-12 weeks; if a full assessment is required, the programme will be dictated by the time of year and survey requirements.

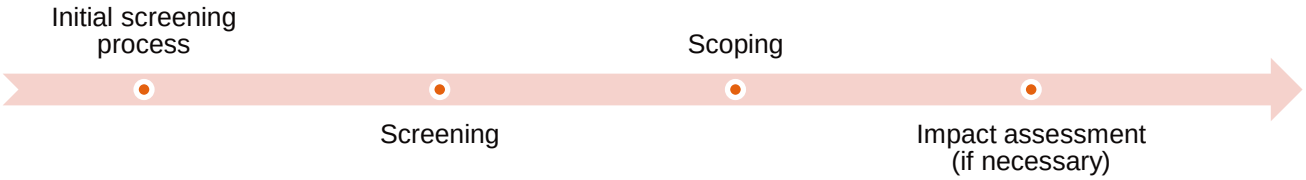

Figure 3-3. Process diagram for water framework directive compliance assessment

3.6 Operational

(49) Clydach reservoir sits within the South East Wales Conjunctive Use System (SEWCUS) water resource zone (WRZ). Arcadis has been advised by DCWW that the reservoir is not included in the drought plan and that the infrastructure required to convey raw water to the nearest treatment facility does not exist. It is DCWW's responsibility to satisfy themselves that the discontinuance of Clydach reservoir will not negatively impact their ability to meet current and future water resource demands.

4 Option development

4.1 Concept design development

A total of five options have been considered in Stage 2 of this project. These are described in the following sub-sections.

4.1.1 Option 1. Retain

(50) This option requires that the remedial works to the valves and pipework are undertaken in accordance with the dam safety asset survey report undertaken by Mott MacDonald in 2017. No other works are included and the reservoir would be maintained at its current capacity.

4.1.2 Option 2. Spillway modification

(51) This option involves modification of the existing spillway to lower the top water level (TWL) of the reservoir by approximately 4 metres, thereby reducing the capacity to approximately 9,190 cubic metres This would equate to a reduction in surface area of approximately 60%, as demonstrated in Figure 4-1.

Figure 4-1. Approximate reduction in reservoir surface area for option 2 and option 3A

4.1.3 Option 3A. Dam modification

(52) This option involves notching the existing embankment to lower the top water level (TWL) of the reservoir by approximately 4 metres, thereby reducing the capacity to approximately 9,190 cubic metres. This would equate to a reduction in surface area of approximately 60%, as demonstrated in Figure 4-2.

4.1.4 Option 3B. Dam modification

(53) This option involves notching the existing embankment to lower the top water level (TWL) of the reservoir by approximately 5 metres, thereby reducing the capacity to approximately 4,520 cubic metres. This would equate to a reduction in surface area of approximately 75%, as demonstrated in Figure 4-2.

Figure 4-2. Approximate reduction in reservoir surface area for option 3B

4.1.5 Option 4. Dam removal

(54) This option involves the removal of the existing embankment and restoration of the basin to a 'natural' river channel, as demonstrated in Figure 4-3. l. No water would be impounded.

Figure 4-3. Approximate reduction in water space for option 4

4.2 Sustainability & optioneering

(55) A sustainability & optioneering (S&O) workshop was held on 24th August 2022 with representatives from DCWW, Morgan Sindall and Arcadis. The pros and cons of each option were identified and are recorded in Table 4-1.

(56) During the S&O meeting, the following three options were short-listed to be taken forward for outline design development:

- Option 1. Retain
- Option 3B. Dam modification
- Option 4. Dam removal

Table 4-1. Record of points discussed during the S&O workshop

Option	Pros	Cons
1	• No change to flood attenuation • No risk of adverse effects on SSSI • No planning permission or OWC required • Water resources retained for use in emergency / future water supply	• The reservoir remains within the Act • Capital investment required to maintain
2	• The smallest amount of material to be removed from the site (excluding Option 1) • Some flood attenuation benefit	• Planning permission & OWC required • Risk of silt mobilisation • Risk of adverse effects on SSSI • Strict liability for residual asset retained – ongoing O&M • Reduced water resources for use in emergency / future water supply • Risk of pollution of the downstream watercourse from cementitious materials • Excavation of reinforced concrete and masonry • Working in a live channel • Requires decommissioning of the tower (assumed grouting and capping of pipes and valves) • DCWW as responsible undertaker would still manage within the spirit of the Act
3A	• Some flood attenuation benefit • The minimum amount of work required to achieve discontinuance	• Planning permission & OWC required • Risk of silt mobilisation • Risk of adverse effects on SSSI • Strict liability for residual asset retained – ongoing O&M • Reduced water resources for use in emergency / future water supply • Requires decommissioning of the tower (assumed grouting and capping of pipes and valves) • Reduction in water level would provide an ecological benefit • Same risk as Option 2 in terms of stored volume – DCWW would continue with O&M requirements
3B	• Optimisation of notch to reduce risk of silt mobilisation • Target cut & fill to amount of material which can be re-used on site (aim for net zero leaving site) • Some flood attenuation benefit • Reduction in water level can provide ecological benefit • Retention of some amenity value – may be more acceptable to the public • Possible opportunity to sell on residual asset	• Planning permission & OWC required • Residual risk of silt mobilisation (but lower than Option 4) • Risk of adverse effects on SSSI • Strict liability for residual asset retained – ongoing O&M (but less than Option 2 and 3B) – unclear if the residual asset can be passed to the Non-Operational Assets team • Reduced water resources for use in emergency / future water supply • Requires decommissioning of the tower (assumed grouting and capping of pipes and valves)

Option	Pros	Cons
4	• No residual asset – no ongoing O&M • Opportunity to sell back to Forestry Commission • Opportunity to use cut and fill to fill residual assets (by wash, spillway) and possibly regrading upstream • Minimal ongoing risk to DCWW • Opportunity for ecological enhancements / natural flood management	• Planning permission & OWC required • The largest amount of material to be removed • Loss of flood attenuation • Risk of silt mobilisation • Risk of adverse effects on SSSI • Total loss of water resources for use in emergency / future water supply • Requires decommissioning of the tower (assumed grouting and capping of pipes and valves) • Reduced amenity value • Likely require the disposal of excavated material off-site

4.3 Outline design development

(57) Following the S&O workshop, Option 3B and Option 4 have been further developed to allow costing by Morgan Sindall and facilitate comparison against the existing cost estimate for Option 1. A preliminary assessment of environmental impacts has been undertaken and is presented in Appendix G.

4.3.1 Option 1. Retain

(58) This option was developed by Mott MacDonald and is to be used as a baseline for comparison with options 3B and 4. It does not form part of Arcadis' scope and is not repeated here.

4.3.2 Option 3B. Dam modification

(59) Outline design drawings are attached in Appendix A. Ancillary works are described in Appendix B.

(60) Side slopes of excavation were modelled at a 1:4 (v:h) gradient. This is a conservative estimate due to the lack of ground investigation and may be steepened at the detailed design stage.

(61) Cut and fill analysis was undertaken using Autodesk Civil 3D and produced an estimate of 5,226 cubic metres of material to be excavated. It is predicted that 100% of this material can be re-used on-site through reprofiling and backfilling of existing structures.

4.3.3 Option 4. Dam removal

(62) Outline design drawings are attached in Appendix A. Ancillary works are described in Appendix B.

(63) Side slopes of excavation were modelled at a 1:4 (v:h) gradient. This is a conservative estimate due to the lack of ground investigation and may be steepened at the detailed design stage.

(64) Cut and fill analysis was undertaken using Autodesk Civil 3D and produced an estimate of 14,868 cubic metres of material to be excavated. It is predicted that approximately 60% of this material can be re-used on-site through reprofiling and backfilling of existing structures.

4.4 Risk & value

(65) A risk & value (R&V) workshop was held on 1st November 2022 with representatives from DCWW, Morgan Sindall and Arcadis. The options were presented and discussed, and outputs were recorded in document reference B167643-0AG967-12-ZZ-GV-KA-GA0001.

(66) An amendment to Option 4 was identified during the R&V workshop. This involved the opportunity to reuse the full amount of excavated material on site (as opposed to the original estimation of 60%). This was later assessed and determined to deliver a nominal increase to the benefit/cost ratio, but this was still lower than for Option 1 and Option 3B.

(67) The ‘identified solution’ was Option 1 due to considerably lower capital expenditure. However, the ‘preferred solution’ was Option 3B. This is based on reduced residual risk, lower carbon impact, greater opportunity for biodiversity and lower operational expenditure.

5 Conclusion

(68) Four discontinuance options were identified as part of this project. Of these, two were selected for further development and comparison against the baseline option.

(69) Following a review of the available site information and further analysis and consultation described in this report, Arcadis concludes that the discontinuance of Clydach reservoir is technically feasible and a suitable alternative to the restoration of the valves and pipework. Option 3B is preferable due to a lesser environmental impact.

(70) The preferred solution of Option 3B is to be put forward to the Asset Investment Group in early 2023.

Appendix A

Outline design drawings

Appendix B

Bill of quantities

Appendix C

Phase 1 geotechnical and geo-environmental desk study

Appendix D

Enabling checklist

Appendix E

Phase 1 habitat survey plan

Appendix F

Preliminary ecological appraisal

Appendix G

Environmental baseline and planning desktop study

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