Poynton Lake Spillway Upgrade – An Engineer's Comments

August 2023, Mark Buttle CEng MCIWEM

The issue of potentially inappropriate construction at Poynton Pool is being raised by the people of Poynton and East Cheshire, and by the Friends of Poynton Pool group, for example through the community gathering at Poynton Pool on 1st July 2023. Predominantly, people seem worried by the number of trees which might be lost from the dam at Poynton Pool, due to a flood risk mitigation scheme slated for imminent construction by Cheshire East Council.

I have been asked to comment as a Chartered Engineer (CEng) and a Member of the Chartered Institution of Water and Environmental Management (CIWEM). Predominantly to check whether the studies are convincing; whether there are any unforeseen risks from the current plans; and whether there are additional solutions, or options previously discounted, that might be worth reconsidering.

1) General Accuracy

On the face of it the Poynton Reservoir Flood Study report[1], 2019, is convincing that there are risks to the dam of Poynton Pool from overtopping during extreme storms, and that some action should be taken, by Cheshire East Council. However, that all assumes we can have faith in the modelling approach and the checking process, used within the study.

Within the flood report, there are a few simple errors: for example, the terms "Annual Exceedance Probability (AEP)" and "Return Period" are used inaccurately, at least twice. On page 11 (Section 4) a 1.5% AEP is misrepresented as a 150 year return period (it is actually a 67 year return period); and on page 38 (Conclusions and Recommendations) a 1% AEP is misrepresented as a 50 year return period.

While these mistakes seem small and innocuous, one of those mistakes (which is within the Conclusions and Recommendations section, page 38) throws some doubt on one of the main statements within the Executive Summary, that "the dam will overtop, for modelled flood events in excess of…a 50 year return period." Such a statement would normally be taken directly, or copied from the conclusions of the report, but clearly there is a mistake within the critical bullet point on page 38. It is possible that Jacobs really meant to say that "the dam will overtop, for modelled flood events in excess of…a 100 year return period". Perhaps this needs checking and clarification so that the people of Poynton can have confidence in the Executive Summary.

Also, whereas some inaccuracies might be expected by a junior engineer drafting the initial report, such reports would normally be reviewed, double checked, and signed off by a very senior engineer. The worry would be that if such *basic* mistakes as the correct usage of key terms, and possible inconsistencies between the Conclusions and the Executive Summary, were not spotted during that review process, it does raise questions of whether the rest of the document was checked properly, and whether the model used to calculate flood flows was checked properly.

Discrepancies in the ALARP graph, used to analyse whether levels of risk are acceptable, also give cause to doubt the overall rigour of the analysis used (see below).

[1] Poynton Reservoir Flood Study Report, November 2019, Jacobs

Concerning the model used by Jacobs:

a) The Emergency Drawdown Plan for Poynton Pool (2019)[2] makes clear that inflows to Poynton Pool, from the Indirect Catchment area, via the catchwater structure, could easily be stopped completely, using a few simple wooden boards and a 600mm diameter pipe bung. I believe it is fair to question whether emergency services might reasonably, or pre-emptively, close off that inflow, if a very large rainfall event were predicted or had started? However, the Jacobs model assumes a constant inflow of 0.3 m3/s flow from the model due to the catchwater, regardless: a potential inaccuracy.
b) Surface drainage, such as flows via the combined sewer along Anglesey Drive are assumed to be negligible within the Jacobs model, but without real explanation. Perhaps it should be noted that surface drainage on Anglesey Drive was investigated in early 2020 and found to be freely draining[3]. Such drainage would reduce the inflow into Poynton Pool, however the volume was not quantified.
c) According to local residents, the geology of the direct catchment area, which includes some old coal mines, had led to underground flows that may prove larger than expected, and some people also challenge the geographic boundaries assumed to contain the direct catchment area. The FOPP have spoken to local farmers, who have clarified where each individual field drains, thus reshaping understood direct catchment area for Poynton Pool. An adjusted understanding of the Direct Catchment size could also affect estimated flood flows, perhaps significantly.
d) Historic flow and levels data has not been used to calibrate the Jacobs model, which again seems to be a weakness. Jacobs seem to rely on the presumption that latest guidance was followed, rather than attempting to make the calculation as accurate as feasibly possible. In my view a 6-12 month study of rainfall in the area versus water levels in Poynton Pool, and outflow volume, would help with that calibration.

e) Perhaps the most worrying issue with the Jacobs model is the very significant difference of **maximum lake inflow** between two seperate studies.
    i. A 30% Probable Maximum Flood (0.30 PMF) flood risk assessment conducted in 2010, and referred to in the Section 10 Inspection Report 2016 Mott Macdonald, which is stated to be more or less equivalent to a 1 in 1000 year flood model; and
    ii. the, 1 in 1000 year flood model by Jacobs.

In 2010, the maximum inflow to Poynton Pool resulting from an approximate 1 in 1000 year flood was estimated to be 2.64 m3/s, whereas in 2019 Jacobs estimates the maximum inflow as 6.9 m3/s: more than two and a half times more inflow, during the same flood.

The 2019 Study states that the previous "…'rapid assessment' use[d] an outdated high-level method", nevertheless the huge difference in these results is still worrying. If the 2010 approach was so badly wrong, there should be an onus on the current engineering team: firstly to explain the difference; and, secondly, to double check the Jacobs model. Perhaps the 2010 calculation was fairly accurate, and the Jacob's model contains errors? Perhaps the Jacobs model is somewhat overcautious? Or, perhaps the truth is somewhere in between the two results?

[2] Reservoirs Act 1975 Section 10 certificate and Drawdown Plan, 2019, Jacobs
[3] Poynton Flood Update Newsletter, January 2020

One might also ask, if the 2010 calculation was so badly wrong, whether CEC and the people of Poynton were incorrectly reassured about the safety of Poynton Pool between 2010 and 2019?

2) Risk analysis

The chance of the dam being washed away, both by overtopping and through erosion from the downstream side, coupled with failure of the 600 mm overflow pipe/culvert are estimated in section 3 of the Initial Options Report[4]. However, those calculations, and the conclusion that the dam may currently be at an annual 1 in 250 risk of failure, do not seem to be based on any knowledge of the actual structure of the dam. It is not clear why a fuller Risk Analysis was not conducted, after ascertaining the actual dam structure, for example by hand-auguring some test holes in the dam. Without knowing the structure of the dam, all estimates of the mode of failure of the dam, and how it might fail due to overtopping seem extremely speculative.

Within the "As Low as Reasonably Practicable" (ALARP) methodology adopted, to avoid excessive construction, and to still minimise risks the assumption that, should the dam collapse, 1.04 people would be likely to die, also seems worth checking. It is assumed that there will be no warning given, which is strange. Sadly, the level of redaction within the public version of the document makes the risk calculation difficult to follow.

There is a second and potentially very serious problem with the ALARP analysis used by Jacobs. On the graphic representation of Likelihood of Dam Failure versus Consequences (the number of people who might die), otherwise known as the "FN plot", the Jacobs version shows the Risk of Failure of the Dam at Poynton Pool in the Unacceptable Risk zone. However other comparable studies have drawn the boundary between Unacceptable Risks and risk that could be managed (the ALARP zone) higher on the plot. For example, see the presentation to the British Dam Society on 11/1/21, where Stillwater Associates, CCH and Hastings Borough Council used different limits, while assessing risks to the city of Hastings, from Buckshole Reservoir.

If the FN plot from Hastings[5], which seems to use industry standard limits to define what risks are acceptable or unacceptable, had been used to assess Poynton Pool's flood risks due to dam failure, even including additional risks from climate change, and assuming no warning is given to downstream residents, then it looks as if the risk would have been classified within the ALARP zone – a zone where risk should still be further minimised if at all possible, but where the assumption is that risks can be managed.

This classification of risk, which appears to have been completed in a way that is inconsistent with comparable studies, could be considered extremely misleading, both to CEC and to residents of Poynton. A, seemingly, incorrect risk categorisation has been the basis for all initial decision-making around the Poynton Pool Spillway project and all technical options considered.

[4] Spillway Upgrade: Initial Options Report, 11 June 2021, Jacobs

[5] British Dam Society Presentation, 11/1/2021 accessed July 2023, https://www.ice.org.uk/events/past-events-and-recordings/recorded-lectures/the-use-of-dam-break-risk-curves-to-optimise-an-alarp-assessment

3) Unforeseen issues

In general, given that the dam is predicted to overtop during a 1 in 100 year flood (1% AEP) it seems likely that *some* dam or spillway improvements will be necessary, even after checking of models and reports.

A report on Further Investigations of Option 3C, from 2022[6] identifies that Option 3C (iii) as the best option. This involves constructing a crest marker at the average level of the dam within the wood, and seems to state the need to remove trees one meter upstream of the new crest (towards the lake) and two meters downstream (towards the road).

Possible risks to the dam itself caused by tree felling

An online summary of the Poynton Pool scheme[7] states that between 44 and 81 trees will be removed, however on 1st July, following public objections that were widely reported, CEC clarified that only 35 trees will be removed under current plans.

Nevertheless, according to internationally published guidance there may be unforeseen risks to the dam stemming from the tree removal itself, due to increased erosion due to water "piping" through holes in the dam caused by decomposition and shrinking of the roots of those felled trees.

Guidelines from South Australia[8] state that "…It may appear intuitive to immediately cut down or pull out any trees that may be of concern, however DEW (2018) and FEMA (2005) note there are potential issues with these methods if an appropriate procedure is not followed. If trees with potentially decaying roots are cut down without treatment of the stump, this will only expedite the decay, and may cause the seepage line to rise, causing further issue."

The "further issue", referred to above, is that trees do not like their roots to be below the level of the groundwater. In fact a tree can die if its roots are inundated. Trees planted close to each other on a dam, lower the average level of groundwater within the dam (as they suck out water). So, if several trees are felled, the rising groundwater level, might then drown the roots of their neighbours, causing more trees to die, and hence a domino effect of more and more trees dying, along the dam.

The SA Guidelines go on to say, "…fully removing the tree and root system without remediation of the surface will leave the area prone to erosion and possibly allow a route for seepage to surface if the excavation is significant".

Risks to local houses

There may be additional risks from current plans which do not seem to have been evaluated or discussed. For example, if the hight of the proposed new crest is "100 mm higher than the average level within the wood". Looking at the Figure 7-1 of the Flood Study, the average level for the lowest 400 m of the existing dam crest (within the wood and therefore where the new crest would be installed) looks to be around 91.1 m AOD, giving a new crest height of around 91.2 m AOD.

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[6] Spillway Upgrade: Further Investigations of Option 3C, 15th October 2022, Jacobs

[7] Poynton Pool Spillway Improvements, online summary, CEC website accessed 10th July 2023

[8] Tree Clearance and Remediation of Earth Dams, 2020, South Australia Water Corporation

If the new heights are correct, then the new crest would be 60-65 cm above the level of the existing overflow spillway weir, which is at 90.55 m AOD. So, during any predicted flood events, be they 1 in 100, 1000 or 10,000, the water levels in the reservoir would exceed 91.2 m AOD: effectively a planned rise given that CEC fully expect the dam to overtop at least once per 50 years. However, this regular 65 cm rise in levels, during overtopping incidents might endanger some houses surrounding the lake, especially even numbered houses which are lakeside, on Anglesey Drive.

CEC might or might not have additional financial liability for any damages to those 10-12 houses caused by the spillway improvements, which are changing the overflow mode for the reservoir, and I would advise CEC to check their legal position on this issue.

4) Alternative options for work at Poynton Pool

There are some options that do not seem to have been considered fully during the decision-making process for the Poynton Pool overtopping risk mitigation scheme. Also, some options initially considered, might now be more feasible than previously thought. For example:

- The use of screw piles and beams to construct a crest that could be implemented in a more tree-friendly way, perhaps, than the crest design currently planned;
- Drainage improvements to Anglesey Drive and Towers Road, to reduce inflows to the lake might be considered;
- Automatic or remotely operated devices to stop water inflows from the Indirect Catchment, in a flood rainfall event, might be relatively simple to install; and
- While enlargement of the existing spillway by installing additional, parallel spillway culvert(s) was initially considered and eliminated as an option, it should be noted that this option might be cheaper, in 2023/2024, than originally predicted, given the downgrading of the A523 to become the B5092.

Conclusions

In my view Cheshire East Council, CEC, should consider a pause in construction in order to double check the accuracy of the Jacobs Flood Model, and to check the ALARP risk categorisation which was fundamental to the initial decision-making. In addition, CEC might reconsider some additional technical solutions that do not seem to have been taken into account fully at this stage.

I suggest to CEC consider the postponement of technical decision-making for 6-12 months so that the following can be addressed:

- The flooding model might be re-checked on the basis of revised predicted inflows. In particular, new information from the community that could radically decrease predicted inflows from East of Towers Road and CEC/Jacobs could reappraise the catchment area used to calculate flood flows. Consider further refining the Jacobs model to incorporate data from a rainfall and lake levels and outflows study, and so that actual data might be used to calibrate the model. Importantly, the calculated 0.1 % AEP maximum inflows from 2010 and 2019 should be reconciled and the differences explained, if at all possible. At present those estimates are grossly different!
- Secondly, risks predicted for people downstream seem somewhat high. The discrepancy between the risks presented to CEC and the public (that the risk is unacceptable) and the risk that would be calculated is using comparable methodology form other locations (that the risk could be managed, and kept As Low as Reasonably Practical) needs to be re-examined and if necessary corrected.
- Risks from overtopping, or from trees being blown over, should be calculated based on the actual structure of the dam, which should be ascertained properly (not just assumed).
- The proposed new flood management strategy assumes fairly regular overtopping of the dam, and the implied lake level rises upstream. This seems different to the previous assumption (even if incorrect), which was that the current spillway was sufficient. This might give CEC some unexpected financially liabilities for any damage to houses (on the upstream side of Poynton Pool) that could be flooded as a direct consequence of the new operating modality. Perhaps a topographic survey is needed to evaluate that possibility, and CEC might check its legal position.
- Lastly there have been proposed, previously unconsidered technical solutions, which might be both preferable and cheaper, given remodelling and topographic survey mentioned above. In light of the redesignation of the A road to a B road, the actual costs of previously rejected options, might now be cheaper and more viable.

Although I am not a “panel” engineer, the penalty for missing the deadline for implementing improvements, before the end of 2023, does not seem to be terrible, although it may be somewhat embarrassing for CEC. The Initial Options Report (2021) states that “if works are proportionate then they should be designed and built by 5th December 2023. If these dates are not met, then a Reservoirs Act Section10 inspection should be called early by the Supervising Engineer.”