Friends of Roath Brook

Roath Flood Risk Management Scheme

Phase 3

Review of alternatives

by

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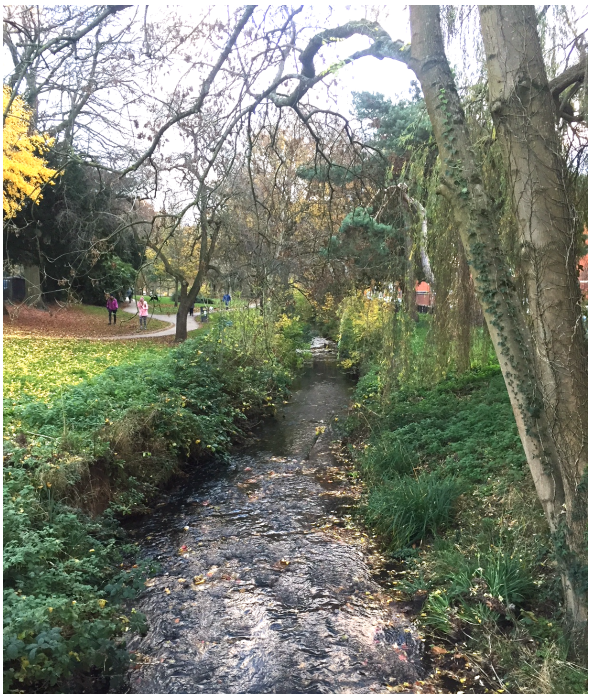

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Summary.

-Phases 1 and 2 of the Roath Brook Flood Management Scheme are effectively complete.

- Phase 3 includes enlarging the channel through Roath Brook Gardens and Roath Mill Gardens and constructing low walls where necessary. Phase 3 has not yet been started so is effectively a new scheme.

- "*the Roath Brook Gardens are well used by locals and visitors seeking a scenic stroll through the gardens. One of the highest rated attributes included the variety of trees*."[1]

_"*clearing and dredging of the existing river channel and removal of any constraints on flows"* such as trees "*would be significantly detrimental to the WFD objectives for the catchment, as it would cause a deterioration of the ecological quality of the watercourse*."[2]

-Phase 3 of the scheme as proposed would result in the removal of about 40 bankside trees. This would lead to deterioration, and thus likely failure under the Water Framework Directive which has been tightened since 2012.

- An alternative scheme is suggested by me that would widen the channel where this can be done without affecting the trees and adapting the flood defence measures to cope with the changed flood levels. Its viability should be investigated.

- Upstream is the Roath Park Lake, a reservoir under the Reservoirs Act. It has a fixed masonry spillway. In the past it was drawn down to reduce flooding downstream. A tilting weir system could be provided to lower the Lake water level when a major flood is forecast. The extra flood storage and control would reduce the peak flood flow and levels downstream. If the top of the tilting weir was at the level of the masonry weir, then there would be no increase in lake peak flood water level and thus meet the Reservoirs Act.

- Further upstream is the offline Llanishen reservoir. The Nant Fawr, a major tributary, could be connected to the reservoir. This would provide flood storage and reduce the downstream peak flood flow from about 16m3/sec to about 13 m3/sec. To ensure safety from floods, a new flood spillway would need to be provided with a lower top water level.

- My experience in such matters is as a Panel AR Engineer under the Reservoirs Act for over 25 years, including reporting on Llanishen reservoir, providing dam safety reports on many others, the design and construction of flood defence reservoirs, the carrying out of many flood risk assessments for developments, and providing evidence to Public Inquiries.

- "*The Key Objective"* set in the June 2012 Scoping Document*" is to implement the most technically, environmentally and economically feasible flood risk management solution*."

-There is no record that the specific alternatives for Phase 3 have been properly studied and I recommend that these specific alternatives be considered, along with their environmental impacts and benefit and cost assessments in line with current protocols.

[1] NRW Roath Flood Risk Management Scheme. The Design Process at Roath Brook Gardens.
[2] NRW Roath and Rhymney Flood Risk Management Scheme Scoping Document

Contents

1. Introduction

The Scheme is Phase 3 of the Roath Brook Flood Risk Management Scheme, primarily involved in reducing the flooding in Roath Park Gardens and associated areas.

Friends of Roath Brook are concerned about the potential impact of the proposed work on the mature trees along the Brook.

I was appointed to advise them on engineering matters. I am a civil engineer with about 30 years experience as a Reservoirs Act Panel Engineer including responsibility for the design of three dams over 50m height, reporting on Llanishen reservoir, preparing section 10 safety reports on many reservoirs, the design and construction supervision of two flood defence reservoirs, member of the ICE Reservoirs Committee interviewing prospective candidates for appointment under the Reservoirs Act, and providing flood risk assessments for a number of developments. I was, for about 20 years, Director of the Water Consultancy of WS Atkins, one of the largest UK consulting engineers. I have given expert evidence to a number of Planning Inquiries and to Parliamentary and other Committees. I was President of Chartered Institution of Water and Environmental Management in its centenary year. I am now an independent water consultant and a Visiting Professor at Exeter University in their Water Centre.

I have been provided with a number of public domain documents and visited the site on 1st and 22nd October.

2. Criteria for the scheme

The criteria for the scheme are set out in the Natural Resources Wales (NRW) Roath and Rhymney Flood Risk Management Scheme Scoping Document dated June 2012. This covers phases 1, 2 and 3 of the scheme.

"Key Objectives.

To implement the most technically, environmentally and economically feasible flood risk management solution..."

There are several hydrology reports. The original design flood appears to be 1 in 100 years but this appears to have been amended to a 1 in 75 year flood. Commenting on the hydrology is not within my Terms of Reference. However the peak flood flow appears to have been taken as about 16 m3/sec.[3]

[3] Water Resource Associates Review of Flood Risk Assessments for Roath Brook Park, Cardiff, April 2018 page 5 quoting Arup report.

3. **Flood flows and ecological impact**

It is stated[4] "*Specific to the Scheme site, Natural Resources Wales's surface water flood risk map is shown in figures 18 and 19. Through Roath Gardens (Figure 19) the surface water flood risk is defined as low (0.1% -1% probability) or very low <0.1% probability."* Thus the proposed works appear to concentrate on retaining fluvial flooding within the Roath Brook channel.

The NRW Roath and Rhymney Flood Risk Management Scheme Scoping Document June 2012 states[5] when referring to "*clearing and dredging of the existing river channel and removal of any constraint on flows*" "*the option would be significantly detrimental to the WFD objectives for the catchment, as it would cause a deterioration of the ecological quality of the watercourse."* Presumably this would also apply to the proposed channel enlarging and tree removal. Thus it would appear that the current proposal would cause deterioration under the WFD which, since 2012, is specifically not allowed under the WFD. Thus the proposed scheme would appear to fail the WFD.

The response to the consultation states [6]"*The Roath Brook Gardens are well used by locals and visitors seeking a scenic stroll through the gardens. One of the highest rated attributes included the variety of trees and the Brookside walk*."

I have gone onto the Cardiff City web site and downloaded the TVO Flood Consequences Assessment Report of October 2015. As I understand it this is later than the Arup and NRW 2012 reports and therefore should be more uptodate.

However, despite the statements above, the TVO report shows the revised channel cross section through both Roath Brook Gardens and Roath Mill Gardens as being widened throughout most of its length.

The TVO plans show the trees that are to be removed as round red circles. On the plans there are about 20 in Roath Brook Gardens and about 20 in Roath Mill Gardens. The removal of about 40 bankside trees along the Brook over a distance of about 500m would be a serious loss of ecology and public amenity.

The Friends of Roath Brook are keen to preserve as many of the trees and ecology in the Gardens as possible.

The proper way to assess flood levels is with a hydraulic model. The one for the scheme is not available to me and nor is sufficient data for me to compile one myself. From the drawings the enlargement of the Brook channel appears limited, seldom more than about 10% of the cross sectional area.

[4] Team Van Oord, Roath Brook Flood Risk Management Scheme, Flood Consequence Assessment, October 2015 page 21.
[5] Page 19
[6] NRW Roath Flood Risk Management Scheme. The Design Process at Roath Brook Gardens.

4. Partial widening scheme

From my site visit it would appear that there are two lengths of the Roath Park Gardens channel where there are no trees. These are about 60m downstream of Walled Gardens and about 80m between the footbridge and Blenheim Road bridge.

Studying TVO drawing ROA-RHD-09-XXDR-L-1000 it would appear that there is about a 70m stretch in Roath Mill Gardens where no tree felling is proposed.

This would amount to about 200m out of a total length of about 500m. Most of the drawings are reduced scale without a scale bar so these dimensions have to be approximate.

Were channel enlargement to be carried out along these stretches of channel, as identified in the paras above, then it would be possible to reduce the hydraulic losses in the un-enlarged channel, and hence lower the no enlargement flood levels which would otherwise occur upstream.

I have compared possible flood levels with the topographic survey. It would appear that it should be possible to cope with the increased flood level using the methods proposed in the scheme but this would need checking by hydraulic analysis.

This alternative should do much to reduce the environmental impact of Phase 3 of the scheme such that it did not lead to deterioration under the WFD.

My suggestion is that such an option should be considered including hydraulic analysis, scheme consideration, and costing.

5. **Individual house protection.**

Rather than flood protection walls, it is possible to provide individual flood defences to each of the properties which could be affected. This technology has advanced considerably over the last five years, ie since the original scheme comparisons were made, and now might be viable at a significant cost saving. The scheme would require new water proof doors, protection of the underfloor ventilation systems, and non-return systems on the sewage and drainage pipes to each house.

Whilst such a scheme may not have been viable for the whole project, it becomes much more viable for smaller projects such as the about 70 homes affected by Phase 3 on a standalone basis.

TVO [7] state "*In order to reduce the flood risk to 2 Westvile Walk the property owner will be given the opportunity to install individual property protection which will include air brick covers, anti back flow valves in the sewerage system and replacement upvc flood doors."* Thus the principle of individual household defence has been accepted.

[7] TVO Roath Brook Flood Risk Management Schemes, Flood Consequences Assessment October 2015 page 1.

This can be a cheap solution. For instance, assuming about £1,000/house for possibly 6-10 houses on the north bank, Westville Road, the cost would be about £10,000. For the total number of houses that are believed to be affected, about 70, the cost might be about £70,000.

6. **Store flood water in Roath Park Lake,**

6.1 General description

Roath Park Lake is on Roath Brook some 1 1/2 km upstream of Roath Brook Gardens, thus commanding much of the catchment.

Roath Park Lake is an impounding reservoir constructed in 1894. It is subject to the Reservoirs Act 1975, almost certainly a category A. I asked the Reservoirs Regulation Section of NRW for a copy of the latest Section 10 report. They provided a highly redacted copy with all the important information removed.

The Lake is impounded by an earth embankment about 6.5m high. It's quoted top water level area is 12 ha (32 acres). It has a masonry spillway at the right abutment. The reservoir depth is reported to be "*between two feet and more than fourteen feet.*"[8]

The catchment area is quoted as 12.23km2[9], appreciable in relation to the catchment downstream.

The flood analysis is redacted. Since the Lake has been subject to the reservoir safety legislation for about 80 years with ten yearly inspection reports, then a reasonable assumption is that it meets the basic requirements. However the unredacted text does talk about the potential for erosion of the downstream face due to overtopping and this could be due to waves. Whatever, it is apparent that safety from overtopping flooding is an issue.

6.2 Previous flood mitigation.

"From 1927 the level of water in the lake was lowered every year between October and March for the additional need to prevent a repeat of the floods that occurred in Roath on 1st-2nd November 1927."[10] Thus the reservoir has previously been used for flood attenuation by lowering the lake water level, reducing the volume in storage and using the spare space to provide flood mitigation downstream.

I am informed that this flooding was not in the area of phase 3 works where there is no history of properties flooding from Roath Brook.

[8] www.cardiffparks.org.uk/roathpark/info/lake downloaded 2nd October 2018
[9] Section 10 report by Alan Brown.
[10] www.cardiffparks.org.uk/roathpark/info/lake downloaded 2nd October 2018.

6.3. Previous considerations.

Scoping Report[11] "*Attenuation at Roath Lake was rejected because the alteration required to the weir to retain flood flows during a 1 in 100 year flood event would result in an unacceptable increase in top water level in the lake during a 1 in 1,000 year storm event. This would result in the dam not being able to safely hold the Probable Maximum Flood without significant alterations."*[12] The actual scheme rejected was not identified in that document.

"We investigated using Roath Lake to retain water during high river flows. This would require major work to the lake, including strengthening the dam and raising its level to ensure public safety was maintained."[13] This scheme appears to include shortening the weir length. "*Even then this would only reduce the level of the flood defences required in Waterloo Gardens by a third of a metre and have no benefit to areas at risk of high tides.*"

Although lake lowering for flood protection purposes for several months had been practised previously it is stated 1.1.27 *"The option of permanently lowering the normal water level was also rejected due to the detrimental impact on the landscape and amenity value of this strategically important asset. Initial discussions held with Cadw and the City of Cardiff Council identified that this option would not be feasible."*

Project Appraisal 2013[14] "*A mechanised weir could alternatively be installed to control flow and water levels in Roath Lake but flood forecasting/warning quality and lead times are insufficient and this presents an unacceptable operational risk to NRW."*

It is now 5 years later. With the latest Met Office supercomputer, weather forecasts are now given five days ahead, and often ten days ahead, and are much more reliable than in 2013. Thus sufficient warning of a major flood event could now be provided.

6.4. Potential flood mitigation scheme.

Because of its Reservoirs Act status, the Lake must continue to pass its design flood.

This could be done by an electrically controlled tilting weir operated by a control system using the latest meteorological forecasting system.

"Our free flood warning service can give advance notice of when flooding from rivers is likely to happen. Flood warnings will give time to prepare for flooding ..."[15]

As an example, Waterscan's intellistorm system has been installed on several development sites in London[16] and elsewhere. The system would need to be designed to draw down the

[11] NRW Roath and Rhymney Flood Risk Management Scheme Scoping Document June 2012 page 19.
[12] NRW Roath and Rhymney Flood Risk Management Scheme Scoping Document. June 2012 page19.
[13] NRW Roath Flood Risk Management Scheme. What options have we considered?
[14] NRW Project Appraisal Report June 2013 page 20.
[15] NRW Roath and Rhymney Flood Risk management Scheme Scoping Document June 2012 page 20.
[16] CIWEM The Environment October 2018 page 30.

lake sufficiently ahead of a major storm. To ensure catching storms with the relevant long return period, this would probably only need to be about once every decade or so, thus maintaining normal Lake water level for almost all of the time. There are similar systems provided by other suppliers.

Such a system would be covered by the Secondary Objectives "*Identify flood warning requirements."*[17]

To ensure no adverse affect on the Reservoirs Act structure, the top of the tilting gate should be no higher than the current crest of the masonry spillway.

Hydraulic analyses would need to be carried out to assess such an arrangement and its costs assessed. However it could be designed to cope with the local flood reduction required and it would be fail safe. Its costs should not be high.

Such an option does not appear to have been considered as a specific alternative to Phase 3 alone.

7. Divert stream or flood into Llanishen reservoir.

7.1 Llanishen history

Llanishen reservoir is a large reservoir further up the Nant Fawr catchment. It was built in the 1880s as a water supply to Cardiff. It has a surface area of 24 ha, a top water level of 45.87mAOD and a storage capacity of 1.4 Mm3. It has embankments all the way round and has no current operating link to the Nant Fawr stream. It fills by natural rainfall and by pipe from a distant source. Because of the housing downstream the reservoir is classed as a category A reservoir. However, because it has minimal catchment, it is classed as a non-impounding reservoir and hence the current incoming "flood" would only be the Probable Maximum Precipitation rainfall, about 250mm[18]. The freeboard, ie the difference between the maximum flood level and the lowest part of the dam, is 1.29m.[19]

Its public water supply use ceased many years back and it was then used as a sailing and recreation lake. In 2010 it was drawn down and is currently effectively empty. It is now owned by Welsh Water who are currently converting it to a non-household water supply to the Cardiff Docks area and a recreation reservoir.

7.2 Connection to the Nant Fawr

The Nant Fawr stream runs along the northern and western sides of the reservoir. I have previously visited this area but during my recent site visit I was unable to do so as the access track from the north is boarded up.

[17] NRW Roath and Rhymney Flood Risk Management Scheme Scoping Document June 2012 page 2
[18] Reservoir inspection report by Dr Hughes May 2008
[19] Reservoir Inspection report by Dr Hughes May 2008.

My memory is that the previous reservoir top water level is marginally below the level of the Nant Fawr near the north west corner of the reservoir.

NRW believe that " *We do not believe that a passive solution"* I take this to be a gravity non-pumped arrangement *" is viable due to the reservoir's full elevation compared to the Brook..."*[20]

The 1994 reservoir inspection report of Dr Hughes states that "*An inlet next to the overflow was seen to be valved and holding water."* Since this is on the north west section of the reservoir this inlet pipe is likely to be a historic link from the Nant Fawr stream.

Andrew Hill of the Reservoir Action Group also believes such is the case, "*You are correct, there is a valve device at the top at the north west corner which would allow the Nany Fawr to be diverted into the reservoir. I believe W W intend to use it to assist in re-filling.*"[21]

I have studied the 1:25,000 Memory Map of the area at enlarged scale. This has elevation icons.

Llanishen water level 144ft. This might not be top water level, but see below.

Top of the surrounding bank 147ft. Considering the quoted freeboard is about 1.3m, ie about 4ft, then the reservoir would have been close to, or at, top water level.

Nant Fawr downstream of B4562, 161ft

Nant Fawr start of the bywash channel 153 ft. This is on Welsh Water land.

Whilst these levels do not transpose to mAOD, (metres above Ordnance datum), they should give a reasonable relative level. Thus there would appear to be sufficient head for the Nant Fawr to flow into the Llanishen reservoir in a new channel.

Were the Nant Fawr to be connected to the reservoir, then the reservoir Probable Maximum Precipitation flood inflow would increase appreciably, thus requiring a significantly larger freeboard. This would require the lowering of the top water level of the reservoir, possibly by the order of magnitude of a metre, and the provision of a new reservoir spillway at a lower level. This in itself would mean even greater scope for Nant Fawr water to enter Llanishen reservoir. The amount of the reduction would depend on the spillway capacity and design. Since the reservoir is surrounded by embankments, this would not have a significant effect on the top water area but would reduce the storage capacity somewhat. For instance a one metre reduction in top water level would result in a 15-20% reduction in storage volume. I have not found any statement about the need for any specific storage volume and believe that the somewhat lower storage volume should

[20] Email Gavin Jones to Melissa Johansson, 12th September 2018.
[21] Email Hill/Binnie 9th October 2018.

not be a show stopping issue. The new spillway would discharge into the by-wash channel and would be an important structure but is unlikely to be an appreciably large structure.

The Nant Fawr flow split structure would need to be designed to cope with both normal flows, flood control and the probable maximum flood conditions.

Thus this scheme would appear likely to be a viable option, albeit this could be a significant expense.

7.3 Water quality

Welsh Water state "*We currently make full operational use of Lisvane for the purposes of water supply to industrial users in the City. By 2020 we will also be bringing Llanishen reservoir back into service. Both reservoirs will be used for water supply and recreational purposes."* [22]

Connecting the Nant Fawr into Llanishen could result in poorer water quality inflow. This would need checking by water quality sampling. However, considering that the reservoir is to be used by birds and for public recreation, (sailing could require a motorised guard boat with the risk of fuel spillages into the reservoir), then there would already be some water quality risk and the extra risk may be limited. This would need assessing by catchment management, water quality safety plans, and water quality sampling.

7.4 Flood reduction benefit

The hydrological assessment by Water Resource Associates showed that, assuming Llanishen and Lisvane reservoirs were both on line, then the peak flood flow downstream would reduce from about 16 m3/sec[23] to about 11.8 m3/sec[24].

From Memory Map at 1:25,000 enlarged, it would appear that the Lisvane potential natural catchment is very small and the northern bywash channel is routed into the Nant Fawr. Thus the Nant Fawr already collects almost all the catchment flow that would previously have flowed into Lisvane reservoir area. However there would be less reservoir area for flood storage. Lisvane reservoir is substantially smaller in area than Llanishen so the reduction of peak flow at Waterloo Road using Llanishen only would be to about 13m3/sec, a significant reduction in the Roath Brook Gardens design flood flow.

7.5 Welsh Water

For Llanishen reservoir to be utilised as a flood mitigation scheme would require the support of the reservoir owner Welsh Water. *" For these reasons, and in the interests of*

[22] Email Peter Perry, MD Welsh Water to David Rowlands AM 2.08.2018.
[23] Water Resources Associates Review of Flood Risk Assessments for Roath Brook Park April 2018 quoting on page 5 Arup February 2013 Table 2.5a
[24] Water Resources Associates Review of Flood Risk Assessments for Roath Brook Park April 2018 page 7 para3.

Dam Safety we will not be able to use them for flood risk mitigation purposes."[25] As a Reservoirs Act Panel Engineer for about 30 years, including previously visiting and reporting on Llanishen reservoir, I have been unable to identify any technical reasons for this view, apart from the potential change in water quality, and potential change in yield due to reduced reservoir storage. Were the full flow of the Nant Fawr to be diverted from the bywash channel to the reservoir, the water supply yield might well increase.

7.6 Conclusion.

Subject to further study, it would appear that flood flows could be routed through Llanishen reservoir for flood benefit but with the cost of the diversion works and a new reservoir spillway.

8. **Phase 3 report of alternatives.**

I understand that Phases 1 and 2 are effectively finished and Phase 3 has not yet started. Thus phase 3 is now effectively a stand alone scheme. Inevitably there will have been some differences in the phases 1 and 2 as originally proposed some 5 years ago to those actually constructed. Some circumstances, including much improved rainfall and flood forecasting, and flood defence funding protocols, have changed since the original study work was done about 5 years ago.

Thus it is important to check that the *Key Objectives of implementing the most technically, environmentally and economically feasible flood risk management option*, are still being met, or the scheme adjusted to do so.

However I have been unable to find a phase 3 scheme document setting out these specific alternatives , an uptodate assessment of the environmental impacts of these alternatives, the updated benefits in accordance with the current flood defence funding protocol, the capital costs of these alternatives, and the recommendations.

9. **Conclusions**
   1. Phases 1 and 2 are now effectively complete and Phase 3 has not yet started, thus Phase 3 is effectively a new scheme.
   2. "*the Roath Brook Gardens are well used by locals and visitors seeking a scenic stroll through the gardens. One of the highest rated attributes included the variety of trees*."
   3. *"clearing and dredging of the existing river channel and removal of any constraints on flows"* such as bankside trees as currently proposed "*would be significantly detrimental to the WFD objectives for the catchment, as it would cause a deterioration of the ecological quality of the watercourse*." Since June 2012 WFD has specifically barred deterioration. Thus it would appear that the current proposal would fail the EU Water Framework Directive.

[25] Email Peter Perry MD Welsh Water to David Rowlands AM 2.08.2018.

4. The public consultation showed *Roath Brook Gardens are well used...One of the highest rated attributes included the variety of trees.*
5. The plans show that for the proposed scheme about 40 trees would be removed.
6. An alternative scheme is suggested enlarging the channel where there are no trees and adapting the flood defences to the revised flood levels.
7. The technology of individual flood protection of houses potentially impacted has been greatly improved since 2012 and should now be considered and costed.
8. The flood flows in the Roath Brook could be reduced appreciably, and hence the flood levels reduced, by changing the fixed masonry outlet weir on Roath Park Lake to a titling weir to be operated when a major storm is forecast. With the crest of the tilting weir no higher than the existing fixed weir, this would not adversely affect the safety of the dam and reservoir. It would rarely need to be operated so would only rarely affect the top water level of the lake for a short time.
9. Alternatively the Nant Fawr could be diverted into the Llanishen reservoir. To maintain safety a new spillway would need to be constructed at a lower top water level such that the safety of the dam and reservoir would not be compromised. A hydrological study would need to be carried out to assess the change in deployable output. There could also be a greater water quality risk.
10. *The Key Objective* set out in June 2012 *"is to implement the most technically, environmentally and economically feasible solution."*
11. It has not been possible to identify an uptodate environmental impact assessment for these alternatives for Phase 3.
12. The method of benefit assessment of flood defence schemes is believed to have changed since the overall scheme was initiated. (It has in England and is likely to have also changed in Wales.) Thus both the costs and the benefits of these alternatives for Phase 3 on its own should be appraised.

20/11/2018