Comhairle an Iúir agus Mhúrn
Newry & Mourne District Council

Oral Presentation by Newry & Mourne DC

To Agriculture and Rural Development Committee

25 February 2014

The Reservoir Bill

In Attendance:

Mr J McGilly: Assistant Director of District Development

Mr E McManus: Deputy Director of Technical & Leisure Services

Newry & Mourne DC

Summary of Main Points - The Committee for Agriculture and Rural Development on the Reservoirs Bill

General Comments

- Within the NMDC area 11 Reservoirs have been identified and considered as 'controlled reservoirs' under the Reservoirs Bill. The Rivers Agency has identified ownership as ranging from Public Sector, Private and Not Registered.

- Whilst Council currently have a direct involvement in a number of the Reservoirs in the District, a number are in the ownership of other agencies or the Private Sector. Currently with no management of a number of reservoirs, this represents an unknown risk to the community downstream.

- Whilst analysis is available on a small number of Reservoirs, no detailed assessment is available on the condition of all Reservoirs, any remedial action, long term maintenance and the number of people potentially affected downstream within the community is unknown.

- With the lack of detailed information on the Reservoirs, the burden on Reservoir Managers within the District is unknown. The concern will be both financial and the skills capacity to meet the requirements of the Reservoir Bill.

- Given Council experience to date with potential impact of the Reservoir Bill on 'controlled reservoirs', it is likely to place a significant financial burden on the Reservoir operator. The ability of the operator to meet the financial requirements is a significant concern. It is important that in introducing the Bill, the Department considers making a grant aided scheme to Reservoir operators.

Camlough Dam

- The Camlough Dam was briefly discussed at the Agriculture and Rural Development Committee on 18 February 2014 by Northern Ireland Water, in their presentation to the Committee on The Reservoir Bill

- **Ownership**

The ownership of Camlough Dam is unclear. The Newry Improvement and Water Act of 1871 given ownership and control of Camlough Lake to the Camlough Lake Waterworks Trustee. It would appear however that all of the trustees have died and no successors were appointed.

Both NI Water and Newry & Mourne DC have an interest in Camlough Lake.

NI Water utilise the reservoir for public water supply.

Newry & Mourne DC has historically a twofold interest in Camlough Dam
Firstly the Newry Improvement and Water Act of 1871 part of which remains part of our legislation stated “and whereas during the summer months there is frequently in the Newry Canal an insufficient depth of water for the navigation of same” and that Act of 1871 went on to protect Newry navigation with the requirement at Section 86 of the Act for the delivery out of Camlough Lake of sufficient gallons of water to protect inter-alia Newry Canal”.
Secondly the lake is widely used a local amenity activities ranging from canoeing, angling to water skiing. The lake is becoming increasingly renowned for swimming and hosts annually the Camloch Triathlon and Camlough Water Festival among other events.
The Council manage recreational access by virtue of a licence from Richardson Estate; the Council have no title at Camlough Lake.
The Council manage recreational access to Camlough Dam through a Sub Committee which includes Council, local users group, environmental group and community sector, the facility is very much regarded as a community asset.

- **Camlough Lake - Area of Special Scientific Interest**

Camlough Lake is a designated Area of Special Scientific Interest. It is one of the few remaining Mesotrophic lakes in Northern Ireland. It is a special place because of its aquatic flora and fauna. A wide range of birds and invertebrates are also found at Camlough. The shore line includes an area of wet woodland supporting several species of Willow and Downey Birch as well fenland and marshy grassland habitats

- **Camlough Lake – The Reservoir Bill**

In the context of The Reservoir Bill to Northern Ireland, Council have been working in partnership with Rivers Agency and Northern Ireland Water. A Section 10 Report on Camlough has been completed in accordance with the current good practice of the Reservoirs Act (1975). The inspection identified a number of serious deficiencies with the existing dam structure therefore a report to investigate the works necessary to bring the Dam to a safe standard was produced. A copy of the Report is attached entitled **Camlough Reservoir Improvement Options Report February 2014 with Addendum Report** A supplementary **Abandonment Scoping Report January 2014 is also enclosed.**

Camlough Reservoir Improvement Options Report February 2014 recommends the Rehabilitation Option at a cost of £2,510,000

At paragraph 8.8 page 24 of the report Camlough Reservoir Improvement Options Report February 2014 attached the capital costs assessment is £2,510,000. Northern Ireland Water has indicated it will make application to the Department for 50% of this cost. There is therefore a budget of £1.255 million to be found.

Given the Council's present activities at Camlough Lake, the Council could be a reservoir manager for the purposes of the Reservoirs Bill when enacted. If Newry & Mourne District Council was to continue to use Camlough Lake then this cost of £1.255 million could fall to the Council.

Section 105 (1) of the draft bill provides as follows:- “The Department may by regulations make provision as to the payment of grants to reservoir managers of controlled reservoirs for the purpose of enabling or assisting the managers to comply with their obligations arising by virtue of this Act.

(2) Regulations made under subsection (1) must require such grants to be subject to such terms and conditions as the Department may determine (including conditions as to repayment in the event of contravention of the other terms or conditions on which the grant is made)”.

The requirement on the Council to raise £1.255million is a significant concern. Camlough Lake is a tourist and recreation amenity not just for the benefit for the people of Newry & Mourne but also for the benefit of a much wider catchment area than the District Council area itself.

The risks to the Community set out at paragraph 3.2 page 8 of Camlough Reservoir Improvement Options Report February 2014 attached are regarded as potential danger to persons and property which is outside the remit and powers of the District Council and is really the responsibility of Government Departments.

The Council believe the 50% cost of £1.255 million requires a multi agency approach which includes Council, therefore Council will be seeking the support of various Government Departments.

If the Council agreed to become the owners on the basis of securing the funding for Rehabilitation Improvements, the ongoing maintenance estimated at £14,000 per annum would be the responsibility in the long-term, of the Council and will require both financial and staff resources.

Reports Attached:

1. Camlough Reservoir Improvements Options Report – February 2014
2. Camlough Reservoir Improvements Options Report – February 2014 – Addendum
3. Camlough Reservoir - Abandonment Scoping Report – January 2014

URS

Camlough Reservoir

Camlough Reservoir Improvements

Options Report

February 2014

47068303

Prepared for:
Northern Ireland Water

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	Dec 2013	Draft	Alan Cooper Panel AR Engineer	David McKillen Technical Director	Alan Cooper Panel AR Engineer
2	Feb 2014	Final	Gareth Briggs Associate Alan Cooper Panel AR Engineer	David McKillen Technical Director	Alan Cooper Panel AR Engineer

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Forecast cost estimates do not include such costs associated with any negotiations, appeals or other non-technical actions associated with the agreement on measures to meet the requirements of the authorities, nor are potential business loss and interruption costs considered that may be incurred as part of any technical measures.

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1 INTRODUCTION

1.1 Scope and objective of this report

In April 2013 RPS and URS were appointed to produce a condition assessment of Camlough Reservoir with the option to extend the appointment to investigate any issues identified and advise on the subsequent remediation of these.

The condition assessment included an inspection and report in accordance with the current good practice of the Reservoirs Act 1975 (GB Legislation), involving the preparation of a Section 10 Report as defined by the Act.

This inspection identified a number of serious deficiencies with the existing dam structure. The appointment scope was subsequently confirmed to include the preparation of a report to investigate the works considered to be necessary to stabilise the structure and enable the reservoir to remain safely in service for public water supply beyond July 2015. The brief stated that the report should set out.

(a) Priority and urgency of any immediate capital works to stabilise the structure – focused on safety

(b) Priority and urgency of the capital works necessary if the dam is to remain in use for an extended period beyond 1 July 2015

(c) Estimated costs of initial works (which must take into consideration that NI Water requires a continuous abstraction be provided until at least June 2015 – hence any 'temporary works' need to be costed accordingly)

(d) Estimated annual operational costs (insurance, inspections, compiling on site and off site plans etc)

(e) Estimated costs of typical annual base maintenance costs (based on the assumption that the initial capital works have been completed) – to include intermittent costs such as 10 yearly Section 10 Surveys.

(f) A section to set out a process for NI Water decommissioning the dam at lowest cost after 1 July 2015 (which will be assumed to include digging out part of the face and using this to landscape the remaining elements), and restoring the natural lake level and river bed to the pre year 1870 level. This should include a timeline, any approvals necessary, and the estimated costs. This option will become viable if NI Water becomes the owner of the impoundment (which may occur if N&MDC determine that the dam is not needed to regulate flows in the Newry Canal, or for recreational activity).

1.2 Limitations of the report

It should be noted at this stage that the report is considered to be a pre-feasibility report and is only to be used to develop the overall strategy for the reservoir and to inform funding considerations. The report does not comment on the need for the management of the site and the role of reservoir undertaker to be confirmed and resolved. Significant investigation works and hydraulic modelling will be necessary to develop the recommended designs through feasibility stage and detailed design.

2 RESERVOIR DETAILS

Camlough Reservoir is located outside the village of Camlough, Co. Armagh, approximately 5km West of Newry City.

The reservoir is currently used by Northern Ireland Water as a water supply source for the Newry area with an abstraction limit of 5Ml/d. The reservoir is also used to supplement and 'top up' the flow within the Newry Canal, although abstraction volumes for this supply are not known.

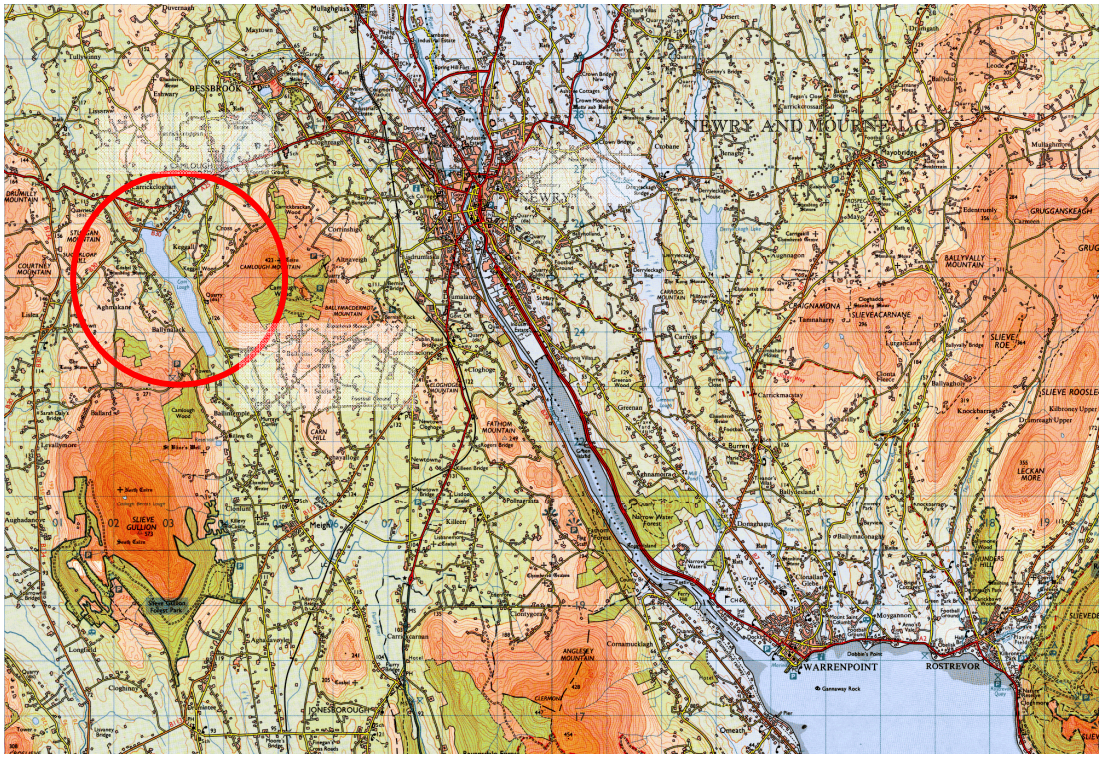


Figure 1 Location Plan

The reservoir was formed in circa. 1872 by raising the original Camlough Lake through the construction of an earthfill dam with two flanks, each of 65m in length, at the Northern end of the Lake. The reservoir has a direct catchment area of 7.73km² with an additional 5.59km² of indirect catchment contributing to the reportable useable storage capacity of 3705Ml. The surface area at top water level of 97.4mAOD is 72ha.

The earthfill dam comprises a main embankment and a return embankment each with a length of 65m. The maximum height above original ground level of the main embankment is approximately 6m. The original specification refers to the use of a puddle clay core. The upstream pitched slopes were to be at 1 vertical: 3 horizontal and the downstream grassed slopes at 1 vertical: 2 horizontal. The crest is approximately 4m wide at a level of 98.40mAOD and forms an irregular access path from the car park to the spillweir area. The road embankment, forming the B30 Newtown Road, at the North end of the reservoir separates the reservoir from the "Commons" pond which forms part of the Camlough impoundment since it is connected by road culverts.

The overflow spillweir from the impoundment is located at the Eastern end of the main embankment. The curved spillweir is 22.5m long and discharges into a channel cut through the rock forming the Eastern abutment of the main embankment. The channel quickly narrows to 3.0m before curving around the Eastern abutment and discharging into a pool at the base of the main embankment.

Access to the reservoir, the embankment crests and the toe of the return embankment is via the B30 road. There is no vehicular access to the toe of the main embankment.

The NIW Operating Manual shows that the water supply draw off arrangement was changed in 1991 with the addition of new 350mm diameter pipes connected to both the original 13" dia pipework and the 24"dia mill supply under the dam. Neither the 13" dia or the 24" dia pipes appear to have any form of upstream control, and all records show valves to be located downstream of the embankment.

The alterations carried out in 1991 reduced the scour capacity by installing a 12" dia scour valve on a tee downstream of the original valve on the 24" draw off pipe, which formed the original mill supply.

Detailed descriptions of the reservoir site, its catchment and the key reservoir features are contained within the Section 10 report.

2.1 Reservoir Usage

The reservoir is currently used by Northern Ireland Water as a water supply source for the Newry area with an abstraction limit of 5Ml/d. The reservoir is also used to supplement and 'top up' the flow within the Newry Canal, although abstraction volumes for this are not known. However, Northern Ireland Water has indicated it will be able to meet the daily demand requirements of the Newry area without the use of Camlough reservoir upon completion of trunk main works in 2015.

The reservoir is also used for a wide range of social activities including canoeing, cycling, coarse angling, day visits/general enjoyment, running, shooting, swimming, triathlon, walking and water-skiing. A number of these events are organised by Newry District Council and the local community.

2.2 Environmental Designations

The water body was designated as an Area of Special Scientific Interest (ASSI) in October 2004. It is described as a Mesotrophic lake due to the diverse aquatic plant community present and, in its unpolluted state, is among the best example of its type in Northern Ireland.

2.3 Valley Downstream of the Dam

The Camlough River valley downstream of the dam is densely populated with the towns of Camlough and Bessbrook immediately downstream, leading to the centre of Newry some 5km to the East.

The downstream consequences that would result from a failure of the dam have been identified by Rivers Agency within its Reservoir Inundation Mapping (RIM) exercise completed in 2010. The associated mapping, while not yet in the public domain, shows that a breach of Camlough dam could pose a significant threat to communities, infrastructure and property downstream.

3 SECTION 10 REPORT SUMMARY

An Inspection was carried out by Mr Alan Cooper OBE on 17th October 2013 and a Section 10 Report was produced. The inspection identified a number of serious issues that need addressed in the interests of safety.

3.1 Matters in the Interest of Safety

Paragraph 15.2 of the Section 10 report included the following recommendations as to measures to be taken in the interests of safety:

1. Responsibility for management of the reservoir should be clarified.
2. The overflow capacity including the stilling basin and outlet culvert are inadequate and all options should be investigated to determine the optimum solution.
3. The stability of the overall embankment and the effectiveness of the puddle clay core should be investigated to ensure long term safety.
4. The upstream revetment and the need for a wave wall should be assessed to ensure its effectiveness against wave action.
5. The draw off arrangements including the pipes under the dam should be investigated both in terms of normal and emergency drawdown.
6. Trees on the dam should be surveyed with the stumps removed or treated as appropriate and the revetment repaired.
7. The toe of the dam should be protected against scouring by flood flows from the spillway and the "Commons" watercourse.
8. The seepage along both mitres should be investigated and options to reduce this considered.
9. Until items 1-8 are carried out, it is recommended that the water level is maintained at least 1.5m below top water level.

In the context of the 1975 Reservoirs Act these recommendations must be actioned as soon as reasonably practicable by the reservoir undertaker.

3.2 Summary of key issues

With the exception of point 1, which is outside the scope of this report the significant issues associated with the reservoir can be summarised under the following general headings.

1. **Hydraulic risks** – The report has identified the dam as having inadequate flood discharge capacity. During the appropriate design flood event the water level within the reservoir would overtop the crest which could result in a catastrophic failure of the embankments. The report also raises concerns about erosion risk to the downstream toe of the main embankment during low return period flood events as a result of the layout of the stilling basin and the 'Commons' watercourse.
2. **Structural risks** – The Section 10 report identified concerns regarding the long term geotechnical stability of the main embankment including the uneven profile of the downstream slope and crest, the presence of significant trees and vegetation on the

embankment, significant levels of seepage along both mitres and the inadequate protection to the upstream slope from wave action.

3. **Control risks** – There are no upstream control arrangements for either the 13" dia or the 23" dia outlet pipes both of which operate under full pressure. A collapse of either pipe under the main embankment could result in a catastrophic failure of the dam.

   The scour pipework is the only means of drawing down the reservoir level for maintenance or in an emergency. The report has identified that the existing scour facility could not draw the reservoir down at an appropriate rate,

This report will assess the implications of these issues in more detail and consider options, both short term and long term to remedy them. It will present and compare options in terms of technical merit, whole life costs, environmental and social impacts.

4 ASSESSMENT OF HYDRAULIC RISKS

The Section 10 report has identified a number of issues that can be broadly grouped under the heading of hydraulic risk, and these are considered in more detail within this Section of the Report.

- Section 4.1 contains an initial assessment of the flood discharge capacity of the existing structure to quantify the risk and inform the design of works to increase the overall discharge capacity.
- Section 4.2 comments on the specific issues associated with the current arrangement of the downstream stilling basin, and
- Section 4.3 comments on the diversion of the 'Commons' watercourse,

4.1 Existing Flood Discharge Capacity

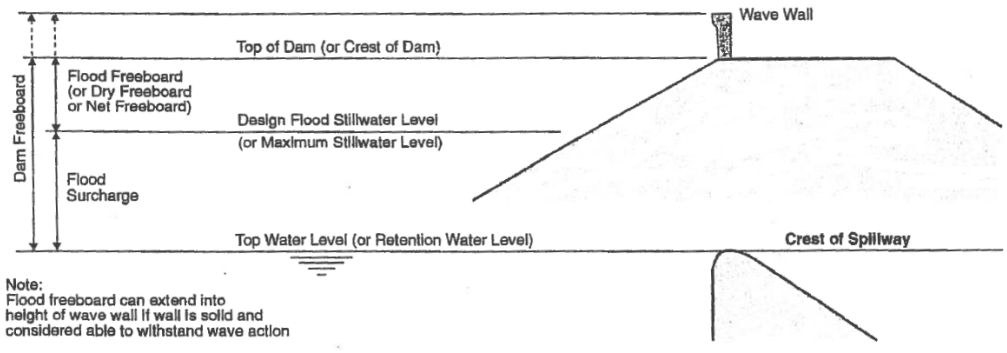
The Section 10 report has identified the dam as having inadequate freeboard for the appropriate design flood and that during the appropriate design flood event the water level within the reservoir would overtop the crest which could result in a catastrophic failure of the main embankment.

4.1.1 Flood and Wave Surcharge Assessment

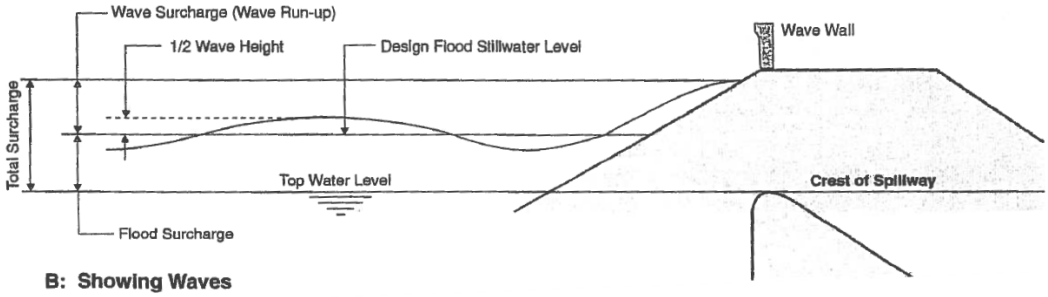
An assessment of the flood and wave surcharge is necessary to ensure that a dam has the required freeboard to pass a flood without being damaged or breached. Although earth fill dams fail for a variety of reasons, an inadequate spillway capacity leading to overtopping and erosion of the fill in the embankments is one of the more likely modes of failure.

The dam freeboard is the height from the top water level to the lowest part of the crest of the dam or solid wave wall and is influenced by the hydraulic capacity of the spillway and the effect of waves and run-up. Dam freeboard, and the influence of waves on freeboard are illustrated in Figure 2 below which can be found within the "Floods and Reservoirs Safety, An Engineering Guide 3rd edition" (FRS), published by the Institution of Civil Engineers.

Figure 2: Example of Dam Freeboard (Generic)



A: Showing Freeboard



B: Showing Waves

The assessment of appropriate overflow capacity is generally carried out using the FRS to:

> "*assist those individuals who bear the personal responsibility that comes from being appointed to the statutory panel of engineers qualified to design and also to inspect reservoirs.*"

The guide categorises dams in terms of potential hazard to life and property downstream.

4.1.2 *Floods and Reservoir Safety - Classification*

As discussed in Section 2.3, a breach of Camlough dam could pose a significant threat to the communities downstream. Consequently, the likely loss of life arising from a breach at either the main or return embankments justifies placing the reservoir in Category A, as defined in the FRS. Category A applies "where a breach could endanger lives in a community".

For a Category A Reservoir, the general reservoir design flood inflow is the Probable Maximum Flood (PMF) with a wave surcharge allowance of not less than 0.6m. If overtopping of the dam crest is tolerable, which is dependent on the profile and surface protection of the revetment of the dam, the less severe 10,000 year flood inflow would apply to the spillweir with the same minimum wave surcharge allowance; the remaining PMF being allowed to overtop the dam.

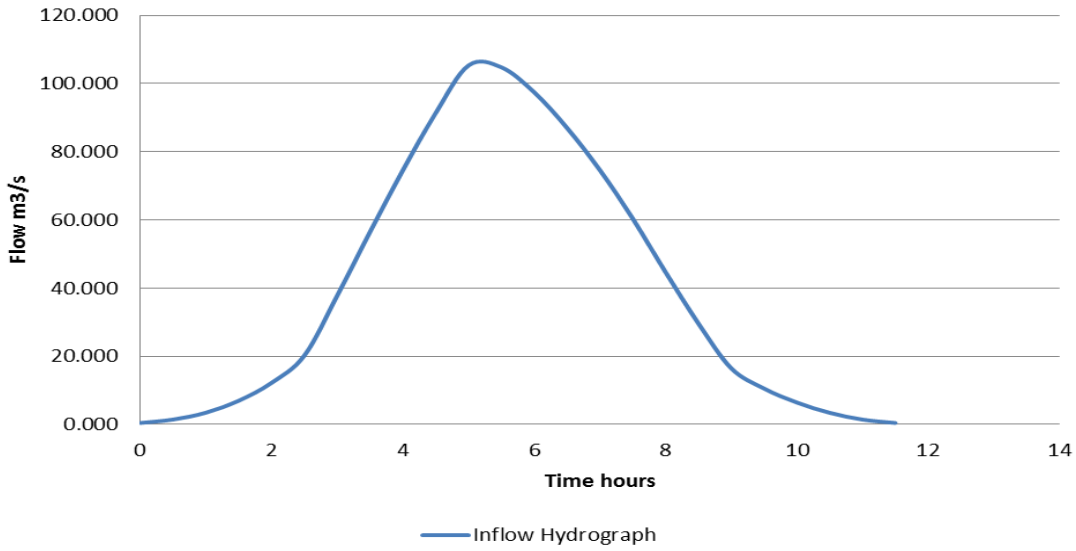
The earth fill embankments at Camlough are not currently protected against overtopping and therefore it should be assumed that overtopping at present could not be tolerated. For the existing condition the full PMF design flow for the spillweir should therefore apply at this location.

4.1.3 *Assessment of the design flood*

The Section 10 Report has demonstrated that the PMF design flood inflow, assessed using the Hydrograph method from the 1975 Flood Studies Report (FSR), has a peak inflow of 105m³/s, refer to Figure 3 for the associated hydrograph.

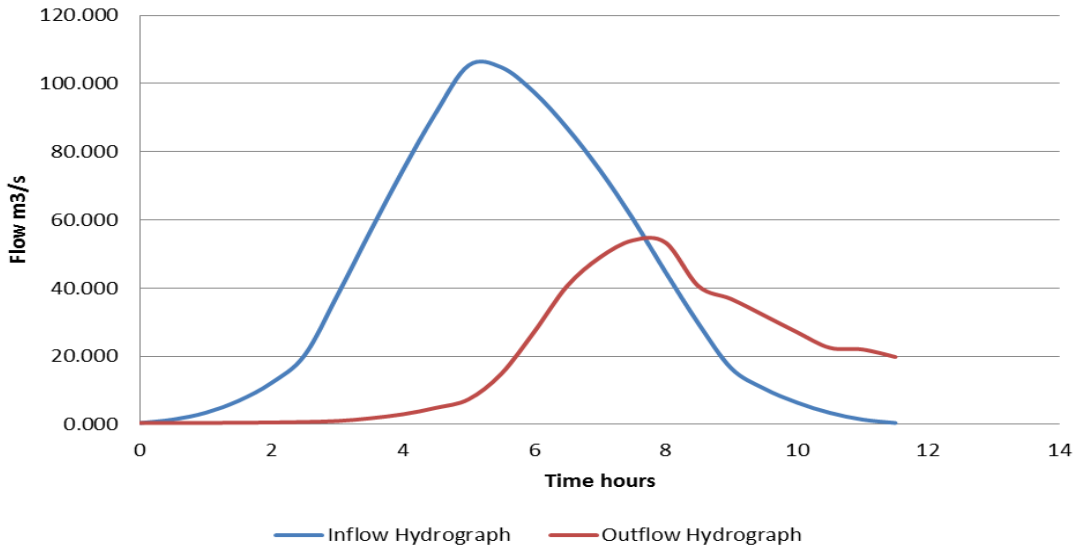
In general, all impounding reservoirs have an attenuation effect on the design inflow hydrograph. This effect reduces the peak flood outflow and creates a lag effect on the time of the peak. The magnitude of this attenuation effect is a function of the reservoir storage characteristics and surface area relative to its catchment area and the overflow weir discharge properties.

Figure 3: Inflow Hydrograph



The Section 10 report also assessed the attenuation effect on the design inflow hydrograph which reduces the peak flood flow and creates a lag effect on the time of the peak. The reservoir routing exercise quantified this attenuation effect and the associated spillway discharge hydrograph for the design inflow reducing the peak inflow from 105m^3/s to an outflow of 52m^3/s. Such a large effect is predominately due to the large surface area of the reservoir, which creates a large flood storage volume. The inflow and outflow hydrographs for the existing spillweir arrangement are shown in Figure 4.

Figure 4: Inflow and Outflow Hydrographs



4.1.4 ***Wave surcharge assessment***

An assessment of the wave surcharge is necessary to ensure that there is sufficient freeboard to prevent overtopping. Factors which have an impact on the wave surcharge include fetch, wind direction, design wind speed and wave run-up. The estimated wave surcharge at Camlough is 0.4m. However the floods and reservoir safety handbook recommends that a minimum wave surcharge of 0.6m must be applied to a Category A reservoirs and must therefore be applied in this case.

4.1.5 ***Freeboard assessment***

An assessment of the freeboard highlights that the existing 22.5m long spillweir and the 3m wide spillway channel, cannot discharge the PMF flow without overtopping the crest of the dam. Camlough Reservoir therefore does not comply with the requirements of the FRS guidelines and cannot safely pass the design flood through the reservoir without risk of damage to the dam.

4.1.6 ***Summary***

The design outflow is 52m^3/s but the existing spillweir/spillway arrangement can only discharge around 10m^3/s without overtopping the crest. Therefore overtopping will occur on a structure not capable of sustaining overtopping flows. Accordingly, based on the dam categorisation of 'Category A', the existing spillweir is insufficient in discharging the design flow. Additional spilling capacity is therefore required in order to meet the current recommended safety standards.

If no remedial action is undertaken then an accidental, uncontrolled escape of water from the dam would present a risk to both life and property downstream. Works to increase the flood freeboard capacity must therefore be undertaken as part of any future scheme which maintains the current level of storage and design inflow.

4.2 Assessment of Downstream Stilling basin

The Section 10 report has identified that the existing stilling basin does not have adequate discharge capacity. In its present arrangement it is likely to flood the toe of the embankment during modest return period floods. Such flooding could increase the risk of slippage of the embankment and also prevents access to the current scour valve arrangement.

Any options to rehabilitate the structure should incorporate works to improve the hydraulic efficiency of the stilling basin and protect the downstream embankment toe from erosion.

4.3 Assessment of 'Commons' Watercourse

The existing watercourse which acts as a discharge from the 'Commons' pond currently passes very close to the embankment and its Western mitre in an open channel before discharging into the existing stilling basin.

As discussed in Section 4.2 the existing stilling basin cannot adequately pass the design flood downstream without flooding the toe of the main embankment. The interface with the 'Commons' watercourse worsens this situation and it is suggested that any option to rehabilitate the structure should separate the 'Commons' flows from those from the spillway. This would be best achieved with the culverting and diversion of the existing watercourse from the point where it emerges from within a 1500mm diameter culvert below the B30 Newtown Road to a point approximately 50m downstream of the main embankment.

5 ASSESSMENT OF STRUCTURAL RISKS

The Section 10 report has identified concerns regarding the long term structural / geotechnical stability of the main embankment. Features identified during the inspection included;

1. The uneven profile of the downstream slope and crest
2. Significant levels of seepage along both mitres

While a detailed assessment of the causes and significance of these features cannot be determined without a detailed site investigation, it is evident that significant works are necessary to protect the long term stability of the embankment structure.

5.1 Profile of Downstream Slope and Crest

The uneven profile visible along the downstream slope and crest suggests that the embankment may have been subject to historic movement and settlement. Such movement may have been caused by a wide number of factors including:

- Changes in the phreatic surface, as a result of a failure in the core material which could lead to stability issues in the downstream embankment
- Internal erosion and subsequent removal of material from the embankment structure
- Inappropriate maintenance which could have damaged or overloaded the structure
- Poor construction and compaction resulting in long term settlement
- Inappropriate design factors of safety to the embankment slope

Limited existing site investigation information is available and information from boreholes completed in 1971 indicates that the core material included patches of decayed wood fragments, sand and peat in the fill material. The underlying embankment seat comprised 2.7m of boulder clay overlying bed rock.

The information currently available is inadequate for advancing detailed design and it is therefore recommended that comprehensive site investigation works are carried out prior to any detailed design work.

However, for the development of options any refurbishment works at the site should assume, as a minimum, that the crest is made to an even profile and the downstream slopes be regraded, to a minimum gradient of 1 vertical:3 horizontal to improve stability. New toe drainage should also be installed and a mechanism for collecting and measuring the toe drainage flows provided.

5.2 Significant levels of seepage along both mitres

The Section 10 Report has noted that there are significant levels of seepage along both mitres. On subsequent inspections the seepage was particularly evident on the Eastern mitre and there was a noticeable softening of the surrounding topsoil.

The seepage could be as a result of a failure of the interface seal between the dam core material and the underlying foundation. If the seepage is not controlled it could increase the risk of internal erosion within the embankment. As with the settlement issues, this requires specific investigation as part of a comprehensive site investigation contract.

With the development of refurbishment options it should be assumed that the works to achieve the following will be necessary:

- works to improve the seal between the core and foundation material
- works to reduce the risk of internal erosion failure
- works to collect and measure seepage flows

6 ASSESSMENT OF CONTROL RISKS

In many cases the only immediate action that a dam engineer can take during an emergency situation, where the stability or structure of the dam is at risk, is to open the scour facility to draw the reservoir level down and reduce the pressure on the embankments. However, at Camlough the existing drawoff arrangements are totally inadequate both because there is insufficient capacity and a lack of upstream control.

The lack of upstream control results in having unguarded pressurised 24" diameter and 13" diameter cast iron mains, which are 140 years old, under the earth embankment. The only available control currently at the site is located immediately downstream of the main embankment in an area that is inundated and inaccessible during modest flood events (see Section 4.2). This could result in a situation where the scour valves cannot be opened during an emergency.

In addition the appropriate rate of drawdown is to achieve a water level reduction of 0.4m per day with the reservoir at top water level. The current scour pipe, assuming it is clear and the valve can be opened, would allow the reservoir to be drawn down at a rate of 0.06m per day with the reservoir at top water level. It will therefore be necessary to provide additional scour capacity to guarantee that at least the top 2m of storage can be drawn down quickly, as this would reduce the impoundment capacity by approximately 50% and would reduce pressure on the dam foundations by approximately 75%.

Therefore any proposed options to rehabilitate the structure should as a minimum include provision for upstream control of the scour pipework and the inspection and replacement if necessary of the existing scour pipework through the dam. They should also include the provision of a supplementary scour facility to satisfactorily augment the rate of drawdown.

7 HIGH LEVEL OPTION APPRAISAL

When the deficiencies which are outlined within Sections 3 - 6 are considered alongside the downstream consequences identified by Rivers Agency within its 2010 Reservoir Inundation Mapping (RIM) exercise, Camlough Dam currently poses a significant risk to life, infrastructure and property. The 'do nothing' option therefore does not exist.

Works should be carried out to reduce these risks and a number of high level options have been considered in broad terms looking at reconstructing the dam, rehabilitating it or abandoning it.

7.1 Reconstruction

Given the spectrum and severity of the issues identified within the Section 10 report, Camlough Dam could be considered as a candidate for full demolition and reconstruction. Such a scheme would allow all the issues identified within the Section 10 Report to be fully resolved and the dam reconstructed to modern standards using modern safe construction techniques.

The costs, environmental impacts and planning issues associated with such works are unlikely to make such an option viable for the current storage level. However, it may be an alternative to reconstruct the dam at a lower level to reduce the associated costs and long term risk of the impoundment on the downstream infrastructure. Such an option could have similar social and environmental issues identified within the assessment of the abandonment option discussed below. Accordingly this option would only be considered in detail following direction from NIEA, Planning Service and Newry and Mourne District Council on an appropriate lowered top water level.

Such an assessment is outside the scope of this report and has not been taken forward to the detailed consideration stage.

7.2 Rehabilitation

As set out in the recommendations of the Section 10 Report significant refurbishment of the structure will be required to reduce the risks associated with the dam to acceptable limits.

These works include stabilising the embankment; providing adequate spillweir/spillway capacity; satisfy freeboard requirements; provide an adequate cut-off; protect the toe and provide suitable scour capacity. This option has the advantage of largely retaining the existing lake conditions, minimising environmental, flooding and planning issues and is therefore discussed in more detail in Section 9 of the report, as Option 1.

7.3 Abandonment

While Camlough reservoir is currently used by Northern Ireland Water as a water supply source for the Newry area, Northern Ireland Water has indicated that it will be able to meet the daily demand requirements without the use of Camlough reservoir by July 2015. Assuming that abstraction from the reservoir will cease following commissioning of this trunk main, the source would become a candidate for abandonment.

Abandonment of a reservoir is defined within the 1975 Reservoir Act as:

> *"Where the use of a large raised reservoir as a reservoir is to be abandoned, the undertakers shall obtain from a qualified civil engineer a report as to the measures (if any) that ought to be taken in the interests of safety to secure that the reservoir is*

incapable of filling accidentally or naturally with water above the natural level of any part of the land adjoining the reservoir or is only capable of doing so to an extent that does not constitute a risk."

Abandoning Camlough reservoir would remove the need for any operational and maintenance costs associated with the reservoir and the removal of the risk to downstream infrastructure. However, any reduction in maintenance costs needs to be offset against the capital costs of abandonment and the impact on the environment, downstream flooding and social amenity associated with the removal of the dam structure.

In order to fully assess the implications of abandonment a detailed abandonment report has been produced separately and Section 9 of this report summarises the main issues identified within the abandonment report along with associated costs, as Option 2.

8 OPTION 1 - RESERVOIR REHABILITATION

The refurbishment of the existing structure will need to address all the hydraulic, geotechnical and scour issues identified within the Section 10 Report. The works will involve three main elements:

A. Increase the reservoir discharge capacity and freeboard

B. Address all the structural issues associated with the main embankment

C. Provide a suitable means of controlling the reservoir for operation and maintenance or in an emergency

8.1 Element A – Improvements to discharge capacity

The existing crest level at Camlough is currently only one metre above the spillweir level. With the minimum wave surcharge provision of 0.6m for a Category A dam, this leaves only 0.4m for the allowable flood lift. The initial analysis has shown that on this basis the existing spillway arrangement is only capable of discharging around 10m^3/s which represents approximately 20% of the routed design Probable Maximum Flood (PMF).

8.1.1 Consideration of Options

As the discharge capacity and dam freeboard are directly dependant on each other there are several of options available to increase the existing discharge capacity. A selection of the main options is discussed below:

Option A1 – Provision of a secondary spillweir

A secondary spillway could be constructed to supplement the existing spillway arrangement. However, if the discharge head over the spillweir remains constrained to the available flood lift then the dam would require the addition of a 90m long spillweir at the same level as the existing spillweir which would occupy most of the length of the embankments.

The works involved in the creation of such a length of new spillweir on an existing embankment with known geotechnical issues are likely to constitute the reconstruction of the full dam. As a result this is unlikely to be a cost effective or technically viable solution.

Option A2 – Widening the existing spillweir and spillway channel

Widening the existing spillweir and channel would increase the flow that can pass downstream within the available flood lift allowance.

However, initial modelling has shown that the spillweir would have to be extended over 90m into solid rock on the Eastern abutment to discharge the PMF, using only the available 0.4m head. The costs associated with this approach are likely to be prohibitive and the option would be complicated by the associated lands issues. It is therefore apparent that such an option is only viable when combined with measures to increase the available freeboard.

Option A3 – Raising the dam crest combined with widening the existing spillweir and spillway channel

As discussed above, trying to maintain the existing freeboard constraint has a significant influence on the development of a revised spillway arrangement that can safely pass the PMF design flood. Consideration must be given to the implications of releasing this constraint and

allowing an increased flood lift value combined with some increase to the spillweir/spillway capacity – i.e. providing a wider weir and allowing a greater head for discharge over it.

There are several combinations of weir width and increased head which will achieve the desired result but our preliminary analysis has shown that the balanced solution to remedy the existing deficiency in the spillway capacity is to raise the dam crest by 0.3m and to provide a wave wall on the crest to protect against the design wave run up. The increase in hydraulic head on the existing spillweir will enable it to safely discharge the Probable Maximum Flood after attenuation and to satisfy the current safety standards for a reservoir with this level of consequence.

In order to ensure that the spillweir does not become "drowned out" by a restriction in the outlet channel, the capacity of the spillway channel should be increased along the 30m length downstream of the spillweir. This could be achieved by deepening the collection basin downstream of the spillweir and marginally widening and lowering the invert of the channel. The collection basin would be lowered to a level of 95.40m AoD and the average lowering of the 30m length of spillway channel would be approximately 1.6m. The channel would have a minimum width of approximately 4m.

Preliminary hydraulic analysis of the preferred option, based on a basic site survey, suggests that the proposed spillway arrangement can safely discharge the attenuated PMF flow within the revised freeboard allowance. However, detailed hydraulic analysis must be carried out in order to finalise the detailed design.

The excavated rock from the spillway area could all be recycled through use in the revetment and other areas of the structure.

This solution makes full use of the existing substantial spillweir which would be reprofiled at its current level and would provide a non-erodible outlet in solid rock. The modest raising of the crest is consistent with other structural improvements of the embankment slopes. The wave wall will also provide a safety feature along the water edge of the crest.

Option A4 - Creation of overtoppable embankments

As an alternative to Option A3, it may be technically feasible to modify the existing crest and downstream slopes of the dam to protect them from overtopping. Where overtopping of an embankment dam structure is tolerable the minimum design flood inflow can, in accordance with the guidance within the Floods and Reservoir Safety Handbook, be reduced to the 10,000-year flood, approximately half the PMF.

This would still require modification to the existing spillway to ensure it can discharge the 10,000-year flood, with the remainder of the PMF being retained before overtopping the embankments. To discharge the 10,000-year flood with 600mm freeboard, would require the existing spillweir and spillway channel to be extended by 40m into the eastern abutment. The crests and downstream slopes of both embankments would require to be protected against erosion from overtopping flows by providing a robust mattress which would be resistant to extreme flood conditions.

While such an option may be technically feasible, the costs associated with the spillweir and spillway extension into the abutment rock are likely to be high and pose similar land issues outlined in Option A2. There would also be more significant maintenance issues associated with an overtoppable embankment which would increase the whole life cost of the solution.

8.1.2 Assessment of options to improve discharge capacity

Of the solutions discussed above only Option A3 appears to be viable both technically and economically. Option A3 is therefore proposed as the preferred option to provide the appropriate flood discharge.

Although outside the normal scope of reservoir safety reports by Panel Engineers, it should also be noted that a wave wall, as included within Option A3, would provide an additional safety feature considering that the public have such easy access.

8.2 Element B – Improvements to embankment structure

8.2.1 Core and downstream slope improvements

The inspection of the dam revealed that the puddle clay core in the embankment was defective, since seepage was clearly evident in several areas, particularly at the mitres of the main embankment. Study of BH B368, which was driven through the crest of the dam at the junction of the two embankments, showed the nature of the puddle clay core. The borehole log from the drilling, carried out in 1971, indicated that the core material included patches of decayed wood fragments, sand and peat in the fill material. The underlying embankment seat comprised 2.7m of boulder clay overlying bed rock, which is satisfactory as a foundation.

Due to the observed seepage, it is recommended that the core forming the central water barrier in the embankment fill should be improved to reduce seepage to acceptable levels.

In this particular instance, the most economical and appropriate form of improvement necessary to secure stability and control against excessive seepage, is the installation of interlocking steel sheet piles. These would be driven through the existing puddle clay core and through the underlying boulder clay down to rock level. The new core would be connected to the reconstructed crest arrangement to provide a continuous barrier.

The downstream grassed slope should be reduced to a gradient of 1 vertical : 3 horizontal to improve stability and facilitate maintenance. In order to ensure stability against any remaining seepage through the improved core, or at the interface with bed rock, the slope should incorporate graded filter layers.

The assessment of the necessary core and embankment improvements will require a detailed site investigation.

8.2.2 Revetment improvements

The existing revetment is comprised of open jointed masonry pitching, which is extensively damaged in some areas by tree roots and erosion. During the removal of all tree roots, there will be further unavoidable damage to the revetment area. It requires to be upgraded by the replacement of suitably sized masonry blocks on a gravel bed in all defective areas.

8.3 Element C – Improvements to Scour and Drawoff facilities

As discussed in Section 6 the existing scour and drawoff arrangements at the site are totally unacceptable. It is proposed that the rehabilitation of the scour and drawoff facilities should include a new reinforced concrete drawoff tower, complete with valves and pipework, located at the upstream toe of the main embankment and connected to the crest by a pedestrian access bridge.

The new valve and pipework arrangement will depend on the intended future use of the reservoir for water supply, and any proposal to refurbish the pipework would use only the

existing 24" diameter pipe, which should be surveyed by CCTV and if necessary strengthened by appropriate relining. If the condition of this pipework is very poor it may need to be replaced and this could result in significant additional costs. In addition the capacity of this pipe is deficient when compared to acceptable drawdown requirements and the need to supplement this is covered in Section 8.3.1.

The drawoff tower would be constructed within a steel sheet pile cofferdam and be provided with drawoff valves at two levels and a bottom scour valve.

The 13" diameter supply main should be cleared of deposits and pumped full with foam concrete to abandon it and reduce the risk of a future collapse of the pipework.

8.3.1 Supplementary drawdown facility

In the event of the need to draw the reservoir level down in an emergency, the existing 24" dia pipe under the embankment cannot provide the necessary capacity. It will therefore need to be augmented to achieve a lowering rate of 0.4m per day from top water level, assuming no inflow.

To install an additional lower level outlet under or through the embankment present significant risks in having to excavate approximately 7m down in the embankment and would be technically extremely difficult and expensive.

The provision of a siphon arrangement to achieve lowering of the top few metres of storage would involve a pipe on the upstream face, over the crest and down to the downstream face to a control valve at the toe. It would also require a priming facility on the crest.

As well as being vulnerable to vandalism, it would be expensive, require maintenance and its operation in an emergency could be difficult.

A further alternative option would be to provide a facility in the spillway to lower the water level more quickly by 2m to 95.40m AoD. This would involve cutting openings in the rock forming the spillweir and installing twin sluices with 700 x 700mm clear openings.

A rapid draw down of the top 2m of storage to 95.40m AoD would reduce the impoundment capacity by approximately 50% and would reduce the pressure on the dam foundations by approximately 75%.

8.4 Spillway outlet and the 'Commons' outlet Works

As discussed in Section 4.2 the existing stilling basin does not have adequate discharge capacity. In its present arrangement it is likely to flood the toe of the embankment during modest return period floods and the interface with the 'Commons' watercourse worsens this situation.

It is therefore proposed to divert the open channel section of watercourse from where it issues below the B30 Newtown Road to a point approximately 50m downstream of the main embankment. The diversion should be via a 1500mm diameter culvert, or box section wijch will have to pass beneath the existing access road.

8.5 Site clearance

In addition to the items listed above the rehabilitation option would also have to include significant site preparation for the major construction items. All trees and vegetation should be removed from the site.

8.6 Control of water levels during construction

Due to the scale of work associated with the core, eduction tower, outlet mains and revetment and the need for some specific elements of this work to be carried out within a cofferdam, it would be preferable for the reservoir to be emptied during the contract.

Consequently the works would be best carried out with the reservoir out of service in terms of water supply. Following this course of action would also prove the most cost efficient solution. However the acceptability of this would have to be discussed with all appropriate stakeholders.

During the construction of the drawoff works, flow diversion of the incoming flows by a mechanism to the downstream side of the dam would be necessary and this is likely to be best achieved by pumping as necessary, possibly to the 'Commons' outlet culvert.

8.7 Summary

The preferred option to rehabilitate the existing dam structure therefore includes:

- widening and deepening of the existing spillway channel by on average 0.7m and 1.6m respectively
- diversion of the 'Commons' watercourse
- replacement of downstream road access bridge and measuring weir
- raising of the dam crest by 300mm
- provision of a wave wall along the dam crest
- sheet piling of the embankment core
- stabilising and protecting the downstream slope
- provision of protection to the downstream toe of the embankment
- reinstatement of the upstream revetments
- construction of a drawoff tower and associated footbridge
- lining the existing scour pipework
- provision of a rapid drawdown facility within the spillweir structure

Drawings of the proposals are included within Appendix A.

8.8 Cost estimates

The capital costs associated with this option are detailed within Table 1 below.

Table 1 – Option 1 Capital Cost Assessment

Item	Quantity
Widening and deepening of the existing spillway channel	150,000
Provision of a rapid drawdown facility within spillweir structure	10,000
Diversion of the 'Commons' watercourse	130,000
Replacement of downstream road access bridge / weir	50,000
Raising of the dam crest by 300mm	20,000
Provision of a wave wall along the dam crest	50,000
Sheet piling of the embankment core	300,000
Stabilising and protecting the downstream slope	60,000
Reinstatement of upstream revetment	10,000
Provision of protection to the downstream toe of the embankment	30,000
Construction of a drawoff tower and associated footbridge	120,000
Lining the existing scour pipework	20,000
Temporary works	300,000
Allowance for preliminaries and general items	230,000
Sub total	**1,480,000**
Allowance for design development risk @ ≈ 20%	300,000
Allowance for construction stage risk @ ≈ 20%	300,000
Total estimated construction budget	**£2,080,000**
Professional fees and Surveys	
Design Fees	150.000
Site Investigation Woks	80,000
Procurement and Contract Management	100,000
Site Supervision (assuming 18 month contract)	100,000
Sub Total	**430,000**
Grand Total	**2,510,000**

8.9 Whole life cost assessment

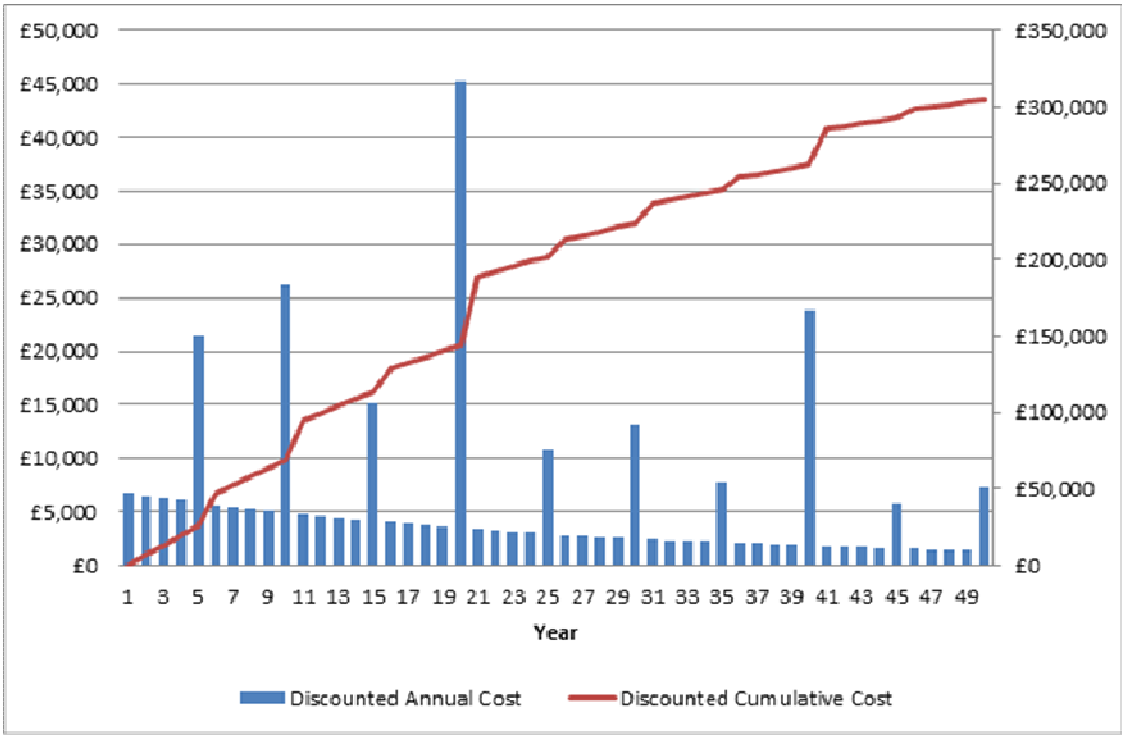
To determine the whole life costs of the option the on-going maintenance and refurbishment costs associated with the refurbished structure have been considered. The general maintenance activities, frequency of interventions and estimated costs are included within Table 2.

Table 2 – Option 1 Maintenance Schedule

Item		Cost	Frequency
Safety Reports	Safety Reports – Site Inspections	£2,000	1
	Safety Reports – Section 10	£3,500	10
	Safety Reports – Section 12	£1,500	1
Landscaping	Landscaping – General	£1,000	1
	Landscaping – Spillway maintenance	£1,000	5
Dam	Dam – Wavewall	£4,000	20
	Dam – Crest Road Maintenace	£6,000	20
	Dam – Revetment	£500	1
Pipework	Pipework – Testing	£500	1
	Pipework – Refurbishment	£2,000	10
	Pipework - Valve Replacements	£20,000	20
Valve Tower	Valve Tower – General	£1,000	1
	Valve Tower – Steel work	£5,000	5
	Valve Tower – Roof	£6,000	10
Footbridge	Footbridge – Maintenance	£5,000	5
	Footbridge – Replacement	£20,000	20
Toe Drain	Toe drain – Maintenance	£500	1
	Toe drain – Refurbishment	£3,000	20
Downstream	Downstream – Stilling Basin	£5,000	5
	Downstream Watercourse	£2,500	5

Based on this assessment, whole life costs have been estimated for the preferred option. Whole life costs have been discounted in accordance with the rates within the July 2011 edition of the Green Book: Appraisal and Evaluation in Central Government, as published by HM Treasury. A rate of 3.5% applied for the first 30 years and a rate of 3% applied between years 31-50. The profile of the discounted operation and maintenance costs and the cumulative discount total are shown in Figure 5. The whole life costs of this option are therefore estimated as £2,821,802.

Figure 5 – Annual Operation and Maintenance Discounted Cost profile



9 OPTION 2 - RESERVOIR ABANDONMENT

Abandoning Camlough reservoir would remove the need for and costs associated with maintaining the reservoir and remove the risk that any storage of water above natural ground can pose to downstream communities and infrastructure. However, as already stated, any reduction in maintenance costs needs to be offset against the capital costs of abandonment and the impact on the environment, change in risk to downstream flooding and the possible loss of social amenity associated with the removal of the dam structure.

9.1 Method of abandonment

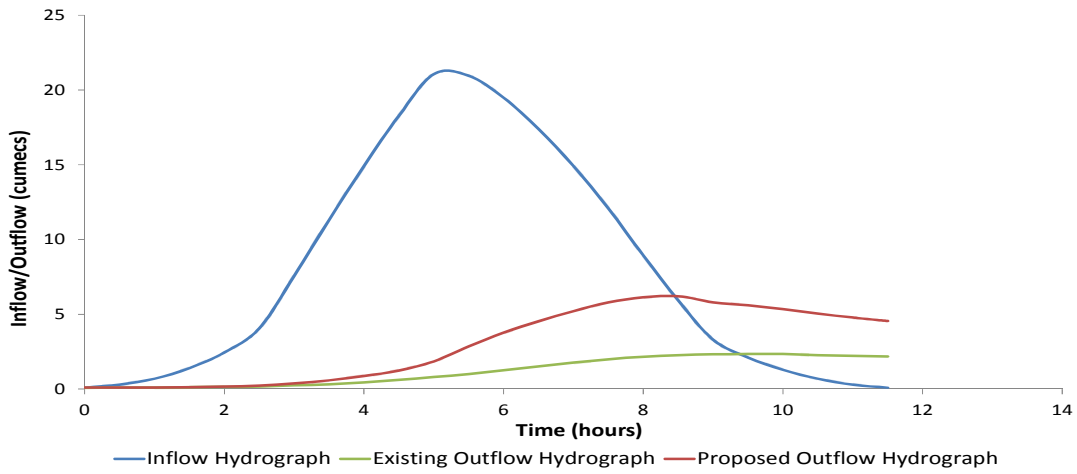
The method of abandonment is discussed in more detail in the separate January 2014 Abandonment Report. In summary, abandonment cannot commence until the water level in the lake is lowered using the existing scour and drawoff facilities. A notch would then be excavated in the main embankment down to river bed level. The existing drawoff, structures, valves and pipelines should then be removed, and the lake would no longer be considered as a large raised reservoir in the context of the 1975 Reservoirs Act..

Abandoning the reservoir would result in a reduction in top water level of 4.5m from 97.4mAOD to 92.9mAOD. The associated reduction in surface area would be 42%, a reduction from its current surface area at top water level of 72ha to 42ha,

The effect of reservoir abandonment needs to be considered in conjunction with the environmental, hydraulic and social impact.

9.2 Hydraulic impact

The abandonment report includes a detailed assessment of the hydraulic impact of abandoning the reservoir in relation to downstream flood risk. It demonstrates that following removal of the impoundment, the Q150 outflow from the lake will be 6.2m³/s. (based on flow being discharged through a trapezoidal channel, 5.0m wide at the base and with 2H: 1V side slopes following abandonment). This is a 265% increase in the current Q150 outflow of 2.3³/s. Figure 6 below shows the Q150 inflow hydrograph for the reservoir, the Q150 outflow hydrograph for the current condition and the Q150 hydrograph for the new outlet channel.



9.3 Environmental impact

Camlough Lake was designated as an Area of Special Scientific Interest (ASSI) in October 2004. The Abandonment Report concludes that a permanent reduction in the top water level will undoubtedly impact on the ASSI. However, it is difficult to assess whether the long term impact on the aquatic flora will be positive or negative and as a result the Abandonment Report recommends that a detailed survey should be undertaken by a qualified botanist. The report also notes that ASSI assent will be required to do any of the works and that an EIA may be required as part of the associated planning process.

9.4 Social impact

The lake is currently widely used as a local amenity for activities ranging from canoeing to water-skiing. Even following abandonment, the lake, which will be restored to its natural level and size, will still cover a considerable area of 42ha. It is therefore likely that many, if not all, activities currently supported by the lake will still be able to continue. However, changes to infrastructure surrounding the lake will be required, for example relocating jetties, to ensure it is still accessible to the public.

The lake is also used by Newry and Mourne District Council to top up water levels in the Newry Canal during dry periods. This impact is considered in further detail in the Abandonment Report.

9.5 Cost estimates

The estimated cost for abandoning the reservoir is £420,000. A detailed breakdown of costs is shown in Table 3.

Table 3 – Abandonment Capital Costs Estimates

Item	Quantity	Units	Rate (£)	Total (£)
Construction				
Excavation and disposal of embankment	1,750	m^3	20.00	35,000.00
Removal of pipelines	220	m	22.50	5,000.00
Removal of valves, valve tower and access		Sum	15,000.00	15,000.00
Landscaping and river channel training		Sum	10,000.00	10,000.00
Allowance for environmental works to			(assume)	100,000.00
Allowance for provision of access points and			(assume)	100,000.00
Downstream infrastructure improvements			*Undefined*	*at this stage*
		Construction Preliminaries		20,000.00
			Sub-Total	**285,000.00**
Professional fees and Surveys				
Planning		Sum	5,000.00	5,000.00
EIA		Sum	50,000.00	50,000.00
ASSI Assent		Sum	15,000.00	15,000.00
Public Consultation		Sum	15,000.00	15,000.00
Design		Sum	50,000.00	50,000.00
			Sub-Total	**135,000.00**
			Estimated Total Cost	**420,000.00**

These costs excludes the upgrade works that may be required to infrastructure downstream all of which require detailed assessment.

9.6 Whole life cost assessment

By its nature abandonment of the reservoir will result in no long term or annual maintenance costs and the net present value of the overall works is £420,000

10 RECOMMENDATION

10.1 Recommended Option

As discussed within Sections 7, 8 and 9 there are two main options that have been identified and reviewed in detail. These options, Rehabilitation and Abandonment, sit at opposite extremes in terms of cost and the approach to maintaining Camlough Dam as a long term asset.

The option to abandon the reservoir has the lowest capital value and a number of advantages in that it permanently removes the risk associated with the structure from the downstream infrastructure and population, and negates future maintenance costs.

However the Abandonment Option has a number of intangible detriments due to its impact on the environment and the loss of the reservoir as an asset for the local community. It also has a real financial detriment in terms of the flood attenuation protection the dam and reservoir currently offers to properties and infrastructure downstream and the costs associated with upgrading this protection. However, quantifying these costs is outside the scope of this report.

The abandonment process is likely to involve a number of environmental studies, a planning application and Environmental Impact Statement. Only when the scheme is granted full Planning Permission can the abandonment option be confirmed as deliverable.

While the Rehabilitation Option involves more capital expenditure and on-going maintenance costs it has a number of intangible benefits, for the local community, Newry and Mourne District Council, and the environment. As discussed above it also has a financial benefit in terms of the flood attenuation protection the dam and reservoir offers to properties and infrastructure downstream.

The Rehabilitation Option does not require planning permission although an ASSI assent would be required alongside environmental assessments and a scour management plan to facilitate the short term draining of reservoir to carry out the works. These issues are not insurmountable and the rehabilitation option is deliverable. It is therefore recommended that the Rehabilitation Option, as set out within Section 8 of this report, is progressed through to detailed design stage.

10.2 Short term measures

The preceding sections have identified the preferred option to bring the structure up to current and acceptable safety standards. However it is recognised that significant discussions must take place amongst stakeholders to agree the appropriate way forward and there are also necessary timescales to complete investigations, detailed design, procurement and construction. It is therefore recommended that the recommendations in paragraph 15 of the Section 10 Report be implemented. In particular:

- Maintaining the water level at least 1.5m below top water level as recommended within the Section 10 report. Additionally a water level gauge should be installed and water levels recorded on a weekly basis.
- Site Investigation works should be carried out to inform the geotechnical design of the embankment stability improvements.
- The remaining trees and vegetation on the embankment should be removed down to stump level to reduce the risk of windfall damage to the embankment or crest.

- A maintenance programme should be implemented to prevent the regrowth of vegetation and maintain growths at a maximum height of 150mm.
- Perforated drainage should be installed within appropriately designed filter stone to drain the seepage from the dam mitres, and that flows from this drainage are recorded on an agreed regular basis.

In addition to the above the dam should be monitored regularly and any unusual observations, which may require an early inspection, should be reported immediately to the Inspecting Engineer, including but not limited to:

- signs of movement in the embankment or crest
- evidence of scouring at the embankment toe
- An increase in the seepage recorded at the mitres
- Any evidence of overtopping
- An inability to maintain the water level 1.5m below top water level
- The identification of additional damp areas on the downstream slope, toe or area immediately downstream of the dam.

Excluding the site investigation contract it is envisaged that these short term measures would cost no more than £15,000 to implement.

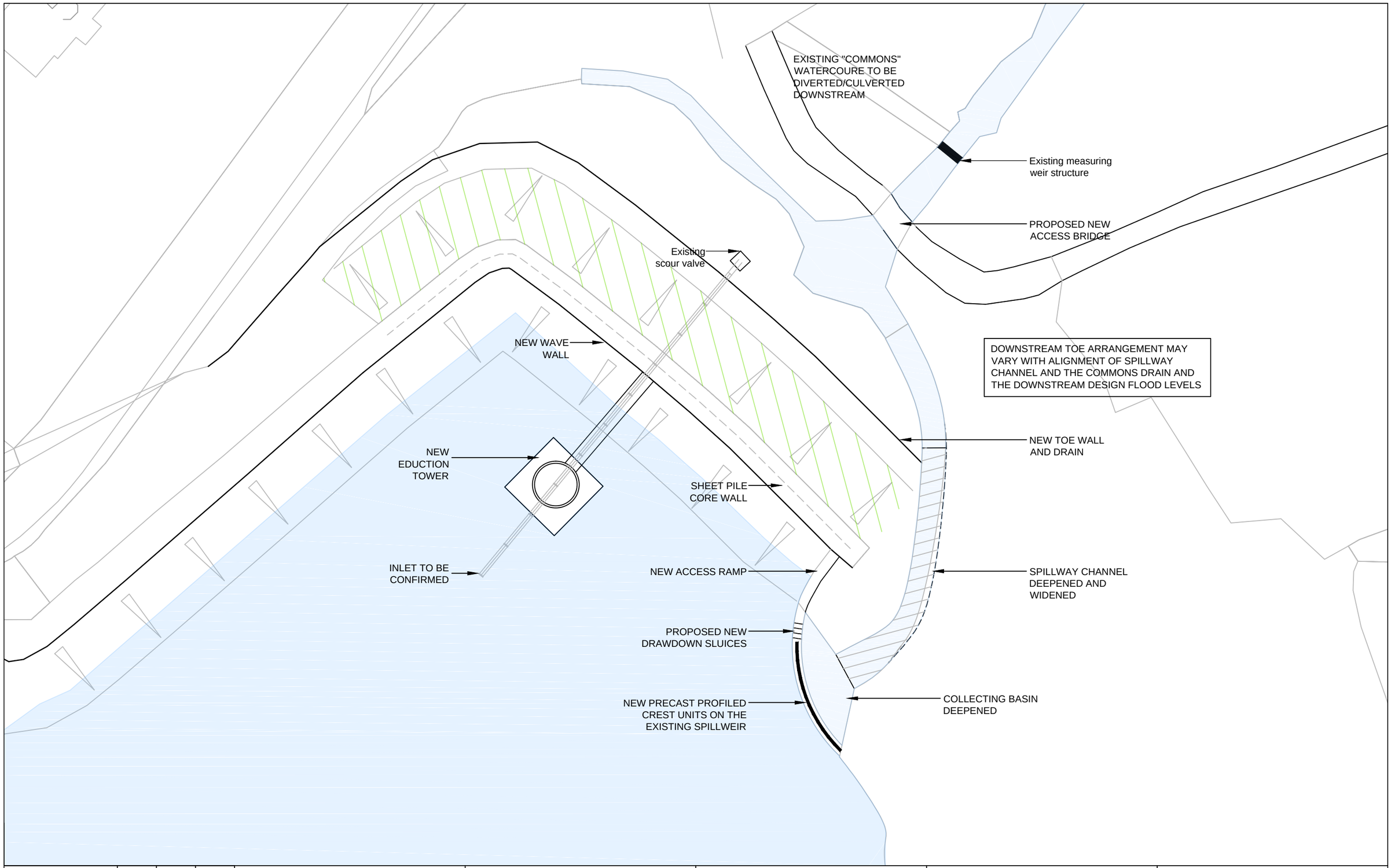
10.3 Implementation Programme

In the context of the 1975 Reservoirs Act the recommendations made within Section 15 of the Section 10 report must be actioned as soon as reasonably practicable by the Reservoir undertaker. In order to implement the recommendations of this report to advance the Rehabilitation Option a summary of key timescales are summarised in Table 4.

Table 4 – Key Milestones

Milestone	Date
Commencement of Design Phase	March 2014
Procurement of Site Investigation	April 2014 – May 2014
Site Investigation Works	June 2014 – July 2014
Completion of Detailed Design	October 2014
PQQ Period	July 2014 – August 2014
Tender Period	December 2014 – January 2015
Tender Assessment and Approval	February 2015 – March 2015
Contract Award	April 2015
Construction Commences	May 2015
Construction Complete	November 2016

APPENDIX A – DRAWINGS



Revision Details	By / Check	Date	Suffix

Project Title: Camlough Impounding Reservoir

Client: NI WATER

Drawing Title: GENERAL LAYOUT PLAN OF DAM IMPROVEMENTS

Purpose of issue: Options Appraisal Report

Designed	Drawn	Checked	Approved	Date
	JRM	GB	GAC	DEC 2013

URS Internal Project No.: 47068303

Scale @ A3: 1:500

Drawing Number: APPENDIX A - 001

Rev:

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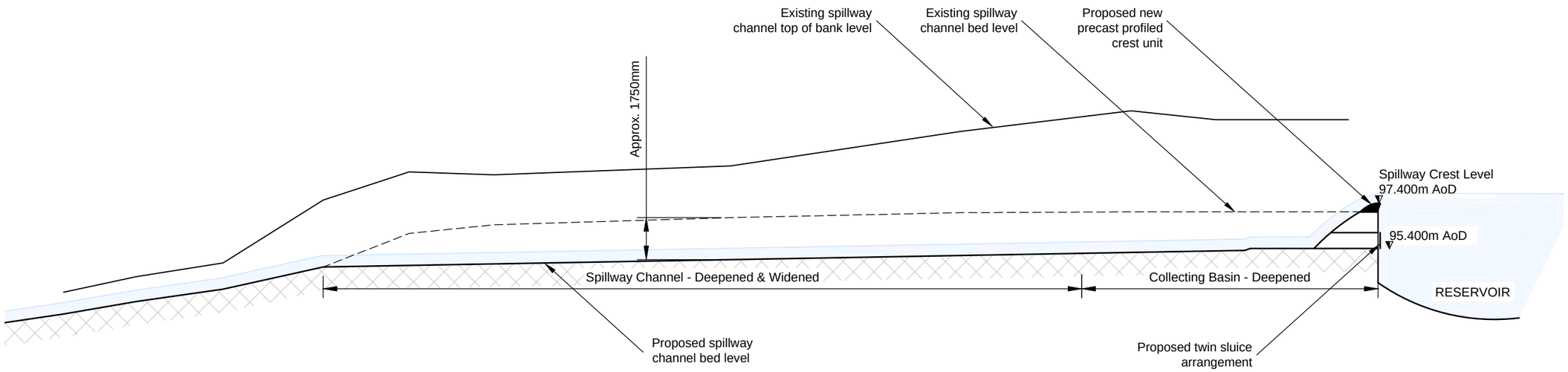

Revision Details	By / Check	Date	Suffix

Project Title
Camlough Impounding Reservoir

Client
NI WATER

Drawing Title
LONGITUDINAL SECTION
ALONG IMPROVED SPILLWAY

Purpose of issue
Options Appraisal Report

Designed	Drawn	Checked	Approved	Date
	TF	GB	GAC	DEC 2013

URS Internal Project No.
47068303

Scale @ A3
1:200

Drawing Number
APPENDIX A - 002

Rev

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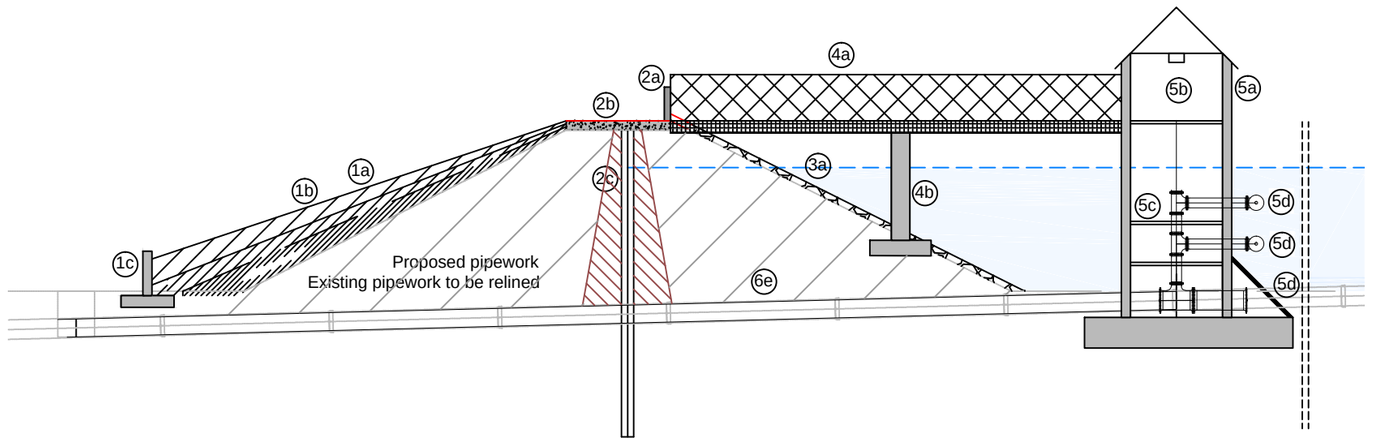

NOTES

Downstream Embankment
- 1a Proposed Slope
  Slope to be regraded from 1:2 to 1:3
- 1b Proposed Filter Berm
  3No. Layers of filter material (TBC)
- 1c Proposed Embankment Toe Wall

Crest
- 2a Proposed Wave Wall
- 2b Reinforced Concrete Slab
- 2c Proposed Core Improvements
  Sheet pile wall driven to rock through existing core material (assumed)

Upstream Embankment
- 3a Proposed Revetment
  Reinstatement of the existing revetment stonework pitching

Footbridge
- 4a Proposed Footbridge
- 4b Proposed Footbridge Support Pier

Drawoff Structure
- 5a Proposed Drawoff Tower
- 5b Control Room
  Operation of valves and lift hoist
- 5c Proposed Platforms
  Steel Mesh flooring with safety access hatch's.
- 5d Proposed Intakes
  2No. Drawoffs - 0.3mØ intakes with low velocity screens
  1No. Scour - 0.6mØ scour intake with trash screen
- 5e Pipeline
  Existing pipeline to be relined

DOWNSTREAM TOE ARRANGEMENT MAY VARY WITH ALIGNMENT OF SPILLWAY CHANNEL AND THE COMMONS DRAIN AND THE DOWNSTREAM DESIGN FLOOD LEVELS

Revision Details	By / Check	Date	Suffix

Project Title: Camlough Impounding Reservoir

Client: NI WATER

Drawing Title: LONGITUDINAL SECTION THROUGH DAM IMPROVEMENTS

Purpose of issue: Options Appraisal Report

Designed	Drawn	Checked	Approved	Date
	JRM	GB	GAC	DEC 2013

URS Internal Project No.: 47068303

Scale @ A3: 1:200

Drawing Number: APPENDIX A - 003

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1 ADDEDNDUM NR 1 – WHOLE LIFE COSTS

1.1 Scope and objective of this Addendum

This addendum to the Camlough Reservoir Improvements Option Report (the 'Report') translates the costs provided in Section 8.9 Table 2 – 'Option 1 Maintenance Schedule' into the figures required by the following elements of the scope:

(d) Estimated annual operational costs (insurance, inspections, compiling on site and off site plans etc).

(e) Estimated costs of typical annual base maintenance costs (based on the assumption that the initial capital works have been completed) – to include intermittent costs such as 10 yearly Section 10 Surveys.

1.2 Operational and Base Maintenance Cost Assessment

Table 2 of the Report identified the on-going operation and maintenance costs associated with the refurbished structure and provided estimates of the frequency of intervention. However, the table did not identify the split between operational and base maintenance costs, or the average annual value of the forecast operational and maintenance expenditure.

Table A1 overleaf has expanded on the detail provided within Table 2 of the Report and the subsequent Tables A2 and A3 split the activities into operational and base maintenance cost schedules, with a total and average annual (undiscounted) figure provided for each.

Based on this assessment the average annual non discounted operational costs are £5,700 and the average annual base maintenance costs have been assessed as £8,270.

Note that insurance costs have not been included within the operational costs at this stage as the value of insurance is unknown and will be dependent on the resolution of the dam ownership issues. The preparation of on-site have also not been considered as part of the operational cost assessment as these would form part of the professional fees associated with the development of the dam included within Table 1 of the Report.

Table A1 – Option 1 - Maintenance Schedule

	Item	Description	Type	Cost	Frequency	Total 50yr	Average 1yr
Safety Reports	Safety Reports - Site Inspection	Site visits by trained operative. 1No per month	Opex	£2,000	1	£100,000	£2,000
	Safety Reports - Section 10	10 year safety inspection	Base Maintenance	£3,500	10	£17,500	£350
	Safety Reports - Section 12	Annual safety inspection (by NIW Staff)	Base Maintenance	£1,500	1	£75,000	£1,500
Landscaping	Landscaping – General	Grass cutting, vegetation control, landscaping,	Opex	£1,000	1	£50,000	£1,000
	Landscaping - Spillway	Clearing of obstructions within spillway or at the inlet	Opex	£1,000	5	£10,000	£200
Dam	Dam - Wave wall	Joint remediation / replacement works	Base Maintenance	£4,000	20	£8,000	£160
	Dam - Crest Road Maintenance	Joint remediation / replacement works	Base Maintenance	£6,000	20	£12,000	£240
	Dam – Revetment	Pitching reinstatement	Opex	£500	1	£25,000	£500
Pipework	Pipework – Testing	Testing of scour valve and intake valves.	Opex	£500	1	£25,000	£500
	Pipework – Refurbishment	General Maintenance, checking bolts, painting etc	Base Maintenance	£2,000	10	£10,000	£200
	Pipework - Valve Replacements	Replacement / refurbishment of valves, spindles etc	Base Maintenance	£20,000	20	£40,000	£800
Valve Tower	Valve Tower – General	General annual maintenance to structure	Opex	£1,000	1	£50,000	£1,000
	Valve Tower - Steel work	Maintenance of metalwork, flooring and ladders	Base Maintenance	£5,000	5	£50,000	£1,000
	Valve Tower – Roof	General maintenance to valve tower roof structure	Base Maintenance	£6,000	10	£30,000	£600
Footbridge	Footbridge – Maintenance	General maintenance, painting	Base Maintenance	£5,000	5	£50,000	£1,000
	Footbridge – Replacement	Replacement of footbridge	Base Maintenance	£20,000	20	£40,000	£800
Toe Drain	Toe drain – Maintenance	Clearance of toe drain of silt material	Opex	£500	1	£25,000	£500
	Toe drain – Refurbishment	Replacement and refurbishment of toe drains	Base Maintenance	£3,000	20	£6,000	£120
Downstream	Downstream - Stilling Basin	Dredging and desilting of stilling basin	Base Maintenance	£5,000	5	£50,000	£1,000
	Downstream - D/S Watercourse	Dredging and desilting of downstream watercourse	Base Maintenance	£2,500	5	£25,000	£500
					Total	**£698,500**	**£13,970**

Table A2 – Option 1 – Operational Costs

	Item	Description	Type	Cost	Frequency	Total 50yr	Average 1yr
Safety	Safety Reports - Site Inspection	Site visits by trained operative. 1No per month	Opex	£2,000	1	£100,000	£2,000
Landscaping	Landscaping – General	Grass cutting, vegetation control, landscaping,	Opex	£1,000	1	£50,000	£1,000
	Landscaping – Spillway	Clearing of obstructions within spillway or at the inlet	Opex	£1,000	5	£10,000	£200
Dam	Dam – Revetment	Pitching reinstatement	Opex	£500	1	£25,000	£500
Pipework	Pipework – Testing	Testing of scour valve and intake valves.	Opex	£500	1	£25,000	£500
Valve Tower	Valve Tower – General	General annual maintenance to structure	Opex	£1,000	1	£50,000	£1,000
Toe Drain	Toe drain – Maintenance	Clearance toe drain of silt material	Opex	£500	1	£25,000	£500
					Total	**£285,000**	**£5,700**

Table A3 – Option 1 - Base Maint0enance Costs

	Item	Description	Type	Cost	Frequency	Total 50yr	Average 1yr
Safety Reports	Safety Reports - Section 10	10 year safety inspection	Base Maintenance	£3,500	10	£17,500	£350
	Safety Reports - Section 12	Annual safety inspection (by NIW Staff)	Base Maintenance	£1,500	1	£75,000	£1,500
Dam	Dam - Wave wall	Joint remediation / replacement works	Base Maintenance	£4,000	20	£8,000	£160
	Dam - Crest Road Maintenance	Joint remediation / replacement works	Base Maintenance	£6,000	20	£12,000	£240
Pipework	Pipework – Refurbishment	General Maintenance, checking bolts, painting etc	Base Maintenance	£2,000	10	£10,000	£200
	Pipework - Valve Replacements	Replacement / refurbishment of valves, spindles etc	Base Maintenance	£20,000	20	£40,000	£800
Valve Tower	Valve Tower - Steel work	Maintenance of metalwork, flooring and ladders	Base Maintenance	£5,000	5	£50,000	£1,000
	Valve Tower – Roof	General maintenance to valve tower roof structure	Base Maintenance	£6,000	10	£30,000	£600
Footbridge	Footbridge – Maintenance	General maintenance, painting	Base Maintenance	£5,000	5	£50,000	£1,000
	Footbridge – Replacement	Replacement of footbridge	Base Maintenance	£20,000	20	£40,000	£800
Toe Drain	Toe drain – Refurbishment	Replacement and refurbishment of toe drains	Base Maintenance	£3,000	20	£6,000	£120
Downstream	Downstream - Stilling Basin	Dredging and desilting of stilling basin	Base Maintenance	£5,000	5	£50,000	£1,000
	Downstream - D/S Watercourse	Dredging and desilting of downstream watercourse	Base Maintenance	£2,500	5	£25,000	£500
					Total	**£413,500**	**£8,270**

URS

Camlough Reservoir

Abandonment Scoping Report

January 2014

47068303

Prepared for:

Northern Ireland Water

UNITED KINGDOM & IRELAND

northern ireland water

Rev	Date	Details	Prepared by	Checked by	Approved by
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The methodology adopted and the sources of information used by URS in providing its services are outlined in this Report. The work described in this Report was undertaken between **September 2013** and **January 2014** and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Unless otherwise stated in this Report, the assessments made assume that the sites and facilities will continue to be used for their current purpose without significant changes.

Where field investigations are carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant delay in issuing this Report.

Costs may vary outside the ranges quoted. Whilst cost estimates are provided for individual issues in this Report these are based upon information at the time which can be incomplete. Cost estimates for such issues may therefore vary from those provided. Where costs are supplied, these estimates should be considered in aggregate only. No reliance should be made in relation to any division of aggregate costs, including in relation to any issue, site or other subdivision.

No allowance has been made for changes in prices or exchange rates or changes in any other conditions which may result in price fluctuations in the future. Where assessments of works or costs necessary to achieve compliance have been made, these are based upon measures which, in URS' experience, could normally be negotiated with the relevant authorities under present legislation and enforcement practice, assuming a pro-active and reasonable approach by site management.

Forecast cost estimates do not include such costs associated with any negotiations, appeals or other non-technical actions associated with the agreement on measures to meet the requirements of the authorities, nor are potential business loss and interruption costs considered that may be incurred as part of any technical measures.

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1. INTRODUCTION

Camlough reservoir is currently used by Northern Ireland Water as a water supply source for the Newry area with an abstraction limit of 5Ml/d. However, Northern Ireland Water would be able to meet the daily demand requirements of the Newry area without the use of Camlough reservoir upon completion of trunk main works in 2015. Assuming that abstraction from the reservoir would cease following commissioning of the trunk main from Castor Bay Water Treatment Works, Northern Ireland Water would no longer have an interest in the impoundment in terms of the need for storage as a water supply and the source could be considered a candidate for abandonment.

1.1 Scope and objective of this report

The appointment scope required the preparation of a report that would include the following:

> *"A section to set out a process for NI Water decommissioning the dam at lowest cost after 1 July 2015 (which shall be assumed to include digging out part of the face and using this to landscape the remaining elements), and restoring the natural lake level and river bed to the pre year 1870 level. This should include a timeline, any approvals necessary, and the estimated costs. This option will become viable if NI Water becomes the owner of the impoundment (which may occur if N&MDC determine that the dam is not needed to regulate flows in the Newry canal, or for recreational activity)."*

The purpose of this report is therefore to assess the environmental, hydraulic, social and economic implications of abandoning Camlough reservoir.

2. RESERVOIR DETAILS

Camlough Reservoir is located outside the village of Camlough, Co. Armagh and approximately 5km West of Newry City.

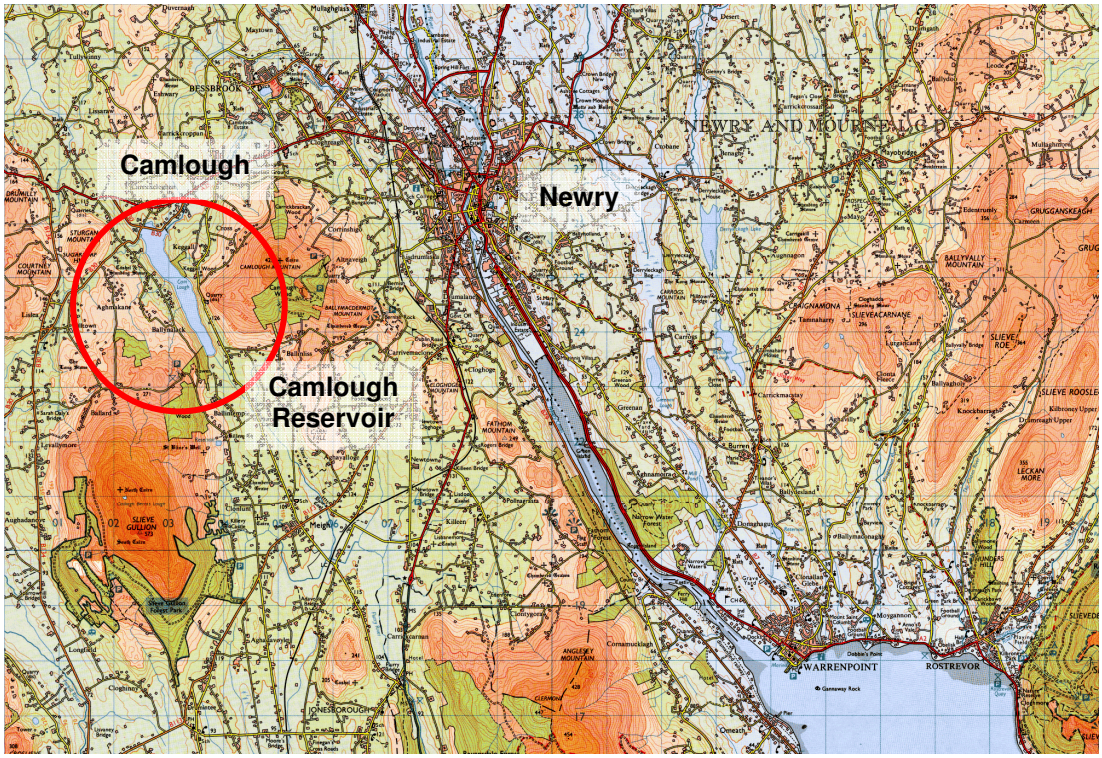


Figure 1 Location Plan

The reservoir was formed in circa. 1872 by raising the original Camlough Lake through the construction of an earthfill dam with two flanks, each of 65m in length, at the Northern end of the Lake. The reservoir has a direct catchment area of 7.73km² with an additional 5.59km² of indirect catchment contributing to the reportable useable storage capacity of 3705Ml. The surface area at top water level of 97.4mAOD is 72ha.

The overflow spillweir from the impoundment is located at the Eastern end of the main embankment. The curved spillweir is 22.5m long and discharges into a channel cut through the rock forming the Eastern abutment of the main embankment. The channel quickly narrows to 3.0m before curving around the Eastern abutment and discharging into a pool at the base of the main embankment.

Access to the reservoir, the embankment crests and the toe of the return embankment is via the B30 road. There is no vehicular access to the toe of the main embankment.

The Camlough River valley downstream of the dam is densely populated with the towns of Camlough and Bessbrook immediately downstream, leading to the centre of Newry some 5km to the East.

3. CONSIDERATIONS FOR ABANDONMENT

The Reservoirs Act 1975 provides a legal framework to ensure the safety of UK reservoirs holding at least 25,000m³ of water above natural ground level. The Act does not apply in Northern Ireland, although many reservoir owners and operators here comply with the spirit of the Act.

The Reservoirs Act 1975 defines abandonment of a reservoir as:

> *"Where the use of a large raised reservoir as a reservoir is to be abandoned, the undertakers shall obtain from a qualified civil engineer a report as to the measures (if any) that ought to be taken in the interests of safety to secure that the reservoir is incapable of filling accidentally or naturally with water above the natural level of any part of the land adjoining the reservoir or is only capable of doing so to an extent that does not constitute a risk."*

Following abandonment, the lake may still be physically capable of storing in excess of 25,000m³ of water but will be incapable of retaining water above natural ground level.

Abandoning Camlough reservoir would remove the need for and costs associated with maintaining the reservoir with the added benefit that reducing the volume of water stored would remove the risk of inundation downstream due to release of impounded water. However, any reduction in maintenance costs needs to be offset against a number of impacts as follows:

1. The capital cost of abandonment
2. The environmental impacts
3. Effect on downstream flooding
4. Impact on social amenity

In the context of Camlough, it should also be noted that the latest Section 10 report completed for the reservoir has identified significant issues with the dam structure that require refurbishment works in order to make the impoundment safe. The costs of these works also need to be considered in the context of this report.

3.1 Method of Abandonment

Before commencing the abandonment of the reservoir, the water level in the lake will need to be reduced using the existing scour and drawoff facilities. Because of the inadequate scour capacity, this facility is likely to need additional support to achieve drawdown within a reasonable timescale.

In order to abandon the reservoir, a notch would be excavated in the main embankment down to river bed level. Appendix A contains a drawing of a typical notch excavation. The notch would require excavation of approximately 1,750m³ of material and would be designed to prevent the reservoir from retaining water once it is emptied. Excavation would be carried out in phases to ensure any remaining water below the level of the drawoffs is released in a controlled manner so as not to impose an adverse risk to downstream infrastructure.

Once the new notch has been excavated the existing drawoff, structures, valves and pipelines should be removed and any silt in the reservoir basin should be risk assessed and, if necessary, made safe by removal or spreading. Landscaping and planting works will be required to help soften the appearance of the area following the abandonment. River bed profiling will also be required to the channel downstream of the lake.

4. EFFECTS OF ABANDONMENT

The effect of reservoir abandonment needs to be considered in conjunction with the environmental, hydraulic and social impact.

This section of the report looks at each of these factors to ascertain how they may be impacted by the removal of the impoundment at Camlough and how any negative effects may be mitigated.

4.1 Environmental and Planning Impact

Camlough is a mid-altitude lake lying in a steep-sided valley between Slieve Gullion and Sturgan Mountain to the west and Camlough Mountain to the east. It was designated as an Area of Special Scientific Interest (ASSI) in October 2004. It is a Mesotrophic lake, meaning that it potentially has the highest diversity of plants and wildlife of any lake. The diverse aquatic plant community is characteristic of unpolluted waterbodies with low levels of plant nutrients and is among the best example of its type in Northern Ireland.

One of the most important features of the lake is the shoreweed located around the shore and in the shallows. Quillwort is also present at these locations as a rare associate of the shoreweed. A number of other rare plants are present within the macrophyte community including eight-stamened waterwort, six-stamened waterwort, red pondweed and lesser pondweed. The lake is also surrounded by wet woodland and marshy grassland habitats.

The citation document for the ASSI, prepared by the Northern Ireland Environment Agency, has identified a number of operations and activities that would appear to the Department to be likely to damage the flora and fauna of the area. It is a requirement of The Environment (Northern Ireland) Order 2002, which is the legislation relating to ASSIs in Northern Ireland, that:

> *"Any Public Body/Competent Authority intending to carry out or permit any operation listed in the ASSI citation schedule, which lists operations thought by the Department to have potential to cause damage to the designated site, is obliged to notify the Department of the Environment."*

The means of notifying NIEA is to submit an Application for Assent to its Conservation Designations and Protection (CDP) section. The assent requires the applicant to provide details as to who will carry out the work, the proposed duration of the works, the measures to be put in place to minimise impact on the ASSI and how any damaged sections of the ASSI will be restored.

If an ASSI is also part of a Special Area of Conservation (SAC) or Special Protection Area (SPA), a 'test of significance' or 'appropriate assessment', as defined in the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 and which come under the umbrella of Habitats Regulations Assessments (HRA), must be carried out. These regulations transpose the EC Habitats Directive into law in Northern Ireland. As Camlough is not designated as either an SAC or SPA there is no requirement to carry out an HRA.

Abandoning the reservoir would result in a reduction in top water level of 4.5m from 97.4mAOD to 92.9mAOD. The associated reduction in surface area would be 42%, a reduction from its current surface area at top water level of 72ha to 42ha in the area of the original lake. Appendix B contains a drawing showing how the surface area of the lake changes following abandonment.

Reducing the water level by this amount will impact on the ASSI. However, it is difficult to assess whether the long term impact on the aquatic flora will be positive or negative. The lower water level may provide an opportunity for the wet woodland and marshy grassland

habitats to expand. There is also the possibility that the shoreweed and quillwort will retreat to the reinstated natural shoreline and shoreline treatment may help to accelerate this regeneration process. It is difficult to fully determine the impact of the reduction in lake level on the aquatic flora; therefore, it is recommended that a detailed survey should be undertaken by a qualified botanist.

Removing the capability for water to be stored above natural ground level at Camlough will mean it is not possible to restore sections of the ASSI that will be impacted by the reduction in water level. Therefore, NIEA may request a more detailed assessment on the works to be carried out to enable them to make a fully informed decision in relation to granting assent. They will be likely to request detailed information on why the works are necessary and the benefit of completing them, the percentage of each type of habitat to be impacted and whether the affect is positive or negative, details on the depth of water to be retained across the lake and details of the consequences of the works on the general biodiversity of the ASSI.

In accordance with the Planning (Northern Ireland) Order a planning application is required when development occurs. In this instance, development means the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land.

In the case of abandoning a reservoir, this would constitute development and would therefore require a planning application.

The Planning (General Development) (Amendment) Order (Northern Ireland) 2007 provides permitted development rights (development that does not require express consent) for water and sewerage undertakers. However, the proposed abandonment works do not fall within any of the categories listed.

Although the proposal does not fall within Schedule 1 or 2 of The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999, since the development is likely to have significant effects on the environment, by virtue of factors such as its nature, size or location, it may require an EIA.

The cost for submitting a planning application and Environmental Impact Assessment (EIA) has been assessed in the order of £5,000 and £50,000 respectively.

4.2 Hydraulic Impact

Reservoir inflows are commonly higher than reservoir outflows. This is due to the ability of the reservoir to attenuate floods and therefore reduce the magnitude of the outflows. This is because the outlet spillweir to the reservoir is only capable of discharging a specific flow at any particular water depth over the spillweir level. The depth of water above spillweir level is effectively storing some of the inflow volume within the reservoir until it can be released. Abandoning the reservoir will reduce the attenuation effect of the reservoir therefore increasing the flows released downstream and potentially adversely impacting on downstream infrastructure.

The hydraulic impact of abandoning the reservoir, particularly in relation to downstream flood risk, will need to be fully assessed. Abandonment of the reservoir would eliminate the risk of release of impounded water to communities downstream. However, it is likely that due to the large reduction in surface area, the current beneficial attenuation effect of the reservoir would be reduced and the downstream flood risk correspondingly increased.

An assessment of the 1 in 150 year return period (Q150) flow at the reservoir site from the catchment has been undertaken in accordance with standard hydrological assessment techniques. Most flood defence systems are constructed to protect against floods with a

return period of between 100 and 200 years. Therefore, the Q150 flood was chosen as a normal urban design flow figure for comparison purposes.

Following removal of the impoundment, it is estimated that the Q150 outflow from the lake will be 6.2m³/s. This is based on flow being discharged through a trapezoidal channel, 5.0m wide at the base and with 2H: 1V side slopes following abandonment. This is 265% greater than the current Q150 outflow of 2.3³/s. The figure below shows the Q150 inflow hydrograph for the reservoir, the Q150 outflow hydrograph for the current condition and the Q150 hydrograph for the new outlet channel.

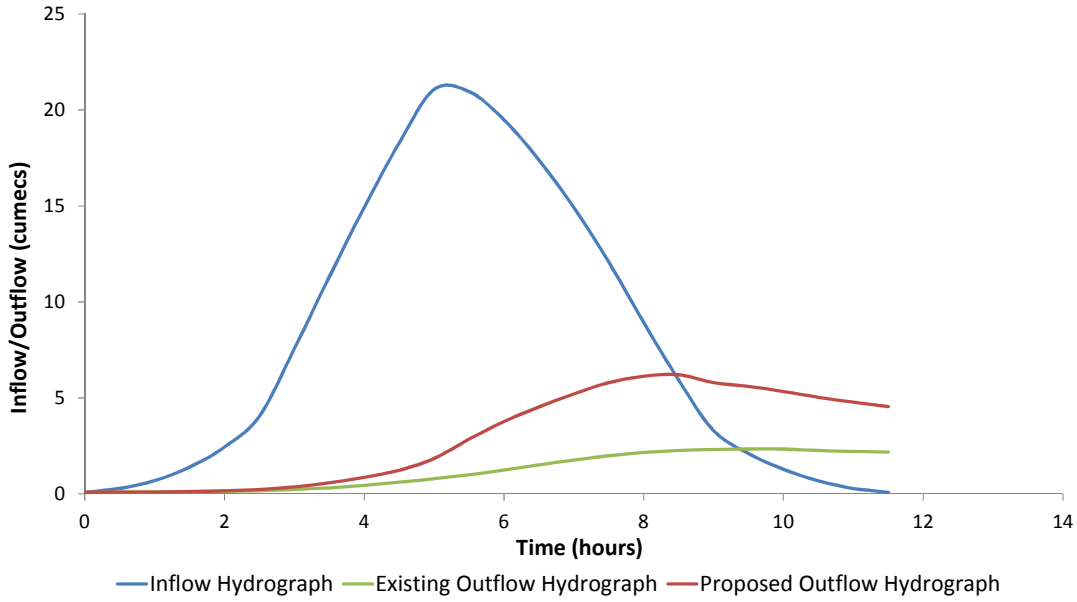


Figure 2 Q150 Inflow and Outflow Hydrographs

Discussions would need to be held with Rivers Agency to determine the implications of removing the flood attenuation currently provided by the reservoir on downstream flood defences and communities. A model would need to be prepared to assess how the flood defences would be impacted by the change in flow released from the reservoir. Any costs associated with modifying these defences to contain the changed flows would need to be considered in the overall costs of the abandonment of the reservoir. However, determining this impact and quantifying the costs are beyond the scope of this report.

One potential solution to mitigate the impact of the removal of the existing impoundment on downstream flood flows, would be to construct a new control structure at the outlet. This structure would allow low flows to pass through a naturalised channel at the lowered top water level but would constrain flood flows below the Q150 flood to provide some temporary storage and maintain the attenuation affect currently provided by the existing dam structure. The option would mean there is no worsening on downstream infrastructure. However, as the structure could provide the ability to store water above natural ground level, the lake would still be considered an impoundment under the 1975 Reservoir Act although it could be engineered as a very simple structure with minimal maintenance and monitoring requirements.

4.3 Social Impact

The social and amenity impact of the abandonment of Camlough Reservoir would be very significant.

The lake is currently used for canoeing, cycling, coarse angling, day visits/general enjoyment, running, shooting, swimming, triathlon, walking and water-skiing. All of these activities provide economic benefits to the area and the removal of these benefits would need to be taken into account when considering abandoning the reservoir.

Even following abandonment, the lake, which would be restored to its natural level and size, will still cover a considerable area of 42ha. It is therefore likely that many, if not all, of the activities currently supported by the lake would still be able to continue.

However, works will be required to the access points around the perimeter of the lake, which would be 4.5m lower than previous. This would include amending, extending and/or relocating jetties, fishing stands and slipways. Works may also be required to construct new paths or tracks.

In 2011, Newry and Mourne District Council issued a Final Draft of its Camlough Lake Masterplan, outlining its aspirations to further develop the lake as a visitor attraction. The proposals detailed in this document would need to be revised to take account of the revised lake area if the abandonment were to proceed

It would be good practice to undertake a public consultation in instances were a public amenity is being significantly changed. The purpose of this would be to inform the public of the proposals to abandon the reservoir and explain why this option is being considered and outline the potential impacts.

During dry periods, Newry and Mourne District Council use water from Camlough to top-up the water level in Newry Canal. If abandoned, the Council will lose the ability to control the volume of water released from Camlough, as the natural water regime would have been restored. This in turn may have a negative impact on water levels in the canal during periods of dry weather.

4.4 Impact on Water Supply Source

Camlough reservoir is currently used by Northern Ireland Water as a source for 5Ml/d of raw water to feed the Water Treatment Works at Camlough which supplies the Newry area.

The removal of Camlough Dam and the lowering of the lake to the pre-1872 level would result in the loss of Camlough Lake as a viable water supply source. However, following completion of trunk main works in 2015, Northern Ireland Water would no longer need to abstract water from the lake to meet the daily demand requirements of the Newry area.

5. COSTS FOR ABANDONMENT

The estimated cost for abandoning the reservoir is £420,000. A detailed breakdown of costs is shown in Table 1.

Item	Quantity	Units	Rate (£)	Total (£)
Construction				
Excavation and disposal of embankment material	1,750	m^3	20.00	35,000.00
Removal of pipelines	220	m	22.50	5,000.00
Removal of valves, valve tower and access gallery		Sum	15,000.00	15,000.00
Landscaping and river channel training		Sum	10,000.00	10,000.00
Allowance for environmental works to shoreline		Sum	(assume) 100,000.00	100,000.00
Allowance for provision of access points and relocation of slipways/jetties		Sum	(assume) 100,000.00	100,000.00
Downstream infrastructure improvements			*Undefined at this stage*	-
			Construction Preliminaries	20,000.00
			Sub-Total	**285,000.00**
Professional fees				
Planning		Sum	5,000.00	5,000.00
EIA		Sum	50,000.00	50,000.00
ASSI Assent		Sum	15,000.00	15,000.00
Public Consultation		Sum	15,000.00	15,000.00
Design		Sum	50,000.00	50,000.00
			Sub-Total	**135,000.00**
			Estimated Total Cost	**420,000.00**

Table 1 Estimated Costs

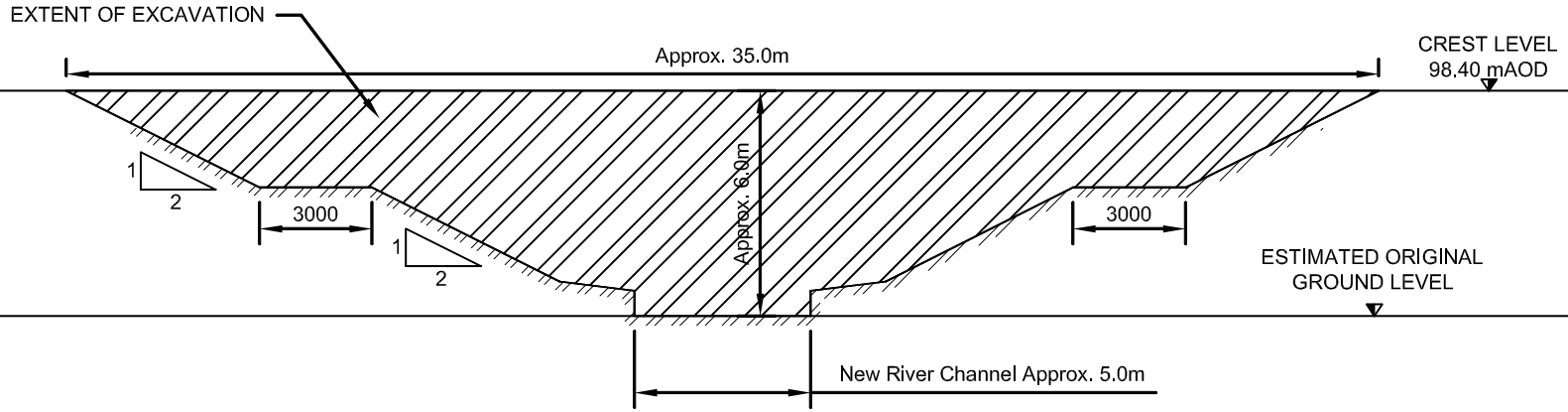
These costs exclude upgrade works that may be required to infrastructure downstream all of which require detailed assessment.

6. RECOMMENDATIONS

As discussed in this report, there are likely to be high social, hydraulic and environmental impacts associated with its abandonment which are difficult to quantify but which should be given further detailed consideration before a decision is reached. In order to achieve this, we recommend that the following work is carried out:

1. Appoint a qualified botanist to undertake a detailed survey of the ASSI and to help quantify the impact of abandonment on the aquatic flora.
2. Discuss the proposal for abandonment with NIEA to determine the level of environmental assessment required to fully assess the impact of abandonment.
3. Further investigation should be undertaken into how abandonment impacts downstream infrastructure. A model should be prepared to determine the effect the increased Q150 outflow from the site would have on existing flood defences and downstream communities.
4. Engage Newry and Mourne District Council to discuss how abandonment would affect the proposals set out in its Masterplan for the lake.
5. Convene a public consultation to inform the public of the purpose and proposal for abandonment and to explain how they could be impacted.

APPENDIX A TYPICAL NOTCH EXCAVATION



Drawing Title

Camlough Reservoir

Abandonment Scoping Report

Typical Notch Excavation

Scale @ A4		
NTS		
Drawn	Checked	Approved
CMcC	GB	GAC
Date		Rev
Jan 2014		-

Drawing Number
Appendix A

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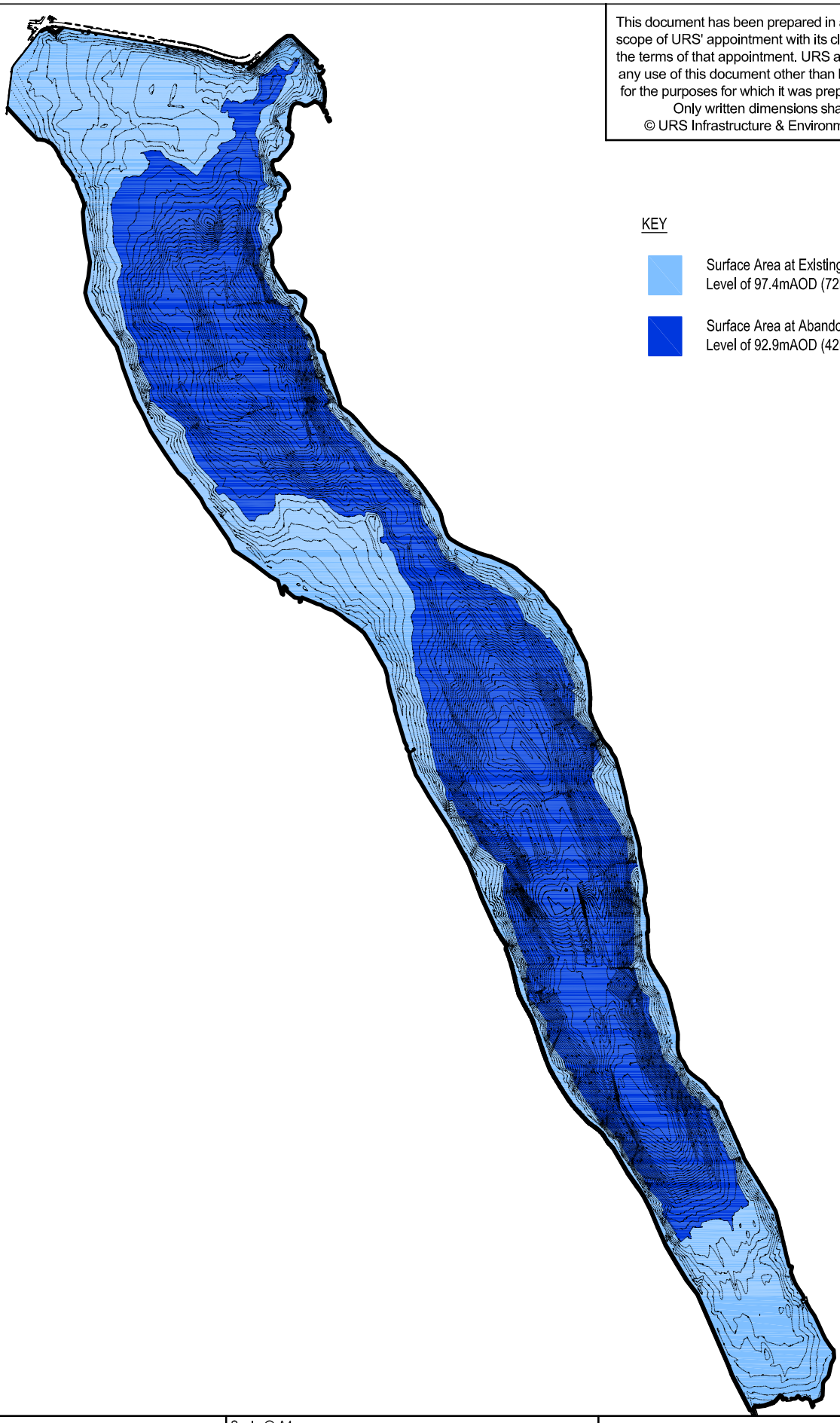
APPENDIX B CHANGE IN SURFACE AREA



KEY

Surface Area at Existing Top Water Level of 97.4mAOD (72ha)

Surface Area at Abandoned Top Water Level of 92.9mAOD (42ha)

Drawing Title

Camlough Reservoir
Abandonment Scoping Report

Change in Surface Area

Scale @ A4		
NTS		
Drawn	Checked	Approved
CMcC	GB	GAC
Date		Rev
Jan 2014		-

Drawing Number
Appendix B

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