BROADWATER

Reservoirs Act 1975 – Section 10 Report

Prepared by:  .....

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Checked by:  .....

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Panel AR Engineer

Approved by:  .....

Robert Mann

Panel AR Engineer

Broadwater – Section 10 Report

Rev No	Comments	Checked by	Approved by	Date
1	Draft	RJM/D Bell	RJM	Feb 16
2	Final	RJM/D Bell	RJM	11 Mar 16

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Broadwater (DARD Rivers Agency Ref No X0301)
Inspecting Engineer's Certificate Inspecting Engineer's Certificate

I, *Robert J Mann*, of *AECOM, 1 Tanfield, Edinburgh, EH3 5DA*, being a member of the *All Reservoirs* Panel under the *GB Reservoirs Act 1975*, appointed by *DARD Rivers Agency* to carry out an inspection of the reservoir known as *Broadwater* situated *3km North of Moira at Grid Ref 313935, 363889* made a report of the inspection on *11th March 2016* which *does include* recommendations as to measures to be taken in the interests of safety. That report includes a recommendation as to the time of the next inspection for the reservoir, which should not be made later than December 2025

Signed: 

Date of Certificate: *11 March 2016*

Table of Contents

1 Name and Situation of Reservoir

1.1 Reservoir Name

Broadwater

DARD Rivers Agency Ref No X0301

1.2 Situation

3km North of Moira

Grid Reference 313935, 363889

2 Name and address of engineer making the report

Robert J Mann,

AECOM,

1 Tanfield,

Edinburgh, EH3 5DA

3 Name of Panel of which the engineer is a member

Panel AR (All Reservoirs Panel) as constituted under Section 4 of the GB Reservoirs Act 1975. Current Appointment is valid until 13 August 2020.

4 Name and address of undertakers

The ownership and responsibility for Broadwater is:

Northern Ireland Rivers Agency

Hydebank

4 Hospital Road

Belfast

BT8 8JP

5 Name and address of supervising engineer

None at present.

The reservoir has to date not been subjected to formal safety regulation or to any inspections in the form of those associated with Section 10 and Section 12 Reports in relation to the GB Reservoirs Act 1975.

The Reservoirs Act 1975 which applies to 'large raised reservoirs' in Great Britain is regarded elsewhere as established good practice in the supervision and maintenance of large reservoirs. The term 'Enforcement authority' as used within the Act, being the body which has legal powers to ensure action is taken to carry out all measures recommended in the interests of safety is at the time of writing not therefore applicable in Northern Ireland. However, there is still an onus on the reservoir owners to put into practice any recommendations made in this report in that they are ensuring best practice. DARD Rivers Agency is currently managing the development of Reservoir Safety legislation specific to Northern Ireland.

6 Date(s) of inspection

14th December 2015.

7 Information available

No information regarding the construction or maintenance of the reservoir has been made available.

8 Description of the Reservoir

8.1 General

The reservoir is reported to have been formed in C1800 to act as a water balance on the Lagan Canal. The reservoir formed the summit of the canal to enable navigation from the reservoir in both directions, to Belfast and Lough Neagh. The Lagan Navigation was abandoned in the 1950s and the construction of the M1 motorway bridge led to the infilling of the Eastern reach of the canal between Broadwater and Belfast, close to the Glenavy Road and Moira Railway Station. [redacted] The reservoir is currently used as an amenity, mainly for angling and is managed by DARD Rivers Agency.

[redacted]

Photograph 8.1.1 General view of reservoir (looking South)

8.2 Geology

The Broadwater, situated approximately 3km to the North of the village of Moira, is an elongated lake which feeds the remaining extent of the Lagan Navigation.

The solid geology of the area comprises generally basalt lava bed from the Lower Basalt Formation, from the Paleogene Period, though to the South East a thin exposure of the Ulster While Limestone (formerly known as Cretaceous Chalk) is exposed below the basalts. The Broadwater lying in a North West / South East direction straddles this junction at approximately half way along its length.

The quaternary geology map of NI indicates that the drift material comprises glacial till or boulder clay.

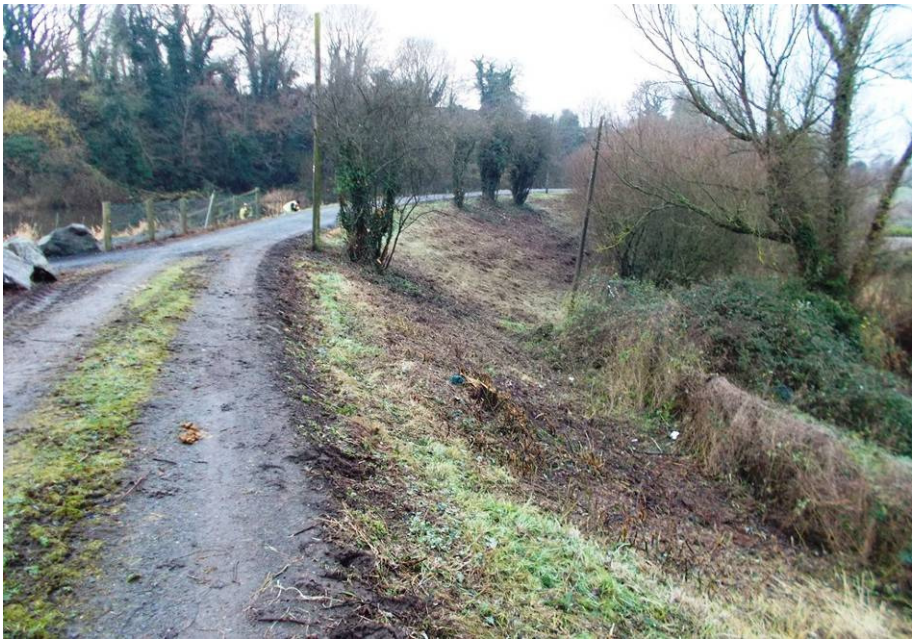
8.3 Catchment

The contributing direct catchment extracted from the Flood Estimation Handbook (FEH) CD-ROM 3 extends over an area of approximately 9.0km^2 and comprises farmland with moderate slopes up to an elevation of approximately 70mAOD.

Item	**Direct Catchment**
Area (km^2)	9.0
Max Elevation (mAOD)	70
Long Term Average Annual Rainfall (mm)	811
Slopes of ground surface	Moderate
Nature of surface	Farmland

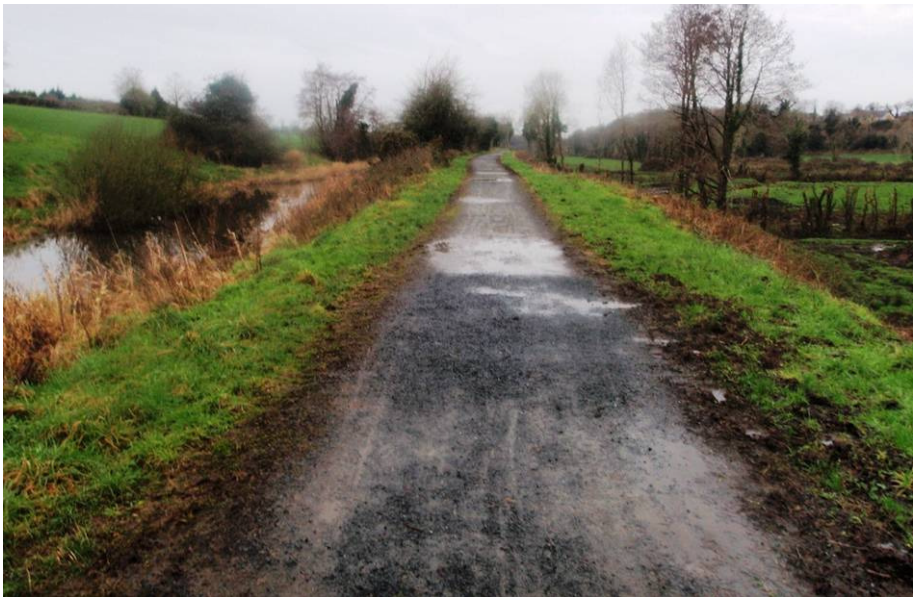
[redacted]

[redacted]



Photograph 8.4.1.1 General view of Reservoir Embankment looking East

[redacted]



Photograph 8.4.1.2 General view of Canal Embankment looking North

[redacted]

8.7 Instrumentation

[redacted]

8.7.1 Method of recording water levels

There is no staff gauge installed at the reservoir.

[redacted]

8.9 Downstream Conditions

Downstream of Broadwater Dam the outlet watercourse passes in a shallow valley down to the village of Aghalee, where the stream passes beneath the main street at a culvert between commercial properties, including a derelict filling station. Further downstream the valley widens over flat agricultural ground with some properties before eventually entering Lough Neagh.

9 Condition of the Reservoir

9.1 General

At the inspection on 14th December 2015 the weather was dry. The previous two weeks had been wet including Storm "Desmond". The inspection was undertaken by Robert Mann who was accompanied by David Bell (AECOM) and Tommy English (DARD Rivers Agency).

The reservoir embankment had been cleared of undergrowth prior to the inspection.

9.1.1 Method of recording water levels

There was no staff gauge installed at the reservoir.

[redacted]

9.2 Catchment Area

Since the abandonment of the canal, there has been no significant change to the catchment which would appreciably affect the runoff. If the canal were to be reinstated with Broadwater forming the summit reservoir, then the catchment area associated with the Western canal reach to Aghalee reservoir would not be below impounding level and would not contribute to the impoundment.

[redacted]

9.3 Embankment

9.3.1 Upstream Slope

Reservoir Embankment

Ch0-47m comprised an overgrown masonry upstream face with a 0.5m high earth bund for the majority of its length. [redacted]

Ch47-88m consisted of a grassed face slope at a gradient of about 1v:2.5h. [redacted]

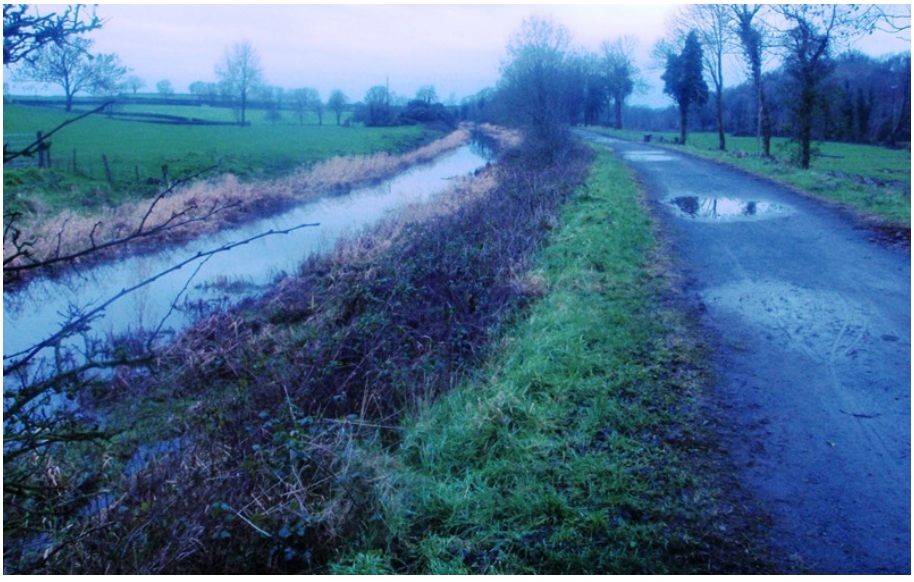
[redacted]

Ch88-150m comprised a grassed face slope at a gradient of 1v:2h. [redacted]

Revetment stone (possibly vertical profile) was observed beneath the grassed upstream embankment face at some locations [redacted]

Canal Embankment

The canal embankment extended from Ch150-1805m and comprised an overgrown slope at an approximate gradient of 1v:2h. Numerous trees and vegetative cover were observed along the majority of the length, Photograph 9.3.1.2.



Photograph 9.3.1.2 Canal embankment upstream slope

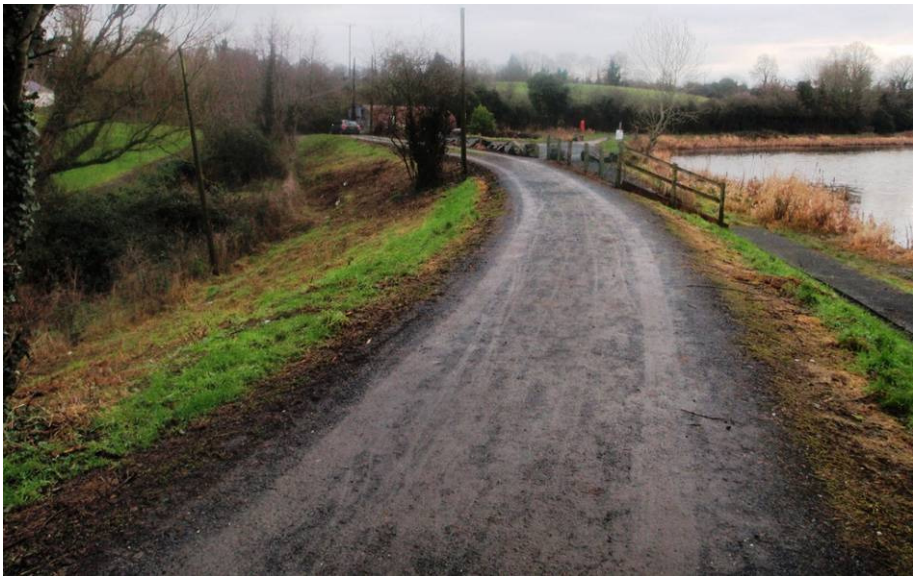
9.3.2 Crest

Reservoir Embankment

Ch0-40m consisted of a wide crest with a waterbound surface to make up a carpark and a waterbound access road to the downstream side. Both were well maintained.

The remainder of the reservoir embankment crest (Ch40-150m) consisted of a 5.5m wide waterbound access road which was well maintained, Photograph 9.3.2.1.

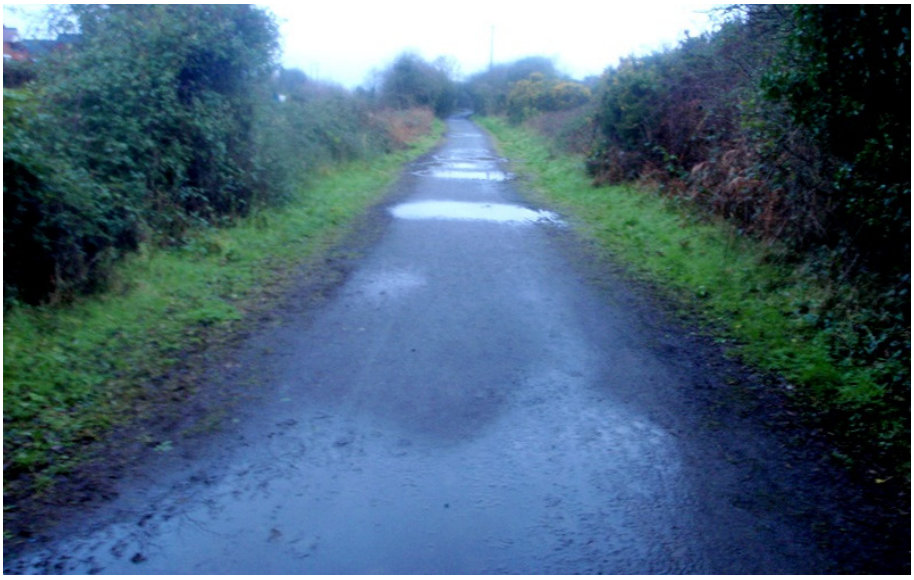
Electric poles were located along the downstream side of the crest.



Photograph 9.3.2.1 Crest of dam, Ch40-150m

Canal Embankment

The canal embankment crest was typically 4.5m wide with a central 2.5m wide waterbound gravel access path. Some areas of localised ponding were observed but the condition was considered satisfactory, Photograph 9.3.2.2.

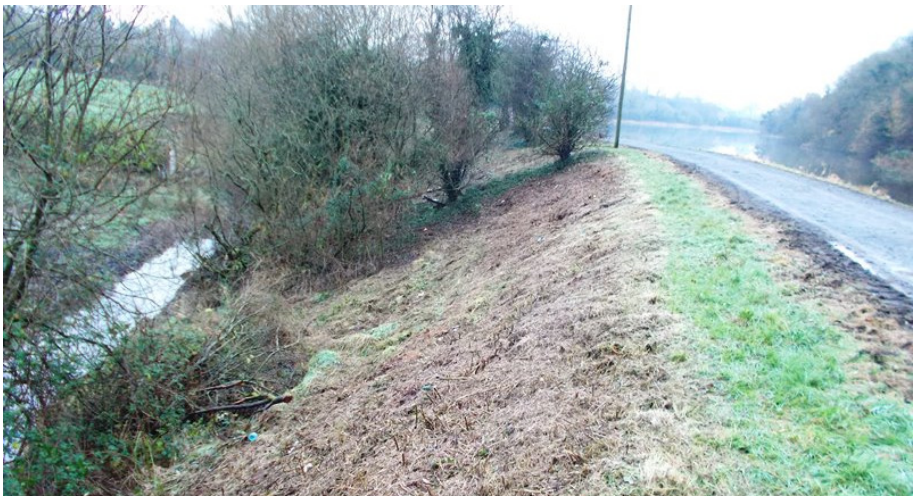


Photograph 9.3.2.2 Canal embankment crest

9.3.3 Downstream Slope

Reservoir Embankment

The downstream slope had been cleared of groundcover prior to the visit. [redacted]



Photograph 9.3.3.1 Reservoir embankment downstream slope

Canal Embankment

The downstream face had been partially cleared from Ch150-750m and the slope was of reasonably consistent profile, typically 1v:2h, Photograph 9.3.3.2. [redacted]

Photograph 9.3.3.2 Canal embankment downstream slope (Ch150-750m)

[redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted] [redacted]

[redacted]

9.7 Area downstream of the dam

Downstream of Broadwater Dam the outlet watercourse passes in a shallow valley down to the village of Aghalee, where the steam passes beneath the main street at a culvert between commercial properties including a derelict filling station. [redacted] Further downstream the valley widens over flat agricultural ground with some properties before eventually entering Lough Neagh.

10 Engineer’s Findings

[redacted]

[redacted]

[redacted]

[redacted]

10.2 Adequacy of the Spillway

10.2.1 Freeboard

The freeboard between overflow level and the top of the dam is [redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

10.4 Adequacy under Seismic Loading

Guidance on seismic safety evaluation is given in 'An engineering guide to seismic risk to dams in the UK' published by the Building Research Establishment in 1991. Based on Tables 2 and 3 of the Guide, the dam is assessed as being in Category II if the capacity is confirmed as being in the order assumed for this report.

Factor	**Amount**	**Score**
Capacity (x10^6 m^3)	0.15-0.25	2
Height (m)	4.5	0
Evacuation requirements	100-1	4
Potential downstream damage	Low	4
Total		10

In terms of safety evaluation, Table 5 of the Guide recommends that, for a dam in Category II and less than 15m high, one should look for features particularly vulnerable to damage (i.e. level E_b). Northern Ireland is in Zone C of seismic risk i.e. 'few or no recorded earthquakes but some events possible.'

The upstream and downstream slopes are those commonly adopted for dams of this era [redacted] The slopes can be expected to be stable provided there is no significant deformation, and no saturated zones or other indicators of high phreatic surface are evident. [redacted] The same applies to seismic stability where a lower transient factor of safety would be acceptable.

The foundation of the embankment is probably either glacial till or boulder clay and these materials are not vulnerable to liquefaction under seismic conditions.

Taking this and the design of the dam into consideration it is reasonable to conclude that the dam would not be vulnerable to earthquake. Consequently, there is no need to undertake a full seismic analysis and on the basis of current knowledge, the dam should be able to withstand any seismic event that can reasonably be expected without significant damage.

[redacted]

11 Supervision provided by the undertaker

The dam is not currently subject to any regular inspections in the form recognised by the Reservoirs Act 1975. A programme of periodic inspection, by appropriate personnel at designated intervals, should be set up and adhered to, arranged in a manner to suit the future requirements of the Reservoir Safety Legislation being adopted for Northern Ireland.

11.1 Correctness of the PFR

The prescribed Form of Record is a Statutory Instrument of the Reservoirs Act 1975 which is applicable in England and Wales. Currently no such form of record exists in Northern Ireland. It would be appropriate to compile a Description of Works and a note of key dimensions and data relating to the reservoir in due course.

11.2 Water Level Monitoring

There is no staff gauge installed at the reservoir.

[redacted]

11.4 Reservoir Surveillance

[redacted] Surveillance should be at a frequency determined by the Reservoir Manager, but no less that that directed under Section 12.8 below for recording of reservoir water levels.

[redacted]

12 Summary of Findings and Recommendations

Summary of findings

i. Following abandonment of the canal the reservoir level is governed by a weir in the canal at Aghalee some 2km down the Western reach of the canal. Although the reservoirs legislation excludes inland navigations, the adjacent sections of canal can be regarded as extensions of the impoundment of the reservoir.

ii. The recent extensive clearance works allowed a meaningful inspection of the reservoir embankment and most of the adjacent ground, [redacted] The current degree of clearance should be continued and grass cover established on the downstream slope in order to facilitate routine surveillance and give the opportunity for early warning of change in conditions.

iii. [redacted]

iv. [redacted]

v. Revetment stone (possibly vertical profile) was observed beneath the grassed upstream embankment face [redacted]

vi. [redacted]

vii. [redacted]

viii. [redacted]

ix. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

12.3 Other measures recommended to be taken but not requiring supervision by a qualified civil engineer

i. Protect the [redacted] reservoir embankment slope with rip-rap along the edge of the GRP walkway.
ii. Investigate [redacted] and reinstate as required [redacted]
iii. Establish grass cover on the downstream face [redacted]
iv. Undertake further local clearance [redacted]

12.4 Matters of maintenance

Based on the findings of the inspection the following routine maintenance should be undertaken:-

i. Control vegetation to prevent woody plants and brambles becoming established and to keep vegetation short enough to allow visual inspection of the embankment and adjacent surfaces.
ii. Undertake normal standards of surveillance and maintenance applicable to canal banks along the banks of the adjacent canal reaches that form part of the impoundment.
iii. Other maintenance should be undertaken as necessary to ensure that there is no deterioration in the condition of the dam or its related structures.

[redacted]

[redacted]

[redacted]

[redacted]

12.7 Directions in respect of records under section 11

The following Directions apply:

Observations and Measurements Directed by the Inspecting Engineer	Directed frequency of monitoring
Part 1	
Water level in the reservoir, by visual inspection or local measurement at the reservoir	Not less than weekly To be tabulated with and plotted against rainfall
Depth of water flowing over waste weir or overflow	As above
Part 2	
Rainfall at nearest publically available rain gauge	Over any period as may be requested by the Supervising Engineer
Any other leakages, movements, settlements or other indicators of performance	As observed during surveillance visits, that shall be at a frequency determined by the reservoir manager but not less than given above for reading water level
Repairs	On completion

12.8 Date of the next inspection under section 10

Unless the Supervising Engineer observes any unusual behaviour or for any other reason calls for an earlier inspection, the next full inspection should take place no later than December 2025.

12.9 Scope of the 10 year safety inspection

The Inspecting Engineer has formed a general opinion on the overall condition of the reservoir, [redacted] His opinion is based on the site visit, his examination of the information provided as listed in Section 7 and discussions with staff employed by the owner.

13 Signature of the Engineer

Signed: [redacted] Current panel appointment to 13 August 2020

14 Date of Report

11 March 2016