



**Haweswater Aqueduct Resilience Programme - Proposed Marl Hill
Section**

Environmental Statement

Volume 4

Appendix 7.3: Geomorphology Proformas

June 2021



Water for the North West



Haweswater Aqueduct Resilience Programme - Proposed Marl Hill Section

Project No: B27070CT
Document Title: Proposed Marl Hill Section Environmental Statement
Volume 4 Appendix 7.3: Geomorphology Proformas
Document Ref: RVBC-MH-TA-007-003
Revision: 0
Date: June 2021
Client Name: United Utilities Water Ltd

Jacobs U.K. Limited

5 First Street
Manchester M15 4GU
United Kingdom
T +44 (0)161 235 6000
F +44 (0)161 235 6001
www.jacobs.com

© Copyright 2021 Jacobs U.K. Limited. The concepts and information contained in this document are the property of Jacobs. Use or copying of this document in whole or in part without the written permission of Jacobs constitutes an infringement of copyright.

Limitation: This document has been prepared on behalf of, and for the exclusive use of Jacobs' client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party.

Contents

1.	Introduction	1
2.	Geomorphology Proformas.....	2
2.1	Unnamed Watercourse 402 (W483).....	2
2.2	Bonstone Brook (W498)	4
2.3	Unnamed Watercourse 430 (W520).....	6
2.4	Unnamed Watercourse 431 (W521).....	8
2.5	Unnamed Watercourse 433 (W523).....	10
2.6	Sandy Ford Brook (W530).....	12
2.7	Bashall Brook (W556).....	15
2.8	Unnamed Watercourse 463 (W557).....	17

1. Introduction

- 1) A fluvial geomorphology site walkover for the Proposed Marl Hill Section was undertaken between 14 and 16 January 2020 and on 22 April 2020. This document provides the fluvial geomorphology baselines for the watercourses in the assessment area, based on data from the site walkover. Where it was not possible to visit a watercourse, the baseline assessment was formed using desk-based sources only. Mitigation, reinstatement requirements, and potential enhancements have also been identified based on the assessment made as part of the Environmental Statement. Watercourse locations are shown in Volume 3 Figure 7.2.

2. Geomorphology Proformas

2.1 Unnamed Watercourse 402 (W483)

Watercourse baseline	
Value	Medium
WFD Surface Water Body	Hodder - conf Easington Bk to conf Ribble
Reach function	Sink
Reach process	Aggrading
Flow	Varied depending on geomorphological features present – broken waves, rippled, chutes, and smooth flow all observed.
Substrate	Unsorted and partly consolidated silt, fine to coarse gravel, and cobbles.
Features observed	Natural: cobble steps Artificial: embankment
Land use	Pasture on both banks.
Riparian vegetation	Grass on both banks (see Illustration 1).
Scheme Interaction	
Scheme components	Temporary outfall, discharge of construction and site run-off, and discharge of commissioning flows.
Mitigation requirements (Enabling)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Construction)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Commissioning)	Mitigation for the commissioning flows would consist of a monitoring programme to identify changes in the bed and banks daily for the duration of the commissioning phase. United Utilities would be notified of any changes and remediation would be sought. The remediation could include scour mats around the outfall and green bank protection at the location of any new erosion as well as channel reinstatement after the commissioning phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Reinstatement of bed, banks, and riparian vegetation following the removal of the temporary outfall. If the commissioning flows cause erosion, it is recommended the bed be reinstated with natural material and augmented with coarser material. During the reinstatement, coarse material is also recommended to be placed along the bank toe to stabilise the bank. It is recommended a decomposable geotextile be used on the upper the banks, to allow for vegetation re-establishment along the upper and mid bank and aid stabilisation. It is recommended that all reinstatement work be supervised by a geomorphologist or Ecological Clerk of

Works with expertise experience in channel restoration to ensure appropriate reinstatement

Photo(s) of watercourse

Illustration 1: Upstream view of riparian vegetation



2.2 Bonstone Brook (W498)

Watercourse baseline	
Value	High
WFD Surface Water Body	Hodder - conf Easington Bk to conf Ribble.
Reach function	Exchange
Reach process	lateral adjustment (upstream) and stable (downstream).
Flow	Varied depending on geomorphological features present – broken waves, rippled, chutes, and smooth flow all observed (see Illustration 2).
Substrate	Partially consolidated and poorly sorted coarse gravels and cobbles. Boulders and bedrock were also observed.
Features observed	Natural: Step pools, lateral and medial bars, 150 m of bank erosion. Artificial: Bridges, culverts, weir, Haweswater aqueduct pipe bridge (see Illustration 3), trash screen, 20 m of bank reinforcement.
Land use	Areas of pasture and woodland on both banks.
Riparian vegetation	Semi-continuous trees and grass on both banks.
Scheme Interaction	
Scheme components	Within 500 m of construction access route and site compound.
Mitigation requirements (Enabling)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Construction)	No impacts would be anticipated during this phase.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	No reinstatement would be required.

Photo(s) of watercourse

Illustration 2: Upstream view at upstream end of surveyed reach. Varied flow



Illustration 3: Downstream view. Haweswater aqueduct pipe bridge



2.3 Unnamed Watercourse 430 (W520)

Watercourse baseline	
Value	High
WFD Surface Water Body	Bashall Brook
Reach function	Source
Reach process	Generally stable with some widening.
Flow	Varied depending on geomorphological features present – broken waves, rippled, chutes, and smooth flow all observed (see Illustration 4).
Substrate	Cobbles and boulders. Bed partially obscured during site visit, therefore unable to assess sorting/entrainment of substrate.
Features observed	Natural: Step pools, berms, 70 m of bank erosion on right bank (see Illustration 5). Artificial: Culvert
Land use	Pasture on both banks, with fencing along the right bank.
Riparian vegetation	Continuous coverage of trees and bushes along both banks.
Scheme Interaction	
Scheme components	Construction access route.
Mitigation requirements (Enabling)	Mitigation measures would be required for the impact of the access route crossing during the enabling and construction phases. These measures would be employed following the removal of the culvert (see reinstatement requirements).
Mitigation requirements (Construction)	Consideration could also be given to lengthening the proposed culvert to minimise the extent of fine sediment from machinery crossing the channel entering the watercourse.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Following removal of the culvert required for access road crossing, it is recommended the bed be reinstated with natural material and augmented with coarser material. During the reinstatement, coarse material is also recommended to be placed along the bank toe to stabilise the bank with a decomposable geotextile used on the upper banks, to allow for vegetation re-establishment. It is recommended that all reinstatement work be supervised by a geomorphologist or Ecological Clerk of Works with experience in channel restoration to ensure appropriate reinstatement.

Photo(s) of watercourse

Illustration 4: Downstream view of varied flow types



Illustration 5: View from right bank to left bank. Left bank erosion



2.4 Unnamed Watercourse 431 (W521)

Watercourse baseline	
Value	Medium
WFD Surface Water Body	Bashall Brook
Reach function	Transfer
Reach process	Stable
Flow	Varied depending on geomorphological features present – rippled, chutes, and smooth flow all observed.
Substrate	Cobbles, although the bed of the watercourse was partially obscured.
Features observed	Natural: Cobble steps Artificial: Culvert (see Illustration 6)
Land use	Pasture on both banks.
Riparian vegetation	Continuous coverage of sedge, bushes, and trees along both banks (see Illustration 7).
Scheme Interaction	
Scheme components	Construction access route.
Mitigation requirements (Enabling)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Construction)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Reinstatement of bed, banks, and riparian vegetation following the removal of the temporary culvert

Photo(s) of watercourse

Illustration 6: Upstream view of culvert



Illustration 7: Downstream view showing riparian vegetation



2.5 Unnamed Watercourse 433 (W523)

Watercourse baseline	
Value	Medium
WFD Surface Water Body	Bashall Brook
Reach function	Source
Reach process	Incising
Flow	Varied depending on geomorphological features present – ripples (see Illustration 8), broken waves and chutes observed.
Substrate	Partially consolidated and poorly sorted coarse gravel and cobbles.
Features observed	Natural: Cobble steps, 10 m of bank erosion (see Illustration 9) Artificial: Culvert
Land use	Rough pasture on the right bank, pasture on the left bank.
Riparian vegetation	Continuous coverage of grass, bushes, and small trees along both banks.
Scheme Interaction	
Scheme components	Construction access route.
Mitigation requirements (Enabling)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Construction)	Mitigation measures would be required for the impact of the access route crossing during the construction phase. These measures would be employed following the removal of the culvert (see reinstatement requirements). Consideration could also be given to lengthening the proposed culvert to minimise the extent of fine sediment from machinery crossing the channel entering the watercourse.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Following removal of the culvert required for access road crossing, it is recommended the bed be reinstated with natural material and augmented with coarser material. During the reinstatement, coarse material is also recommended to be placed along the bank toe to stabilise the bank with a decomposable geotextile used on the upper banks, to allow for vegetation re-establishment along the upper and mid bank and aid stabilisation. It is recommended that all reinstatement work be supervised by a geomorphologist or Ecological Clerk of Works with experience in channel restoration to ensure appropriate reinstatement.

Photo(s) of watercourse

Illustration 8: Upstream view. Rippled flow



Illustration 9: Undercutting on left bank



2.6 Sandy Ford Brook (W530)

Watercourse baseline	
Value	High
WFD Surface Water Body	Bashall Brook
Reach function	Transfer on upstream reach. Exchange on downstream reach.
Reach process	Stable
Flow	Varied depending on geomorphological features present – rippled, chutes, broken standing waves, and smooth flow all observed (see Illustration 10).
Substrate	Poorly sorted and mobile, coarse gravel, cobbles, and boulders.
Features observed	Natural: Point, lateral, and medial bars, step pools, berms, several areas of bank erosion (totalling 60 m). Artificial: Culvert (see Illustration 11), bank reinforcement.
Land use	Woodland on both banks.
Riparian vegetation	Continuous grass and trees on both banks.
Scheme Interaction	
Scheme components	Construction access route, temporary outfall, discharge of construction and site run-off, discharge of commissioning flows, within 500 m of site compound.
Mitigation requirements (Enabling)	Mitigation measures would be required for the impact of the access route crossing during the enabling and construction phases. These measures would be employed following the removal of the culvert (see reinstatement requirements).
Mitigation requirements (Construction)	
Mitigation requirements (Commissioning)	Mitigation for the commissioning flows would likely take the form of green bank protection opposite the outfall, with scour matting around the outfall. Monitoring changes in the bed and banks for erosion daily for the duration of the commissioning phase is also recommended. United Utilities would be notified of any changes and remediation would be sought. The remediation could include additional scour matting and green bank protection at the location of any new erosion as well as channel reinstatement after the commissioning phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Following removal of the culvert required for access road crossing, it is recommended the bed be reinstated with natural material and augmented with coarser material. Coarse material is also recommended to be placed along the bank toe to stabilise the bank with a decomposable geotextile used on the upper banks, to allow for vegetation re-establishment along the upper and mid bank and aid stabilisation. It is recommended that all reinstatement work be supervised by a geomorphologist or Ecological Clerk of Works with experience in channel restoration to ensure appropriate reinstatement. Reinstatement of bed, banks, and riparian vegetation following the removal of the temporary outfall.

If the commissioning flows cause erosion, it is recommended the bed be reinstated with natural material and augmented with coarser material. Coarse material is also recommended to be placed along the bank toe to stabilise the bank. It is recommended a decomposable geotextile be used on the upper the banks, to allow for vegetation re-establishment. It is recommended that all reinstatement work be supervised by a geomorphologist or Ecological Clerk of Works with expertise experience in channel restoration to ensure appropriate reinstatement.

Photo(s) of watercourse

Illustration 10: Downstream view. Varied flow types



Illustration 11: Upstream view of culvert



2.7 Bashall Brook (W556)

Watercourse baseline	
Value	Medium
WFD Surface Water Body	Bashall Brook
Reach function	Exchange
Reach process	Stable
Flow	Varied depending on geomorphological features present –broken waves, rippled, chutes and smooth flow all observed.
Substrate	Poorly sorted and partly consolidated coarse gravels and cobbles.
Features observed	Natural: Point, lateral, and medial bars, cobble steps, berms, 60 m of bank erosion (see Illustration 12). Artificial: 65 m of bank reinforcement and an earth embankment on left bank, bed reinforcement, clear span bridge, weir (10 m wide, 3 m high) (see Illustration 13).
Land use	Woodland and fences along on both banks, with some isolated residential properties also observed.
Riparian vegetation	Semi-continuous trees and grasses along both banks.
Scheme Interaction	
Scheme components	Overflow
Mitigation requirements (Enabling)	No impacts would be anticipated during this phase.
Mitigation requirements (Construction)	No impacts would be anticipated during this phase.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Decommissioning)	To mitigate the impact of the overflow, post-scheme geomorphological monitoring would be recommended. Augmentation of the bed sediment with coarser material would be recommended, if the monitoring shows the bed substrate has been disturbed.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	No reinstatement would be required.

Photo(s) of watercourse

Illustration 12: Left bank to right bank view. Bank erosion on left bank



Illustration 13: Downstream view of weir



2.8 Unnamed Watercourse 463 (W557)

Watercourse baseline	
Value	Medium
WFD Surface Water Body	Bashall Brook
Reach function	Source
Reach process	Stable
Flow	Varied depending on geomorphological features present – broken waves, rippled, chutes, and smooth flow all observed.
Substrate	Poorly sorted and partially consolidated, coarse gravels and cobbles.
Features observed	Natural: step pools, 20 m of bank erosion (see Illustration 14) Artificial: Culvert (see Illustration 15)
Land use	Pasture on the right bank, woodland on the left bank.
Riparian vegetation	Continuous coverage of grasses, sedges, and trees on both banks.
Scheme Interaction	
Scheme components	Construction access route.
Mitigation requirements (Enabling)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Construction)	No specific mitigation would be required. Impacts would be mitigated by embedded mitigation.
Mitigation requirements (Commissioning)	No impacts would be anticipated during this phase.
Mitigation requirements (Operational)	No impacts would be anticipated during this phase.
Mitigation requirements (Decommissioning)	No impacts would be anticipated during this phase.
Reinstatement requirements (where watercourse is physically crossed, or riparian zone is interrupted)	Reinstatement of bed, banks, and riparian vegetation following the removal of the temporary culvert.

Photo(s) of watercourse

Illustration 14: Upstream view. Bank erosion



Illustration 15: Upstream view of culvert

