CONSULTING CIVIL, STRUCTURAL,
HIGHWAY AND TRANSPORTATION ENGINEERS

GCA

Structural Appraisal

of

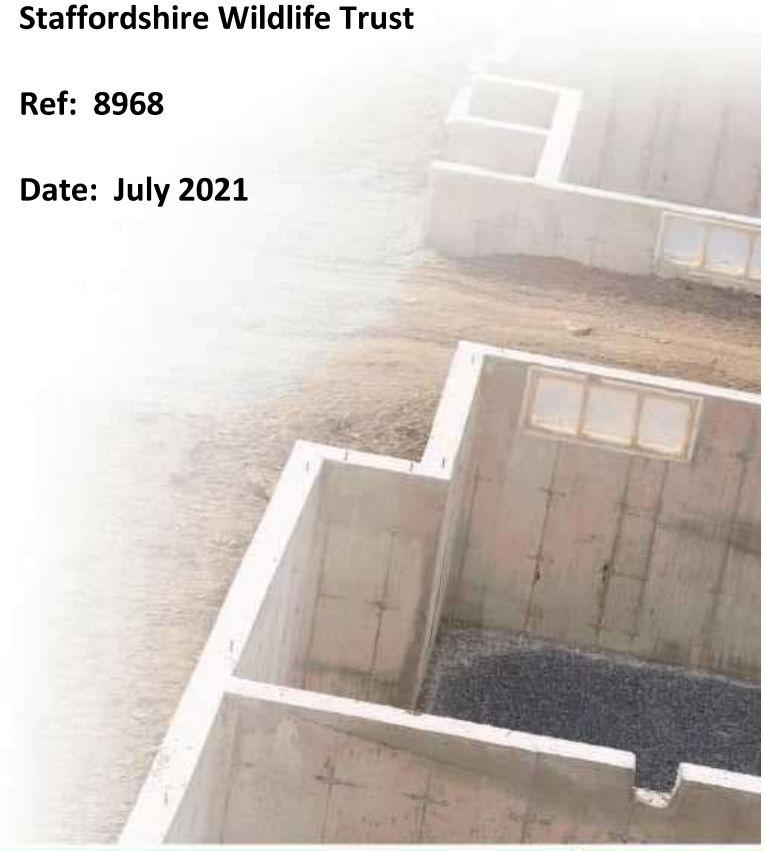
Cotton Dell Bridge Culverts

for

Staffordshire Wildlife Trust

Ref: 8968

Date: July 2021



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CONTENTS

Structural Appraisal of

Cotton Dell Bridge Culverts

1. Introduction

101. GCA were requested by Staffordshire Wildlife Trust to undertake a re-inspection of the culvert structure at the Cotton Dell Nature Reserve.

Limitations

102. External inspection of the Culvert has been carried out from ground level and from within the stream by visual and optical sighting and without special access arrangements we cannot confirm that obscured parts are free from defect.

103. Access into the culvert was limited as outline in Appendix A.

General Description

104. See GCA report dated November 2005. See Appendix C.

105. At the time of the survey the weather was predominantly dry and the level within the stream at the location of the culvert was an approximate depth of 150mm to 300mm.

Scope

106. We were requested to report on any apparent defects, giving an opinion to the cause and the structural significance together with recommendations for further investigations where required or where appropriate suggest in outline only, the scope of any necessary remedial works including general advice about the likely effects and need to treat any nearby trees and vegetation where it could affect the structure.

107. We have not investigated the presence of asbestos and all other non-structural elements or biohazards, including the presence of invasive non-native plants.

108. External inspection of the Culvert has been carried out from ground level by visual and optical sighting and without special access arrangements we cannot confirm that obscured parts are free from defect.

109. Whilst we have used all reasonable skill and care in preparing this report, it should be appreciated that we cannot offer any guarantee that the property will be free from future defects or that existing ones will not suffer from further deterioration.

110. The locations of all defects are shown on the Key Plan included within Appendix A.

2. OBSERVATIONS

201. Refer to Appendix A for locations of the defects and descriptions.

202. Refer to Appendix B for the associated photographs.

3. CONCLUSIONS

301. There was evidence that any repairs recommend in appendix C have been carried out.

302. There was excessive vegetation and trees within the vicinity of the wall and growing out of the structure throughout.

303. Regarding defect NW1 the abutment is considered to be in inadequate condition and offers insufficient support to the wall and deck over.

304. Regarding NWW1 there is evidence to suggest that the embankments and the gabion retaining wall structure is unstable.

305. Regarding BD1 the tilting of the sleepers at ground level to the sides of the bridge deck suggest that there is slight instability of the roadway at the fringes.

306. Regarding SE1 there was significant debris noted at the base of the southeast wall which left unaddressed could cause issues with potential blockages and restriction of flow.

307. Regarding SE3 the stone soffit appears to be inadequately supported at this location. This is thought to have been previously identified within GCA's report of November 2005.

308. Regarding SWW1 there was evidence to suggest that a landslide had occurred. As the embankment is considered to remain relatively steep, we anticipate that there is further risk of potential landslides within this area.

309. Regarding the culverts we advise that the previous comments made in GCA report dated November 2005 remain applicable.

4. RECOMMENDATIONS

401. Recommendations and repair proposed outline in appendix C remain applicable.

402. We advise that all vegetation and trees growing adjacent or within the culvert structure are removed to mitigate further risk of movement and to assist with further surveys/inspections.

403. Regarding defect NW1 and NW2 we recommend local rebuilding of the abutment is undertaken.

404. NWW1 though it is thought that the embankments and gabion structures have undergone movement, we are not able to predict whether further movement of the gabion walls or the embankments is likely to occur. We therefore recommend that regular inspections of the structure are introduced on an annual basis to establish whether significant movement can be identified.

405. Regarding BD1 we recommend that the sleepers on the top of the bridge deck are reset so they are in line and level so any further movement of the edges of the deck can be observed and if required, addressed.

406. Regarding SE1 we recommend that suitable measures are introduced to mitigate the risk of significant build of debris. We advise that at regular intervals, perhaps a 3-monthly basis, or after extraordinary weather events, the stream is inspected and cleared of any debris that may potentially block the flow of the stream.

407. Regarding SE3 we advise that the recommendations proposed in the GCA report of November 2005 remain applicable.

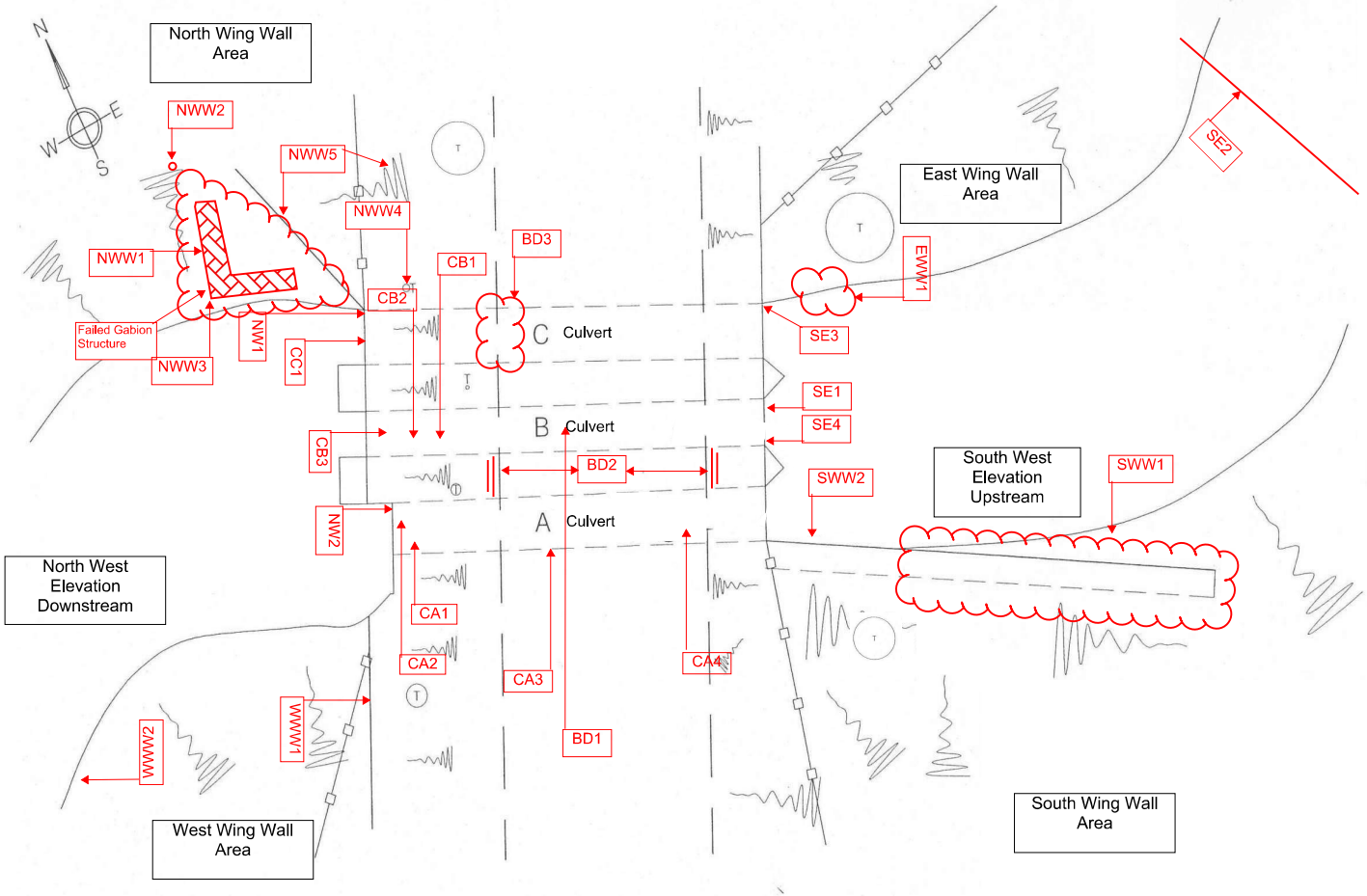
408. Regarding SWW1 we advise that the slope is battered back to a 1 in 2 gradient and inspected at regular intervals. Removal of trees and vegetation may require necessary approvals.

File Ref: 8968
Date: 6th July 2021

Appendix A – Key Plan

GCA Consulting Ltd Babington Lodge 128 Green Lane Derby DE1 1RY	Project: Cotton Dell Bridge				Job No.: 8968	
	Title: Structural Defects Observations				Drawing No./Rev.: SK 01	
	Drawn by: EH	Date: 22/06/21	Chk'd by: SA	Date: 22/06/21	App'd by: SA	Date: 22/06/21

NOT TO SCALE



WWW1 – Wing Wall to culvert is significantly overgrown with vegetation. There also appears to be a tree growing out of the side/top of the wall. The tree appears to have been cut off approximately 2m above the bridge deck level.

WWW2 – There is evidence to suggest that a low level retaining wall existed at the water's edge which at some point has failed and there is evidence of large pieces of stonework in this vicinity having fallen on to the bed of the stream.

NW1 – Partial support of the first soffit slab was noted. It appears that the wall above the soffit slab has become dislodged and is now partially supported on what could be considered loose stonework.

NW2 – The wall is heavily obscured by vegetation, therefore the survey of the face of the wall was limited. There was evidence of a number of saplings growing out of the wall.

NWW1 – There is evidence to suggest that some form of landslide, or earthworks, may have been undertaken in this area.

NWW2 – There was evidence of a fallen tree within the vicinity of the Wing Wall.

NWW3 – There is evidence of a more recent gabion wall construction in front forming part of the slope.

NWW4 – There is a healthy tree growing out the side of the Wing Wall approximately 200mm in diameter and circa 10m tall.

NWW5 – Further evidence of earthworks being undertaken were identified within this vicinity. The embankment, from the bridge deck level down to the bottom of the stream, appears to be approximately 1:1 gradient.

BD1 – The bridge deck generally appears in line, and no obvious significant undulations to the surface were noted.

BD2 – There were two timber sleepers, one on each side located at the edge of the roadway. Both timbers appear to have rotated towards the Wing Wall.

BD3 – 4No. stones sat proud above the level of the road surface to the corner of the bridge deck.

SE1 – A significant amount of branches and debris was noted at the base of the wall.

SE2 – It was noted that a makeshift fence/gate had been installed crossing the brook approximately 20m upstream from the structure.

SE3 – It appears that the first soffit stone is partially supported at the corner of the Wing Wall.

SE4 – There is evidence of stonework having fallen from the face of the wall. It was difficult to determine the extent of the fallen stone due to the extensive vegetation growing over the face of the wall.

EWW1 – There is evidence of fallen stones at the edge of the stream. It is thought that a stone retaining structure may have existed at some point at this location. Above this location there is a large tree, circa 900mm diameter and estimated at 12-15m high.

SWW1 – There is evidence to suggest that the Wing Wall has undergone a significant collapse and a large landslide. It is thought that this has occurred between the time of the last survey in November 2005 and this inspection.

SWW2 – There is slight bulging of the remaining section of the Wing Wall within the vicinity of a tree. The tree is approximately 500mm in diameter and stands approximately 12-15m tall.

CA1 – Dislodged stonework was noted to the face of the wall.

CA2 – Dislodged stonework was noted to the face of the wall.

CA3 – The stonework appears to have become distorted and shows some signs of slight bulging.

CA4 – There is a cracked soffit stone noted overhead.

CB1 – There is evidence of some dislodged stonework to the wall.

CB2 – There is evidence of a partially supported soffit slab overhead.

CB3 – The stone walls appear to display signs of slight curvature and bellying inwards at this location. It is unclear whether the walls were originally constructed in this manner.

CC1 – access into Culvert C was not possible hence observations could only be made from the downstream end. No obvious signs of significant distortion were noted.

Appendix B - Photographs

WWW1

WWW2

NW1

NW2

NWW1

NWW2

NWW3

NWW4

NWW5

BD1

BD2

BD3

SE1

SE2

SE3

SE4

EWW1

SWW1

SWW2

CA1

CA2

CA3

CA4

CB1

CB2

CB3

CC1

Appendix C – Structural Appraisal Report

SURVEY AND CONDITION REPORT

Cotton Dell Bridge

Churnet Valley
Oakamoor
Staffordshire

For

STAFFORDSHIRE MOORLANDS DISTRICT COUNCIL

REPORT REF: 31499
Date: November 2005

GCA

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APPENDICES

1.0 INTRODUCTION

1.1 GCA (UK) Limited were instructed by Staffordshire Moorlands District Council in October 2005 to undertake a geometrical and condition survey of the aged stone culvert bridge, which crosses Cotton Brook, and to make recommendations for its sensitive repair.

1.2 The bridge is situated at the southern end of the Cotton Dell nature reserve which includes Oulsclough Wood, in the side valley offshoot at Oakamoor. The site is presently managed by the Staffordshire Wildlife Trust.

1.3 The age and original purpose of the small bridge structure is not known, but it may have had connections with historic ironstone working which preceeded the lime kiln smelting and wire mill industries, which were established in Oakamoor from the end of the 18th century up until the late 19th century.

1.4 The narrow access track across the structure is presently used only by short wheel base maintenance vehicles and a few private property owners located at the top end of the valley, as well as by many pedestrian ramblers to the nature reserve.

1.5 There is an urgent need to repair severe scour and erosion damage affecting the structure, to safegaurd the bridge from collapse and prolong its life expectancy.

1.6 The survey and close inspection was carried out on Monday 31st October 2005 using a co-ordinated team of three persons due the hazardous nature of the inspection within shallow fast flowing water and confined spaces.

2.0 DESCRIPTION

2.1 The bridge comprises three simply constructed, dry stone culverts or tunnels with a headwall at each end. There is a splayed wingwall at the SE (upstream) approach and NW (downstream) exit.

2.2 The three tunnels vary in height and width. All have large flat capping stones placed at roof level to form a semi-continuous soffit.

2.3 Hammer dressed sandstone blocks generally form both abutments and dividing walls in regular coursed rangework with open (unmortared) joints. The facing upstream headwall has carved angular stone to form the cut-water splitter to dividing walls.

2.4 The geometric arrangement is shown on drawing 3/1499/01 and 02 (Appendix B). The three culvert tunnels are labelled 'A' , 'B' and 'C' for ease of reference.

2.5 Then length of the culvert is approximately 5.8metres. The width of the brook at the upstream entrance is approximately 3.0metres, widening to 3.8metres at the downstream end because of erosion at the SW corner embankment. The depth of cover to the middle soffit slab is approximately 2.0metres.

3.0 OBSERVATIONS

3.1 Schematic representation of the abutments, divding walls and roof condition is shown on drawing 3/1499/03 in Appendix B.

3.2 There is much debris blocking the upstream entrance to Culverts 'A' and 'B'. The majority of the water flow is presently using Culvert 'C'. The depth of water dipped at the downstream exit was 360mm in Culvert 'C', 300mm in Culvert 'B', and 430mm in Culvert 'A'

3.3 The southern abutment wall generally consists of regular coursed sandstone blocks of approximate size 500mm long by 240mm high by 500mm deep, (approximate unit weight 145kg). Five courses of rubble stonework give 1.27metre height. Bottom $1^1/_2$ courses stained dark due to mineral deposits showing normal water level.

3.4 Soffit slab stones to side Culvert 'A ' measure generally 370mm deep and up to 690mm in width. Soffit slab stones to middle Culvert 'B' measure generally 330mm deep and vary between 450mm and 600mm in width. Soffit slab stones to side Culvert 'C' measure generally 360mm deep. The estimated dead weight of the largest slab stones is in the region of 750kg.

3.5 The northern abutment consists of larger stones, three courses over 1140mm height to culvert 'C'

3.6 Localised collapse at the SW corner of the south abutment has resulted in significant disturbance of the earth fill and erosion to the embankment on the SW approach.

3.7 There is little evidence of significant seepage of water through the deck and soffit leading to staining and loss of supporting material from the road above.

3.8 The headwalls, spandrel walls and wingwalls are heavily overgrown with moss and other micro-vegetation growth.

3.9 There are a few semi-mature trees growing close to the structure. Several roots have penetrated the open joints in the downstream headwall.

3.10 Observation and defects noted to the structure are:

<u>Culvert 'A'</u>

Ch. 0.1 – 1.6m Corner section of S Abutment completely missing at upstream end behind wingwall junction. All except 3No large stones have been washed out leaving a scalloped void behind extending into earth bank a distance of up to 1120mm from the abutment face. Soffit stones slabs have been left hanging, supported only as a cantilever by the downward pressure at the internal wall support.

Ch. 1.6 – 2.4m Adjacent section of south abutment wall has major scour to the lower section of wall with 50% of the stonework missing.

Ch. 3.0m	200mm dia. void at upper level of south abutment wall (birds nest)
Ch 3.0 – 4.5m	Severe scour to lower section of south abutment wall, 500mm back to earth face.
Ch 4.6 – 5.1m	South abutment stonework missing, and roof slab minimal support
Ch 4.8m	North side dividing wall has small stone infill (past repair?)
Ch. 5.1 – 5.8m	South abutment and soffit slab stonework completely missing, exposing earth behind.

Culvert 'B'

Ch. 0.0 – 0.6m	Soffit slab has missing stone support in RH (north) wall.
Ch 1.8m	Small hole through to Culvert 'A' at high level.
Ch. 2.8m	Small loose stones in bed floor and drop 100mm
Ch. 4.0m	Small wier in floor drops further 200mm in level.
Ch. 4.8m	Small stone infill (repair?) to LH wall at low level, measures 200mm by 250mm.

Culvert 'C'

Ch. 0.8 – 2.3m	Small stone rubble has been placed at low level on LH dividing wall.

4.0 CONCLUSIONS & RECOMMENDATIONS

4.1 With the exception of the southernmost culvert 'A', Cotton Dell bridge is considered generally to be in a fair condition, if appearing slightly tired and worn.

4.2 Culvert 'A' is in a poor, and unstable condition. There is an acute risk of partial collapse as sections of the roof slab are presently not well supported if at all, due to the severe scour condition and loss (washout) of material.

4.3 Because of the current very frail condition, we would advise that a 1.5T weight limit be immediately be placed on the bridge until such time as permanent repairs and/or stabilisation work can be carried out. . Under normal circumstances, there would be no great concern over the load carrying capacity of the masonry structure as there is a considerable depth of cover compared to the bridge span.

4.4 The severe scour and loss of stone from the south abutment has most probably occurred over many years during storm torrent flow conditions.

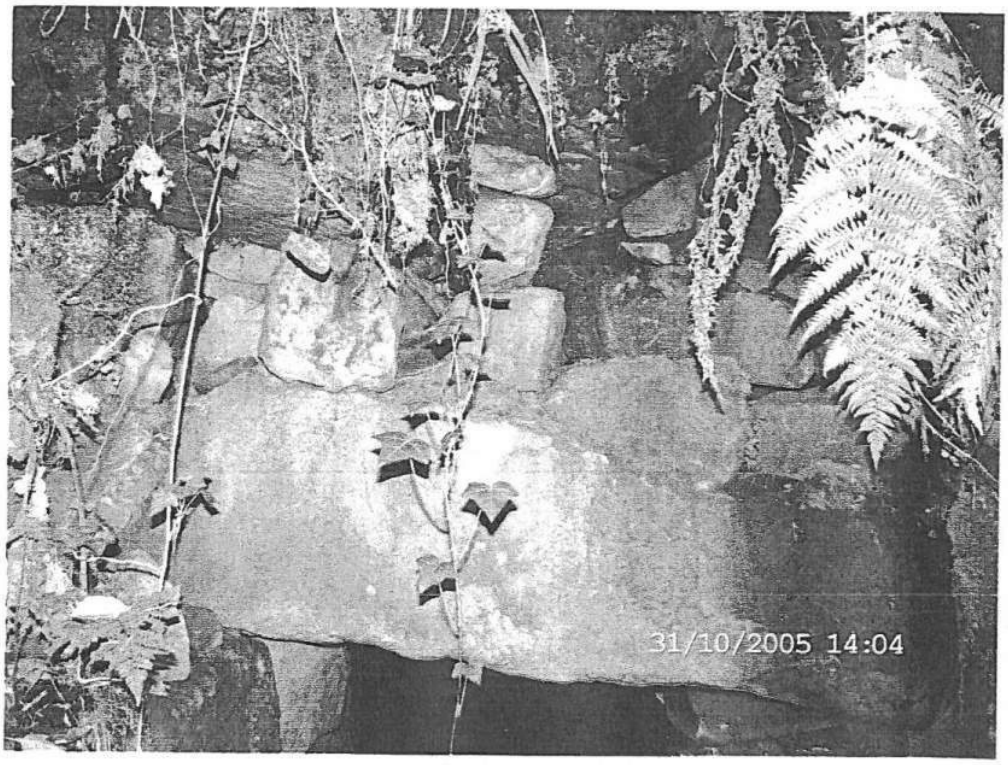
4.5 Options for repair are limited by the economics and logistics for carrying out the necessary work in a safe and practicable manner. Alternative strategies are suggested in Appendix C.

Appendix A

Photographs

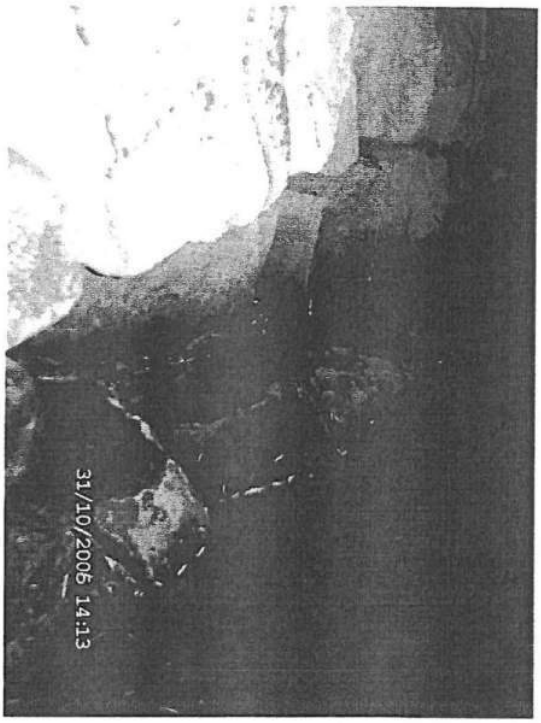
Note: Unless specified otherwise, any chainage dimensions through the culverts are taken from the downstream entrances.

Photograph 1 – Downstream Headwall, Culvert "B".

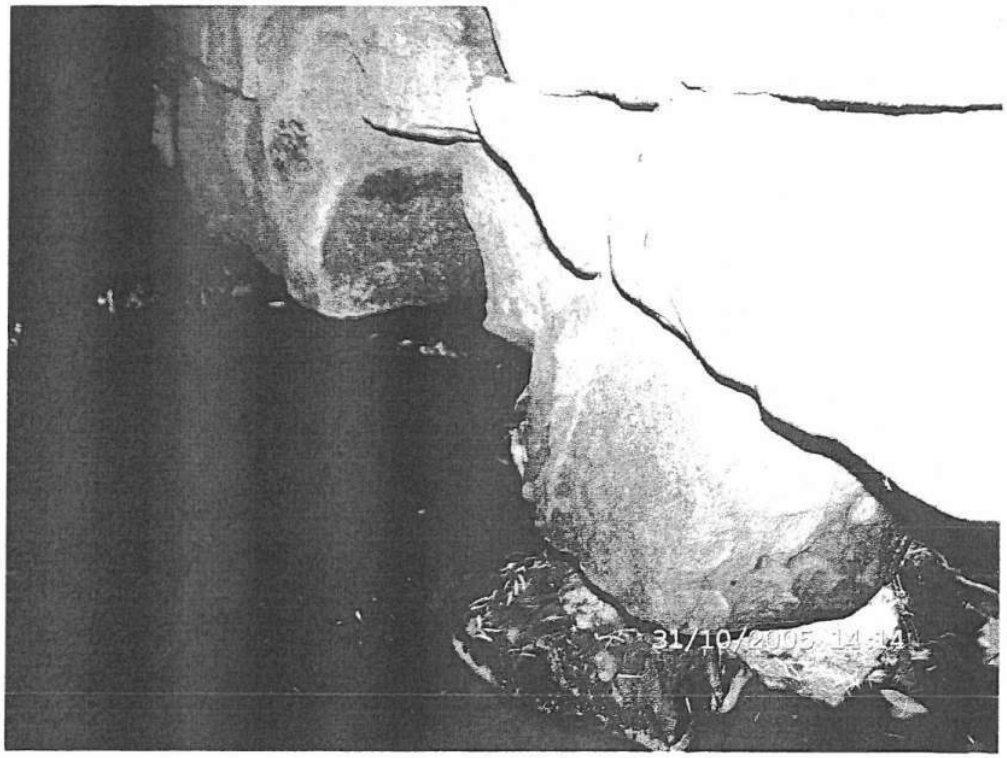


Photograph 2 – Downstream Collapsed Headwall, Culvert "A".

Photograph 3 – Downstream Headwall, Culvert "C".

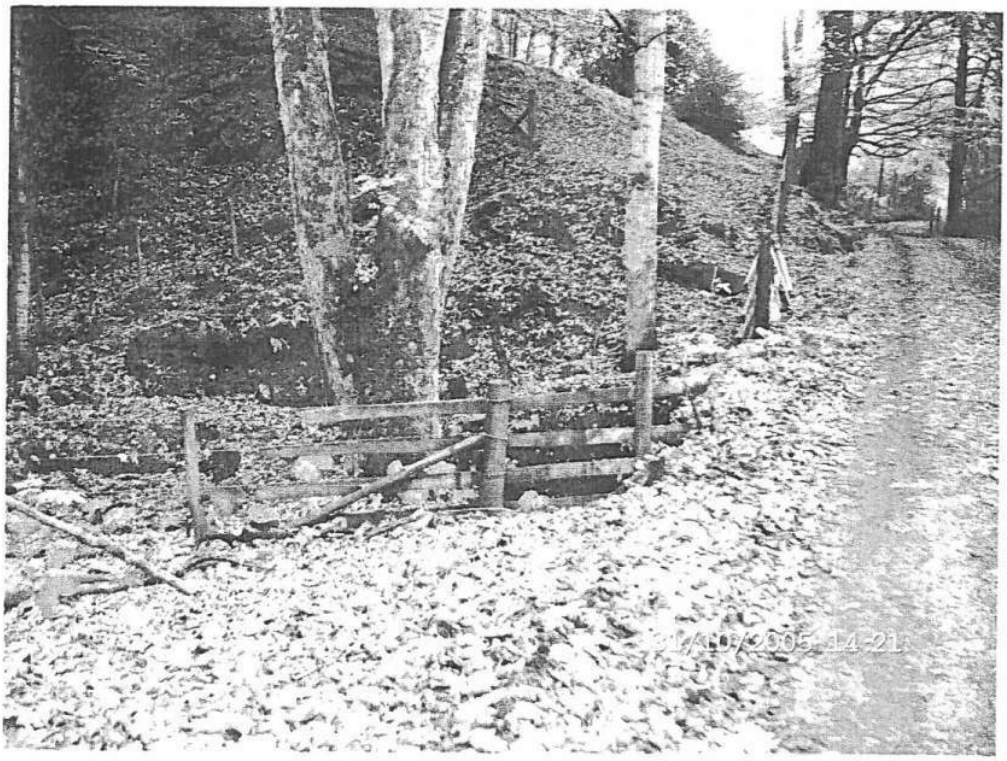


Photograph 4 – Culvert "A" at 1.0m, Left Hand Wall.



Photograph 5 – Culvert "A", at 1.0m to 3.0m, Right Hand Abutment Wall.

Photograph 6 – View Along Track Looking North.

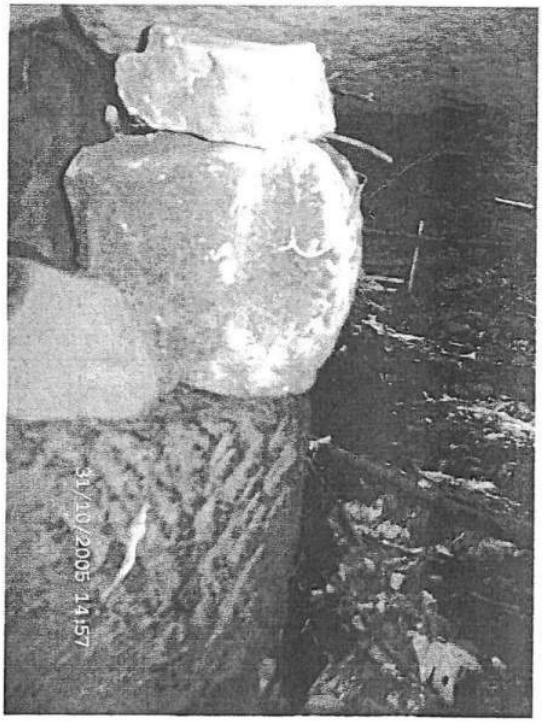


Photograph 7 – View Looking South Across Upstream Headwall.

Photograph 8 – View Looking South Across Downstream Headwall.

Photograph 9 – Scour at Downstream Entrance to Culvert "A".

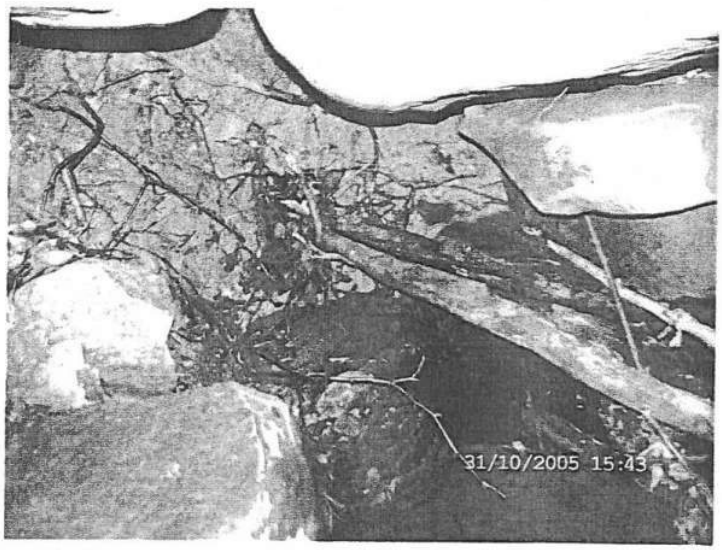
Photograph 10 – Culvert "B" at 1.8m, Step Weir in Floor.



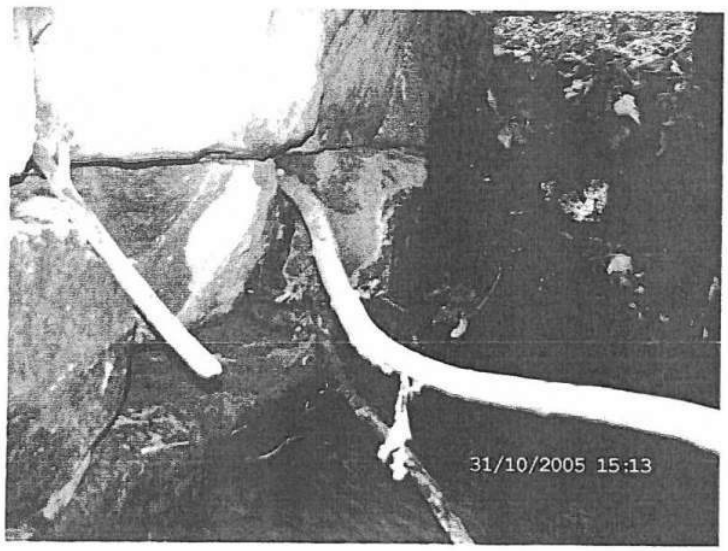
Photograph 11 – Culvert "B" at 4.6m, Left Hand Wall Support.

Photograph 12 – Culvert "B", Debris Blockage at Upstream Entrance.

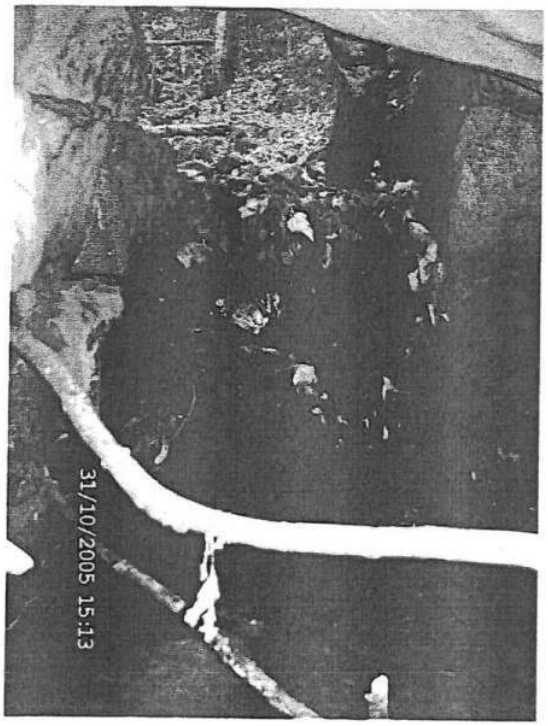
Photograph 13 – Culvert "A" at 4.2m to 5.5m, Right Hand Abutment, Deep Scour.



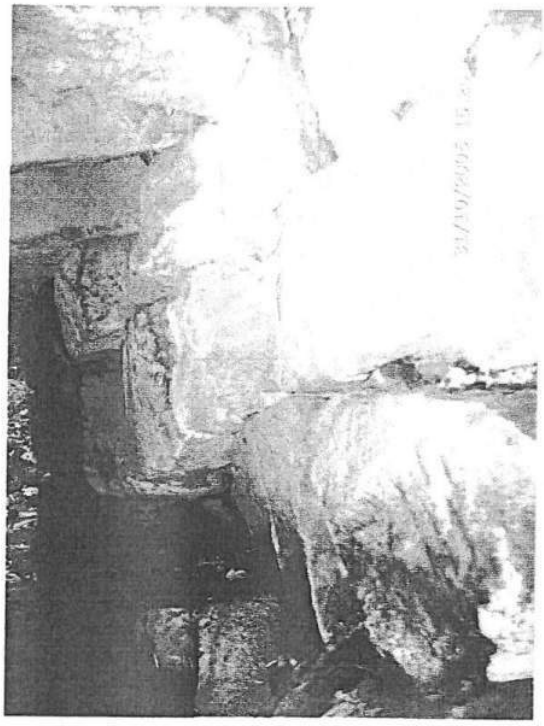
Photograph 14 – Culvert "A" at 4.2m, Right Hand Abutment, Deep Scour.



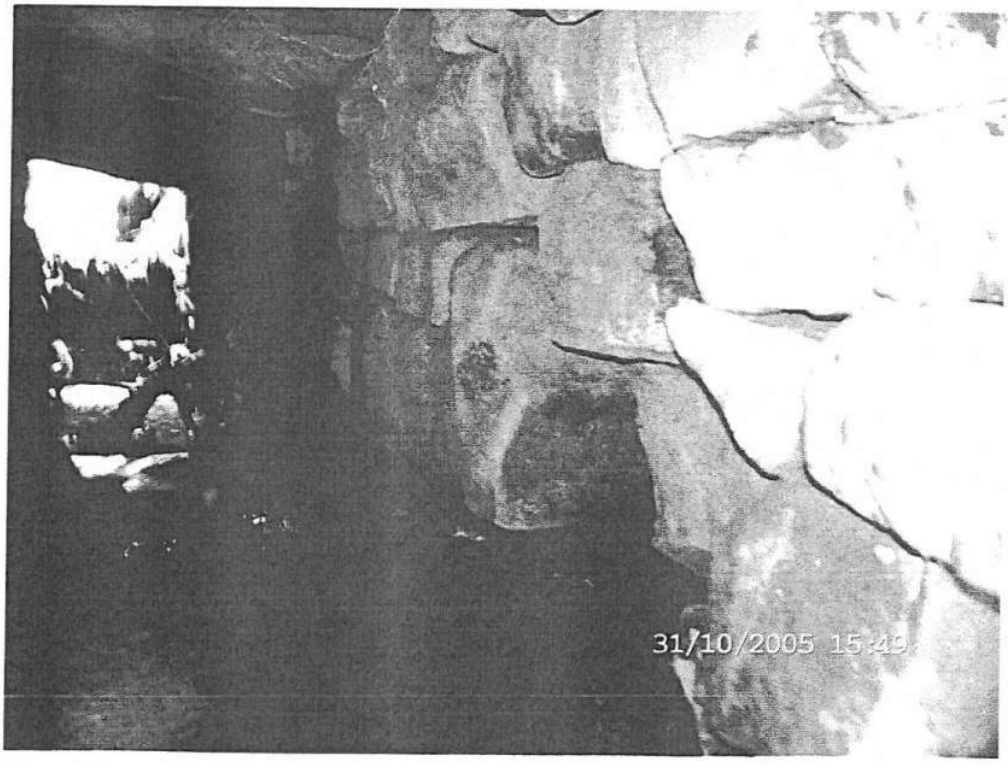
Photograph 15 – Culvert "A" at 4.5m to 5.5m, Left Hand Wall Support.



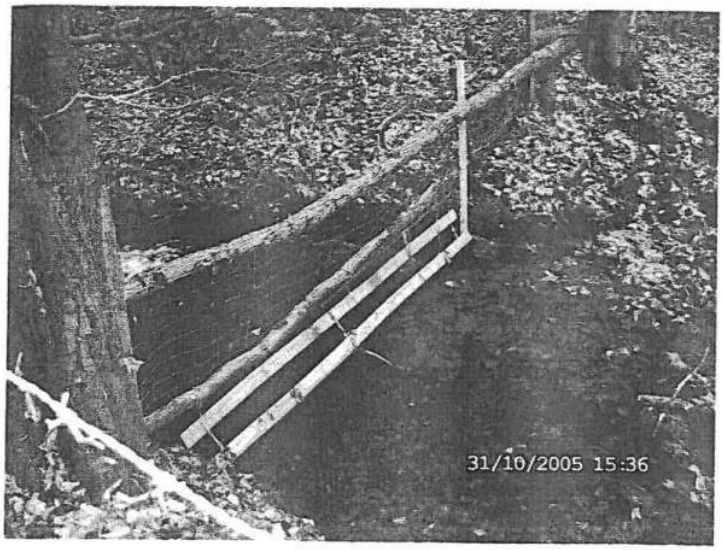
Photograph 16 – Culvert "A", Debris Blockage at Upstream Entrance.



Photograph 17 – Culvert "A" at 3.0m to 1.0m, Left Hand Wall Support.

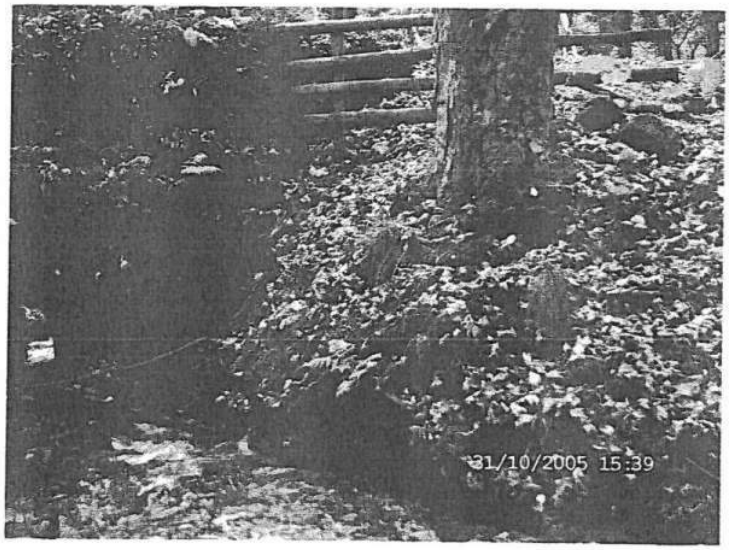


Photograph 18 – Culvert "A" at 1.0m to 3.0m, Right Hand Abutment Scour.



Photograph 19 – Debris Trap Barrier Upstream.

Photograph 20 – South East Upstream Wingwall.



Photograph 21 – North East Upstream Wingwall

Photograph 22 – South East Wingwall Voids.

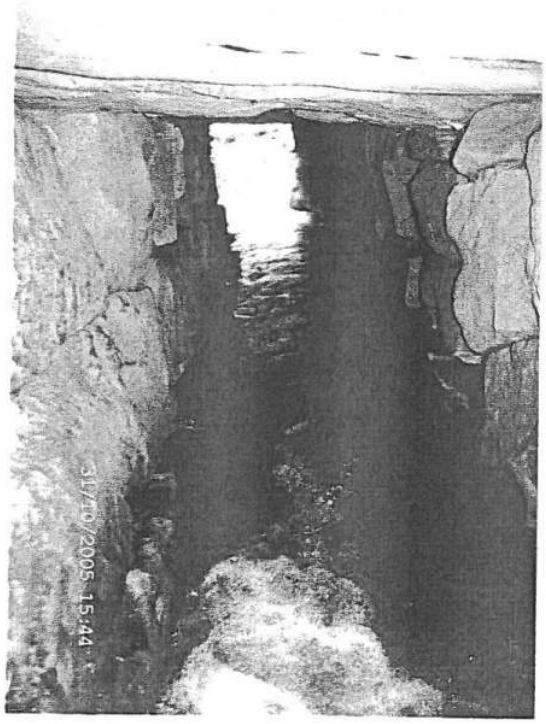
Photograph 23 – Upstream Headwall, Culvert "A".

Photograph 24 – Upstream Headwall, Culvert "B".

Photograph 25 – Upstream Top Spandrel Soldier Course.

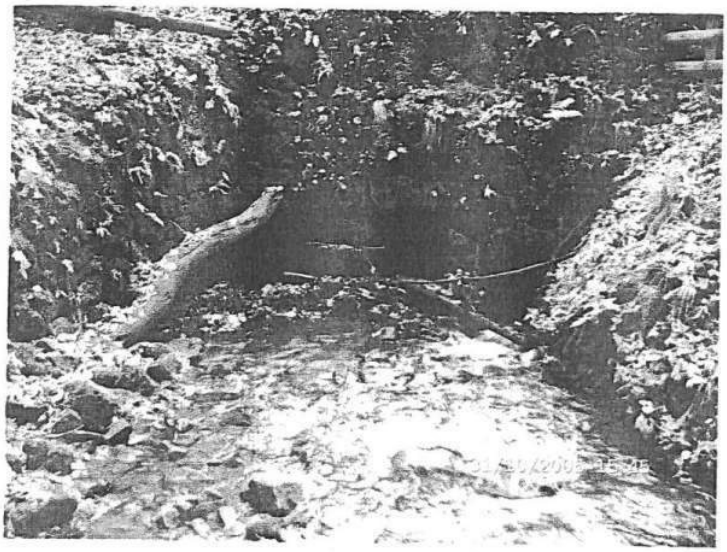
Photograph 26 – Upstream Headwall, Culvert "C".

Photograph 27 – View Through Culvert "A" From Upstream Entrance.

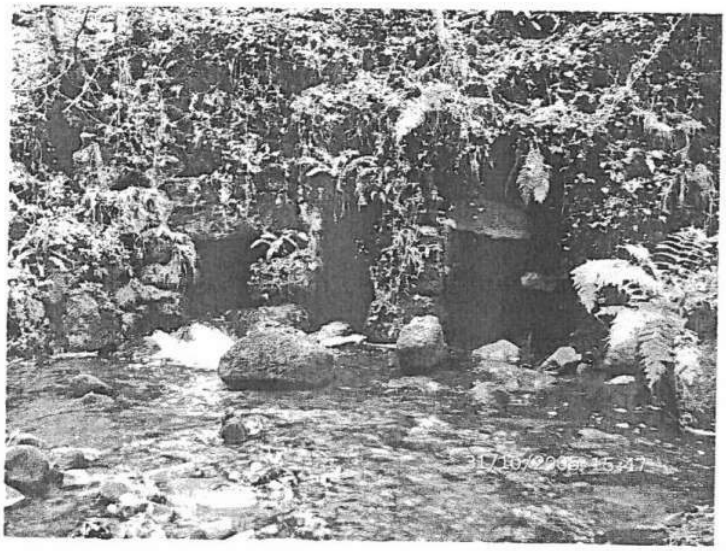


Photograph 28 – View Through Culvert "B" From Upstream Entrance.

Photograph 29 – Loose Boulders in Stream Bed Upstream.

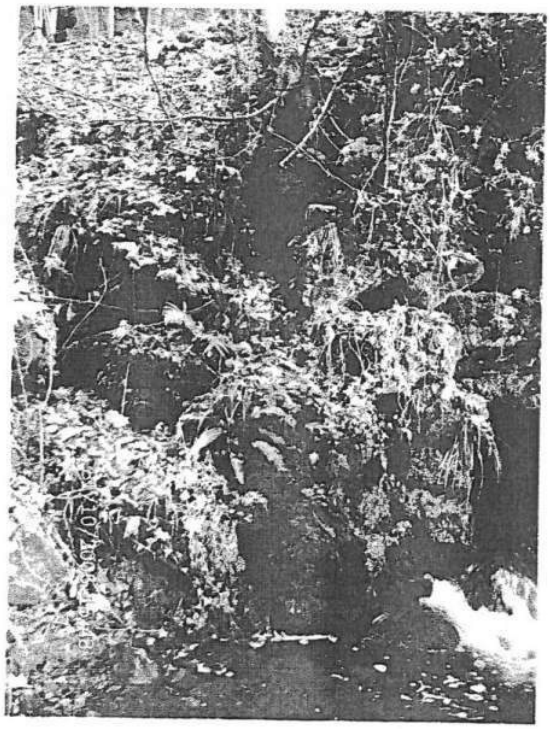


Photograph 30 – Upstream Elevation.

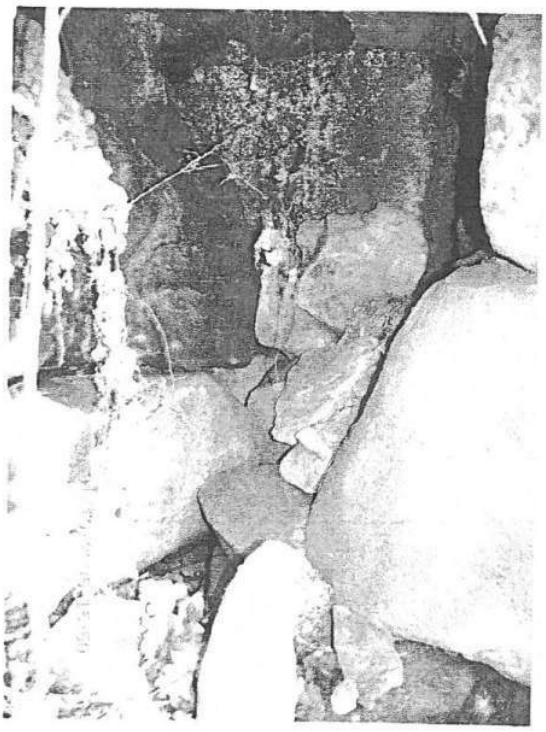


Photograph 31 – Downstream Elevation.

Photograph 32 – Downstream South West Wingwall.



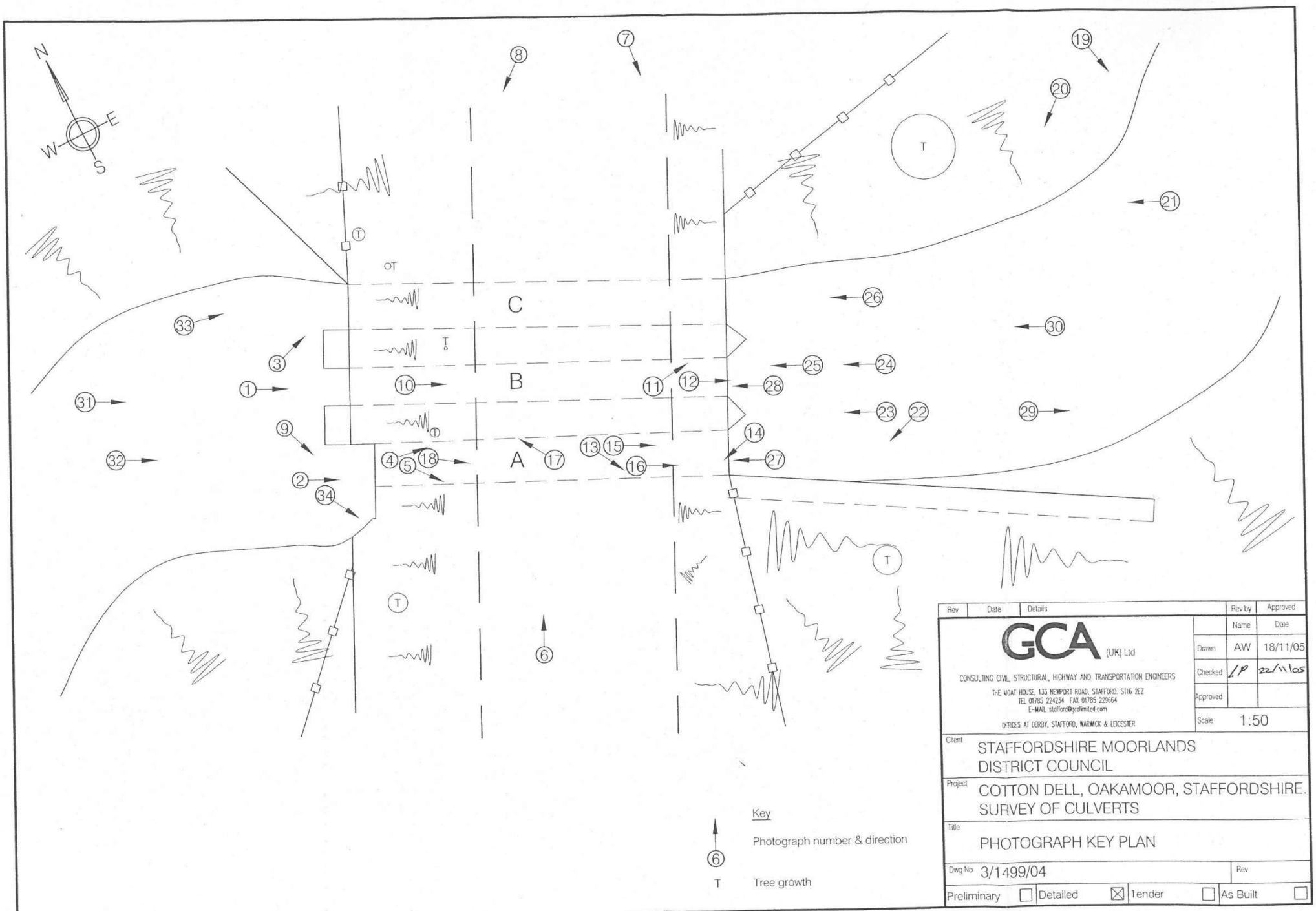
Photograph 33 – Downstream North West Wingwall.



Photograph 34 – Back Face of Downstream (Missing) Headwall at Culvert "A".

Appendix B

Geometrical arrangement survey drawings



Rev	Date	Details	Rev by	Approved

GCA (UK) Ltd

CONSULTING CIVIL, STRUCTURAL, HIGHWAY AND TRANSPORTATION ENGINEERS

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	Name	Date
Drawn	AW	18/11/05
Checked	LP	22/11/05
Approved		
Scale	1:50	

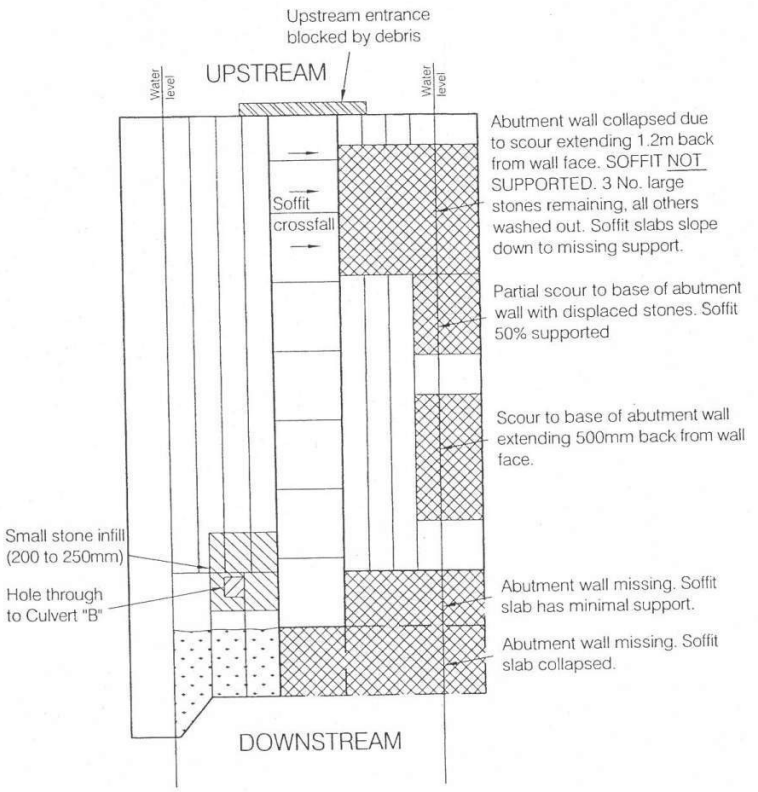
Client: STAFFORDSHIRE MOORLANDS DISTRICT COUNCIL

Project: COTTON DELL, OAKAMOOR, STAFFORDSHIRE. SURVEY OF CULVERTS

Title: PHOTOGRAPH KEY PLAN

Dwg No 3/1499/04 Rev

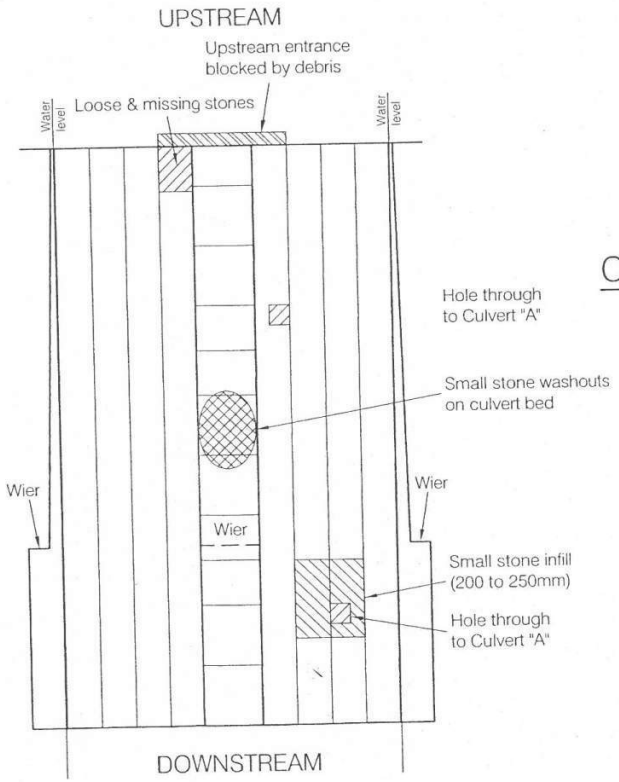
Preliminary ☐ Detailed ☒ Tender ☐ As Built ☐



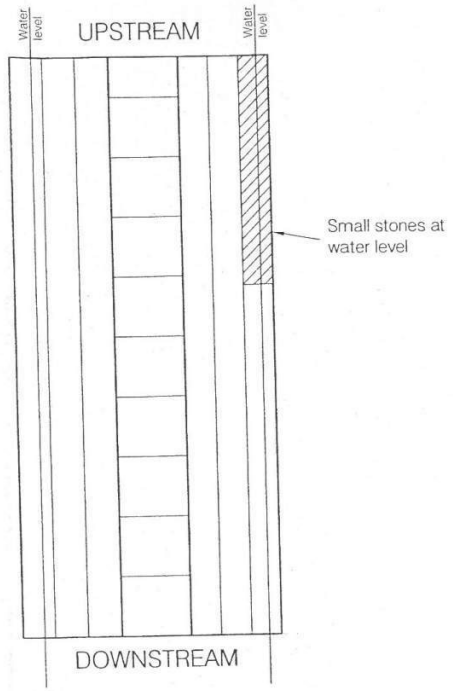
Culvert "A" - Abutment Walls & Roof

Key

- Wall overgrown with vegetation
- Wall covered with moss growth
- Area of damage to stonework
- Area of missing stonework
- T Tree growth



Culvert "B" - Walls & Roof



Culvert "C" - Abutment Walls & Roof

Note: Flow is mostly through Culvert "C" due to Culverts "A" & "B" being blocked by debris at their upstream entrances.

Rev	Date	Details	Rev by	Approved

GCA (UK) Ltd
CONSULTING CIVIL, STRUCTURAL, HIGHWAY AND TRANSPORTATION ENGINEERS
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	Name	Date
Drawn	AW	18/11/05
Checked	I.P.	22/11/05
Approved		
Scale	1:50	

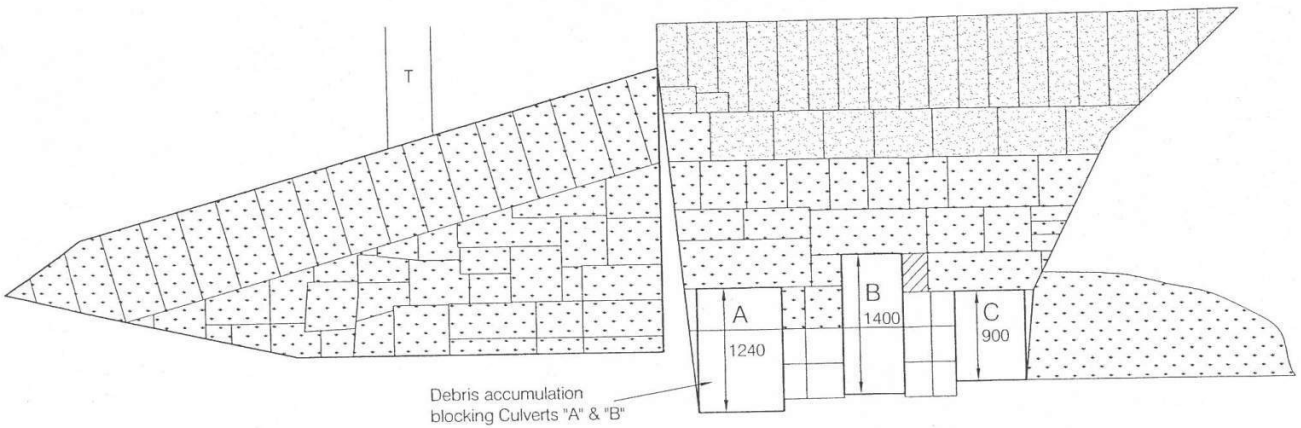
Client: STAFFORDSHIRE MOORLANDS DISTRICT COUNCIL

Project: COTTON DELL, OAKAMOOR, STAFFORDSHIRE. SURVEY OF CULVERTS

Title: CULVERT SCHEMATIC PLANS

Dwg No: 3/1499/03 Rev

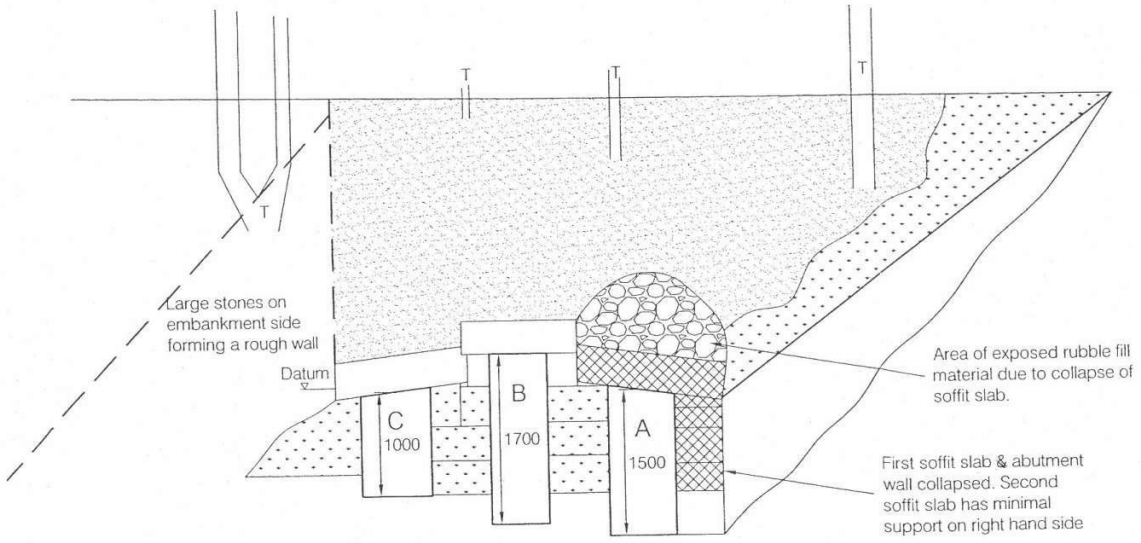
Preliminary ☐ Detailed ☒ Tender ☐ As Built ☐



Upstream Elevation (1:50)

Key

- Wall overgrown with vegetation
- Wall covered with moss growth
- Area of damage to stonework
- Area of missing stonework
- T Tree growth



Downstream Elevation (1:50)

Rev	Date	Details	Rev by	Approved

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	Name	Date
Drawn	AW	18/11/05
Checked	LP	22/11/05
Approved		
Scale	1:50	

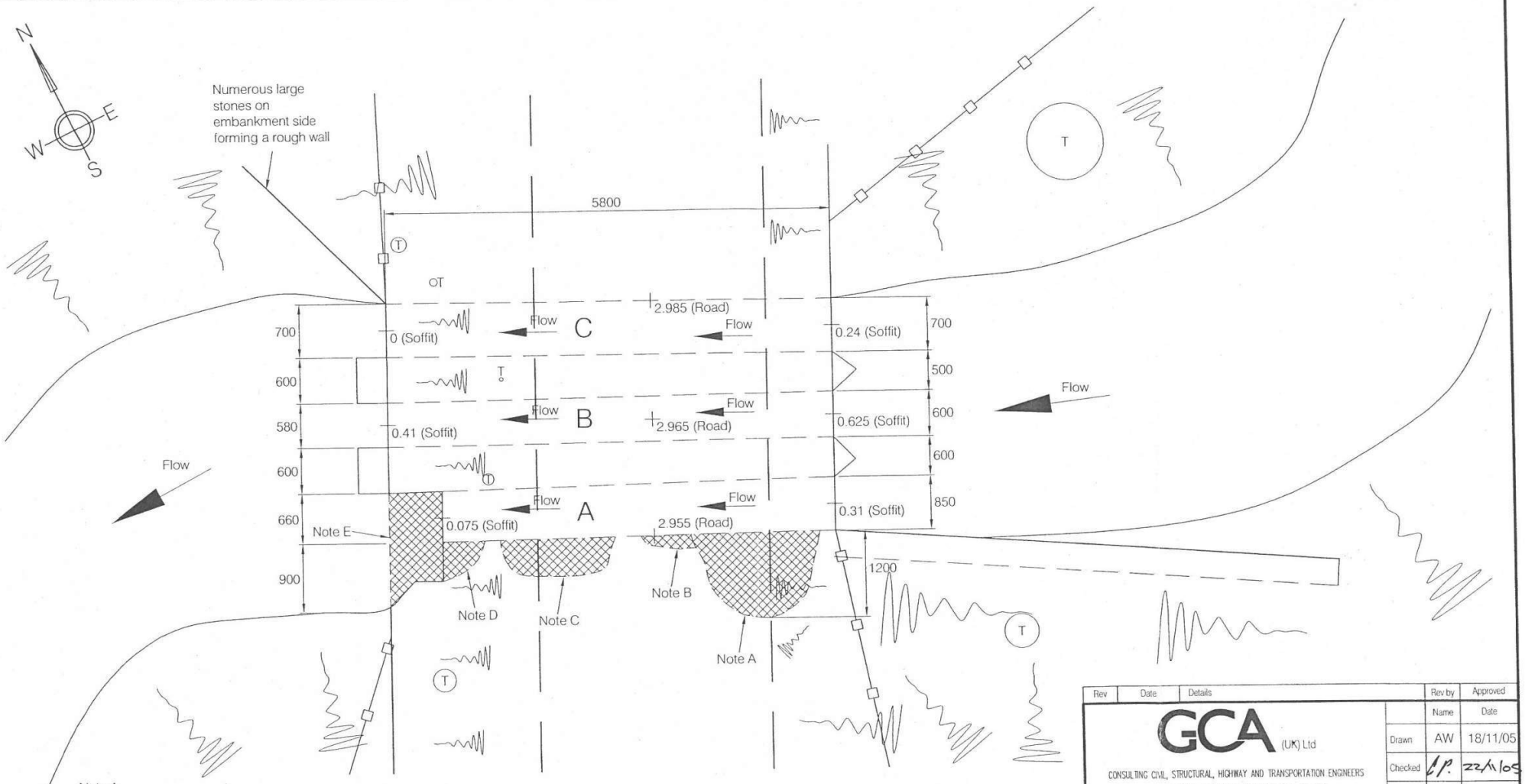
Client: STAFFORDSHIRE MOORLANDS DISTRICT COUNCIL

Project: COTTON DELL, OAKAMOOR, STAFFORDSHIRE. SURVEY OF CULVERTS

Title: ELEVATIONS

Dwg No: 3/1499/02 Rev

Preliminary ☐ Detailed ☐ Tender ☒ As Built ☐



Note A
Abutment wall collapsed due to scour. SOFFIT NOT SUPPORTED. 3 No. large stones remaining, all others washed out. Soffit slabs slope down to missing support.

Note B
Partial scour to base of abutment wall with displaced stones. Soffit 50% supported

Note C
Scour to base of abutment wall extending 500mm back from wall face.

Note D
Abutment wall missing. Soffit slab has minimal support.

Note E
Spandrel wall missing. Soffit slab collapsed.

Key

- Wall overgrown with vegetation
- Wall covered with moss growth
- Area of damage to stonework
- Area of missing stonework
- T Tree growth

Rev	Date	Details	Rev by	Approved
			Name	Date
		Drawn	AW	18/11/05
		Checked		
		Approved		
		Scale	1:50	

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Client: STAFFORDSHIRE MOORLANDS DISTRICT COUNCIL

Project: COTTON DELL, OAKAMOOR, STAFFORDSHIRE. SURVEY OF CULVERTS

Title: GENERAL ARRANGEMENT PLAN

Dwg No: 3/1499/01 Rev

Preliminary ☐ Detailed ☒ Tender ☐ As Built ☐