

CSB – ABUTMENT GEOTECHNICAL WORKS

TITLE CLIFTON SUSPENSION BRIDGE - ABUTMENT
GEOTECHNICAL WORKS – REV 02

DATE 18th June 2020

TO Key Stakeholders

COPY Trish Johnson (CSBT)

FROM Sam Wood (SAWO)

PROJECT NO A065600-086

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1 Project Background

Clifton Suspension Bridge spans the Avon Gorge joining Clifton in Bristol to Leigh Woods in North Somerset. The bridge towers are founded on two masonry abutments. The Clifton Abutment, on the eastern side of the Avon Gorge, is situated on the top of a high, steep cliff face.

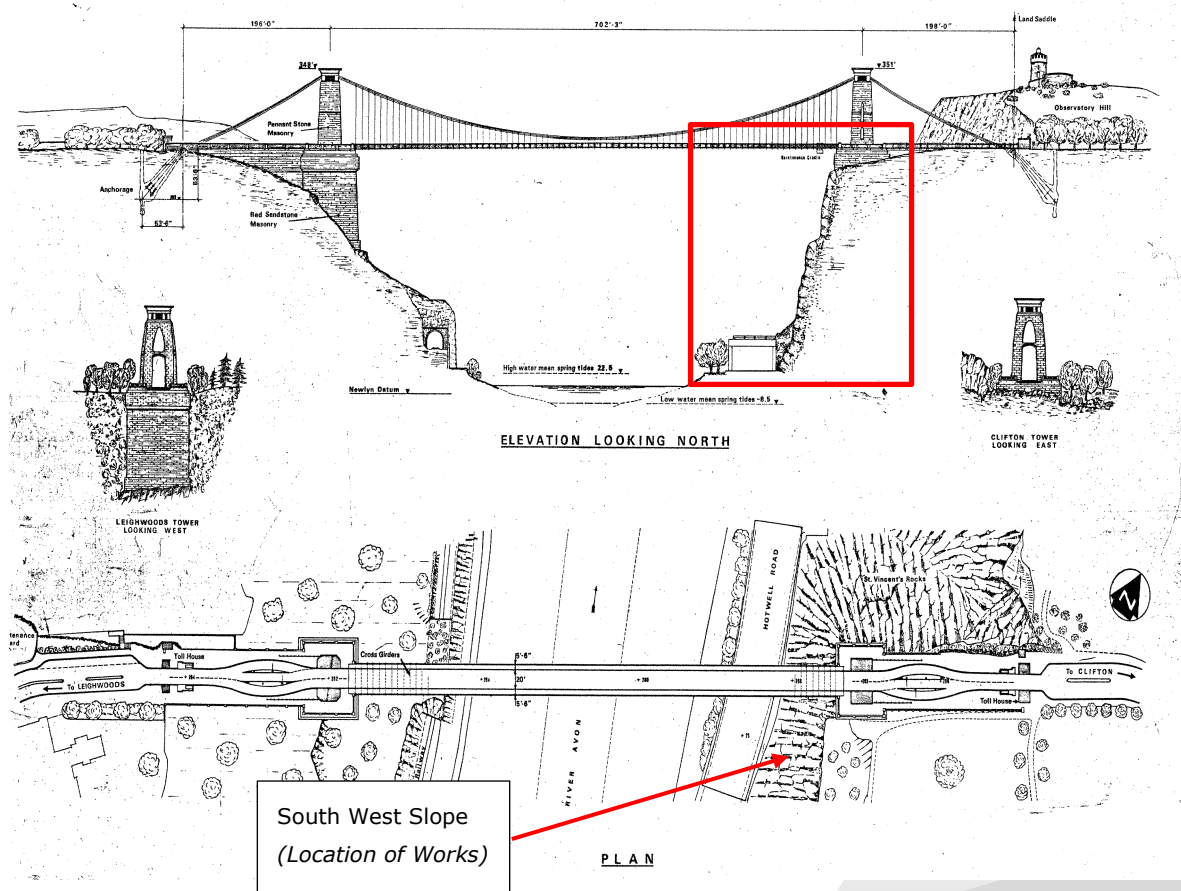


Figure 1 – Clifton Suspension Bridge General Arrangement

Image taken from CSBT Archive drawing by Howard Humphrey's (Consultant Engineers to the CSBT prior to 2006)

In accordance with the aims of the Clifton Suspension Bridge Trust (CSBT), CSBT invests each year in investigation, evaluation and maintenance of the Bridge superstructure. In recent years CSBT appointed Geo-Design to undertake an assessment of the stability of the Clifton Abutment.

The Bridge Abutment Foundation Stability Assessment was completed in 2017 and made the following recommendations for the ongoing maintenance of the slope:

Based on the studies carried out, the outermost zone of the Outer Abutment Zone (OAZ), see Figure 2, has been found to have undergone deformation in the past arising from gorge formation and subsequent bridge loading. It is currently in a de-stressed and weak condition and although the zone does not contribute directly to the load bearing capacity of the foundation it provides confinement to areas of the rock mass that does carry the bridge loads. It is vital therefore that this area of the slope is maintained, and further deterioration or displacement is prevented.

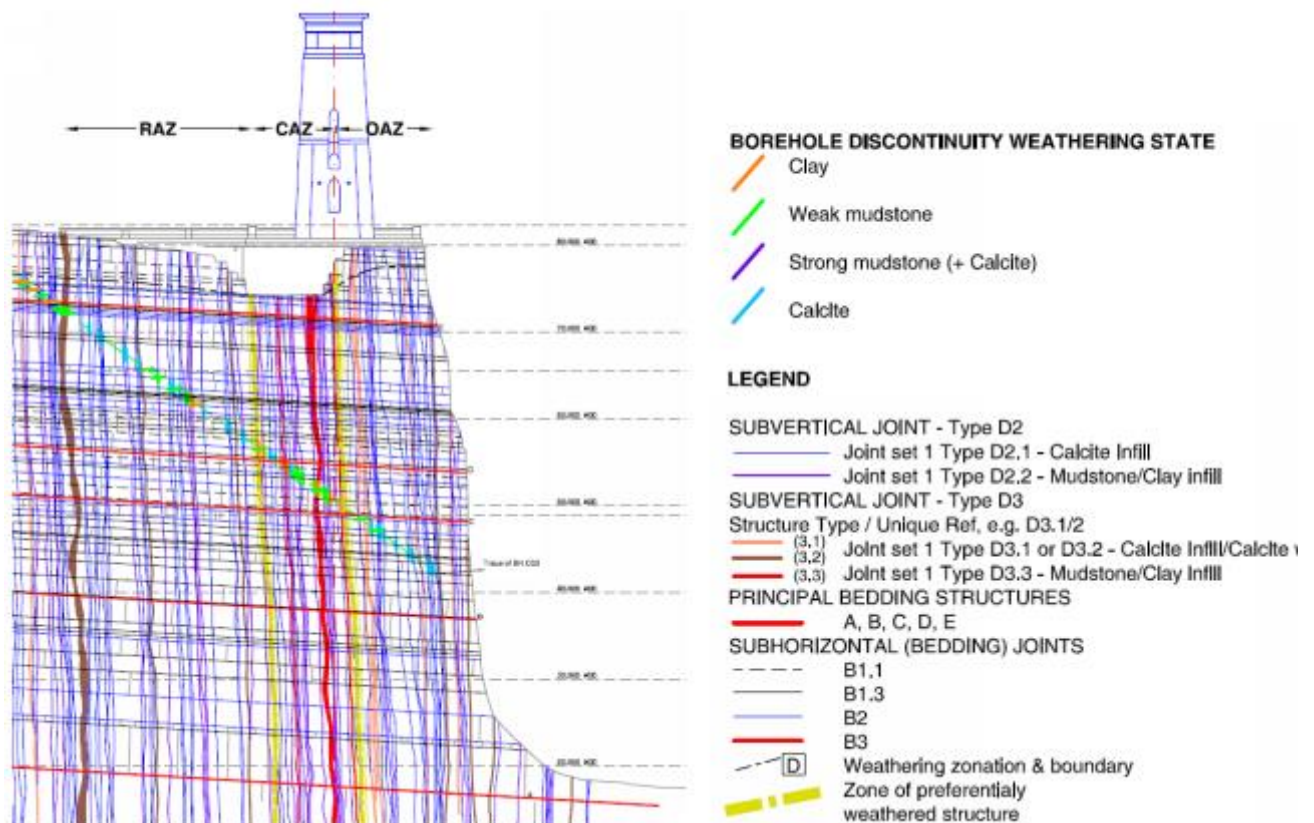


Figure 2 - Longitudinal section through Clifton Abutment

(RAZ – Rear Abutment Zone, CAZ – Central Abutment Zone, OAZ – Outer Abutment Zone)

Maintenance and limited stabilisation work has been done in this area of the slope in the past and this needs to be updated and upgraded. The past practice of prising off loose blocks (scaling) during annual inspections should be discontinued and a new regime of maintenance put in place. Future work should comprise the following:

- > Carry out strengthening works based on rock reinforcement of the adversely affected regions of the face, comprising the exposed edges of the joint bounded columns / slabs. There are approximately 9 No. existing rock bolts of unknown length and capacity in these areas of the slope, that were installed in the 1970's (or early 80's) these should be replaced and enhanced.
- > Repair and extend areas of dentition and joint infill protection works.

2 Project Scope

CSBT intend to proceed with Geo-Design's recommendations for preserving the rock slope and have been working with COWI and Geo-Design to develop the design, prepare tender documents and engage with stakeholders to secure consent for the works.

The proposed works consist of the following:

- > Rock Bolting – installation of 23No. passive rock bolts approx. 4-5m long in the Clifton Abutment rock face. Subvertical joints (fractures in the rock referred to as 'JS1 joints') trend sub-parallel to the rock face and form rock 'slabs' on the face, the purpose of the rock bolts is thus to preserve these vulnerable sections of the 'Outer Abutment Zone' (i.e. the Clifton Southwest Slope) such that it continues to provide confinement to the load bearing central abutment zone (CAZ) located immediately beneath the Clifton Tower.
- > Dentition – dentition of selected principal JS1 joints to reduce surface water infiltration, prevent vegetation growth and protect erodible material. Dentition comprises infilling of naturally occurring gaps and voids that are present between the JS1 joint (fracture) surfaces with a small volume of cementitious grout, an example of the nature of the dentition proposed is presented below.



Figure 3 - Example joint dentition showing sketch cross section of dentition (left) and example of open section of JS1 joint

- > Temporary Works – the design, checking, supply, erection, testing, maintenance and dismantling of all temporary works necessary for the safe execution of the Works.

Refer to Geo-Design Drawing CSB/GD/SB/001 for further details of the location of the rock bolts and dentition. The works will be undertaken using rope access techniques.



Figure 4 - Example drilling rig

Initial discussions with Contractors indicate the works are likely to last approximately 12 weeks and will be undertaken in Autumn 2020 subject to securing consents and tendering the works.

Disruption to bridge users and local residents will be minimal, with the carriageway and both footways open to the public at all times. The majority of works will be below the level of the bridge deck, however, a small temporary compound will be required adjacent the Clifton abutment to provide storage and welfare facilities for the contractor (subject to Landowner approval). An access route from the compound along Sion Hill will be used to access the rockface (again subject to Landowner approval). The works will be undertaken during normal working hours. Information boards will be displayed on site to inform members of the public about the scope of works, progress and items of interest.

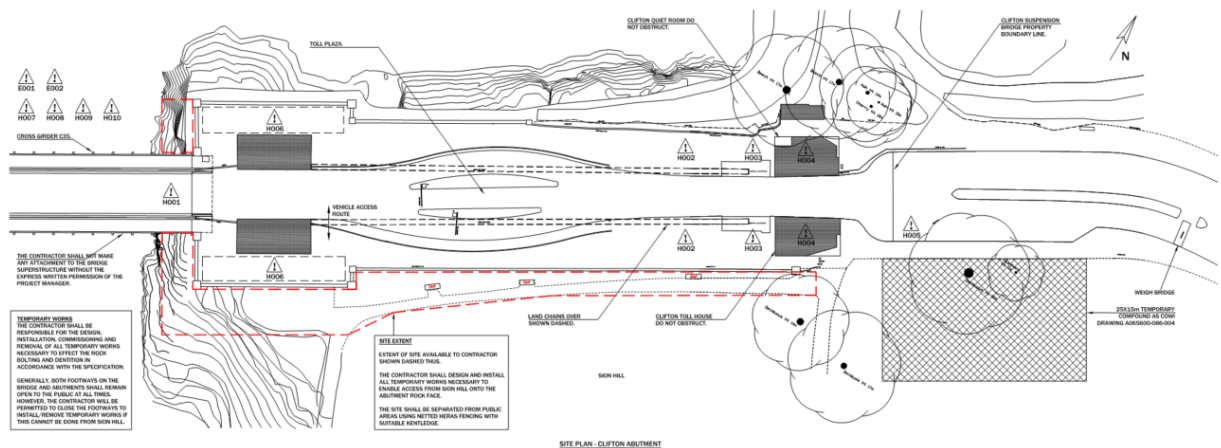


Figure 5 - Plan of Clifton Abutment (Proposed Temporary Compound shown hatched)

The Avon Gorge is a Site of Special Scientific Interest (SSSI). Consent for the Works is currently being requested from Natural England and CSBT will work with the Contractor to implement suitable environmental controls.

3 Next Steps

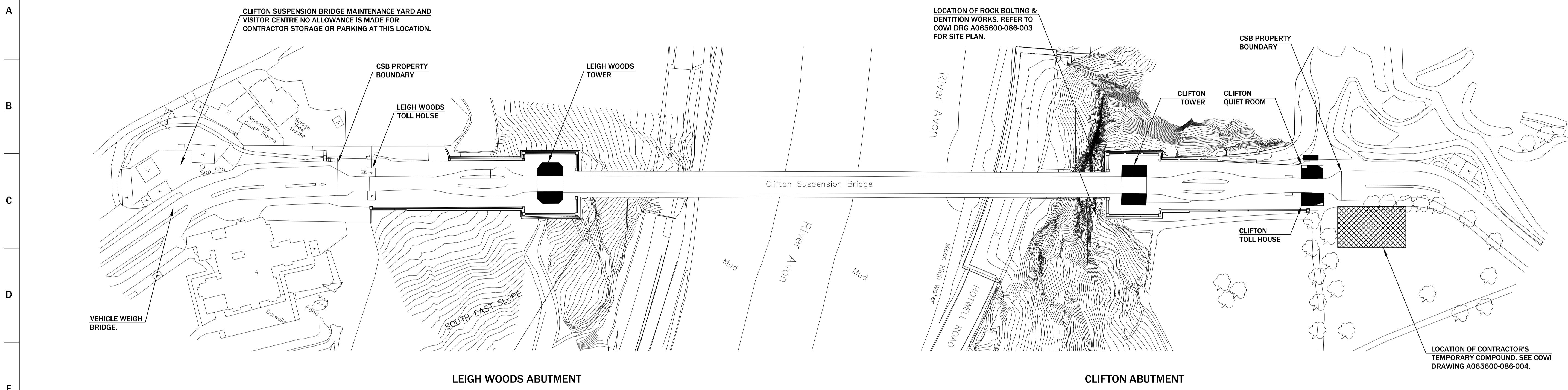
This document has been prepared to inform key stakeholders of the proposed works and to provide a basis for further discussion of the project.

CSBT look forward to discussing the project with stakeholders over the coming months with a view to securing relevant consents for these necessary maintenance works. In the meantime, if you have any questions, comments or concerns please do not hesitate to contact the Bridge Master – Trish Johnson (bridgemaster@cliftonbridge.org.uk).

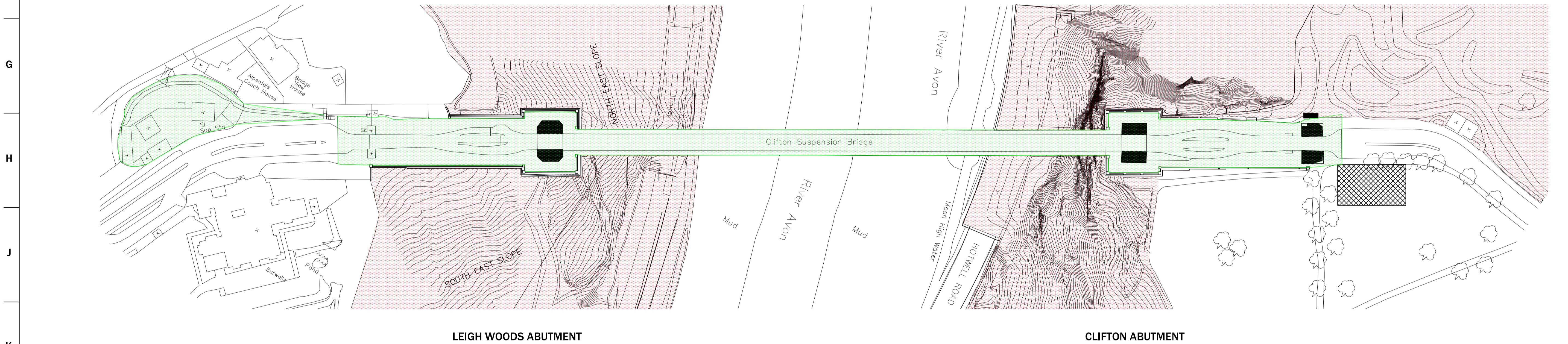
Sam Wood
For COWI UK Ltd.

Enclosures:

- > Geo-Design Drawings
- > COWI Drawings



CLIFTON SUSPENSION BRIDGE - SITE LAYOUT
SCALE 1:750



CLIFTON SUSPENSION BRIDGE - LAND OWNERSHIP
SCALE 1:750

LAND OWNED BY CLIFTON SUSPENSION BRIDGE TRUST

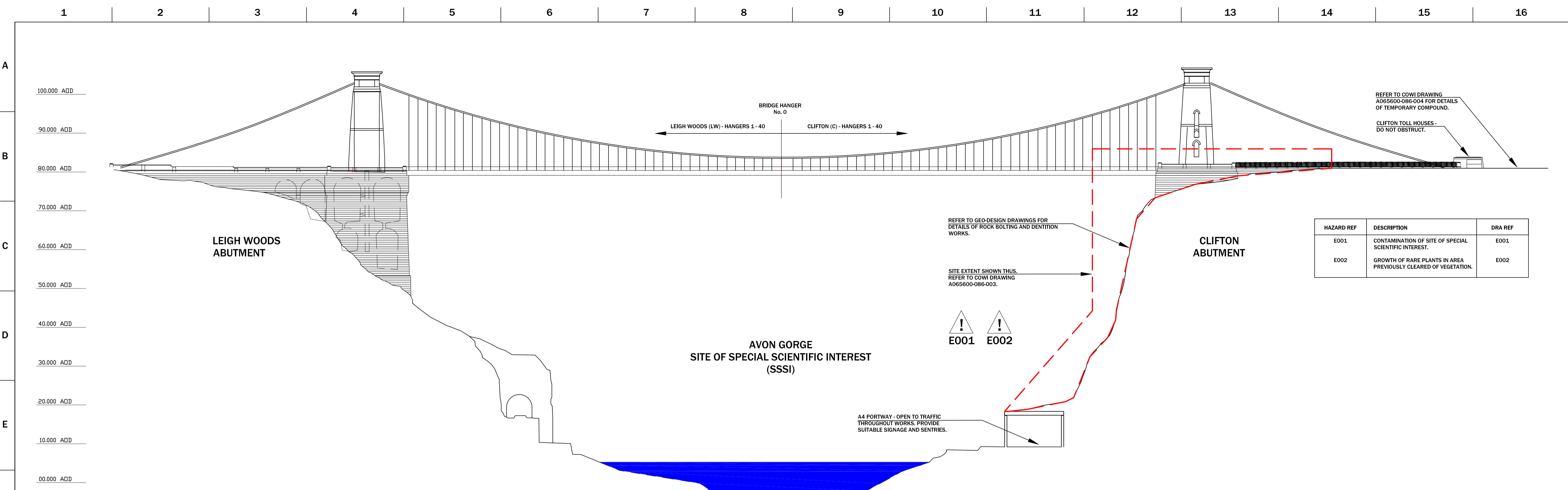
AVON GORGE SITE OF SPECIAL SCIENTIFIC INTEREST

Designers:

Client:

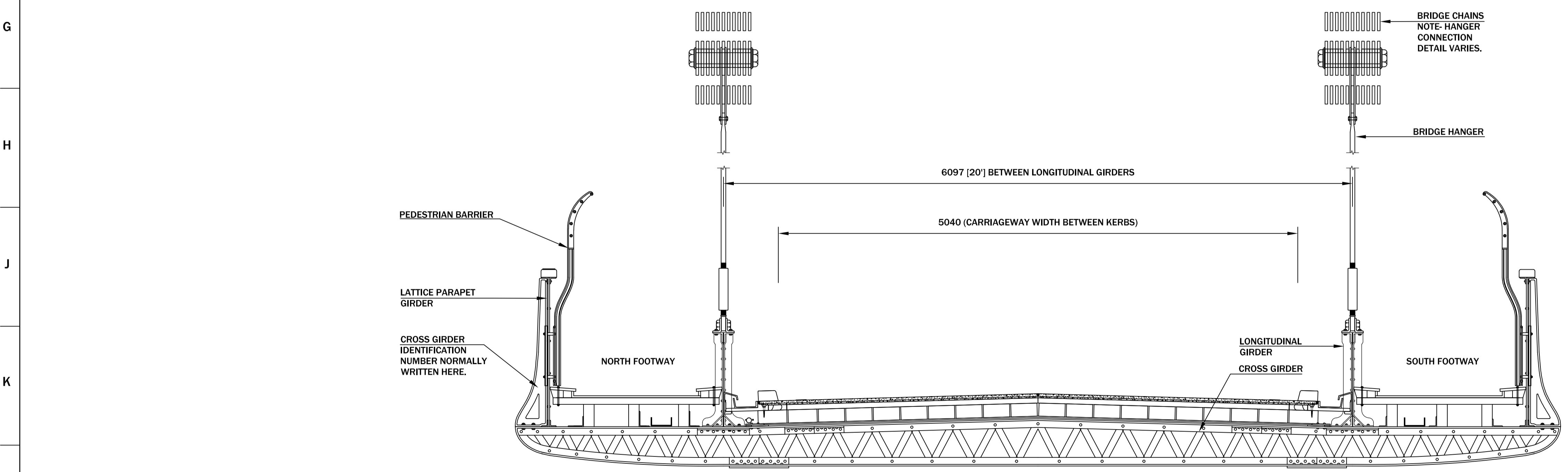
DESIGNED:	SAWO	DATE:	MARCH 2020
DRAWN:	SAWO	DATE:	MARCH 2020
CHECKED:	ASM	DATE:	MARCH 2020
APPROVED:		DATE:	
OWNER:	COWI	PROJECT NO.:	A065600-086
STATUS:	PRELIMINARY		
SCALE:	1:750 @ A1		

Project:	CLIFTON SUSPENSION BRIDGE		
Drawing Title:	ABUTMENT ROCK BOLTING & DENTITION		
	SITE LAYOUT		
Drawing No.:	A065600-086-001		
Rev:	A		



HAZARD REF	DESCRIPTION	DRA REF
E001	CONTAMINATION OF SITE OF SPECIAL SCIENTIFIC INTEREST.	E001
E002	GROWTH OF RARE PLANTS IN AREA PREVIOUSLY CLEARED OF VEGETATION.	E002

CLIFTON SUSPENSION BRIDGE - SOUTH ELEVATION
SCALE 1:750



TYPICAL CROSS SECTION THROUGH BRIDGE
SCALE 1:25

GENERAL NOTES:

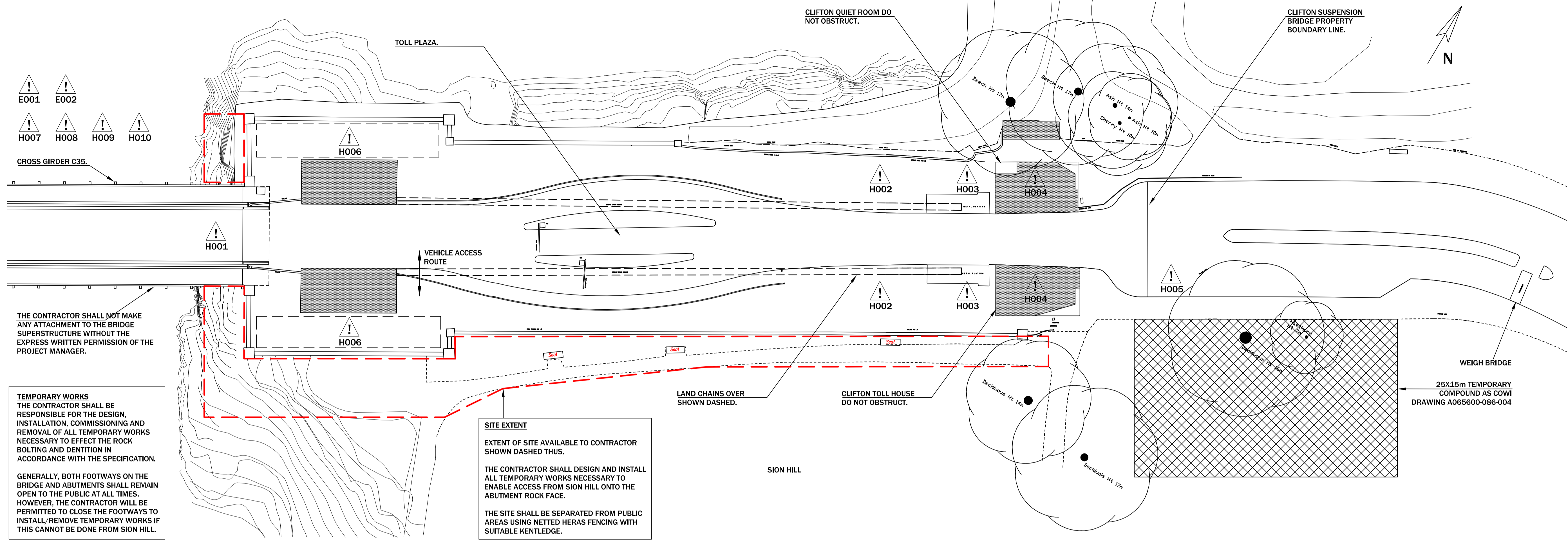
- THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEER'S DRAWINGS, SPECIFICATIONS & DESIGNER'S RISK REGISTERS.. ALL SETTING OUT AND SITE DIMENSIONS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
- THE CONTRACTOR SHALL ENSURE THE STABILITY OF THE EXISTING STRUCTURE IS MAINTAINED AT ALL STAGES OF CONSTRUCTION. HE SHALL DESIGN, INSTALL AND MAINTAIN ALL NECESSARY TEMPORARY WORKS AND PROGRAMME THE WORKS ACCORDINGLY.
- THE CONTRACTOR SHALL LOCATE AND PROTECT ALL SERVICES IN THE VICINITY OF THE WORKS FOR THE DURATION OF THE WORKS.
- THE DRAWINGS AND DETAILS ARE PREPARED USING THE INFORMATION AVAILABLE AND MAY BE AT VARIANCE WITH HIDDEN HISTORIC FABRIC. THE CONTRACTOR SHALL REPORT ANY VARIATIONS OR DIFFERENCES FOUND DURING THE WORK TO COWI.

SITE SPECIFIC NOTES:

- BRIDGE WEIGHT LIMITS ARE AS FOLLOWS:
4 TONNE GROSS VEHICLE WEIGHT
2.5 TONNE AXLE WEIGHT
- NO OVERWEIGHT VEHICLES ARE PERMITTED ON THE BRIDGE AT ANY TIME.
- SITE VEHICLES ARE NOT PERMITTED TO DRIVE OR PARK ON THE FOOTPATHS.
- SITE VEHICLES, EQUIPMENT OR MATERIALS SHALL NOT BE PARKED OR STORED IN ANY LOCATION WHICH MAY CAUSE AN OBSTRUCTION TO THE FOOTWAYS IN USE BY THE PUBLIC, THE BRIDGE TOLL BOOTHS, THE VISITOR CENTRE OR THE BRIDGE MAINTENANCE YARD.
- CROSS GIRDER AND HANGER NUMBERING SYSTEM & COMMON ABBREVIATIONS:
C = CLIFTON LW = LEIGH WOODS
S = SOUTH N = NORTH

CG = CROSS GIRDER
LG = LONGITUDINAL GIRDER
PG = PARAPET GIRDER
- THE BRIDGE NUMBERING SYSTEM STARTS AT 0 AT MID SPAN AND CONTINUES UP TO 40 IN BOTH DIRECTIONS (C AND LW). I.E. LW8 CG = CROSS GIRDER No.8 ON THE LEIGH WOODS SIDE OF THE BRIDGE. C23S = HANGER No.23 ON THE CLIFTON SOUTH QUADRANT.
- ONE FOOTWAY SHALL REMAIN OPEN TO PEDESTRIANS AT ALL TIMES DURING THE WORKS.

		Designed: SAWO Date: MARCH 2020 Drawn: SAWO Date: MARCH 2020 Checked: ASM Date: MARCH 2020 Approved: Date:	Project: CLIFTON SUSPENSION BRIDGE Drawing Title: ABUTMENT ROCK BOLTING & DENTITION Drawing No.: A065600-086-002
		Owner: COWI Project No.: A065600-086 Scale: 1:750 @ A1 Status: PRELIMINARY DO NOT SCALE FROM THIS DRAWING. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE STATED.	Rev: A



THE CONTRACTOR SHALL NOT MAKE ANY ATTACHMENT TO THE BRIDGE SUPERSTRUCTURE WITHOUT THE EXPRESS WRITTEN PERMISSION OF THE PROJECT MANAGER.

TEMPORARY WORKS
THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN, INSTALLATION, COMMISSIONING AND REMOVAL OF ALL TEMPORARY WORKS NECESSARY TO EFFECT THE ROCK BOLTING AND DENTITION IN ACCORDANCE WITH THE SPECIFICATION.

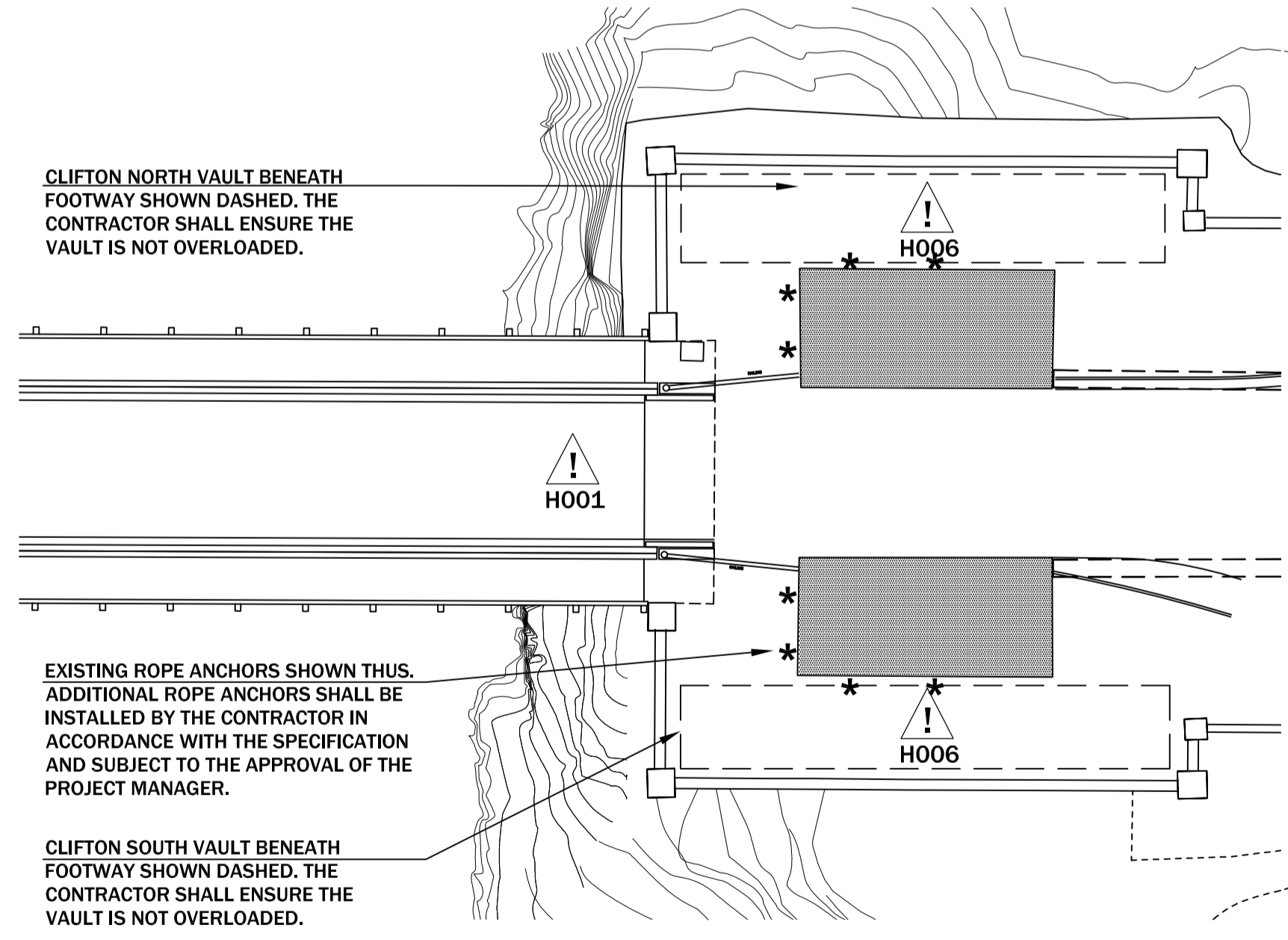
GENERALLY, BOTH FOOTWAYS ON THE BRIDGE AND ABUTMENTS SHALL REMAIN OPEN TO THE PUBLIC AT ALL TIMES. HOWEVER, THE CONTRACTOR WILL BE PERMITTED TO CLOSE THE FOOTWAYS TO INSTALL/REMOVE TEMPORARY WORKS IF THIS CANNOT BE DONE FROM SION HILL.

SITE EXTENT
EXTENT OF SITE AVAILABLE TO CONTRACTOR SHOWN DASHED THUS.

THE CONTRACTOR SHALL DESIGN AND INSTALL ALL TEMPORARY WORKS NECESSARY TO ENABLE ACCESS FROM SION HILL ONTO THE ABUTMENT ROCK FACE.

THE SITE SHALL BE SEPARATED FROM PUBLIC AREAS USING NETTED HERAS FENCING WITH SUITABLE KENTLEDGE.

SITE PLAN - CLIFTON ABUTMENT
SCALE 1:200



CLIFTON NORTH VAULT BENEATH FOOTWAY SHOWN DASHED. THE CONTRACTOR SHALL ENSURE THE VAULT IS NOT OVERLOADED.

EXISTING ROPE ANCHORS SHOWN THUS. ADDITIONAL ROPE ANCHORS SHALL BE INSTALLED BY THE CONTRACTOR IN ACCORDANCE WITH THE SPECIFICATION AND SUBJECT TO THE APPROVAL OF THE PROJECT MANAGER.

CLIFTON SOUTH VAULT BENEATH FOOTWAY SHOWN DASHED. THE CONTRACTOR SHALL ENSURE THE VAULT IS NOT OVERLOADED.

CLIFTON TOWER - LOCATION OF ROPE ACCESS ANCHORS & VAULTS
SCALE 1:200

HAZARD REF	DESCRIPTION	DRA REF
H001	BRIDGE WEIGHT RESTRICTION	H001
H002	BRIDGE CHAINS OVERHEAD	H002
H003	LAND SADDLE CHAMBER COVERS	H003
H004	OCCUPIED TOLL HOUSE BUILDINGS	H004
H005	PEDESTRIAN-VEHICLE INTERFACE	H005
H006	CLIFTON VAULTS BENEATH FOOTWAY	H006
H007	ROCK FALL - LOOSE ROCKS DISLODGED	H007
H008	UNIDENTIFIED BURIED SERVICES	H008
H009	THRILL SEEKERS ACCESSING SITE	H009
H010	VULNERABLE INDIVIDUALS	H010
H011	TEMPORARY WORKS	H011
E001	CONTAMINATION OF SITE OF SPECIAL SCIENTIFIC INTEREST.	E001
E002	GROWTH OF RARE PLANTS IN AREA PREVIOUSLY CLEARED OF VEGETATION.	E002

Designers:

Client:

Designed:	SAWO	Date:	MARCH 2020
Drawn:	SAWO	Date:	MARCH 2020
Checked:	ASM	Date:	MARCH 2020
Approved:		Date:	
Owner:	COWI	Project No.:	A065600-086
Status:	PRELIMINARY		
Scale:	1:200 @ A1		

Project: **CLIFTON SUSPENSION BRIDGE**

Drawing Title: **ABUTMENT ROCK BOLTING & DENTITION**

SITE PLAN - CLIFTON ABUTMENT

Drawing No.: **A065600-086-003**

Rev: **A**

REV.	DATE	DESCRIPTION	DES.	DRW.	CHK.	APP.
A	22.05.20	PRELIMINARY ISSUE	SAWO	SAWO	ASM	

DO NOT SCALE FROM THIS DRAWING. ALL DIMENSIONS ARE IN mm, UNLESS OTHERWISE STATED.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z



NOTES

1. Ortho rectified image from photogrammetric survey of the Clifton Southwest Slope.
2. Joint traces show approximate location of joints only, actual location and orientation may vary.
3. Refer to Table 1 for rock bolt specification.
4. Rock bolt and dowel locations indicative only and subject to change during construction.
5. Any errors or omissions to be notified to Designer.

LEGEND

- Dowel
- Pre-tensioned rock bolt

OA	CONCEPT DESIGN	MS	07.02.20	
Rev.	Description	Drawn	Date	Chkd

Client:
CLIFTON SUSPENSION BRIDGE
COWI

Project:
CLIFTON SUSPENSION BRIDGE
SOUTHWEST SLOPE

Title:
CLIFTON ABUTMENT
SOUTHWEST SLOPE
SCHEME 1

COWI

GEO-DESIGN
www.GEO-DESIGN.co.uk
Tel: 01425 473005 E-mail: info@geo-design.co.uk

Scale: 1:200 @ A3 Project Ref: 2191208
Drawn: MS Date: 20.01.20 Drawing No: CSB/GD/S1/001
Checked: RM Date: 03.02.20



NOTES

1. Any errors or omissions to be notified to Designer.

LEGEND

D-T6(4m) Dowel ref and length

Rev.	Description	Drawn	Date	Chkd
OA	CONCEPT DESIGN	MS	07.02.20	

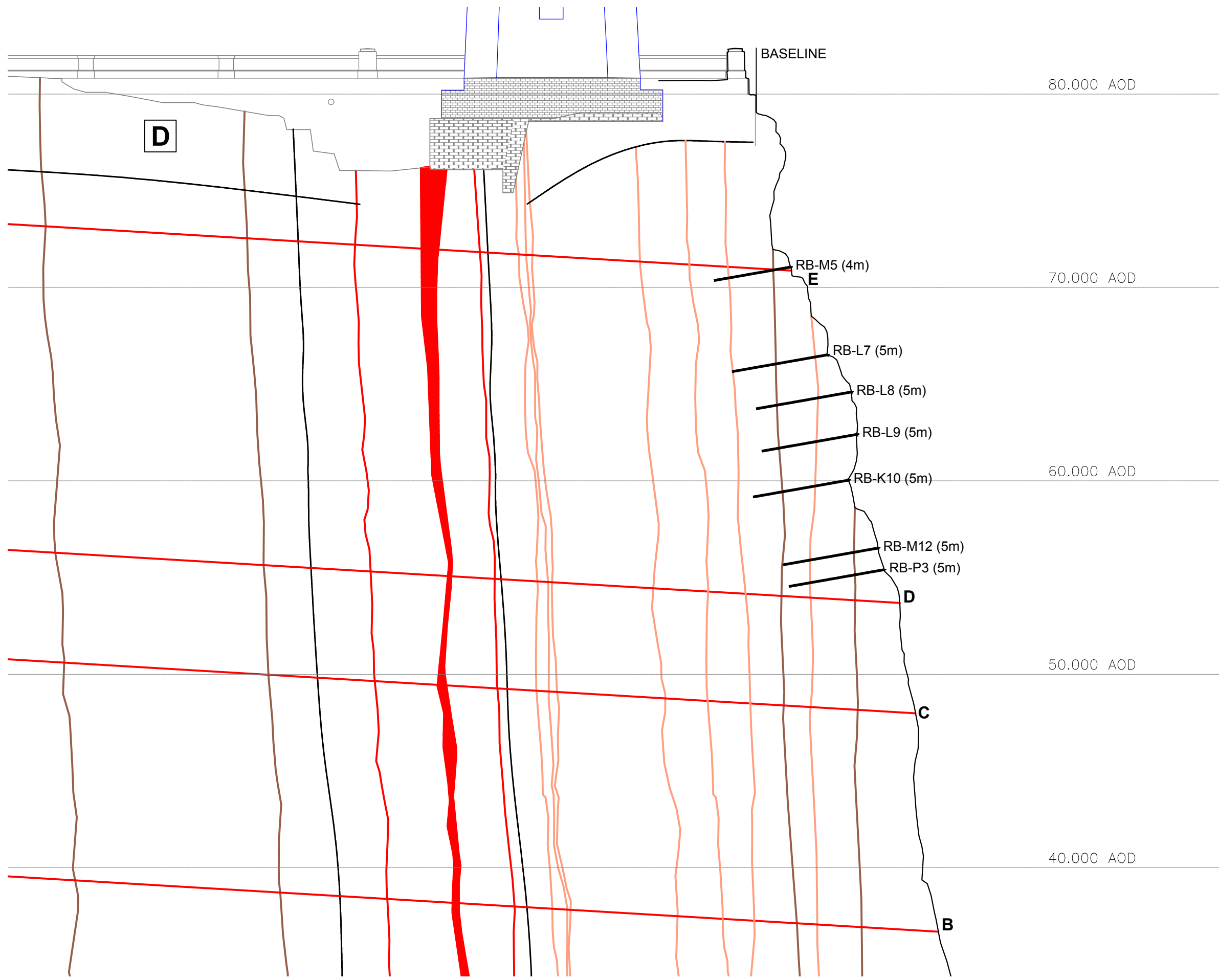
Client:
CLIFTON SUSPENSION BRIDGE
COWI

Project:
CLIFTON SUSPENSION BRIDGE
SOUTHWEST SLOPE

Title:
CLIFTON ABUTMENT
SOUTHWEST SLOPE
SECTION G - SCHEME 1



Scale:	1:200 @ A3	Project Ref:	2191208
Drawn:	MS	Date:	20.01.20
Checked:	RM	Date:	03.02.20
		Drawing No:	CSB/GD/S1/003



NOTES
 1. Any errors or omissions to be notified to Designer.

LEGEND
 D-T6(4m) Dowel ref and length

Rev.	Description	Drawn	Date	Chkd
OA	CONCEPT DESIGN	MS	07.02.20	
Client:				
CLIFTON SUSPENSION BRIDGE COWI				
Project:				
CLIFTON SUSPENSION BRIDGE SOUTHWEST SLOPE				
Title:				
CLIFTON ABUTMENT SOUTHWEST SLOPE SECTION L - SCHEME 1				

COWI

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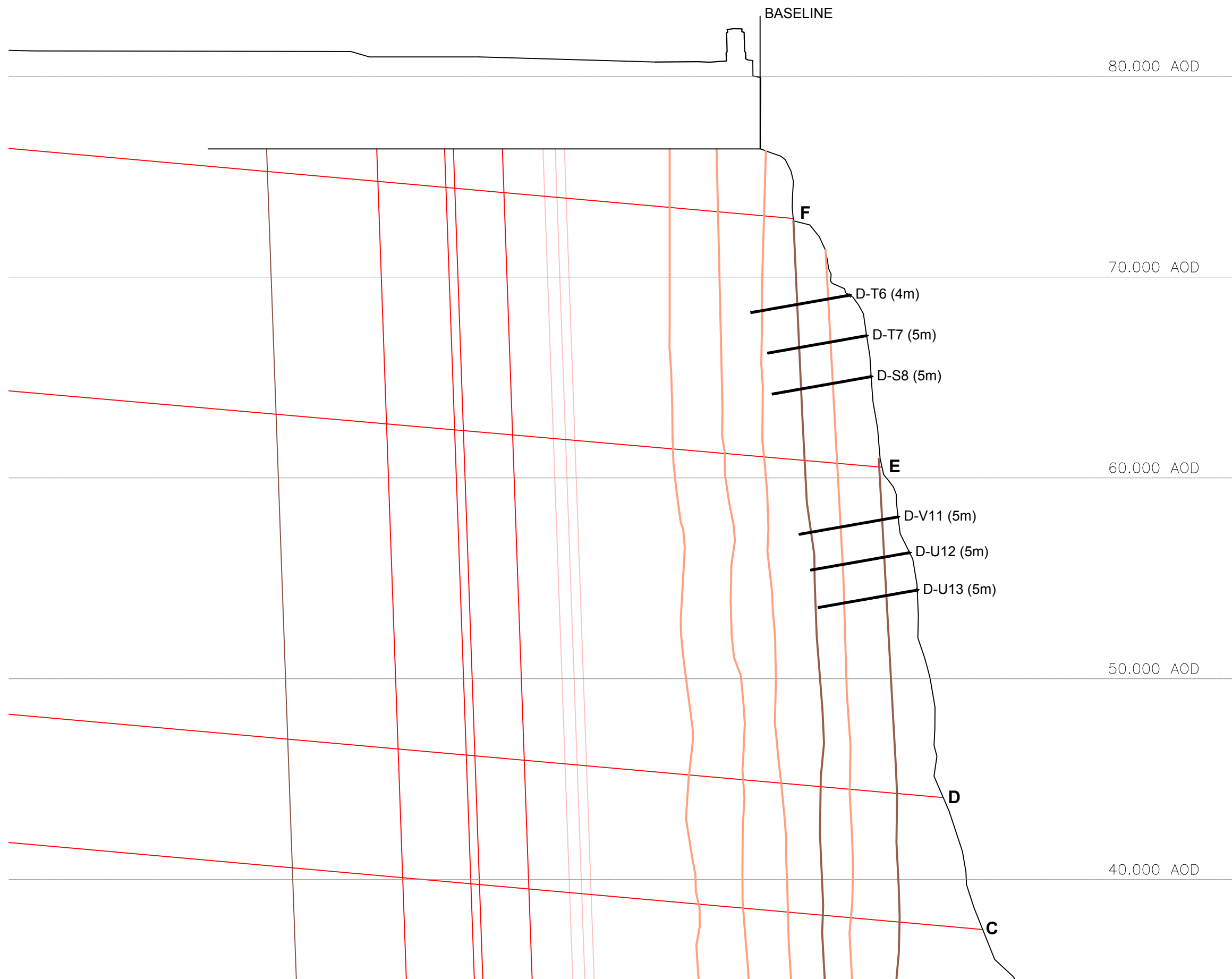
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Checked:	RM	Date:	03.02.20
		Drawing No:	CSB/GD/S1/004

NOTES

- Any errors or omissions to be notified to Designer.

LEGEND

D-T6(4m) Dowel ref and length



Rev.	Description	Drawn	Date	Chkd
OA	CONCEPT DESIGN	MS	07.02.20	

Client:
CLIFTON SUSPENSION BRIDGE
COWI

Project:
CLIFTON SUSPENSION BRIDGE
SOUTHWEST SLOPE

Title:
CLIFTON ABUTMENT
SOUTHWEST SLOPE
SECTION U - SCHEME 1



Scale:	1:200 @ A3	Project Ref:	2191208
Drawn:	MS	Date:	20.01.20
Checked:	RM	Date:	03.02.20
		Drawing No:	CSB/GD/S1/005