



Rock Slope Stability Assessment, Plas Power

Coed Cadw / Woodland Trust

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Prepared By **Daeare Geo Consulting**
Llanidan Lodge, Brynsiencyn, Llanfairpwll, Ynys Môn, LL616HJ
daeargeo@outlook.com

	Name	Position	Qualifications	Date
Author	Alan Jones	Partner	BSc MSc CGeol	22/11/2020

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TABLE OF CONTENTS

1.0	INTRODUCTION	2
2.0	THE SITE	3
2.1	Site Location and Description	3
3.0	GEOLOGY AND STABILITY ASSESSMENT	4
3.1	Geological Setting	4
3.2	Area 1	4
3.3	Area 2	4
4.0	STABILISATION OPTIONS	5
4.1	Area 1	5
4.2	Area 1 - Preferred Option	6
4.3	Area 2	6
4.4	Area 2 - Preferred Option	7
5.0	SUMMARY & CONCLUSIONS	8

FIGURES

- Figure 1 – Site Location
- Figure 2 – Area 1 & 2
- Figure 3 – Preferred Stabilisation Solution
- Figure 4 – Area 1 – Details for 6m Section by Listed Wall
- Figure 5 – Rock Trap Bund Detail
- Figure 6 – Area 2 Large Block Removal

1.0 INTRODUCTION

The Woodland Trust have submitted a planning application to construct a gabion wall to segregate and protect the public from rock faces near the entrance to their woodland in Plas Power.

Daeaf Geo Consulting (Daeaf) have been appointed by Colin Jones (Rock Engineering) Ltd. (CJRE), on behalf of the Woodland Trust. The initial brief was to design freestanding gabion walls in areas identified by WT. However following completion of the initial works and a site visit, the brief has been extended to include:

- Carry out an initial site visit to identify initial/emergency works;
- Carry out a stability risk assessment;
- Identify suitable stabilisation measures, with due consideration of the environmental setting.

This report presents the findings of the stability assessments and presents the preferred stability options.

2.0 THE SITE

2.1 Site Location and Description

The Plas Power Woods and adjacent Nant Mill Wood, which make up 42.3 hectares (104.6 acres), are situated in the Clywedog valley between Bersham and Coedpoeth, 2.5km (1.6 miles) west of Wrexham.

Plas Power Wood extends downstream from the Nant Mill Visitor Centre. The site, in relation to the stability risk assessment, comprises the rock faces near the entrance gate of the footpath into Plas Power Wood, directly north of the stone arch bridge over the river Clywedog.

For the purpose of this note we describe two separate areas, as follows:

- Area 1 – area north of the bridge, adjacent to footpath;
- Area 2 – area south of bridge; adjacent to road.

Area 1

This area has a rock face extending from a historic (listed) stone wall to the gate to the footpath, approx. 25m in length, see Photo 1. The section closest to the stone wall, approx. 6m long is positioned c. 3m from the verge, see Photo 2. The rock face is undulating generally with a steep (>60°) dip towards the road, though locally there are overhangs, unfavourable discontinuities and evidence of historical failure, see Photo 3.

The rock face then returns at 90° (perpendicular to the road) for a distance of 3.5m then continues in line with the road for a further 19m or so, see Photo 4, before returning to the footpath, with the boundary following the natural sloping ground. The 19m section comprises a vertical cut face, 5-7m high, with the appearance of a man made cutting orientated E-W. The cut was shown on the earliest OS map although no buildings were shown.

There are a number of mature trees growing out of the upper rock slopes over much of Area 1.

Area 2

This section extends for c. 35m from the bridge. A description of the rock and stability risks is provided by Chainage (Ch. 35 = bridge)

Ch.	Description
0-3	Gently sloping ground, from upper ground to road, see Photo 6;
3-13	Appears to have been a significant historic failure, triggered by a large tree being blown over and roots ripping out the rock mass. Some well-developed roots are evident on the face, which has a very blocky appearance. Mature tree at top of slope. Upper rock face is 3 - 4m from road with slope below leading to road; no verge, see Photo 7 & 8
13-20	As above but upper rock face is 6-7m from road with slope below leading to verge.
20-24	Vertical sandstone faces, 2-3m from road. Large oak at crest with roots penetrating the rock mass. Oak has previously been felled, but is still alive and roots are penetrating the rock mass. There are large dilated joints perpendicular to the road and also a large diagonal joint dipping towards the road with risk of large failure, see Photo 9 & 10.
24-35	Rock face generally vertical and offset from road by c.10m, see Photo 11.

3.0 GEOLOGY AND STABILITY ASSESSMENT

3.1 Geological Setting

The geology of the site has been studied on the BGS geindex online database using the 1:50,000 scale coverage, Ref. 1, and is summarised below:

- Superficial deposits are shown to be absent from the site, and the sides of the Clywedog River Valley. Glacial till deposits are shown to the north and south of the river
- The bedrock beneath the site is shown to comprise the Cefn Sandstone formation, a 37m thick horizon of quartzitic sandstone within the Middle Pennine Coal Measures.

There are no significant faults shown on or in close proximity to the site.

3.2 Area 1

The rock in this section is horizontal bedded sandstone, with quite widely spaced discontinuities. Joints are predominantly orthogonal, a near vertical joint dipping 85° north to 85° south defines the E-W face, which locally reduces to angles of 60°, which introduces toppling and planar failure risks. Another near vertical joint set is perpendicular to the face, providing release joints for block failure.

The joints are locally dilated on the face; predominantly caused by root penetration, see Photo 3. Differential/Accelerated weathering of weaker horizons results in local undermining of larger blocks.

There is a risk of medium and large block instability due to root action and toppling due to the orientation of joints, see photo 2. The presence of large trees growing from the upper face can also lead to largescale failure as roots cause dilation of joint and the strong winds make the large trees act as levers.

3.3 Area 2

This section extends for c. 35m from the bridge. A description of the rock and stability risks is provided by Chainage (Ch. 35 = bridge)

Ch.	Description
0-3	Gently sloping ground, low risk of failure, see Photo 6;
3-13	Appears to have been a significant historic failure, triggered by a large tree being blown over and roots ripping out the rock mass. Some well-developed roots are evident on the face, which has a very blocky appearance. Mature tree at top of slope therefore future risk of similar failure. Upper rock face is 3 - 4m from road with slope below leading to road; no verge, see Photo 7 & 8
13-20	As above but upper rock face is 6-7m from road with slope below leading to verge.
20-24	Vertical sandstone faces, 2-3m from road. Large oak at crest with roots penetrating the rock mass. Oak has previously been felled, but is still above and roots are causing significant risk of instability. There are large dilated joints perpendicular to the road and also a large diagonal joint dipping towards the road with risk of large failure, see Photo 9 & 10.
24-35	Rock face generally vertical and offset from road by c,10m, therefore consequence of failure is low, see Photo 11.

4.0 STABILISATION OPTIONS

There are a number of options that can be considered for the site. Primarily rock slope stabilisation falls into either:

- Stabilise rock on the face – combination of dowels, anchors and rock mesh;
- Intercept rockfall to protect site users – generally by constructing suitable catch fences, walls, berms or rock traps/interception ditches

In addition the disruptive action of tree roots and weathering needs to be considered.

Due to the sensitive environmental setting and the presence of the historical/listed wall, a sympathetic / non-intrusive solution was required.

4.1 Area 1

The following works were identified as emergency works and to allow closer inspection during the initial site visit and were completed in early march 2021:

- Hand Scale loose blocks on face;
- Remove large trees from the face and apply herbicidal treatment to roots;
- Remove trees in front of face to allow detailed inspection.

Permanent stabilisation options are presented below:

Option	Benefits	Negative
Berm and catchpit	Intercepts rockfalls with vegetated berm, therefore no visual impact. Low cost and rapid construction	Insufficient space to install in front of 6m section by listed wall
Catchfence	Permanent engineered solution. Prevents foot traffic and cars from accessing 19m recess area	Visually Intrusive Deflection of fence in case of failure would impact the footpath and road adj. to 6m area Temporary stabilisation of 6m area needed prior to installing fence. Maintenance needed to remove debris after failure. Relatively expensive compared to berm.
Gabion Wall	Permanent engineered solution. Prevents foot traffic and cars from accessing 19m recess area Matching rocks could be used as facing to blend in to wall. No need to remove debris from rear following rockfall	Visually Intrusive. Deflection of fence in case of failure would impact the footpath and road adj. to 6m area Temporary stabilisation of 6m area needed prior to installing wall. Relatively expensive compared to berm.

Option	Benefits	Negative
Rock face stabilisation	Stabilise blocks onto face with combination of rock anchors, rockbolts, dowels and rock mesh if needed. Dowels do not need plated and have low visual impact, particularly if grout is coloured with rock drilling dust. Can be installed safely using MEWP or rope access	Relatively expensive compared to berm. Anchors with plates and mesh are visually intrusive.

4.2 Area 1 - Preferred Option

Due to the variable conditions over a relatively short section, it is recommended that a combination of the 'Berm and Catchpit' and 'Rock Face Stabilisation' options listed above are implemented, as follows:

- 6m section by 'listed' wall; lower slope – Coarse Granular berm to be constructed to support the lower face and overhang, adjacent to the road/footpath and along the return. The granular fill can be placed safely using an excavator and overlaid by site won topsoil and seedbank to allow natural localised vegetation to re-establish, see Figure 4 for details.
- 6m section by 'listed' wall; upper slope – once the berm has been placed works can safely be carried out using rope access or a MEWP to stabilise the potentially loose blocks with unfavourable discontinuity planes. Due to the large size of the blocks, this can be done using dowels, drilled perpendicular to the main release surfaces. This will allow installation without face plates, which makes the dowels practically invisible when the surface of the rock is infilled with coloured grout or a rock core is re-inserted, see Figure 4 for details.
- 19m section adjacent to footpath – there is sufficient space in this area to construct a bund to intercept any rockfalls before they reach the footpath or road. A fence and warning signs could be erected to prevent/discourage site users from crossing the Bund. The bund may be formed from granular or suitable cohesive fill and should be covered with site won topsoil and seedbank to allow natural localised vegetation to re-establish, see Figure 5 for details.
- A Regular maintenance schedule is recommended to carry out hand scaling and keep new vegetation growth on the rock slopes under control, which could also be extended to the initial section of footpath.

4.3 Area 2

The following works were identified as emergency works and to allow closer inspection during the initial site visit and were completed in March 2021:

- Hand scaling of all loose blocks from the face;
- Removal of vegetation and trees at the crest. All roots should be treated with appropriate herbicide to prevent future re-growth;
- Carry out detailed stability inspection from MEWP / rope access during scaling works;
- Assessment of stability risk of larger block failure in Ch. 20-24.

Space is limited for the installation of a catchfence or gabion wall along much of this section from Chainage 0 – 24, however there is sufficient room for a berm and catchpit between Ch. 24 – 35

4.4 Area 2 - Preferred Option

Due to the variable conditions over a relatively short section, it is recommended that a combination of the options outlined above are implemented, as follows:

Ch.	Recommended Stabilisation Treatment
0-3	None required
3-20	Regular rope access inspections and maintenance schedule to carry out hand scaling of loose blocks and keep new vegetation growth under control.
20-24	Removal of large block risk by long reach excavator. This rock debris could be broken down using a crushing bucket to gain material to construct the bunds in Area 1 and 2. See Figure 6 for details
24-35	Place bund to segregate rock face and prevent potential use of area for car parking, as Area 1. Erect fence and warning signs, see Figure 5 for details.

5.0 Summary & Conclusions

There are numerous rock slope instability issues at the site.

Emergency/Preliminary works have been carried out to scale the rock face and remove vegetation to allow a more detailed assessment to be carried out.

Stabilisation measures have been recommended to two separate areas. A number of different techniques are recommended to provide the most cost effective and least intrusive solution.

The proposed works do not have a negative impact on the listed wall.

The proposed solutions are shown on Figures 3, 4, 5 & 6, which are appended to this report.

Photographs

Photo 1 – Area 1 General View



Photo 2 – 6m section closest to listed wall – unfavourable dip of fractures



Photo 3 Area 1 – dilated joints and root penetration



Photo 4 – 19m long rock face, offset by c. 7m from verge



Photo 5 – displaced clocks and rock face along path (up to 25m from gate)



Photo 6 – Area 2; Ch. 0-3



Photo 7 – Area 2 Ch. 3 - 8



Photo 8 – Area 2 Ch. 8 - 20



Photo 9 – Area 2 Ch. 20 - 24

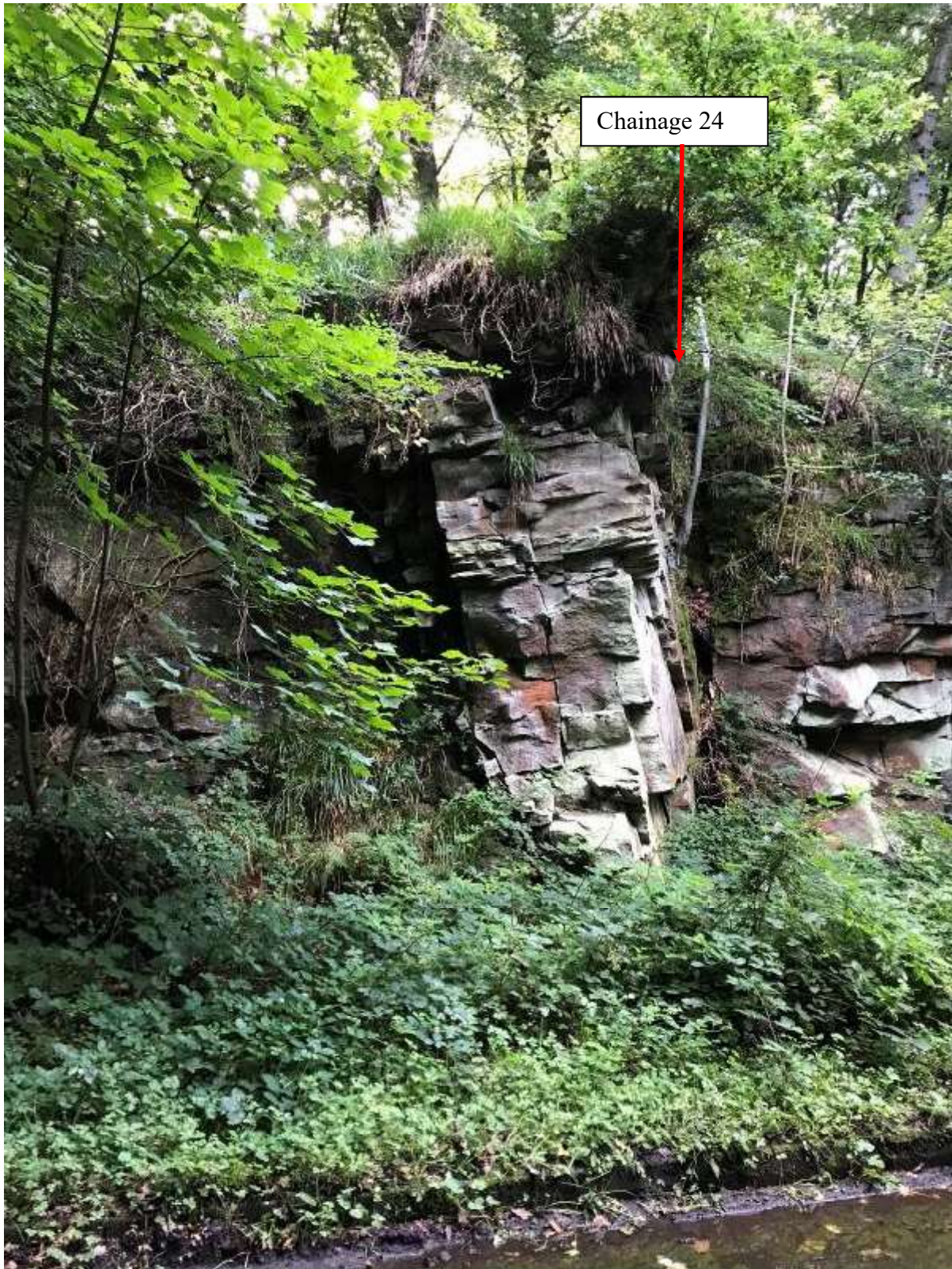


Photo 10 – looking onto Ch. 24 from the bridge



Photo 11 – Area 2 Ch. 24 - 35



Figures

Figure 1 – Site Location

Figure 2 – Area 1 & 2

Figure 3 – Preferred Stabilisation Solution

Figure 4 – Area 1 – Details for 6m Section by Listed Wall

Figure 5 – Rock Trap Bund Detail

Figure 6 – Area 2 Large Block Removal

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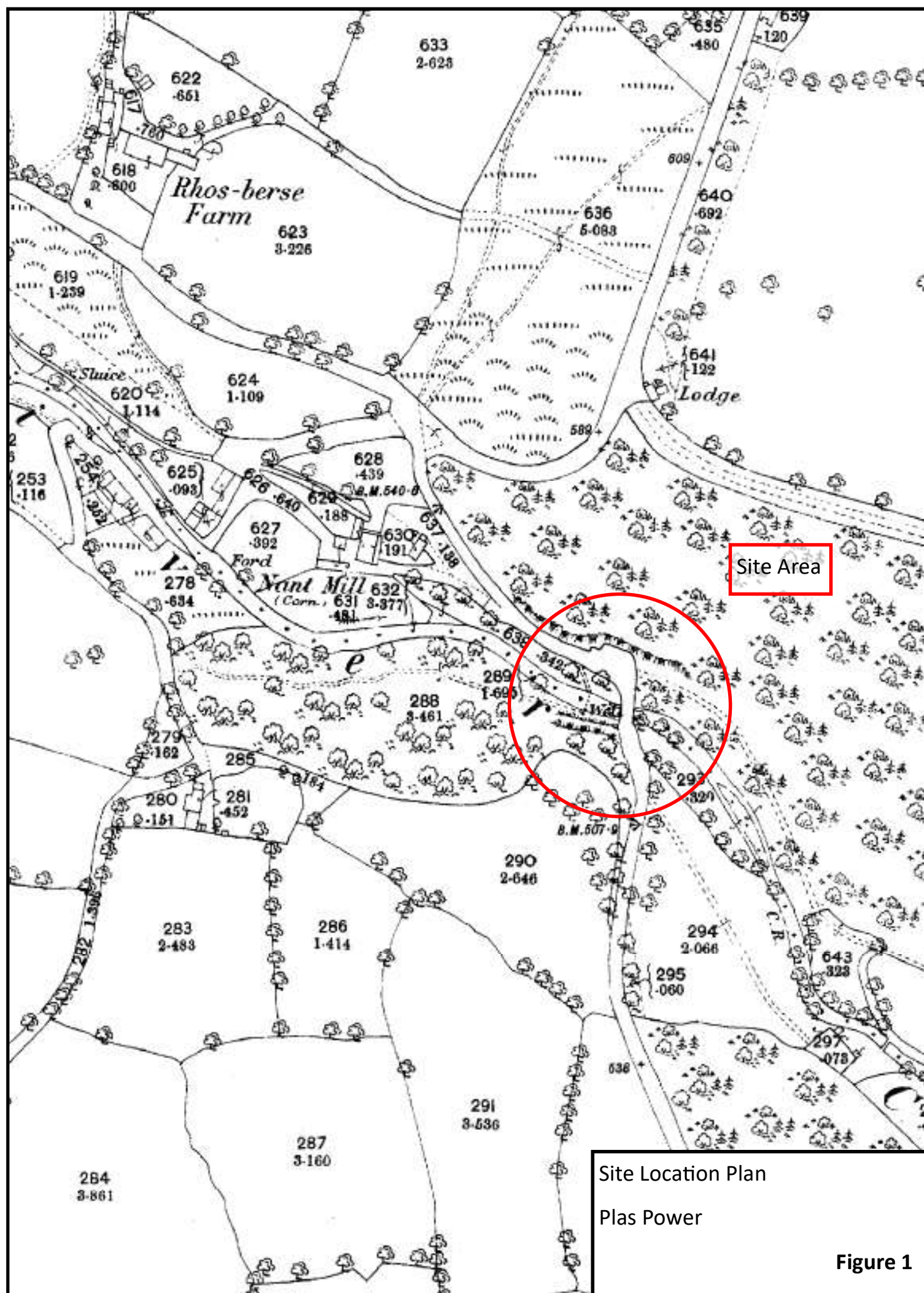
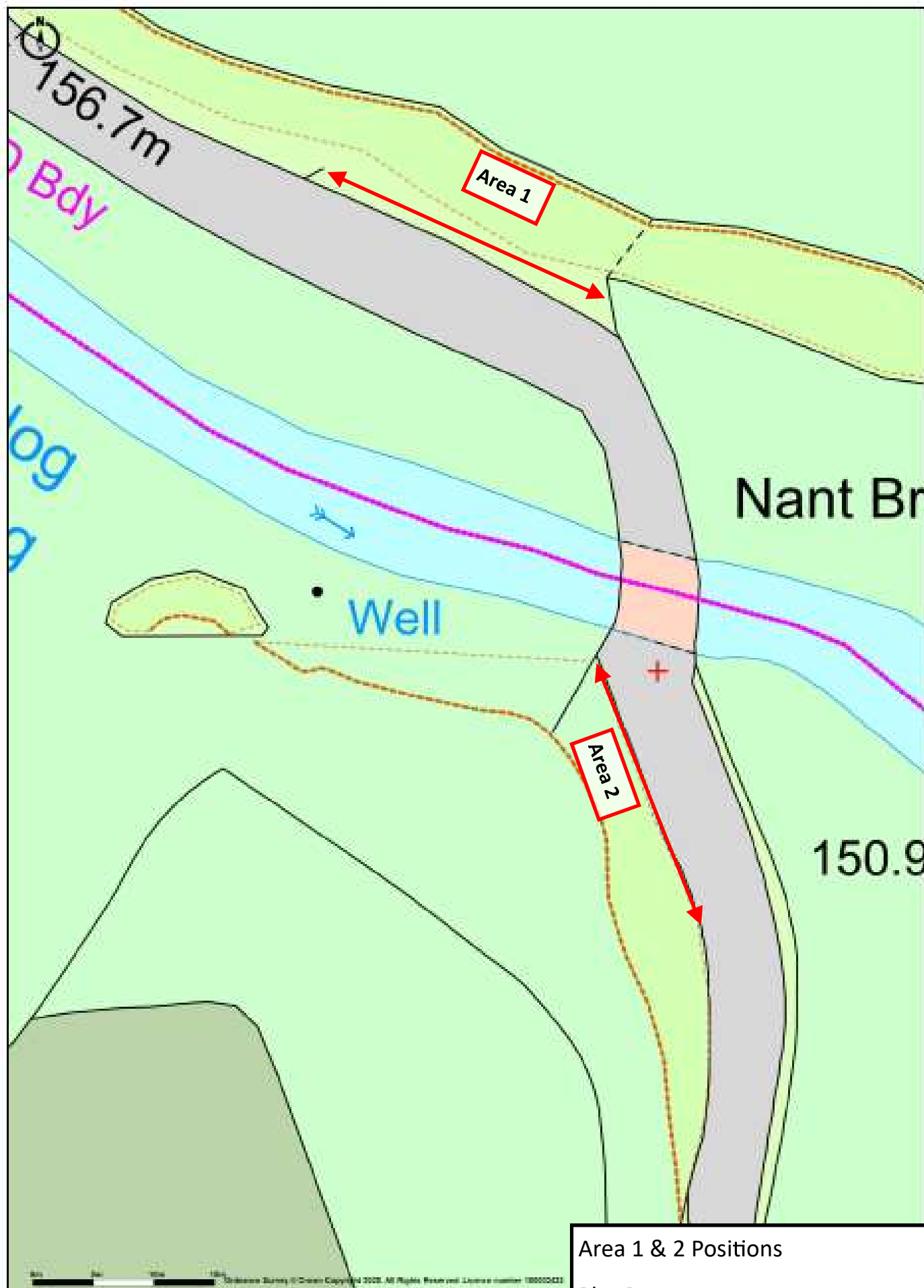


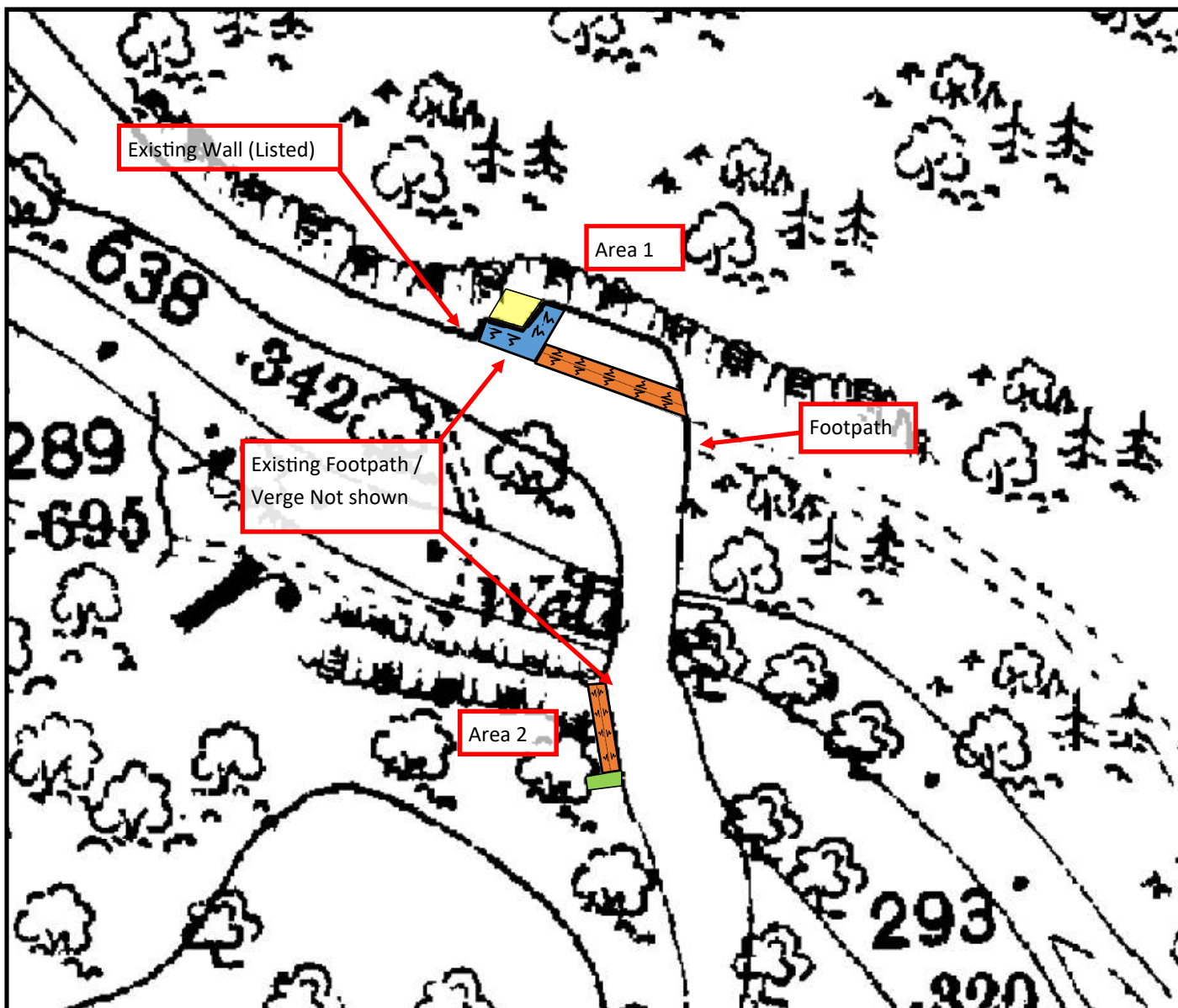
Figure 1



Area 1 & 2 Positions

Plas Power

Figure 2



Legend

-  Granular Berm extends approx.2m up against Rock Face
-  Rock Face stabilised with dowels
-  Rock Trap
-  Removal of unstable block with long reach excavator

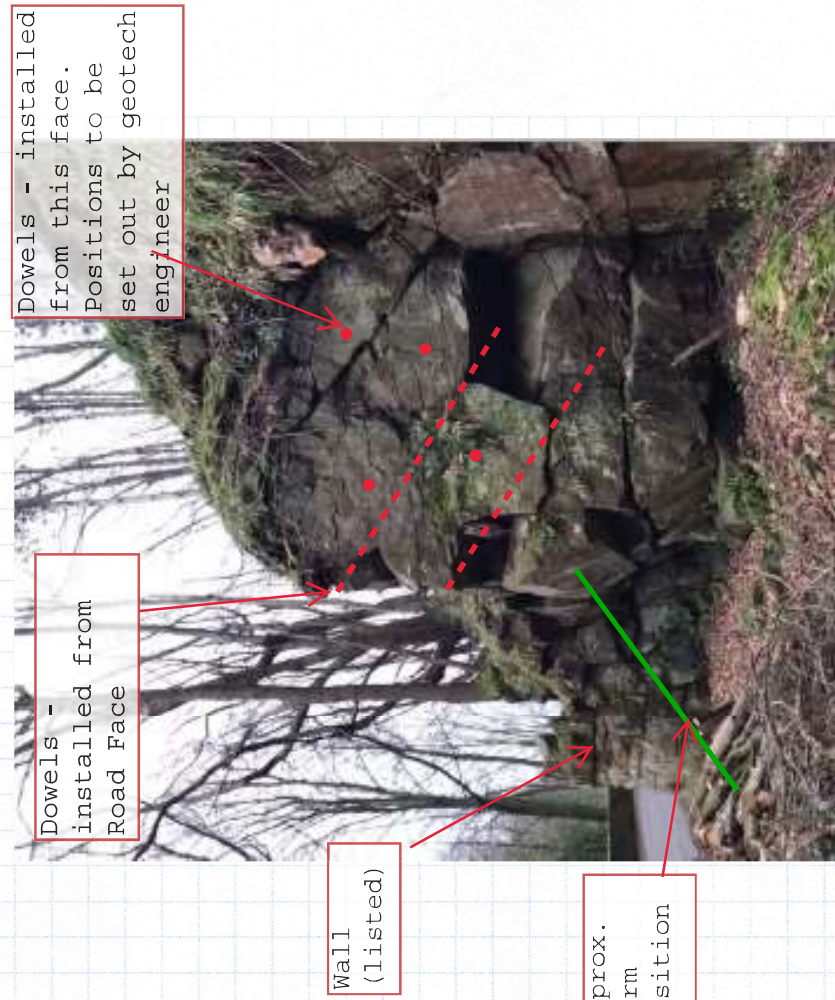
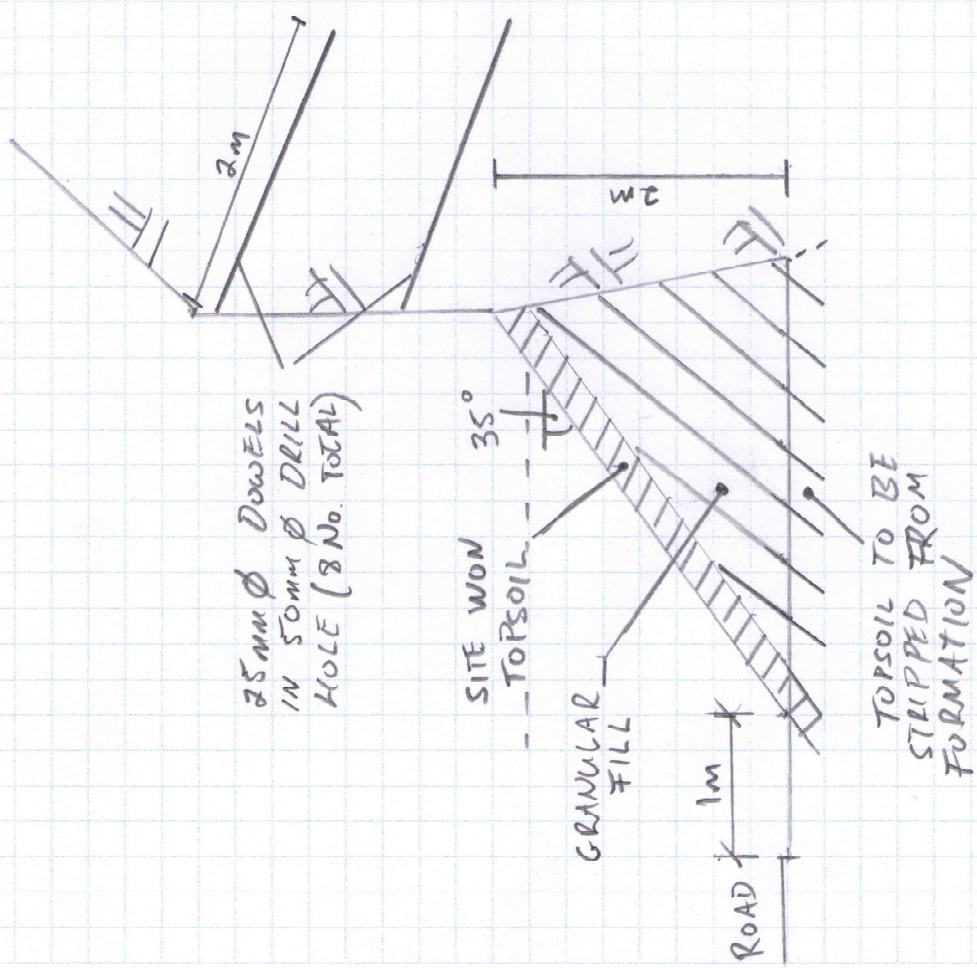
See Figures 4, 5 & 6 for details of above

Preferred Stabilisation Solution

Plas Power

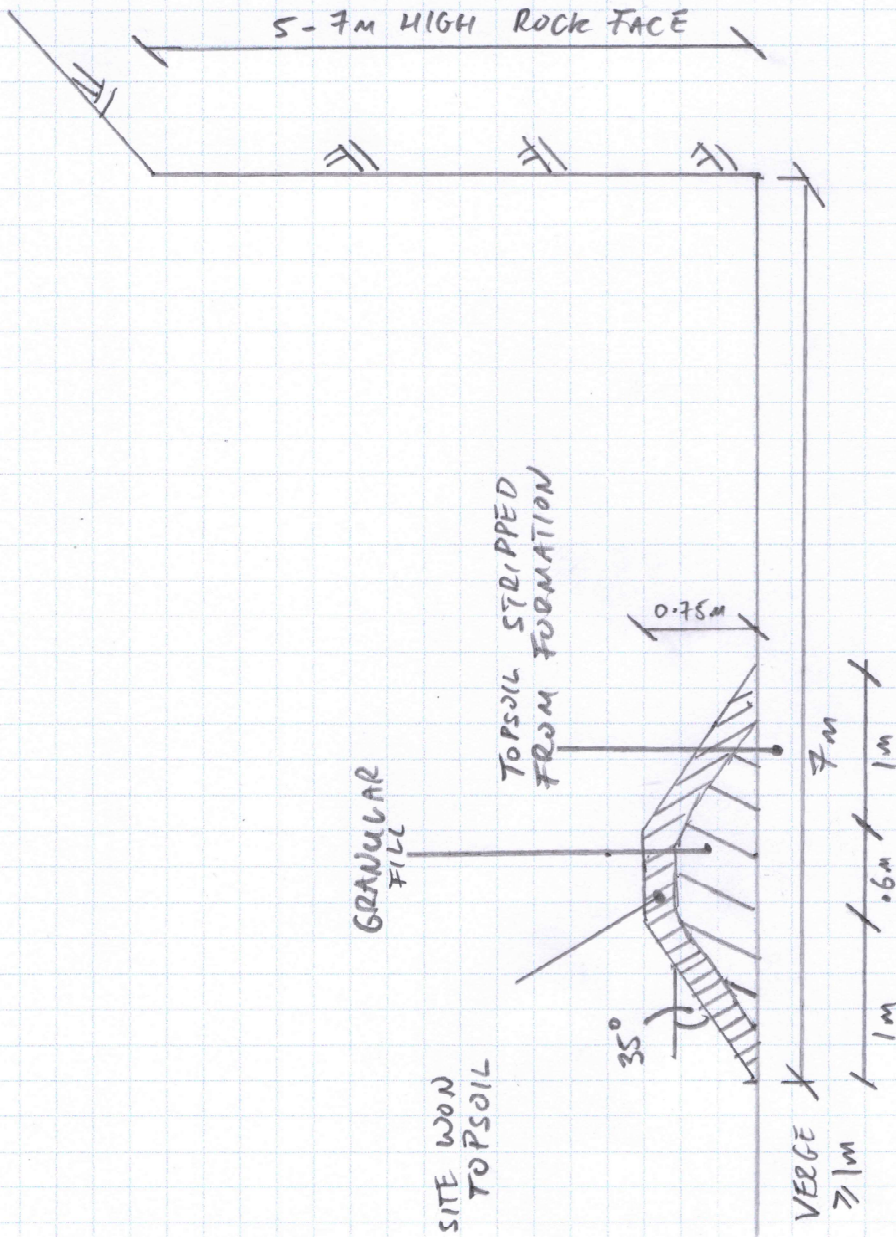
Figure 3

Client: Woodland Trust	Project No. / Name: Plas Power – Rock Stabilisation			Status C	Page. 1 / 2
	Work Element / Reference: Indicative Cross Sections Area 1 / Figure 4	Prepared by APJ	Date: 07/21		



PROPOSED STABILISATION - AREA 1 - 6m SECTION

Client: Woodland Trust	Project No. / Name: Plas Power – Rock Stabilisation			Status C	Page. 2/2
	Work Element / Reference: Indicative Cross Sections Area 1 / Figure 4	Prepared by APJ	Date: 07/21		



PROPOSED STABILISATION - AREA 1 - 19m Rock TRAP BUND

- AREA 2 - Ch. 24 - 35 Rock TRAP BUND

Client: Woodland Trust	Project No. / Name: Plas Power – Rock Stabilisation			Status C	Page. 1
Work Element / Reference: Large Block Removal Area 2 / Figure 6	Prepared by APJ	Date: 07/21			

View From Side:



View From Bridge:



Block to be removed highlighted in red above.

Removal with Long reach excavator under supervision and direction of geotechnical engineer to ensure that rock mass left stable. Engineer to carry out stability assessment of exposed face to rear and design rock bolts if required.

Rock Debris to be broken down crushed on site with use of hydraulic breaker and/or crusher bucket.

Rock fragments to be retained on site in rock bunds in Area 1 & 2.