



CHALK MINE STABILISATION PROJECT HIGHBARNES, HEMEL HEMPSTEAD

Treatment Area 12: 1 & 3 Pond Road

Report Number: 0013-UA000857-TR-01-TAR-0012

OCTOBER 2015



Incorporating

CONTACTS

ROGER BARSBY
Technical Director
Geotechnics and Tunnelling
Approver

Signature.....

Date: 20 October 2015

dd +44 (0)148 3803156
m +44 (0)774 8188683
e roger.barsby@arcadis.com

Arcadis.
The Surrey Research Park
Medawar Road, Guildford
Surrey, GU2 7AR
United Kingdom

ANDREW HOPE
Senior Geotechnical Engineer
Geotechnics and Tunnelling
Checker

Signature.....

Date: 20 October 2015

dd +44 (0)203 3014 9247
e andrew.hope@arcadis.com

Arcadis.
The Surrey Research Park
Medawar Road, Guildford
Surrey, GU2 7AR
United Kingdom

ALEX BLAKE
Senior Geotechnical Engineer
Geotechnics and Tunnelling
Author

Signature.....

Date: 20 October 2015

dd +44 (0)1483 803168
m +44 (0)7809 594523
e alex.blake@arcadis.com

Arcadis.
The Surrey Research Park
Medawar Road, Guildford
Surrey, GU2 7AR
United Kingdom

CONTENTS

1 INTRODUCTION	1
2 SUBSURFACE INVESTIGATIONS.....	1
3 MINE TREATMENT	2
4 VALIDATION	2
4.1 No. 1 Pond Road	3
4.2 No. 3 Pond Road	4
5 CONCLUSIONS	5
6 REFERENCES	5

APPENDICES

APPENDIX A

Drawing TA12-01 – Treatment Area Plan for TAR0012 with Grout Holes

Drawing TA12-02 – Treatment Area Plan for TAR0012 with Validation Probes

1 INTRODUCTION

Dacorum Borough Council (DBC) has commissioned Arcadis Consulting (UK) Ltd (Arcadis) (formerly Hyder Consulting (UK) Limited) to oversee the treatment and validation of abandoned chalk mines identified beneath residential areas in the Nash Mills area of Hemel Hempstead, Hertfordshire. The mine workings identified at the site have been assessed to comprise a single level of chalk mine galleries in the vicinity of Highbarns, Pond Road and East Green Road junction. The mine treatment has been funded under the Land Stabilisation Programme (LSP), administered by the Homes and Communities Agency (HCA).

The background to the scheme, interpretation of the mine, and treatment works are set out in the overarching Treatment Report (Arcadis, 2015). This report forms an addendum to the above report and should be read in conjunction with it.

The objective of this report is to set out the works that were undertaken to treat the mines and provide the results of post mine treatment validation probing. The properties discussed in this report are as follows:

- Nos 1 & 3 Pond Road

The broader site location, treatment areas and interpreted extent of mine workings within the Derelict Land Clearance Order site boundary are shown in Appendix A of the overarching Treatment Report (Arcadis, 2015).

This Treatment area, validation probes and extent of grouting work specific to this treatment area are shown on drawings TA0012-01 and 02 in Appendix A.

Factual information relating to the investigative probes, validation probes and extent of grouting work are contained in the BAM Ritchies Sectional Validation Report for the treatment works (BAM Ritchies, 2015).

2 SUBSURFACE INVESTIGATIONS

The subsurface investigations at these properties were undertaken in response to historical subsidence events across the site.

The pre-contract investigations were undertaken by Soil Engineering Ltd in 2012 and included investigative dynamic probes and dynamic windowless sampled boreholes. A review of historical information, the natural topography and the geotechnical investigations were used to identify zones of probable mining related disturbed ground.

Following and during each stage of the treatment works, validation dynamic probing was undertaken to establish the effectiveness of the mine treatment.

The scope of the validation dynamic probing completed during and following the treatment works for 1 & 3 Pond Road are summarised in Table 1 below.

Table 1: Summary of Validation Investigations

Type of Investigations	Number
Total No. of External Validation Dynamic Probes (VP)	26
Total No. of Internal Validation Dynamic Probes (VP)	-

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR009 for this treatment area (BAM Ritchies, 2015). For the purposes of this report, additional dynamic probes

undertaken concurrently with the grouting works in order to further investigate the extent of mine workings are designated validation probes.

Findings of the pre-contract design phase ground investigation undertaken by Soil Engineering and subsequent interpretations are contained in the Interpretive Ground Investigation Report for the site (Hyder, 2012a).

3 MINE TREATMENT

Mine treatment works have been undertaken in accordance with the Hyder Specification for site works (Hyder, 2012b). The techniques of mine treatment adopted at the site consisted of bulk infilling of open voids and compaction grouting of collapsed ground.

A summary of the treatment works are set out in

Table 2 below.

Table 2: Summary of Treatment Works

Property	Location	Type of Hole	Number of Holes	Range of Grout volumes ¹ (m ³)	Total Grout volume ¹ (m ³)
No. 1 Pond Road (Total Grout Holes = 32, Total Grout Volume = 358.8m ³)	Front garden	Bulk infilling	2	57 (BG010) to 69.5 (BG009)	126.5
	Front garden	Vertical compaction grout holes	3	1.64 (CGV200A) to 7.23 (CCGV203)	13.78
	Beneath the property	Inclined compaction grout holes	17	1.2 (CGI139) to 24.3 (CGI067)	90.97
	Rear garden	Vertical compaction grout holes	10	1.091 (CGV640) to 49.2 (CGV629)	127.53
No. 3 Pond Road (Total Grout Holes = 18, Total Grout Volume = 99.1m ³)	Beneath the property	Inclined compaction grout holes	12	0.89 (CGI128) to 29.3 (CGI074)	74.34
	Front garden	Inclined compaction grout holes	6	0.196 (CGV195) to 10.41 (CGV194)	24.72

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 1, 3, 5, 7, 9 & 11 Pond Road (BAM, 2015). The factual report should be referenced for further details of treatment works including the volumes of grout injected and injection pressures per grout hole.

The treatment was undertaken in a phased approach with several stages of grouting and validation dynamic probe testing. Additional stages of grouting and validation testing were completed where validation testing raised doubts as to the extent of the grout penetration beneath properties or where additional mining related disturbed ground was identified.

4 VALIDATION

Validation of the treatment works has been based upon a combination of factors including a comparison of pre-treatment investigations, validation probing and grout volumes recorded during treatment. The number of grout holes, their location and the phasing of the grouting was adjusted as the work proceeded in order to accommodate the findings of the treatment works. Experience gained from other chalk mine projects has identified that dynamic probe blow counts of less than 3 per 100mm penetration is indicative of the presence of mine workings. Consequently, treatment was only

considered complete where validation probes proved blow counts greater than 3 per 100mm penetration at the level of the suspected mine as interpreted from the pre-contract investigations.

A detailed scope of validation procedures adopted during the treatment works is presented in the Highbarns Chalk mine Stabilisation Treatment Report (Arcadis, 2015).

The total volumes of grout at 1 & 3 Pond Road are generally comparable to the expected volumes as indicated by the pre-contract ground investigation, microgravity and dynamic probe validation surveys, however a number of locations were treated with greater than expected volumes of grout as explained in the following sections.

4.1 No. 1 Pond Road

Different phases of pre-treatment investigative dynamic probing carried out along the Highbarns and Pond Road junction identified evidence of voids and disturbed ground conditions indicative of open mine workings in the area. Further detailed investigations using laser scanning surveying techniques identified conclusive evidence of mine workings extending beneath No. 1 Pond Road.

Initial treatment works involved bulk grouting aimed at infilling the known open mine workings located at the front garden of the property. The high grout volumes at two locations, BG009 (69.5m³) and BG010 (57m³), confirmed the scale of open mine workings in the area as identified during pre-treatment investigation. Further treatment was carried out along the front garden employing compaction grouting techniques to treat any further collapsed mine galleries. The grouting holes in the front gardens had relatively low grout volumes (CGV204 – 4.9m³) confirming that bulk filling had been effective in treating the open voids.

Inclined compaction grouting beneath the property was subsequently carried out and aimed from the back and front gardens. The resultant grout volumes were generally considered as average results, typical of generally collapsed ground conditions. The highest grout volume was in grout hole CGI067 drilled from the back garden (24.3m³). This was the first inclined grout hole location aimed beneath the property and this has most likely filled the residual open mine workings extending beneath the property. Subsequently inclined holes under the property had significantly reduced grout volumes typically around 4m³.

Vertical compaction grout holes were also undertaken in the back garden of No. 1 Pond Road to treat an area around the known shaft in Highbarns road and connecting passages under No 1. Grout hole locations CGV129 (21.2m³) and CGV132A (25.7m³) suggested that the mine workings may extend further into the back garden of No. 1.

Following completion of scheduled treatment works as described above, validation probing was carried out at the front and side of the property. Dynamic probing in the front garden showed an improvement at the previous bulk infilling locations (VC305, VC306) as well as close to previous compaction grouting locations (VP548). Validation probing along the side of the property suggested competent treatment had been carried out. Following the high grout volumes at the back of the property (CGV129 and CGV132A), further sets of dynamic probes (VP475-478; VP501-504; VP550-551) were carried out to investigate the ground conditions to the rear of the house. Evidence of weak ground was uncovered at VP476, VP503 and VP504 in the rear garden suggestive of further mine workings. Grouting was carried in the area of this suspected mine workings with significant grout volumes recorded. The first grout hole CGV629 carried out to treat this area recorded a grout volume of 49.2m³. Subsequent grout holes recorded reduced volumes but still higher than normal (CGV639 (9.05m³) and CGV641 (9.0m³)) confirmed the need for the additional treatment, while subsequent treatment resulted in average grout volumes (CGV640

(1.09m³). Validation dynamic probing at VP725 did not identify any residual weak ground following treatment.

4.2 No. 3 Pond Road

The scope of treatment works carried out at No. 3 Pond Road included inclined grout holes aimed to treat the suspected mine workings beneath the property as well as the assumed mine junction along the front of the property.

Grout volumes along the front garden were characterised by two high grout volumes at adjacent hole locations CGV193 (10.1m³) and CGV194 (10.4m³). The smaller grout volumes (CGV195 (0.195m³) and CGV192 (0.199m³)) at the adjacent locations suggested generally more competent ground conditions showing that the ground had been stabilised by previous treatment. In general, low grout volumes were also observed in the inclined grout holes at these locations. Higher grout volumes in two inclined grout hole locations (CGI074 – 29.3m³) at the back of the property were thought to be related to weak ground extending from the adjacent property (No. 1 Pond Road).

A validation dynamic probe, VP25, initially planned to be carried inside the property was eventually carried out in the shared alleyway due to access difficulties. Additional validation probes (particularly VP549) were carried out in areas of high grout volumes at the front of the property. The resultant probes showed did not identify any residual weak ground following treatment.

5 CONCLUSIONS

Grouting has been completed under 1 and 3 Pond Road to stabilise mining related disturbed ground due to former chalk mining. From the investigations and treatment work undertaken and the subsequent validation testing it can be reasonably concluded that;

- based upon the evidence, all mined ground encountered has been treated and that compaction and consolidation of collapsed voids and mine shafts has taken place;
- as a result of the above assessment, significant risk from chalk mine workings within the treatment area has reduced to an acceptably low level following treatment;
- there is no evidence of any adverse impacts on groundwater quality beneath the site as a consequence of the work;
- there is no evidence of any significant movement or other adverse effects on buildings or infrastructure during the works; and
- the risks from further untreated workings in the treatment area is considered to be no higher than elsewhere in Hemel Hempstead.

The grouting work undertaken has only targeted the treatment of mined ground for the current site use and building layout. It is still the responsibility of the land owner to seek appropriate design advice prior to future development.

Dacorum Borough Council Building Control should be informed if any evidence of mine workings (such as shafts, voids or collapsed ground) is found during any future works undertaken as part of redevelopment.

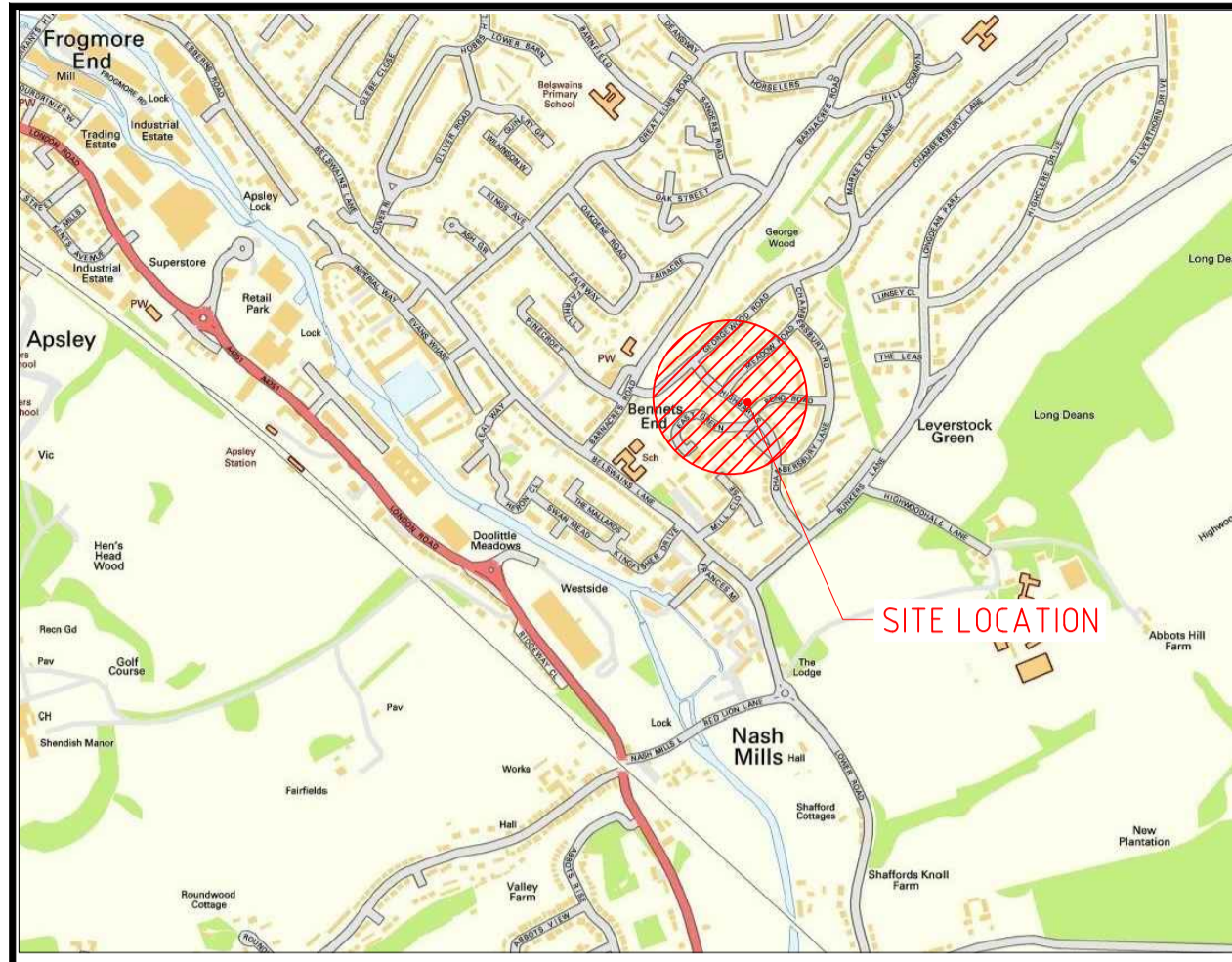
6 REFERENCES

1. Arcadis Consulting (UK) Limited (2015), Chalk Mine Stabilisation Project, Highbarns, Hemel Hempstead, Treatment Report, No 0013-UA000857-TR-01, October 2015.
2. BAM Ritchies (2015), *Highbarns Sectional Validation Reports ref. BBK704U, VR-001 to 012*. March 2015.
3. Hyder Consulting (UK) Limited (2012a), *Highbarns Chalk Mines Project, Interpretive Ground Investigation Report*, No 0010-UA000857-GDR-01, September 2012.
4. Hyder Consulting (UK) Limited (2012b), Highbarns, Hemel Hempstead, Chalk Mine Stabilisation Project, Specification for Site Works, No 0007-UA000857-GDR-01, September 2012.

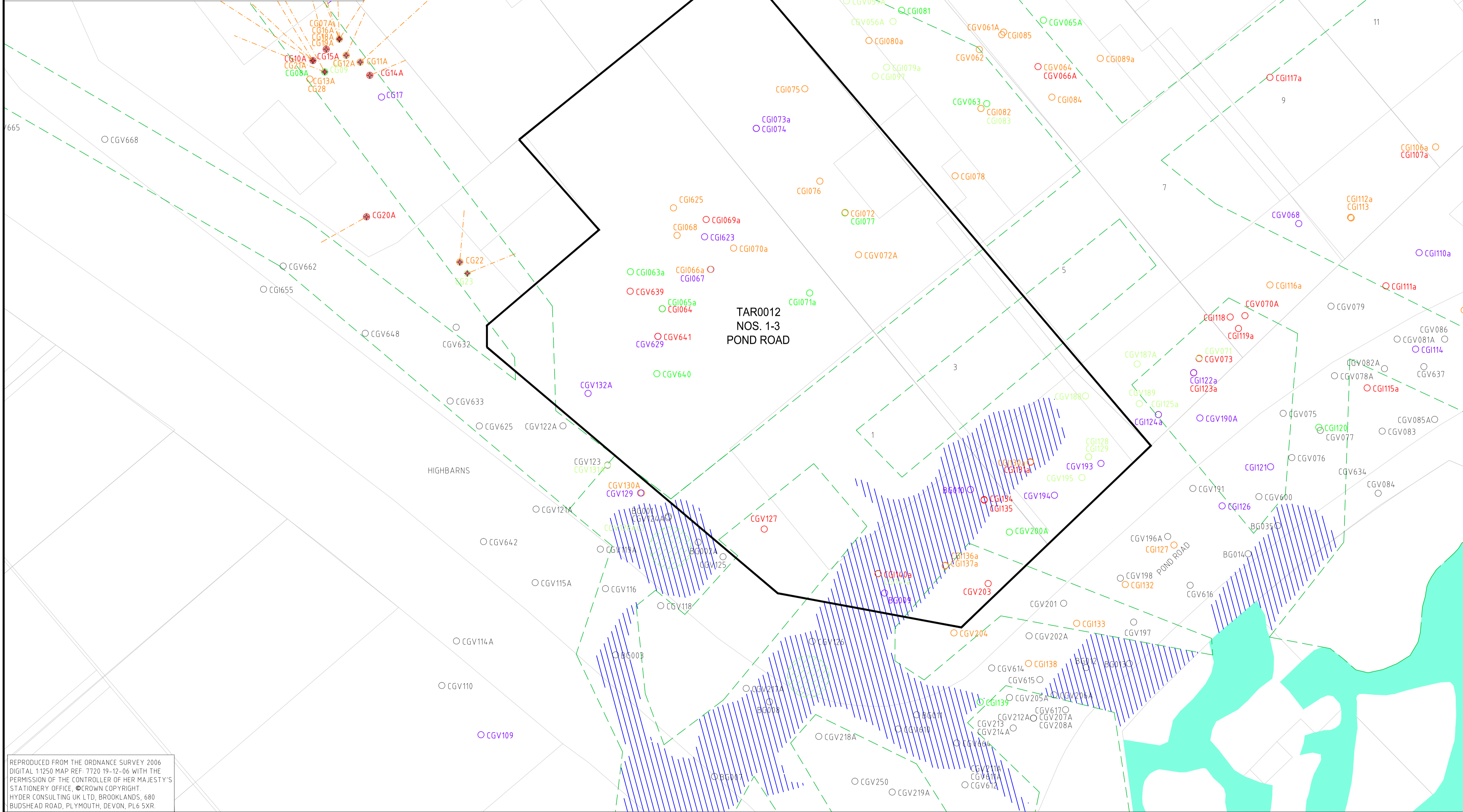
APPENDIX A

**Drawing TA12-01 – Treatment Area Plan for TAR0012
with Grout Holes**

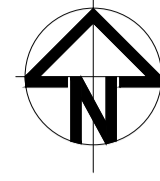
**Drawing TA12-02 – Treatment Area Plan for TAR0012
with Validation Probes**



SITE MAP
NTS



TREATMENT AREA PLAN
SCALE 1:100



- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
 3. VALIDATION AND GROUTING DATA BASED ON BAM RITCHIES' SECTIONAL VALIDATION REPORT (IBK706E VR0001 TO VR00012) AND DATED APRIL 2015.
 4. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 ARE BASED ON PETER BRETT ASSOCIATES (2008), INTERPRETATIVE GEOTECHNICAL REPORT - PHASE 1, NO 2024.7/004.3/INT01/REV2, JULY 2008.
 5. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 ARE BASED ON INSPECTAHIRE (2012), CALS AND CCTV INSPECTION OF VOIDS REPORT NO 6658, ISSUE 02, AUGUST 2012.

LEGEND	
PATTERN	DETAIL
	TREATMENT AREA BOUNDARY
	DERELICT LAND CLEARANCE ORDER BOUNDARY
	INTERPRETED MINE EXTENTS FOLLOWING TREATMENT
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 (SEE NOTE 5)
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	INTERPRETED SHAFT LOCATION FOLLOWING TREATMENT
	CGV138 / CGVM138 COMPACTION VERTICAL GROUT HOLES
	CGI138 / CGIM138 COMPACTION INCLINED GROUT HOLES (ORIENTATION INDICATED BY DASHED LINE WHERE INFORMATION PROVIDED IN FACTUAL REPORT (SEE NOTE 3))
	CGI138 COMPACTION GROUT HOLES (INCLINED OR VERTICAL (SEE NOTE 3))
	BGI138 / BGM138 BULK GROUT INFILL HOLES (SEE NOTE 3)

GROUTING LEGEND	
PATTERN	DETAIL
	CGV138 CGI108 COMPACTION GROUT HOLES (0.0-1.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (1.0-2.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (2.0-5.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (5.0-10.0m³)
	CGV138 CGI108 COMPACTION GROUT HOLES (>10.0m³)

Rev	Date	Auth	Description	AH	RB
A01	16.10.15	AB	FIRST ISSUE		



Project: HIGHBARNES
CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title: TREATMENT AREA PLAN
FOR TAR0012
WITH GROUT HOLES

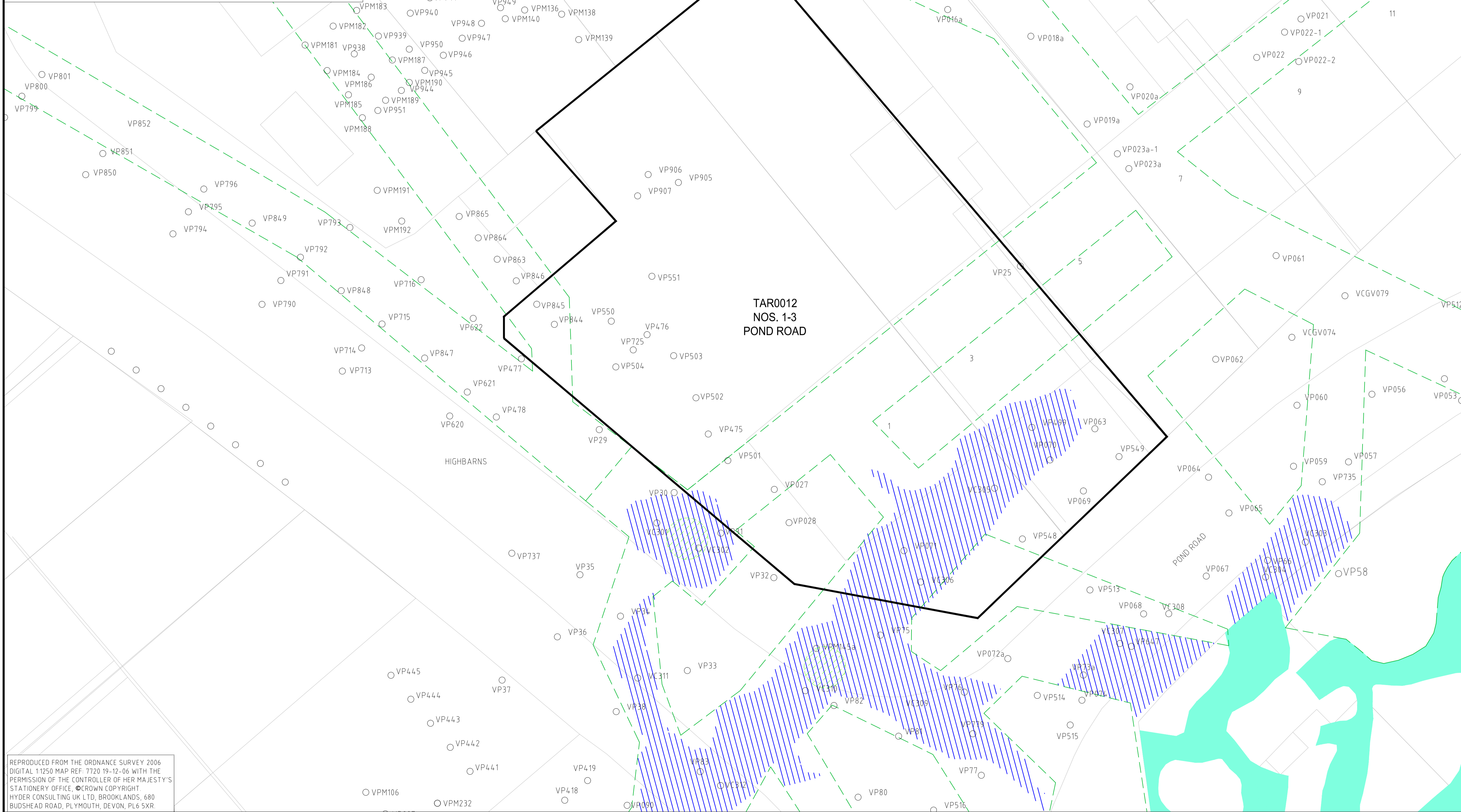
Drawn by: SANDIP P	Date: 16.10.15	Author: A.BLAKE	Date: 16.10.15
Checker: A.HOPE	Date: 16.10.15	Approver: R.BARSBY	Date: 16.10.15

Scale: AS SHOWN ON DRAWING	Sheet No.: 01
Drawing No.: TA0012-01	Revision: A01

REPRODUCED FROM THE ORDNANCE SURVEY 2006 DIGITAL 1:250 MAP REF. 7720 19-12-06 WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE. ©CROWN COPYRIGHT. HYDER CONSULTING UK LTD, BROOKLANDS, 680 BUDSHEAD ROAD, PLYMOUTH, DEVON, PL6 5XR.



SITE MAP
NTS

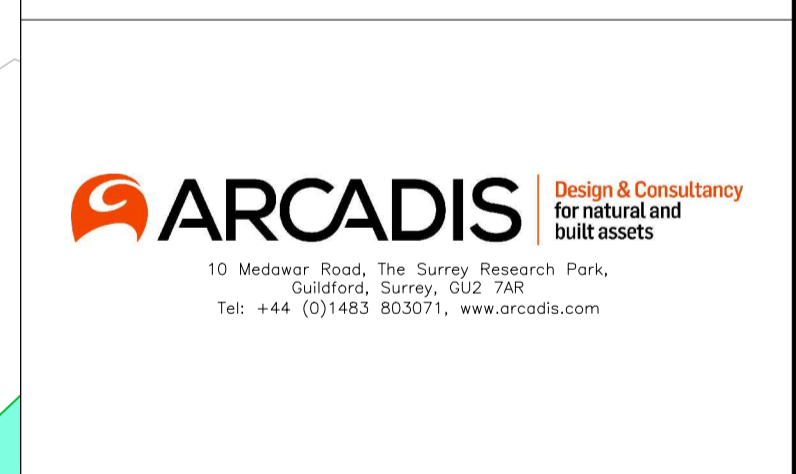


TREATMENT AREA PLAN
SCALE 1:100

- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
 3. VALIDATION AND GROUTING DATA BASED ON BAM RITCHIES' SECTIONAL VALIDATION REPORT (IBK706E VR0001 TO VR00012) AND DATED APRIL 2015.
 4. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 ARE BASED ON PETER BRETT ASSOCIATES (2008), INTERPRETATIVE GEOTECHNICAL REPORT - PHASE 1, NO 2024.7/004.3/INT01/REV2, JULY 2008.
 5. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 ARE BASED ON INSPECTAIRE (2012), CALS AND CCTV INSPECTION OF VOIDS REPORT NO 6658, ISSUE 02, AUGUST 2012.

LEGEND	
PATTERN	DETAIL
	TREATMENT AREA BOUNDARY
	DERELICT LAND CLEARANCE ORDER BOUNDARY
	INTERPRETED MINE EXTENTS FOLLOWING TREATMENT
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 (SEE NOTE 5)
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	INTERPRETED SHAFT LOCATION FOLLOWING TREATMENT
	VALIDATION DYNAMIC PROBES

Rev	Date	Auth	Description	Ckd	Apprd
A01	16.10.15	AB	FIRST ISSUE		



Project: HIGHBARNES CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title: TREATMENT AREA PLAN FOR TAR0012 WITH VALIDATION PROBES

Drawn by: SANDIP P	Date: 16.10.15	Author: A.BLAKE	Date: 16.10.15
Checker: A.HOPE	Date: 16.10.15	Approver: R.BARSBY	Date: 16.10.15

Scale: AS SHOWN ON DRAWING	Sheet No.: 01
Drawing No: TA0012-02	Revision: A01

REPRODUCED FROM THE ORDNANCE SURVEY 2006 DIGITAL 1:250 MAP REF. 7720 19-12-06 WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE. ©CROWN COPYRIGHT. HYDER CONSULTING UK LTD, BROOKLANDS, 680 BUDSHEAD ROAD, PLYMOUTH, DEVON, PL6 5XR.

Arcadis (UK) Limited

Manning House, 22 Carlisle Place
London
SW1P 1JA
United Kingdom
T: +44 20 3014 9000

[arcadis.com](https://www.arcadis.com)

