



CHALK MINE STABILISATION PROJECT HIGHBARNS, HEMEL HEMPSTEAD

Treatment Area 9: Nos. 5, 7, 9 and 11 Pond Road

Report Number: 0013-UA000857-TR-01-TAR-0009


OCTOBER 2015



Incorporating

CONTACTS

ROGER BARSBY
Technical Director
Geotechnics and Tunnelling
Approver

Signature.....

Date: 16 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: 16 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: 16 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 TREATMENT RECORDS.....	2
4 VALIDATION	4
4.1 No. 5 Pond Road	4
4.2 No. 7 Pond Road	5
4.3 No. 9 Pond Road	5
4.4 No. 11 Pond road	5
5 CONCLUSIONS	6
6 REFERENCES	6

APPENDICES

APPENDIX A

Drawing TA09-01 – Treatment Area Plan for TAR0009 with Grout Holes

Drawing TA09-02 – Treatment Area Plan for TAR0009 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 5, 7, 9 and 11 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 TA0009-01 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 5, 7, 9 and 11 Pond Road are summarised in Table 1 below.

Table 1: Summary of Validation Investigations

Type of Investigations	Number of Investigations
Total No. of External Validation Dynamic Probes (VP)	20
Total No. of Internal Validation Dynamic Probes (VP)	6

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 TREATMENT RECORDS

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. 5 Pond Road (Total Grout Holes = 33, Total Grout Volume = 434.8m ³)	Front of property	Vertical compaction grout holes	4	0.71m ³ (CGV071) to 30.7m ³ (CGV190).	33.3
	Back of property	Bulk Infilling grout holes	1	-	167.6
	Back of property	Vertical compaction grout holes	10	1.0m ³ (CGV063) to 4.2m ³ (CGV053)	22.9
	Back of property	Inclined compaction grout holes	6	1.69m ³ (CGI624) to 44.9m ³ (CGI628)	134.2
	Beneath the property	Inclined compaction grout holes	12	0.91m ³ (CGI083) to 21.2m ³ (CGI126)	76.8
No. 7 Pond Road (Total Grout Holes = 22, Total Grout Volume = 114.4m ³)	Front of property	Vertical compaction grout holes	3	5.4m ³ (CGV073) to 10.2m ³ (CGV068)	21.2
	Back of property	Vertical compaction grout holes	6	1.13m ³ (CGV065) to 5.7m ³ (CGV066)	18.7
	Beneath the property	Inclined compaction grout holes	13	1.92m ³ (CGI086) to 24.1m ³ (CGI114)	74.5
No. 9 Pond Road (Total Grout Holes = 12, Total Grout Volume = 38.7m ³)	Front of property	Vertical compaction grout holes	1	-	3.45
	Beneath the property	Inclined compaction grout holes	11	0.4m ³ (CGI094) to 12.2m ³ (CGI110)	35.2
No. 11 Pond Road	Beneath the property	Inclined compaction grout holes	13	0.49m ³ (CGI097) to 5.2m ³ (CGI107)	35.0

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 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 grout volumes at 7, 9 and 11 Pond Road did not generally indicate open mines but were in excess of what might be expected from natural ground. Occurrences of infilling greater than 12m³ were encountered in the front garden and back garden of No.5 Pond Road that indicated open mine workings. Validation probing generally shows that an improvement in the ground conditions has been achieved from the treatment works. The results of low dynamic probe blow counts outside the region of the expected mine depths indicated additional areas of possible mine workings. Consequently, additional grouting was undertaken beneath these areas and grout volumes confirmed potential mining related disturbed ground.

Specific observations for each property are set out in the subsequent sections.

4.1 No. 5 Pond Road

Treatment at No. 5 Pond Road was initially targeted at a possible junction of mine passages located along the front of the property, adjacent to the area of a previous collapse. Grout holes drilled from the front of the property and Pond Road resulted in high grout volumes indicating treatment of mine galleries in this area (CGV190a (30.7m³), CGI126 (21.2m³) and CGI123 (9.5m³)). Low grout volumes observed in CGV187A (0.95m³) and CGV089 (0.95m³), drilled at a similar time, did not indicate an extension of mine working in the direction of the house.

Treatment was carried out along the back garden of No. 5 due to indications of disturbed ground from the pre-treatment investigations. Higher than normal grout volumes were observed near the back of the garden in CGV053 (4.2m³) and CGV055 (3.6m³). Evidence of an open void was identified during drilling at grout hole CGV050a at depths between 20.5m and 21.7m bgl. The resultant grout volume (167.6m³) confirmed evidence of further mine workings extending towards Meadow Road (see Treatment Area Report TAR0011). Following grouting of CGV050a, a review of treatment at the property was undertaken to assess the potential further mine workings. An additional grid of six inclined compaction grout holes were carried out to complete treatment along the back garden. These were inclined from No. 1 Pond Road (CGI623 – CGI628) with the resultant grout volumes confirming the necessity of further treatment in the area.

Dynamic probing carried out to validate the treatment did not find weak ground at the typical depth of the mine found elsewhere. A proposed internal validation probe at the property (VP25), which was moved to the shared alleyway between the property and No. 3 Pond Road, could not penetrate deeper than 18.0m confirming competent ground where the mine could be expected.

4.2 No. 7 Pond Road

A notable reduction in grout volumes was observed at No. 7 compared with No.5 indicating that the mine workings were likely to be in a more collapsed state. Relatively low grout volumes (around 5-6m³) resulted at these properties compared to No.5. The only notable grout volumes were along the front garden of the property (CGV068, 10.2m³) and an inclined compaction grout hole drilled just off the front garden and aimed beneath the property (CGI114 – 24.2m³).

The results of vertical compaction grout holes carried out behind the property suggested evidence of collapsed mine workings in the area along the boundary with No.5 Pond Road (CGV66A, 5.76 m³ and CGV61A (3.28m³)).

Validation probe VP023A carried out inside the property had to be repeated due to an early refusal at 4.9m. The resultant VP023A-1 penetrated to 21.2m and did not reveal weak ground in the zone of the expected mine. The remaining validation probe results following treatment did not indicate any further mining related disturbed ground.

4.3 No. 9 Pond Road

Less than half the grout volume (35.2m³) was used below this property when compared to the adjacent property at No. 7 Pond Road (74.5m³) even though approximately the same number of grout holes were drilled. Inclined compaction grout holes aimed beneath the property indicated the potential for mining related weak ground (CGI111 (5.3m³), and CGI112 (4.5m³)) in the front garden. Compaction grout holes in the back garden resulted in volumes between 1.0-2.0m³ (CGI 90 to 95) and did not indicate an extension of the mine workings in this area.

A series of validation dynamic probes were carried out at the property following treatment. Initial validation probes VP021 and VP021-1 both refused early (4.6m and 4.8m respectively) and had to be subsequently repeated. Further dynamic probes located close by managed to penetrate down to below the anticipated mine depth at VP022 and VP022-2, without any indication of weak ground at the interpreted mine depth remaining following the treatment.

4.4 No. 11 Pond road

Thirteen inclined grout hole were carried out beneath No. 11 Pond Road from the front and back gardens of the property. No noticeable high grout volumes were observed at the property with grout totals typical of the general volumes in the area.

Following treatment, a row of (external) validation dynamic probes were carried out along the length of the property to further confirm the termination of the anticipated mine workings at the end of the property. The resultant dynamic probes (VP436 – 440) did not show any mining related disturbed ground, indicating termination of the mine in the area.

5 CONCLUSIONS

Grouting has been completed under Nos. 5, 7, 9 and 11 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 void | collapsed voids has taken place;
- as a result of the above assessment, the risk of settlement 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.

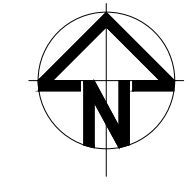
APPENDIX A

**Drawing TA09-01 – Treatment Area Plan for TAR0009
with Grout Holes**

**Drawing TA09-02 – Treatment Area Plan for TAR0009
with Validation Probes**



SITE MAP
NTS

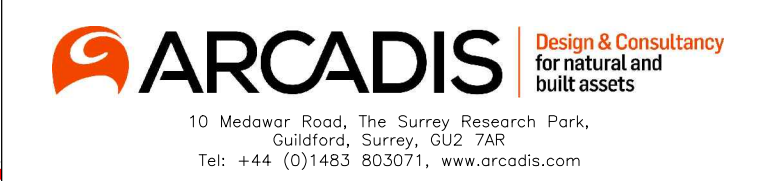


- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
 3. VALIDATION AND GROUTING DATA BASED ON BAM RITCHIES' SECTIONAL VALIDATION REPORT (IBK706E VR0001 TO VR00012) AND DATED APRIL 2015.
 4. VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 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 / CGM138 COMPACTION INCLINED GROUT HOLES (ORIENTATION INDICATED BY DASHED LINE WHERE INFORMATION PROVIDED IN FACTUAL REPORT (SEE NOTE 3))
	CGI38 COMPACTION GROUT HOLES (INCLINED OR VERTICAL (SEE NOTE 3))
	BGI38 / BGM138 BULK GROUT INFILL HOLES (SEE NOTE 3)

GROUTING LEGEND	
PATTERN	DETAIL
	CGV138 CGI108 COMPACTION GROUT HOLES (0.0-1.0m ³)
	CGV138 CGI108 COMPACTION GROUT HOLES (1.0-2.0m ³)
	CGV138 CGI108 COMPACTION GROUT HOLES (2.0-5.0m ³)
	CGV138 CGI108 COMPACTION GROUT HOLES (5.0-10.0m ³)
	CGV138 CGI108 COMPACTION GROUT HOLES (>10.0m ³)

Rev	Date	Auth	Description	Ckd	Apprd
A01	15.10.15	AB	FIRST ISSUE	AH	RB



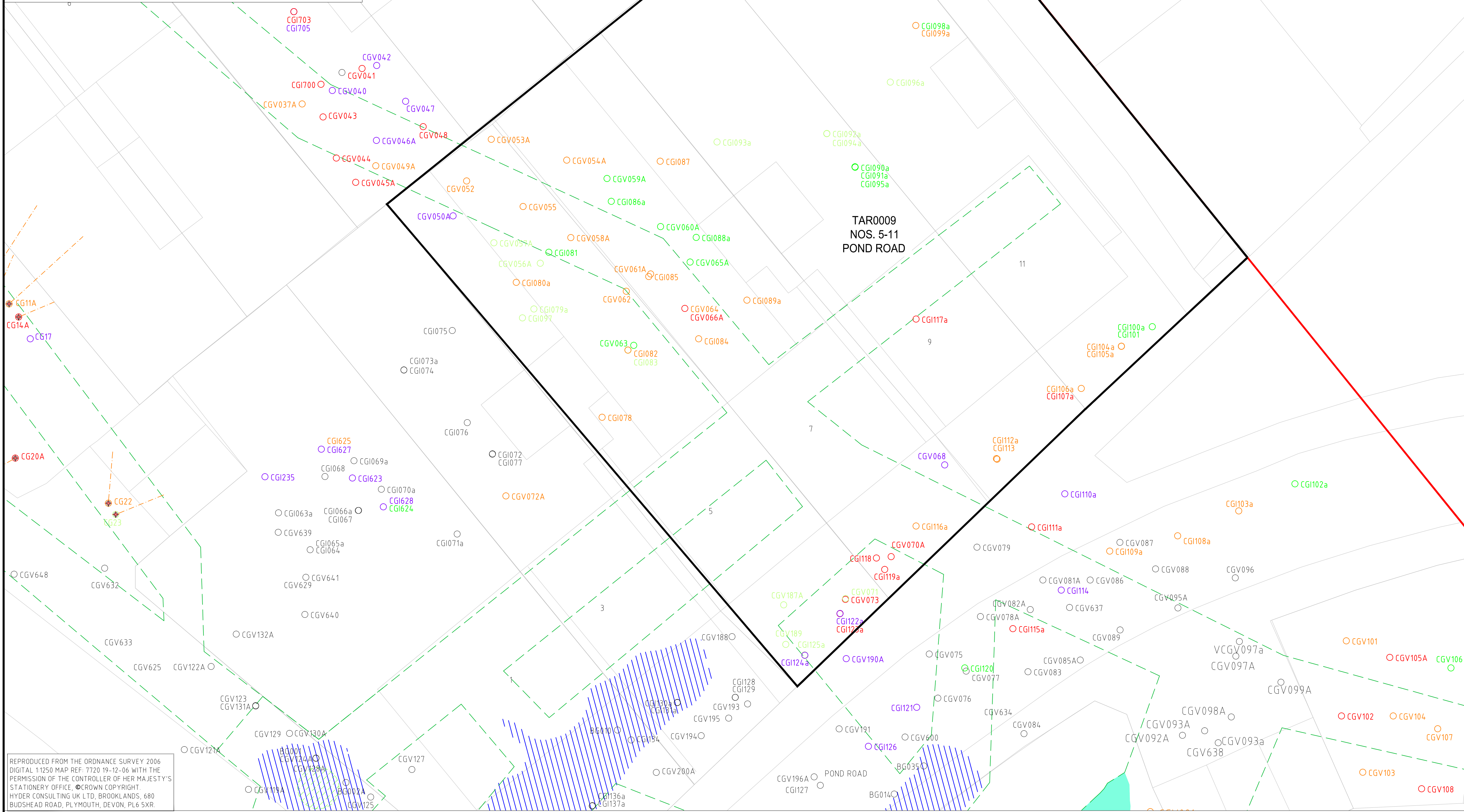
Project: HIGHBARNES
CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title:
TREATMENT AREA PLAN
FOR TAR0009
WITH GROUT HOLES

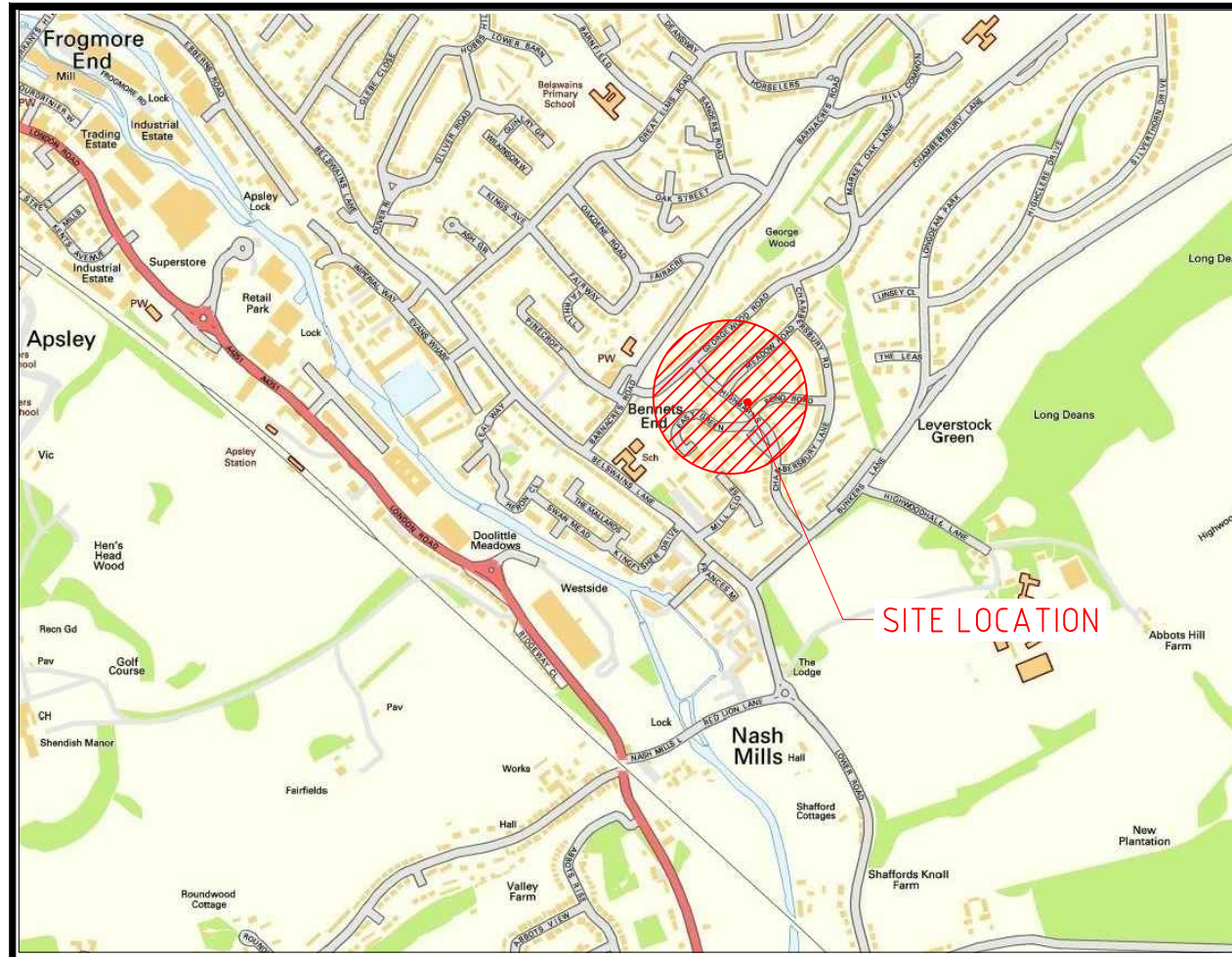
Drawn by: D.MORE	Date: 15.10.15	Author: A.BLAKE	Date: 15.10.15
Checker: A.HOPE	Date: 15.10.15	Approver: R.BARSBY	Date: 15.10.15

Scale: AS SHOWN ON DRAWING	Sheet No.: 01
Drawing No.: TA0009-01	Revision: A01

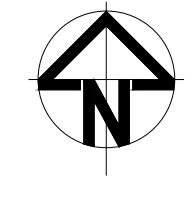


REPRODUCED FROM THE ORDNANCE SURVEY 2006 DIGITAL 1:250 MAP REF. 7720 19-12-06 WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE. ©CROWN COPYRIGHT. HYDER CONSULTING UK LTD, BROOKLANDS, 680 BUDSHEAD ROAD, PLYMOUTH, DEVON, PL6 5XR.

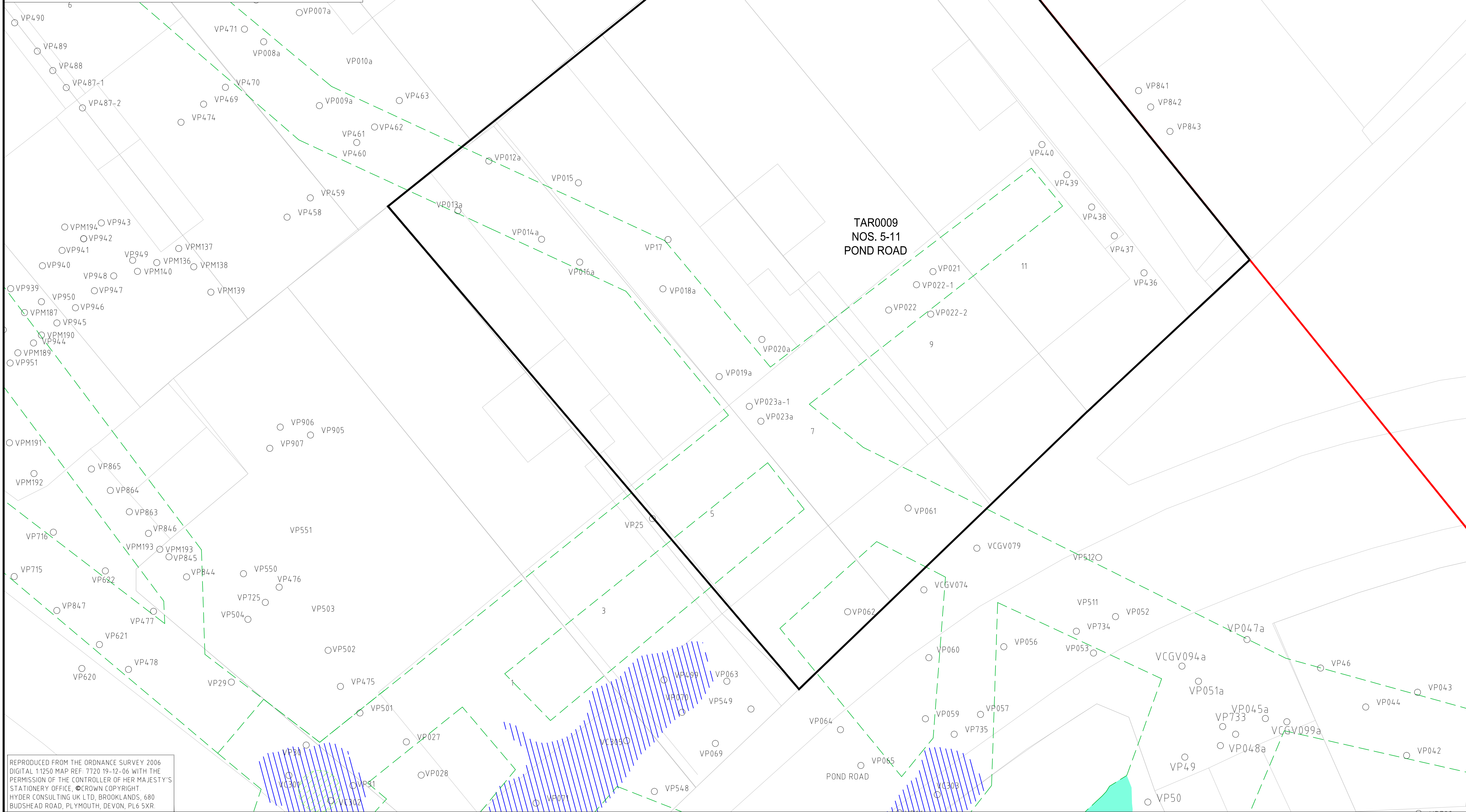
TREATMENT AREA PLAN
SCALE 1:100



SITE MAP
NTS



- 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/REV.2, 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.



TREATMENT AREA PLAN
SCALE 1:100

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

A01	15.10.15	AB	FIRST ISSUE	AH	RB
Rev	Date	Auth	Description	Ckd	Apprd



Project: HIGHBARNES CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title: TREATMENT AREA PLAN FOR TAR0009 WITH VALIDATION PROBES

Drawn by: D.MORE	Date: 15.10.15	Author: A.BLAKE	Date: 15.10.15
Checker: A.HOPE	Date: 15.10.15	Approver: R.BARSBY	Date: 15.10.15

Scale: AS SHOWN ON DRAWING	Sheet No: 01
Drawing No: TA0009-02	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)

