CHALK MINE STABILISATION PROJECT
HIGHBARNS, HEMEL HEMPSTEAD

Treatment Area 10: Highbarns and Meadow Road Junction

Report Number: 0013-UA000857-TR-01-TAR-0010

OCTOBER 2015

Incorporating

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APPENDICES

APPENDIX A

1 INTRODUCTION

Dacorum Borough Council (DBC) and Herts Highways (HH) 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) and subsequent funding from HH.

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 roadways discussed in this report are as follows:

- Highbarns and Meadow Road junction
- Part of Meadow Road extending from the road junction in a north easterly direction
- Part of Highbarns extending from the road junction in a north westerly direction

The broader site location, treatment areas and interpreted extent of mine workings within the Derelict Land Clearance Order site boundary are shown in the overarching Treatment Report (Arcadis, 2015), Figures 1, 2 and 3 respectively.

This Treatment area, validation probes and extent of grouting work specific to this treatment area are shown on drawings TA0010-01 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 undertaken within these roadways consisted of two phases:

- Phase 1 – Pre-treatment ground investigations
- Phase 2 – Validation ground investigations (concurrent with treatment works)

Phase 1 investigations were undertaken in response to historical subsidence events across the site. The phase 1 ground investigations were completed as part of the mine treatment design stage.

The phase 1 investigations were undertaken by BAM Ritchies in 2015 and included investigative dynamic probes (denoted DPM or MP). 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, phase 2 investigations were undertaken to establish the effectiveness of the mine treatment.

The scope of the phase 1 and 2 ground investigations completed during and following the treatment works for Meadow Road and Highbarns Junction are summarised in Table 1 below.

Table 1: Summary of Pre-treatment and Validation Investigations

Phase	Type of Investigations	Number
Phase 1 Pre-treatment design phase ground investigation	Total No. of Investigative Dynamic Probes (DPM/MP)	120
Phase 2 Validation Investigation (concurrent with Treatment works)	Total No. of External Validation Dynamic Probes (VPM)	124

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR0010 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.

3 TREATMENT RECORDS

Mine treatment works have been undertaken in accordance with the Hyder Specification for Site Works (Hyder, 2012). 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

Location	Type of Hole	Number of Holes	Range of Grout volumes[1] (m^3)	Total Grout volume[1] (m^3)
Highbarns and Meadow Road Junction (Total Grout Holes = 58, Total Grout Volume = 713m^3)	Bulk Infilling	1	-	26.3
	Vertical Compaction Grouting	47	0.27m^3 (CGVM37) to 180.11 m^3 (CGVM29)	664.5
	Inclined Compaction Grouting towards 1 and 1a Meadow Road	10	1.49m^3 (CGIM08B) to 9.0m^3 (CGIM09A)	48.2

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Highbarns and Meadow Road junction (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).

An initial row of investigation dynamic probes (denoted MP) were carried out along Highbarns and Meadow Road to identify the extent of potential mine galleries extending from adjacent treatment areas. Evidence of weak ground was identified at various depths in pre-treatment investigative probes such as MP4 (16-17m), MP25 (15-20m) and MP37 (17-20m) suggesting the presence of mine workings extending outside the original DLCO boundary. Several probes also suggested evidence of void migration with poor ground at very shallow depths, such as MP17 where voids were identified near the surface.

Grouting works were carried out along the line of the interpreted mine workings identified during the investigation stage along Highbarns. High grout takes were recorded in CGVM18 (94m^3), BGHM01b (26.3m^3) and CGVM14 (83.7m^3) located just outside the original DLCO boundary. This indicated that the mine extended beyond the original site boundary and confirmed the need for a continuation of treatment. A consistently high series of grout volumes were observed radiating out from the junction along Highbarns and Meadow Road. These included CGVM8 (12.9m^3), CGVM11 (37.7m^3) and CGVM13 (24.8m^3) extending along Highbarns and CGVM29 (180.11m^3) and CGVM30 (14m^3) along Meadow Road. The high grout volume at CGVM26 (36.8m^3) suggested the possibility of a further mine gallery extending away from the junction towards No. 2 Meadow Road. This confirmed previous areas of poor ground identified by investigation probes MP79 and MP82 (see Treatment Area Report TR0011). Validation probes were completed following treatment and did not identify any residual mining related disturbed ground.

The extent of mined ground in a North West direction along Highbarns was interpreted to terminate due to reduced grout volumes observed at CVGM33 (2.5m^3) and CVGM34 (3.6m^3). Several rows of dynamic probes along the end of the road did not indicate mine related disturbed ground and suggesting a termination to the mine workings (VPM120 to VPM122).

The extent of mined ground in a North East direction along Meadow Road was interpreted to terminate due to reduced grout volumes observed at CGVM43 (2.5m^3) and CGVM44 (3.64m^3). Several rows of dynamic probes along the end of the road did not indicate mine related disturbed ground suggesting a termination to the mine workings (VPM210 to VPM220).

5 CONCLUSIONS

Grouting has been completed under the Highbarns and Meadow Road Junction 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 and Herts Highways 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.

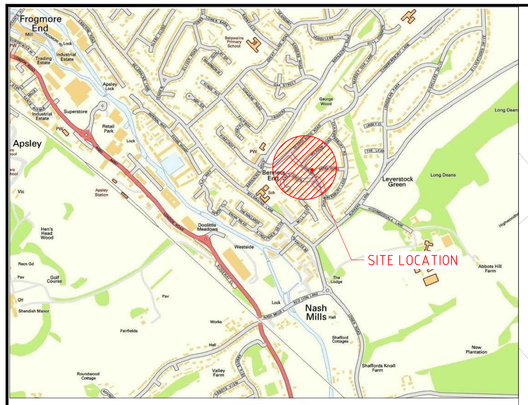
6 REFERENCES

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 (2012), Highbarns, Hemel Hempstead, Chalk Mine Stabilisation Project, Specification for Site Works, No 0007-UA000857-GDR-01, September 2012.

APPENDIX A

Drawing TA0010-01 – Treatment Area Plan for TAR0010 with Grout Holes

Drawing TA0010-02 – Treatment Area Plan for TAR0010 with Investigative and Validation Probes



SITE MAP

NTS

REPRODUCED FROM THE ORDNANCE SURVEY 2006 DIGITAL 1:1250 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 1:150

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 (BBK706E 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 20247/0043/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
	COLLAPSED GROUND RECORDED DURING 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))
CG138	COMPACTION GROUT HOLES (INCLINED OR VERTICAL (SEE NOTE 3))
BG138 / BGHM138	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	Ckd	Apprd
A01	15.10.15	AB	FIRST ISSUE	AH	RB

Client

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Project:

HIGHBARNS
CHALK MINE STABILISATION PROJECT

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Drawing title:

TREATMENT AREA PLAN
FOR TAR0010
WITH GROUT HOLES

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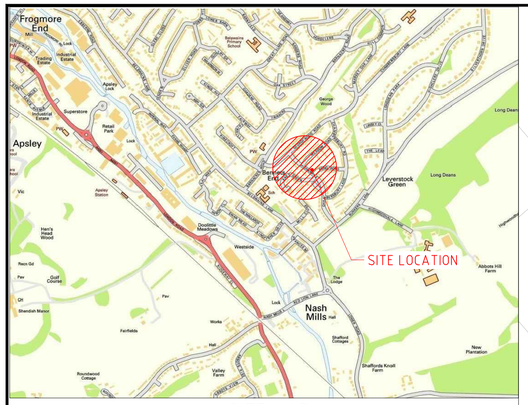
Checker:	Date:	Approver:	Date:
A.HOPE	15.10.15	R.BARSBY	15.10.15

Scale: AS SHOWN ON DRAWING

Sheet No.: 01

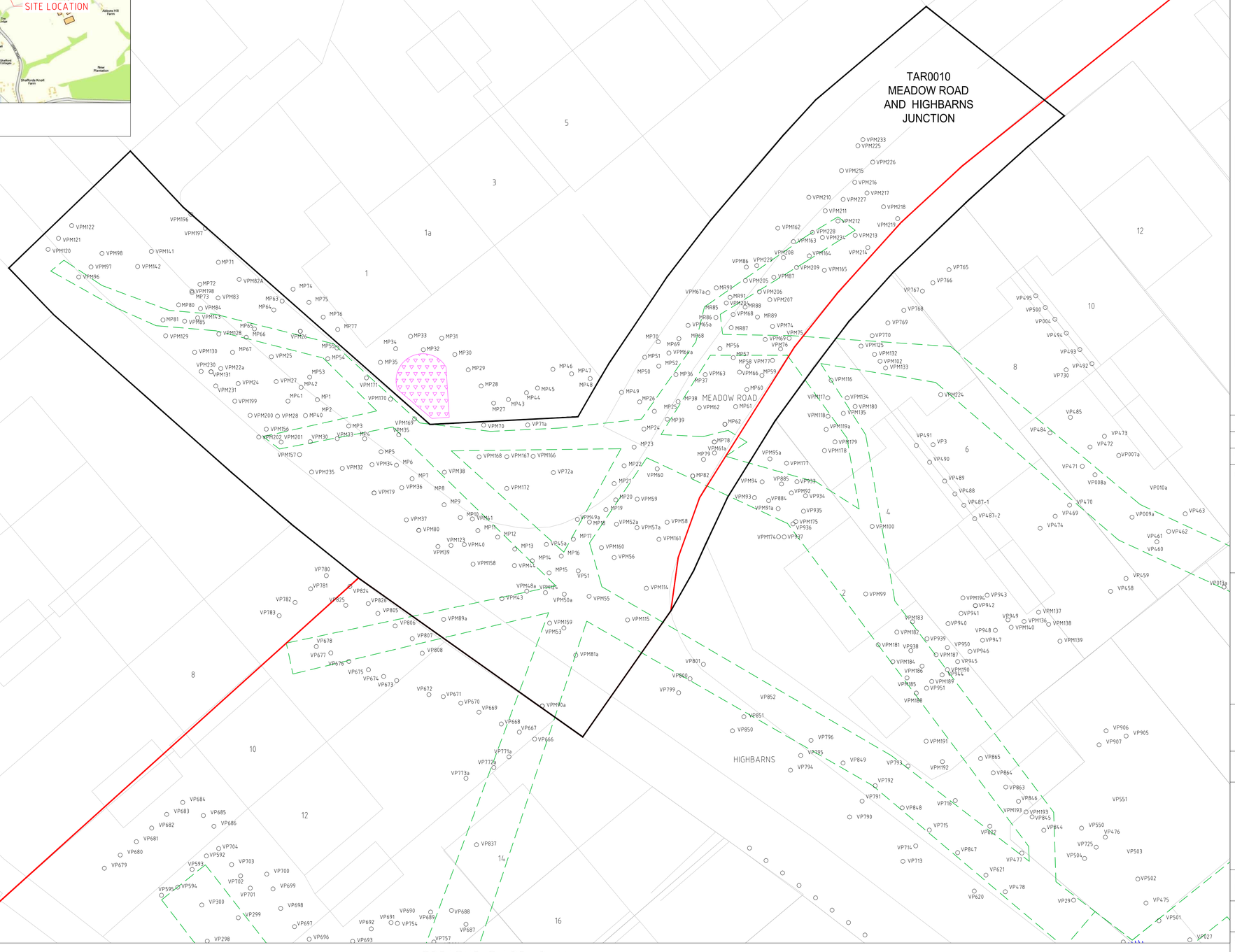
Drawing No.: TA0010-01

Revision: A01



SITE MAP

NTS



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	INTERPRETED SHAFT LOCATION FOLLOWING TREATMENT
	COLLAPSED GROUND RECORDED DURING TREATMENT
VP249/VPM249/ DPM249/VPP249	VALIDATION DYNAMIC PROBES

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TREATMENT AREA PLAN
FOR TAR0010
WITH VALIDATION PROBES

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

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