# CHALK MINE STABILISATION PROJECT
# HIGHBARNS, HEMEL HEMPSTEAD

## Treatment Area 7: Nos. 25, 26 & 27 East Green

Report Number: 0013-UA000857-TR-01-TAR-0007

OCTOBER 2015

Incorporating

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# APPENDICES

## APPENDIX A

# 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 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 25, 26 & 27 East Green.

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 TA0007-01 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 Nos. 25, 16 and 27 East Green (BAM, 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 25, 26 & 27 East Green are summarised in Table 1 below.

Table 1: Summary of Validation Investigations

| Type of Investigations | Number |
|---|---|
| Total No. of External Validation Dynamic Probes (VP) | 33 |
| Total No. of Internal Validation Dynamic Probes (VP) | 2 |

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR007 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 Project 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. 25 East Green** (Total Grout Holes = 16, Total Grout Volume = 86.7$m^3$) | Beneath the property | Inclined compaction grout holes | 6 | 1.577 (CGI641) to 7.324 (CGI643) | 21.08 |
| | Front garden | Vertical compaction grout holes | 10 | 1.907 (CGV477) to 17.7 (CGV474) | 65.58 |
| **No. 26 East Green** (Total Grout Holes = 18, Total Grout Volume = 91.9$m^3$) | Beneath the property | Inclined compaction grout holes | 6 | 0.52 (CGI265) to 9.09 (CGI264) | 21.91 |
| | Front garden | Vertical compaction grout holes | 12 | 1.61 (CGV434) to 13.86 (CGV478) | 70.00 |
| **No. 27 East Green** (Total Grout Holes = 26, Total Grout Volume = 153.8$m^3$) | Beneath the property | Inclined compaction grout holes | 12 | 1.12 (CGI272) to 18.42 (CGI258) | 59.20 |
| | Front and Back gardens | Vertical compaction grout holes | 14 | 1.645 (CGV444) to 15.95 (CGV447) | 94.60 |

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 25, 26 & 27 East Green (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. A correlation of dynamic probe blow values of less than 3 per 100mm penetration and the presence of workings was the specified

approach. Based on the results of the pre-contract ground investigation, blow counts greater than 3 per 100mm were determined to be acceptable.

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 25, 26 & 27 East Green 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 additional grout volumes as explained in the following section.

## 4.1 No. 25 East Green

The initial treatment works were designed following a review of pre-treatment ground investigation that identified evidence of poor ground at the front of the property. Notable high grout volumes at CGV482 (15.2m3) and CGV483 (9.1m3) located near the property indicated likely extension of mine workings beneath the property. A gradual reduction in grout volumes were noted following an initial high take at CGI643 (7.3m3). A review of the grout volumes carried out beneath the property was indicative of generally collapsed mine workings terminating at some point beneath the house.

Validation dynamic probing was carried out at No. 25 East Green following completion of the treatment works. A row of dynamic probes (VP583-VP589) carried out along the Derelict Land Clearance Order (DLCO) boundary did not provide evidence of further mine workings extending outside the treatment boundary. A validation probe inside the building was carried out to confirm the competency of ground conditions beneath the property following treatment while two dynamic probes carried out along the back garden aimed to confirm the termination of the assumed mine gallery. Both sets of dynamic probes did not suggest any further evidence of possible mine-related disturbed ground in the area.

## 4.2 No. 26 East Green

Treatment works at No. 26 East Green were designed to confirm the termination of the known mine workings extending from the back garden of No. 27 East Green. Initial high grout takes along the back garden of No. 26 East Green, particularly at CGV387a (8.9m3) were seen to stabilize to site-wide average grout volumes (CGV386, CGV434A), indicating that mined ground had been treated. Grout volumes along the front garden were also seen to reduce in successive grout holes, particularly closer to the property. High grout takes at CGV445A (12.1m3) and CGV478 (13.9m3) were related to the untreated ground at No. 25 East Green and confirmed the necessity of subsequent treatment works at No. 25 East Green where the mine was expected and confirmed to end.

## 4.3 No. 27 East Green

A full scope of treatment works were undertaken at No. 27 East Green to stabilise the mine galleries expected from the interpretation of the pre-treatment investigation. Grout volumes along the front garden were seen to decrease to generally average site values following an initial high grout volumes at CGV442 (11.7m3) and CGV447 (16.0m3) indicating that mined ground had been treated.

Treatment carried out along the back garden resulted in higher grout volumes. These were seen as possibly filling up the likely intersection of two mine galleries converging along the back garden. Two high grout takes located closer to the property at CGV435A (7.3m3) and CGV437b (12.08m3) also suggested the likely extension of the mine beneath the property and confirmed the need for the proposed inclined grout

holes under the property. These grout holes confirmed the extension of the mine gallery running along the property, with particularly high grout volumes at CGI271 (13.2m3). The final grout volume recorded in the area, CGI258 (18.4m3), was the highest beneath the property and suggested further mined ground extending along the adjacent properties and subsequent grouting confirmed the extension of the mine under both Nos 25 and 26 East Green.

A validation dynamic probe was carried out inside the dwelling out following the completion of treatment works. The results (VP639) did not suggest any further evidence of possible mine-related disturbed ground in the under the building.

# 5 CONCLUSIONS

Grouting has been completed under 25, 26 and 27 East Green 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.

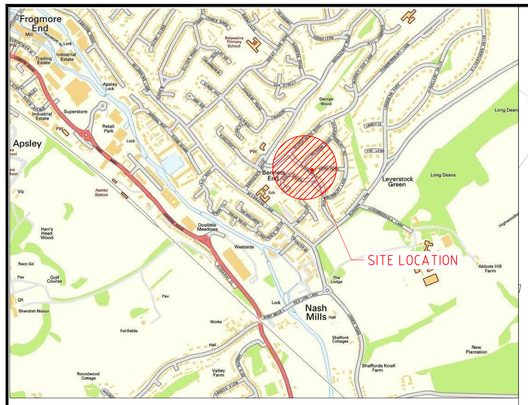
# 6 REFERENCES

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 (2014), *Highbarns Sectional Validation Reports ref*. BBK704U, VR-001 to 012. March 2014.
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 TA07-01 – Treatment Area Plan for TAR0007 with Grout Holes

## Drawing TA07-02 – Treatment Area Plan for TAR0007 with Validation Probes




SITE MAP
NTS

TAR0007
NOS. 25-27
EAST GREEN

EAST GREEN

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 1:100

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 (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 |
| 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 |
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Project: HIGHBARNS CHALK MINE STABILISATION PROJECT

Drawing status: PRELIMINARY

Drawing title: TREATMENT AREA PLAN FOR TAR0007 WITH GROUT HOLES

| 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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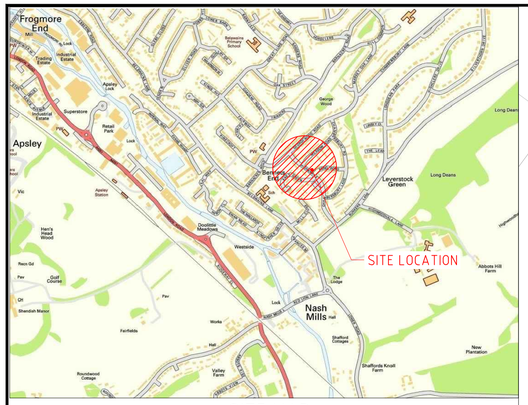
Drawing No.: TA0007-01
Revision: A01




SITE MAP
NTS

TAR0007
NOS. 25-27
EAST GREEN

EAST GREEN

TREATMENT AREA PLAN
SCALE 1:100



NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
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| 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 |
| VP249/VPM249/ DPM249/VPP249 | VALIDATION DYNAMIC PROBES |

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Project:
HIGHBARNS
CHALK MINE STABILISATION PROJECT

Drawing status:
PRELIMINARY

Drawing title:
TREATMENT AREA PLAN
FOR TAR0007
WITH VALIDATION PROBES

| Drawn by: | Date: | Author: | Date: |
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