



CHALK MINE STABILISATION PROJECT HIGHBARNNS, HEMEL HEMPSTEAD

Treatment Area 1: Nos. 2, 4, 6 and 8 Pond Road

Report Number: 0013-UA000857-TR-01-TAR-0001

OCTOBER 2015



Incorporating

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Drawing TA01-02 – Treatment Area Plan for TAR0001 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 2, 4, 6 and 8 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 the overarching Treatment Report (Arcadis, 2015), Appendix A.

This Treatment area, validation probes and extent of grouting work specific to this treatment area are shown on drawings TA0001-01 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. 2, 4, 6 & 8 Pond Road. (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 2, 4, 6 and 8 Pond Road are summarised in Table 1 below.

Table 1: Summary of Pre-contract and Validation Intrusive Investigation

Type of Investigations	Number of Investigations
Total No. of External Validation Dynamic Probes (VP)	45
Total No. of Internal Validation Dynamic Probes (VP)	5

The results of the validation dynamic probes undertaken during and after treatment works are presented in the relevant sectional factual report VR001 for this treatment area (BAM, 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. 2 Pond Road (Total Grout Holes = 32, Total Grout Volume = 127.666m ³)	Front of property	Inclined compaction grout holes	4	0.58 (CGI145) to 4.6 (CGI173).	5.227
	Rear garden	Vertical compaction grout holes	11	1.9 (CGV156) to 12.9 (CGV653).	57.9
	Rear garden	Inclined compaction grout holes	9	5.0 (CGI651) to 6.3 (CGI652)	30.839
	Side garden	Vertical compaction grout holes	8	1.4 (CGV106) to 9.7 (CGV105A).	33.7
No. 4 Pond Road (Total Grout Holes = 9, Total Grout Volume = 34.16m ³)	Beneath the property	Inclined compaction grout holes	9	0.93 (CGI149) to 14.5 (CGI164)	34.16
No. 6 Pond Road (Total Grout Holes = 14, Total Grout Volume = 36.071m ³)	Beneath the property	Inclined compaction grout holes	14	0.51 (CGI150) to 5.2 (CGI151)	36.071
No. 8 Pond Road (Total Grout Holes = 5, Total Grout Volume = 14.2m ³)	Beneath the property	Inclined compaction grout holes	5	2.192 (CGI603) to 3.434 (CGI600)	14.2

Notes:

The above extract is based on data from BAM Ritchies' Sectional Validation Report for Nos. 2, 4, 6 & 8 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 2, 4, 6 & 8 Pond Road did not generally indicate open mines but, in some locations, are in excess of what might be expected from natural ground. Grout volumes across the treatment area generally ranged between a minimum of 0.58m³ and an average around 5.0m³ with occasional grout volumes in excess of 10m³. Additional grout treatment was undertaken at specific locations across the treatment area where higher than expected grout volumes were encountered or validation probes indicated weak ground not previously identified. Specific observations for each property are set out in the subsequent sections.

4.1 No. 2 Pond Road

Grouting at No. 2 Pond Road was designed to treat a possible mine passage trending east-west beneath the property. In review of the Phase 1 ground investigation dynamic probe data, an anticipated grout volume of between 0.5m³ and 5.0m³ was expected in the region of the possible mine passage. Grout volumes of between 0.577m³ and 9.711m³ were recorded during a first phase of treatment works at No. 2. CGV105 recorded a grout volume of 5.5m³ between depths of 21.0m and 23.0m. A review of adjacent validation probe VP043 did not indicate the presence of mine workings at this depth or at any level in the probe. Therefore, the high grout volume recorded at this location is considered to represent a locally weak band or a heavier fractured zone of chalk. With the exception of VP146, validation probe results from the initial phase of validation/investigation testing undertaken during March and April 2013 confirmed a general improvement of the relative density of the ground following treatment. Results from validation probe VP146 showed low blow counts and a potential for mine workings between depths of 12.2m and 13.2m below ground level (bgl). As a result, a second phase of investigative probes were undertaken.

This second phase of investigative probes was carried in September 2013 with the objective of investigating the extent of potential mine workings in the vicinity of, and extending from VP146. A review of results indicated weak potentially mined ground in the rear garden of No. 2 Pond Road. As a result, a third phase of investigative probes was carried out in November 2013. Validation probes VP710 and VP711 recorded low blow counts between depths of 12.3 and 15.4m bgl and results of validation probing in adjoining areas (VP709, VP712 and VP664) indicated potential mined ground between depths of 11.2m and 15.3m bgl.

Consequently, a secondary phase of treatment involving both vertical and inclined compaction grouting was undertaken during December 2013 in the rear garden of No. 2. Recorded grout volumes ranging between 2.336m³ and 12.913m³ were comparable with the anticipated quantities as based on the identified vertical and lateral extents of mining related ground and there was a gradual reduction in volumes as grouting work progressed.

4.2 No. 4 Pond Road

Grouting of No. 4 Pond Road was designed to treat the possible mine galley extending from No. 2 Pond Road beneath the building. An interpretation of the expected mine layout for No. 4 Pond Road is shown on Drawing TA0001-02 presented in Appendix A.

A total grout volume of 37.0m³ was injected from ten inclined compaction grout holes directed beneath the dwelling during one single phase of treatment. Grout volumes ranging between 0.93m³ and a maximum volume of 14.5m³ recorded in CGI164 located in the rear garden. This was located in relatively close proximity to mining related ground identified in the rear garden of No. 2 and indicates a general improvement of the relative density of the ground following treatment works and the records show a gradual reduction in grout volumes as treatment progressed.

4.3 No. 6 Pond Road

Grouting of No. 6 Pond Road was designed to treat the possible mine passage trending east-west from No. 2 and No. 4 Pond Road. A total of 50m³ of grout was injected into nineteen inclined grout holes directed beneath the property during one single phase of treatment. Grout volumes consistently ranged between 0.51m³ and 5.2m³ with an average volume of approximately 3.0m³ indicating the treatment of collapsed ground rather than open mine voids.

Three validation probes undertaken within the building (VP039, VP040 and VP486) all indicated a general improvement in the relative density of the ground in this area .

4.4 No. 8 Pond Road

Grouting of No. 8 Pond Road was designed to treat the possible mine passage trending east-west from No. 4 Pond Road. A total of 14.2m³ of grout was injected into five inclined grout holes drilled from No. 6 Pond Road directed beneath No. 8. Grout volumes consistently ranged between 2.192m³ and 3.434m³ indicating the treatment of collapsed ground rather than open mine voids.

Validation probing was undertaken within the garden of No. 8 Pond Road to investigate the western extent of the mine. This phase of validation probes could not penetrate deeper than between 15.0m and 21.6m and did not find weak ground indicative of collapsed mine workings as found elsewhere in the gardens of adjacent properties.

5 CONCLUSIONS

Grouting has been completed under 2, 4, 6 and 8 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.

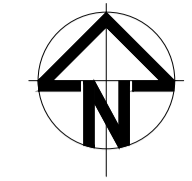
APPENDIX A

**Drawing TA01-01 – Treatment Area Plan for TAR0001
with Grout Holes**

**Drawing TA01-02 – Treatment Area Plan for TAR0001
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 (IBBK706E 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)
	CGV138 / CGV138 CGM138 / CGM138
	CGV138 / CGM138 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 / BGM138 BULK GROUT INFILL HOLES (SEE NOTE 3)

GROUTING LEGEND	
PATTERN	DETAIL
	CGV138 / CG108 COMPACTION GROUT HOLES (0.0-1.0m ³)
	CGV138 / CG108 COMPACTION GROUT HOLES (1.0-2.0m ³)
	CGV138 / CG108 COMPACTION GROUT HOLES (2.0-5.0m ³)
	CGV138 / CG108 COMPACTION GROUT HOLES (5.0-10.0m ³)
	CGV138 / CG108 COMPACTION GROUT HOLES (>10.0m ³)

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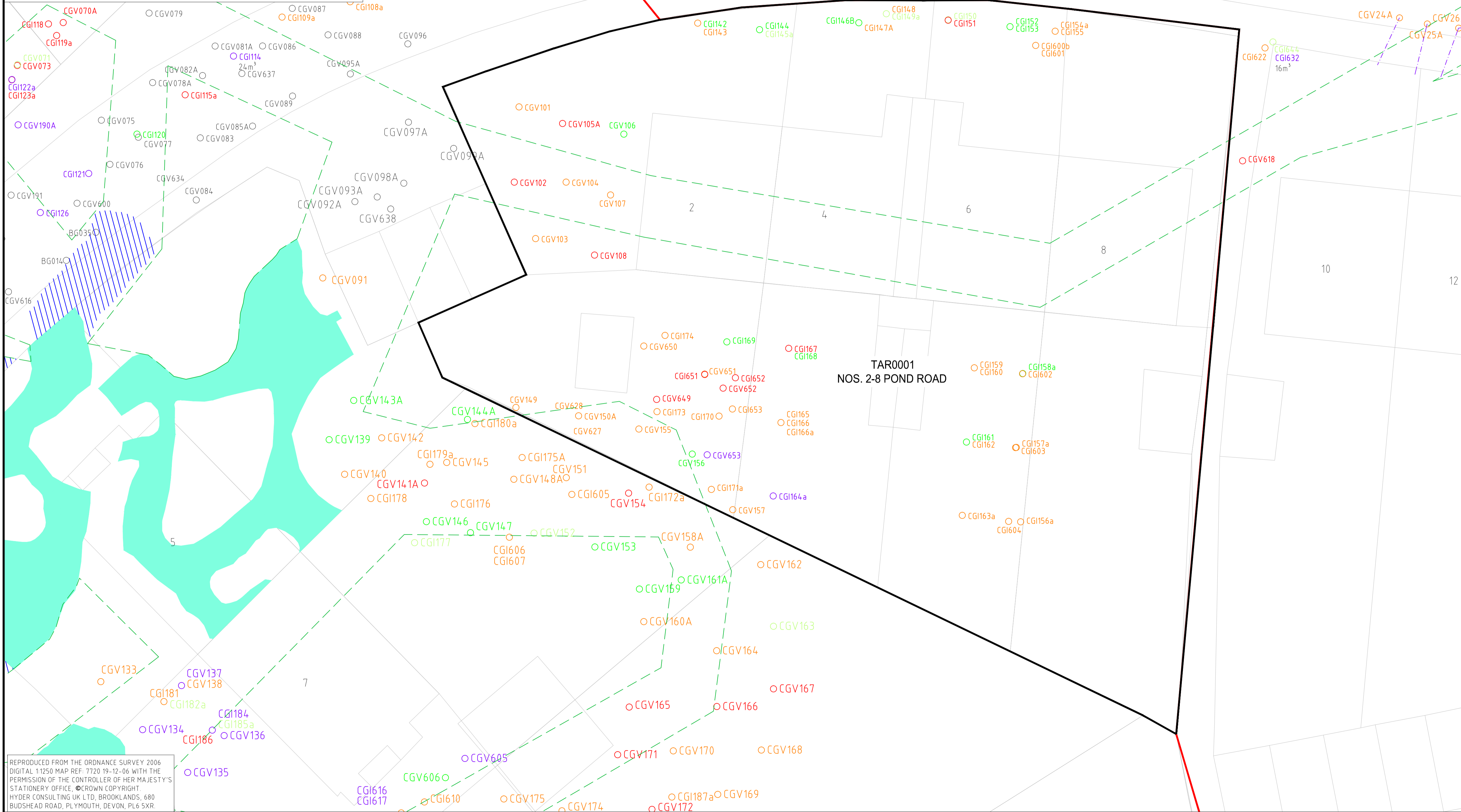
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Drawn by: D.MORE	Date: 15.10.15	Author: A.BLAKE	Date: 15.10.15
Checker: A.HOPE	Date: 15.10.15	Approver: R.BARSBY	Date: 15.10.15

Scale: AS SHOWN ON DRAWING	Sheet No.: 01
Drawing No: TA0001-01	Revision: A01

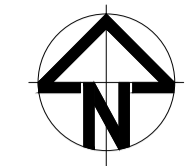


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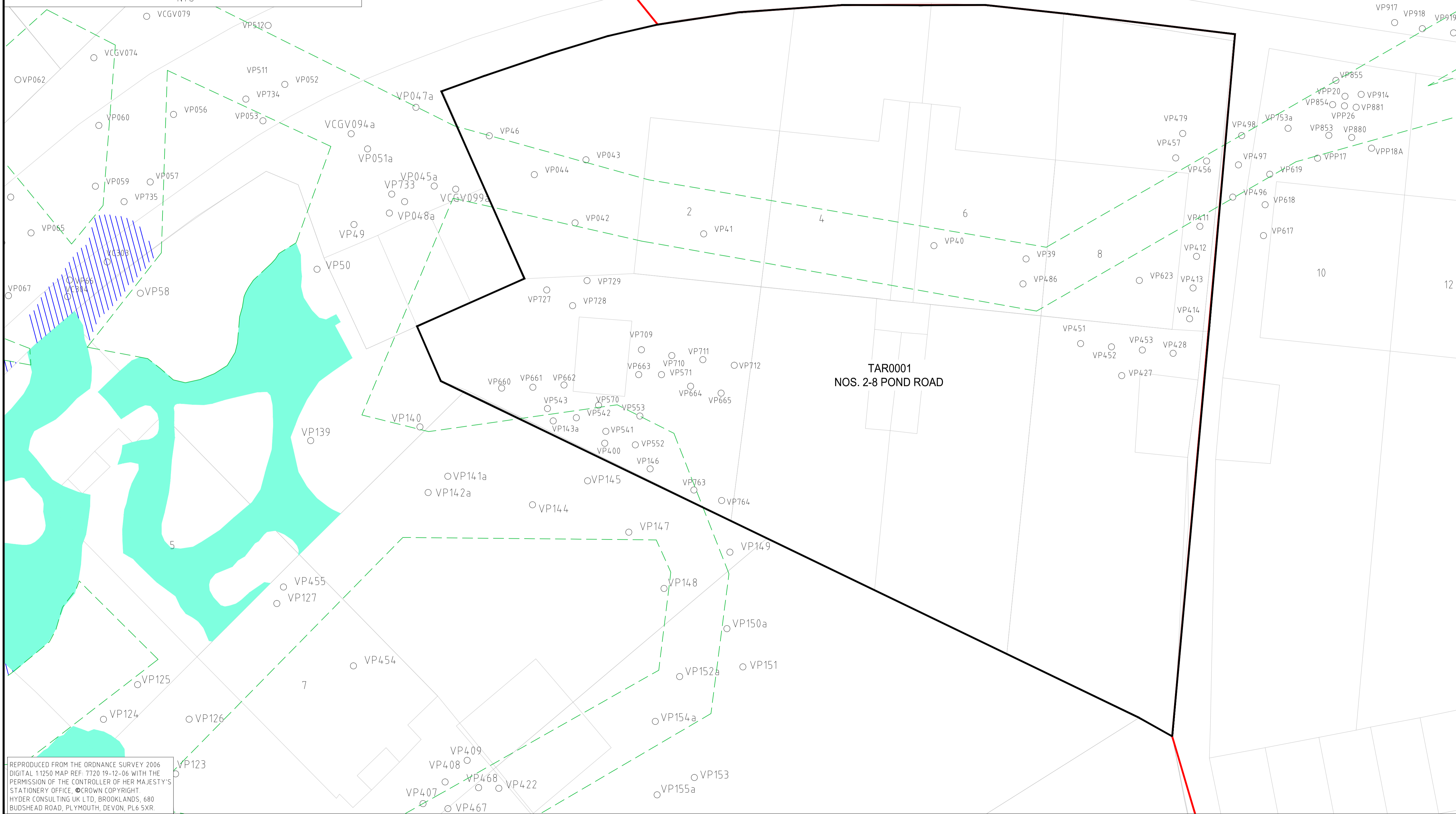
TREATMENT AREA PLAN
SCALE 1:100



SITE MAP
NTS

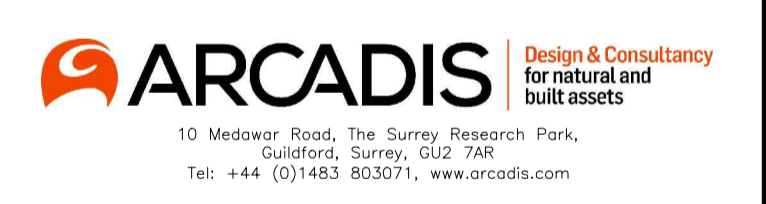


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	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2012 (SEE NOTE 5)
	VOIDS IDENTIFIED BY LASER SURVEYS UNDERTAKEN IN 2008 AND REMEDIATED IN 2008 (SEE NOTE 4)
	VALIDATION DYNAMIC PROBES

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TREATMENT AREA PLAN
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