CONFIDENTIAL REPORT

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Project Title:	Evaluation of Brick Earth Deposit
Client:	Wardell Armstrong LLP Sir Henry Doulton House Forge Lane, Etruria Stoke on Trent Staffs ST1 5BD
For the Attention of:	Mr Stephen Barry
Author(s):	Dr Richard White
Report Date:	24 March, 2022
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Work Location:	Lucideon UK

This report supersedes the report issued on 11.03.22.

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APPENDIX A – Test Certificates

SUMMARY

Wardell Armstrong LLP require evaluation of brick earth from a potential development site, in order to determine whether the material is suitable for brickmaking.

Clay samples will be initially visually assessed and chemically analysed. The brick making potential of the material will be assessed by prepared briquettes, which will be inspected.

The clay samples were found to be relatively low in clay, which would result in a relatively low strength brick. The laboratory samples and briquettes show a good textured brick with a suitable fired colour. There is no evidence of efflorescence or residual chalk particles that would result in lime blow. The briquettes are vitrified but due to the relatively low clay content are relatively weak. Bricks produced from this clay would be of relatively low strength compared to currently commercially available products.

1 INTRODUCTION

Wardell Armstrong LLP require evaluation of brick earth from a site, in order to determine whether the material is suitable for brickmaking.

Samples will be initially assessed and photographed. Coarse material such as flint and chalk that exceeds 10 mm in size if present will be removed. Bulk chemical composition, carbon and sulphur contents will be determined. The basic brick making potential of the material will be assessed. After material exceeding 10 mm in size has been removed from the sample, the sample will be crushed to be capable of passing through a 2 mm sieve. The clay will be wetted to a consistency that is compatible with brick extrusion and pressed to form a briquette and fired at 1060°C. Assessment of the briquettes will include shrinkage on drying and shrinkage on firing. The fired colour and texture will be examined along with assessing uniformity, acceptability of the fired colour, the presence of excessive sandy material in the clay and evidence of severe shrinkage or cracking.

Clay samples were referenced: Sittingbourne MRA, ST18667 with samples derived from five boreholes from less than 2.2 m in depth.

2 PROCEDURE

2.1 Visual Examination of Clay Samples Supplied

The clay samples were examined and photographed upon receipt.

2.2 Chemical Composition by XRF

A representative sample of each material was chemically analysed using X-Ray Fluorescence (XRF) analysis. This technique gives information concerning the compositional make-up of the sample.

A fully quantitative mode was used on the sample, whereby the material was ground to a fine powder to homogenise it, then ignited at 1025°C and then fused with lithium borate to form a homogenous glass bead. The analysis was performed on the bead using a Panalytical Axios wavelength dispersive XRF Spectrometer. The method used was in-house Method C201, which is based on BS EN ISO 12677:2011.

2.3 Total Carbon and Sulphur

Total carbon and sulphur in the clay samples were determined on a representative sub sample of the material provided. The material is ground and homogenised and dried at 110°C. The ground material is mixed with a catalyst and pyrolysed in a Leco Carbon sulphur analyser. Carbon is converted to CO and CO_2, sulphur is converted to SO_2 and SO_3, the quantities of the resulting gases are determined using Infrared detection and converted to initial carbon and sulphur content.

2.4 Fired Appearance

Clay as received was wetted to form a thick clay, this was hand-pressed to form briquettes. Any visible organic debris was removed prior to pressing. These briquettes were air dried and then fired at 1060°C to mimic a typical brick firing. The process was performed as a

quick evaluation. With additional time, the clays would have been ground, dried, wetted, then thoroughly mixed and extruded to form briquettes.

Once fired the briquettes were examined and photographed to assess the fired colour and body texture.

2.5 Drying Shrinkage and Fired Shrinkage

The clay was dried, crushed and sieved until it passed through a 2 mm sieve. Water was then added, and the clay was tempered to a plastic consistency, wedged into clots and pressed to produce two 75 x 37 x 25 mm briquettes.

Each briquette was air dried for 4 days in laboratory conditions and an initial measurement was taken. Following this, each briquette was placed into a ventilated oven at 110°C for 24 hours, removed and allowed to cool, then remeasured.

A single briquette (B) was then placed into a kiln and heated to 1060°C for 24 hours, when cool a final measurement was taken.

3 RESULTS

3.1 Visual Examination of Clay Samples Supplied

In all the five clay samples examined, the particles are only visible with hand-lens, and are not visible with the naked eye. All the samples stick together readily when wet. The description of each sample is given below and is followed by photomicrographs.

3.1.1 BH1 B1. 1.2–2.2 m

The sample (Figures 1 and 2) is light brown in colour with uniform texture. When wet, it displays plasticity and does not disintegrate quickly. It is cohesive and can be moulded or crushed. It can be powdered easily between fingers when relatively dry. It does not react with dilute hydrochloric acid. The sample displays clay characteristics.

Figure 1 - General View of BH1 B1. 1.2–2.2 m

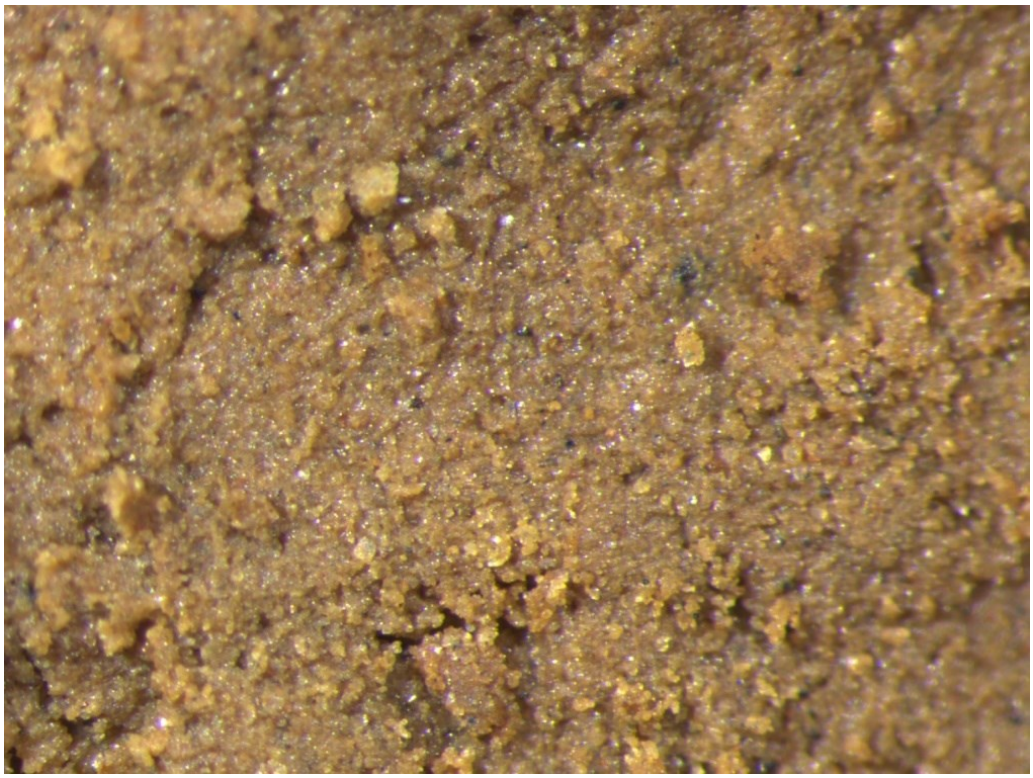

Figure 2 - Close Up View of BH1 B1. 1.2–2.2 m

3.1.2 BH2 B1. 1.0–1.7 m

The sample (Figures 3 and 4) is light brown in colour with uniform texture. When wet, it displays plasticity and does not disintegrate quickly. It is cohesive, can be moulded or crushed. It can be powdered easily between fingers when moderately dry. The sample contains occasional dark material organic matter and chalk fragments. The clay does not react with dilute hydrochloric acid; however, the chalk fragments react. The sample displays clay characteristics.

Figure 3 - General View of BH2 B1. 1.0–1.7 m

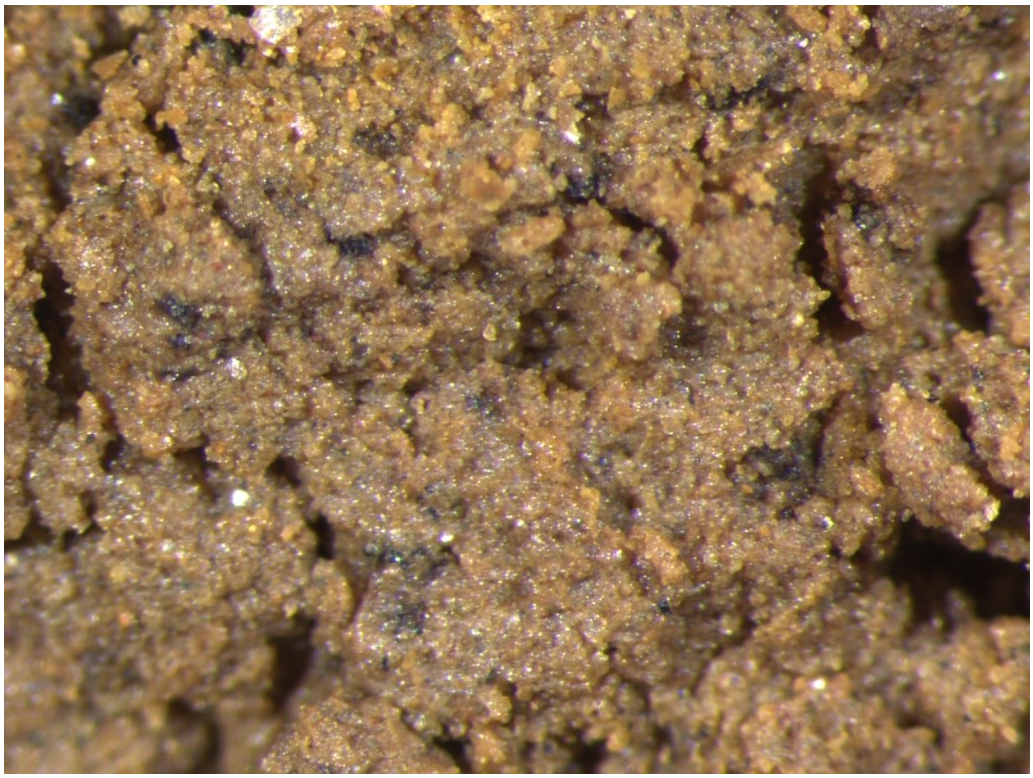

Figure 4 - Close Up View of BH2 B1. 1.0–1.7 m

3.1.3 BH3 B1. 0.5–1.2 m

The sample (Figure 5 and 6) is mottled orange-brown in colour, exhibits little plasticity, slightly granular compared to the other samples and disintegrates in water. It dries quickly. It possesses cohesion but can be powdered easily between fingers. It does not react with dilute hydrochloric acid. The sample is silty clay.

Figure 5 - General View of BH3 B1. 0.5–1.2 m

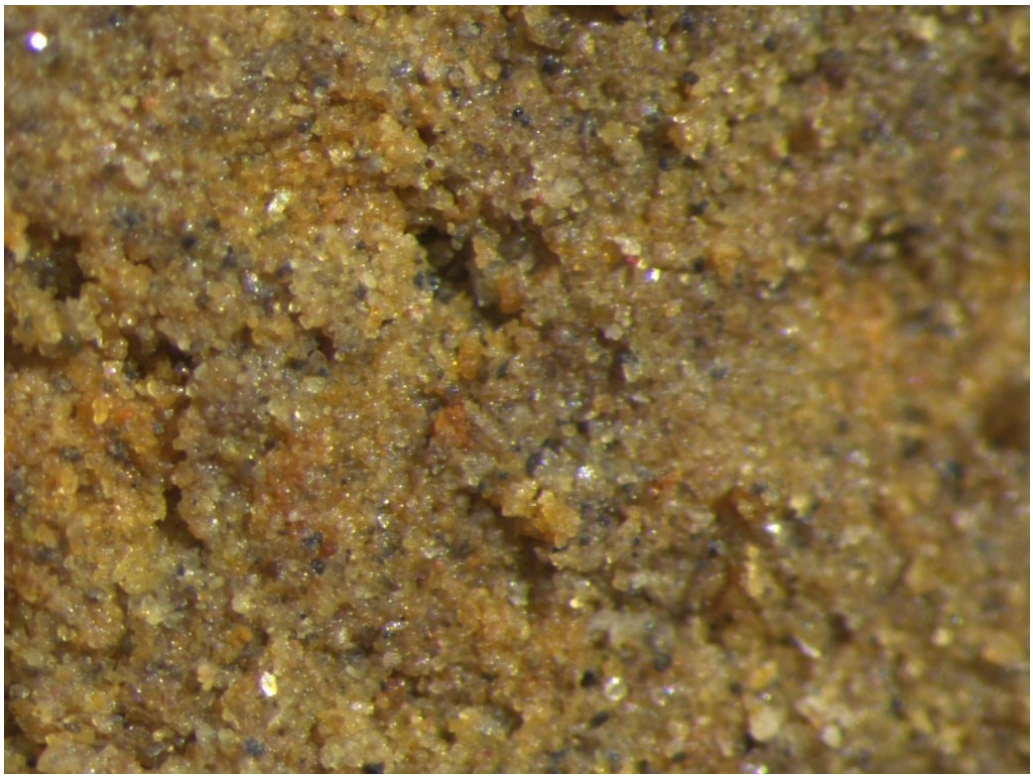

Figure 6 - Close Up View of BH3 B1. 0.5–1.2 m

3.1.4 BH4 B1. 1.0–2.0 m

The sample (Figure 7 and 8) is light brown in colour with uniform texture. When wet, it displays plasticity and does not disintegrate quickly. It is cohesive. It can be moulded or crushed. It can be powdered easily between fingers when moderately dry. The sample contains occasional dark material organic matter. It does not react with dilute hydrochloric acid. The sample displays clay characteristics.

Figure 7 - General View of BH4 B1. 1.0–2.0 m

Figure 8 - Close Up View of BH4 B1. 1.0–2.0 m

3.1.5 BH5 B1. 1.0–2.0 m

The sample (Figure 9 and 10) is light brown in colour with uniform texture. When wet, it displays plasticity and does not disintegrate quickly. It is cohesive. It can be moulded or crushed. It can be powdered easily between fingers when relatively dry. The sample contains occasional dark material organic matter. It does not react with weak hydrochloric acid. The sample displays clay characteristics.

Figure 9 - General View of BH5 B1. 1.0–2.0 m

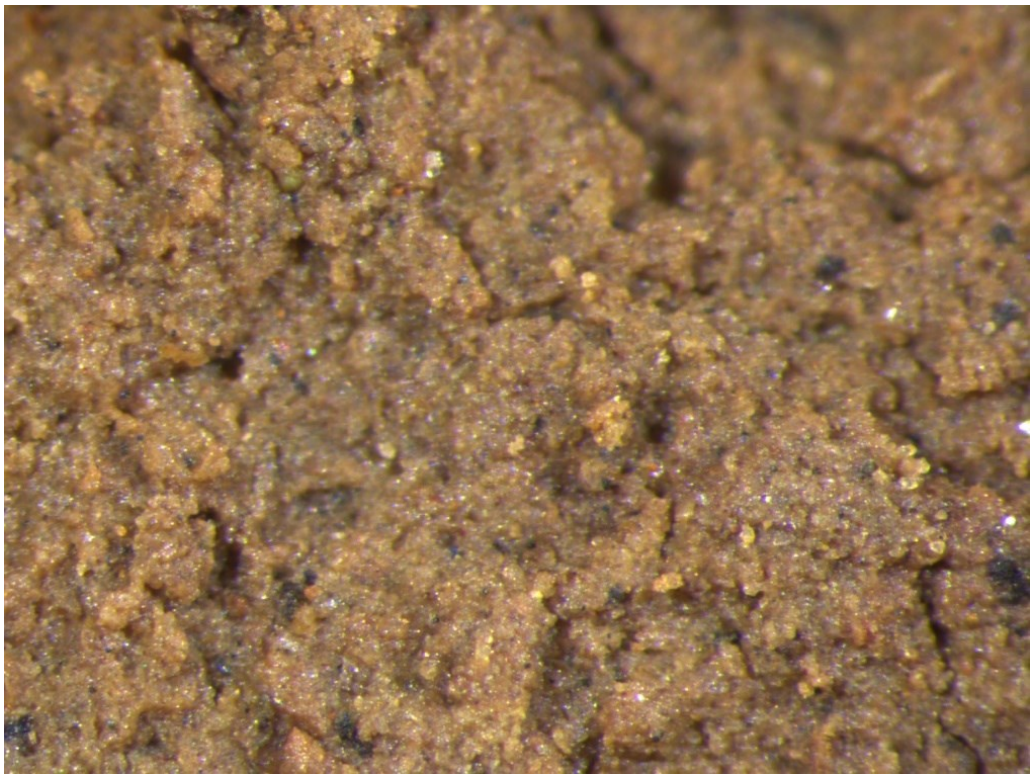

Figure 10 - Close Up View of BH5 B1. 1.0–2.0 m

3.2 Chemical Composition by XRF

Results of XRF analysis and loss on ignition at 1025°C to BS EN ISO 12677:2011 are tabulated below in Table 1 with the certificate of analysis reproduced in the Appendix A.

Table 1 - XRF Composition of Clay Samples Provided

Reference	UK22106-704	UK22106-705	UK22106-706	UK22106-707	UK22106-708
Mark	BH1 B1 1.2-2.2 m	BH2 B1 1.0-1.7 m	BH3 B1 0.5-1.2 m	BH4 B1 1.0-2.0 m	BH5 B1 1.0-2.0 m
SiO_2	76.22	75.06	78.43	76.74	75.53
TiO_2	0.82	0.83	0.69	0.81	0.85
Al_2O_3	10.42	10.45	8.80	10.10	10.77
Fe_2O_3	4.43	4.70	4.08	4.53	4.64
CaO	0.65	0.66	0.61	0.70	0.74
MgO	0.87	0.90	0.77	0.87	0.94
K_2O	2.29	2.26	1.70	2.23	2.31
Na_2O	0.75	0.72	0.52	0.71	0.75
P_2O_5	0.10	0.11	0.05	0.12	0.12
Cr_2O_3	0.02	0.02	0.02	0.01	0.01
Mn_3O_4	0.07	0.07	0.02	0.08	0.07
ZrO_2	0.07	0.08	0.05	0.08	0.07
HfO_2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
PbO	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
ZnO	0.01	0.01	< 0.01	0.01	0.01
BaO	0.05	0.05	0.03	0.05	0.05
SrO	< 0.01	0.01	< 0.01	< 0.01	< 0.01
SnO_2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
CuO	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Loss	3.36	3.46	3.92	3.13	3.49
Total	100.14	99.39	99.69	100.17	100.35
SO_3	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

3.3 Total Carbon and Sulphur

Results of Leco total carbon and sulphur are tabulated below in Table 2 with the certificate of analysis reproduced in the Appendix A.

Table 2 - Total Carbon and Sulphur Contents of Clay Samples Provided

Reference	UK22106-704	UK22106-705	UK22106-706	UK22106-707	UK22106-708
Mark	**BH1 B1 1.2-2.2 m**	**BH2 B1 1.0-1.7 m**	**BH3 B1 0.5-1.2 m**	**BH4 B1 1.0-2.0 m**	**BH5 B1 1.0-2.0 m**
Total C	0.29	0.26	0.36	0.22	0.18
Total S	0.02	0.03	0.03	0.04	0.03
Total S as SO_3	0.05	0.07	0.07	0.10	0.07

3.4 Dried and Fired Appearance

The following was noted for each of the five clay samples after firing at 1060°C. Briquettes were fired with a 48 hour soak time and allowed to cool slowly to avoid cracking. Briquettes were examined after drying and after firing.

3.4.1 BH1 B1. 1.2–2.2 m

The fired briquette was a reddish-brown in colour with relatively smooth surface, indicative of the presence of enough content of clay/fine material. The material is dense with a moderate to low internal porosity. The briquette had a ring to it suggesting that it was well fired. The briquette does not show drying shrinkage. Examination shows occasional cracks occur in the fired briquette, these might be due to thermal shock on cooling, or the cracking has been introduced during pressing the briquette.

Figure 11 - Dried and Fired Briquettes BH1 B1. 1.2–2.2 m

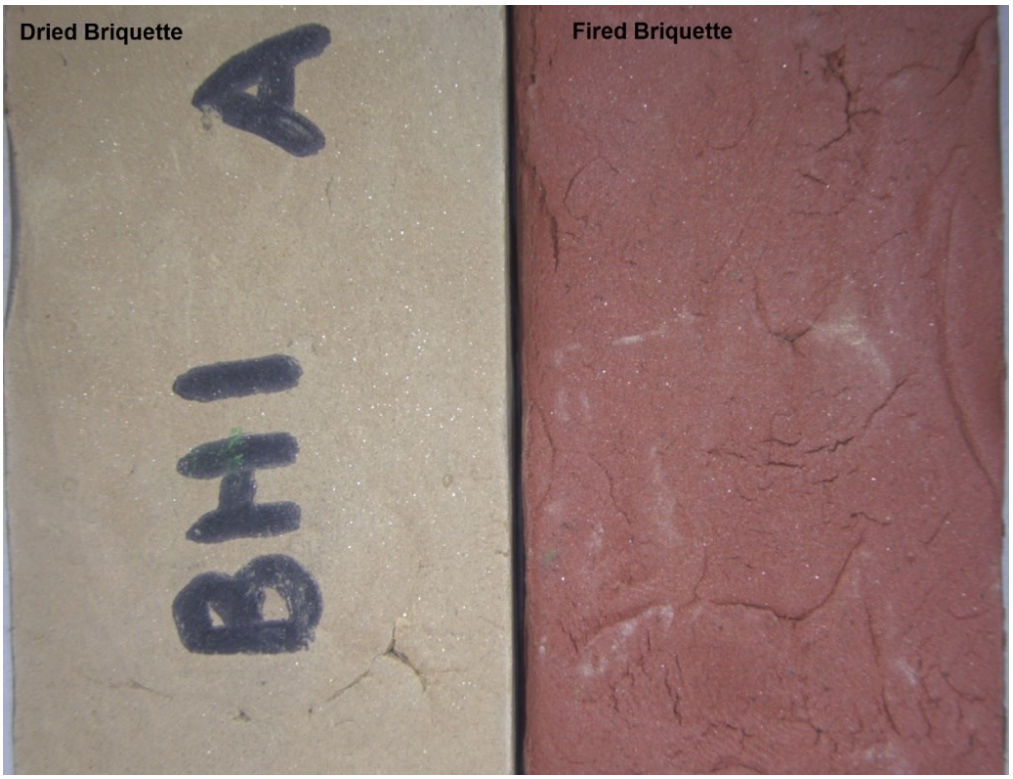

Figure 12 - Surface Texture of Dried and Fired Briquettes BH1 B1. 1.2–2.2 m

3.4.2 BH2 B1. 1.0–1.7 m

The fired briquette was a reddish-brown in colour with relatively smooth surface, indicative of the presence of enough content of fine material. The material is dense with a moderate to low internal porosity. The briquette had a ring to it suggesting that it was well fired. Drying the pressed briquette did not introduce shrinkage cracking. Cracks occur in the fired briquette.

Figure 13 - Dried and Fired Briquettes BH2 B1. 1.0–1.7 m

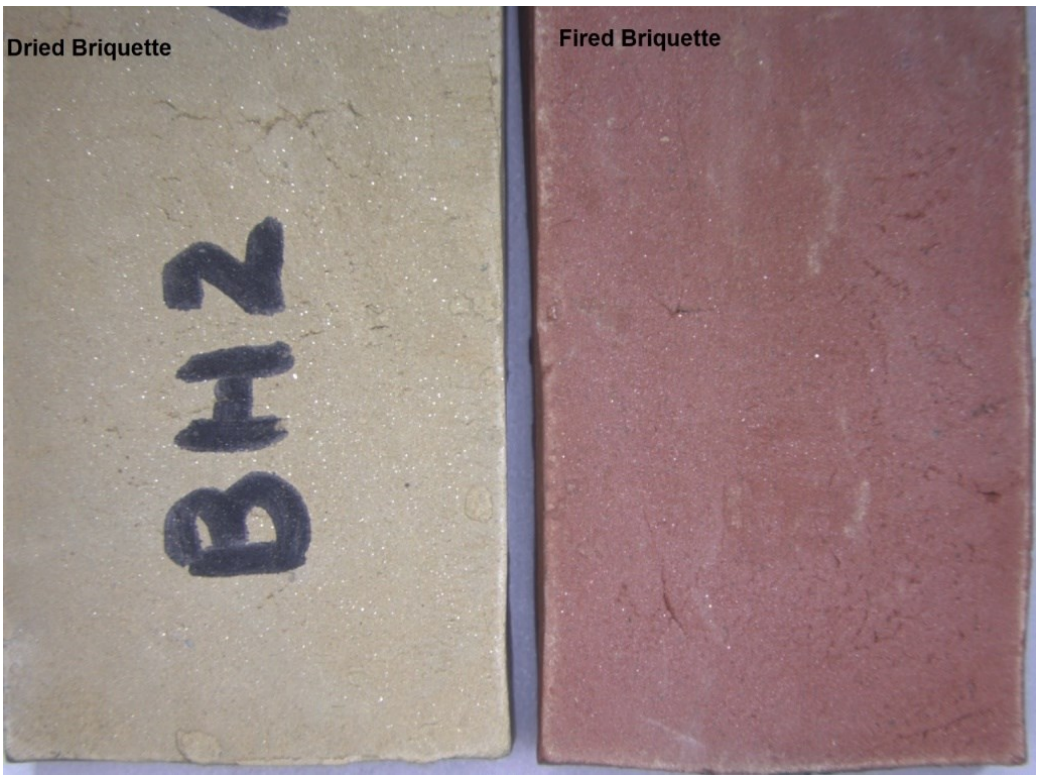

Figure 14 - Surface Texture of Dried and Fired Briquettes BH2 B1. 1.0–1.7 m

3.4.3 BH3 B1. 0.5–1.2 m

The fired briquette was a reddish-brown in colour with relatively smooth surface, indicative of the presence of enough content of fine material. The material is dense with a moderate to low internal porosity. The briquette had a ring to it suggesting that it was well fired. The briquette does not show any cracking when dried. Examination shows cracks occur in the fired briquette, might indicate that the briquette has cracked due to thermal shock on cooling, or the cracking has been introduced during pressing while making the briquette.

Figure 15 - Dried and Fired Briquettes BH3 B1. 0.5–1.2 m

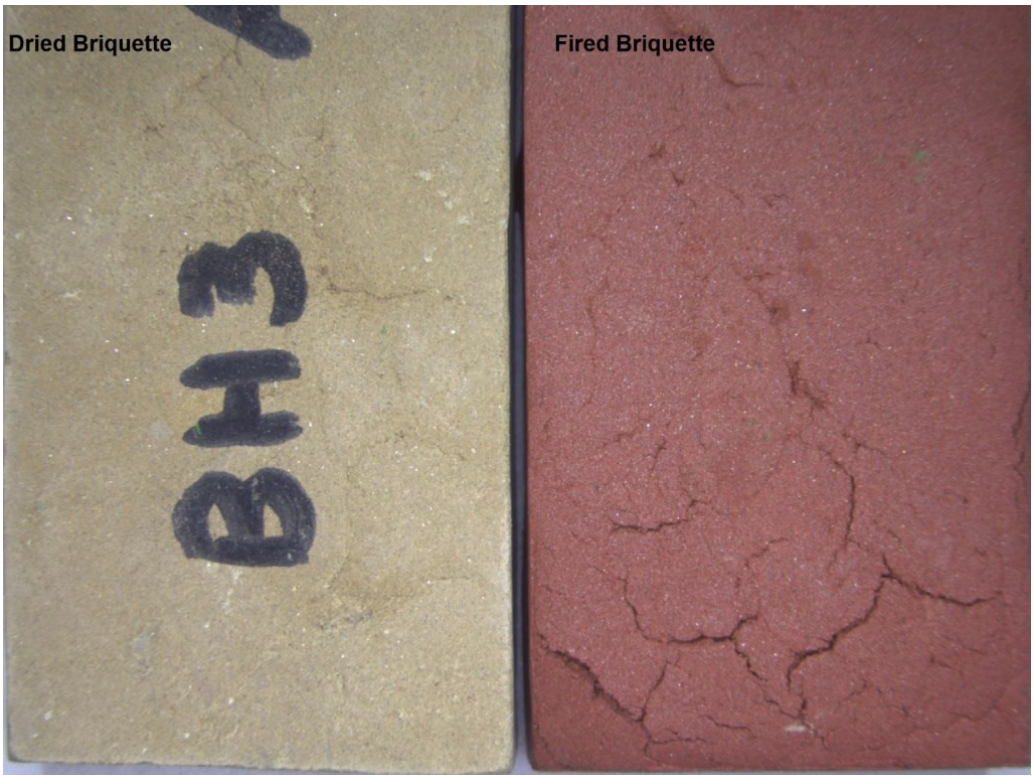

Figure 16 - Surface Texture of Dried and Fired Briquettes BH3 B1. 0.5–1.2 m

3.4.4 BH4 B1. 1.0–2.0 m

The fired briquette was a reddish-brown in colour with relatively smooth surface, indicative of the presence of enough content of fine material. The material is dense with a moderate to low internal porosity. The briquette had a ring to it suggesting that it was well fired. The dried briquette is devoid of cracks. Examination shows that hairline and horizontal cracks occurs in the briquette, indicate that the briquette has cracked due to thermal shock on cooling, or the cracking has been introduced during pressing while making the briquette.

Figure 17 - Dried and Fired Briquettes BH4 B1. 1.0–2.0 m

Figure 18 - Surface Texture of Dried and Fired Briquettes BH4 B1. 1.0–2.0 m

3.4.5 BH5 B1. 1.0–2.0 m

The fired briquette was a reddish-brown in colour with smooth surface, indicative of the presence of enough content of fine material. The material is dense with a moderate to low internal porosity. The briquette had a ring to it suggesting that it was well fired. Neither shrinkage cracks nor cracking after firing are observed.

Figure 19 - Dried and Fired Briquettes BH5 B1. 1.0–2.0 m

Figure 20 - Surface Texture of Dried and Fired Briquettes BH5 B1. 1.0–2.0 m

3.5 Drying Shrinkage and Fired Shrinkage

Drying and firing shrinkage of the pressed clay briquets gave the following results (Table 3).

Table 3 - Indicative Shrinkage of Extruded Clay Briquettes

Sample Reference	Sample Mark	Wet to Dry Shrinkage %	Dry to Fired Shrinkage %	Wet to Fired Shrinkage %
UK22106-704	BH1 B1 1.2-2.2 m	0.34	-	-
UK22106-704	BH1 B1 1.2-2.2 m	0.20	2.50	2.70
UK22106-705	BH2 B1 1.0-1.7 m	0.06	-	-
UK22106-705	BH2 B1 1.0-1.7 m	0.13	2.97	3.09
UK22106-706	BH3 B1 0.5-1.2 m	0.10	-	-
UK22106-706	BH3 B1 0.5-1.2 m	0.13	0.20	0.32
UK22106-707	BH4 B1 1.0-2.0 m	0.14	-	-
UK22106-707	BH4 B1 1.0-2.0 m	0.11	2.21	2.33
UK22106-708	BH5 B1 1.0-2.0 m	0.04	-	-
UK22106-708	BH5 B1 1.0-2.0 m	0.11	1.19	1.31

4 DISCUSSION

The five clay samples examined were prepared as briquettes and evaluated for potential brick making. Compositions of four of the five samples are very consistent. The samples are relative rich in silica and depleted in alumina, soda and potash compared to many typical modern brick clays. The high silica was particularly apparent in the BH3 sample, which was recorded as a silty-clay. Analysis therefore indicates a relatively low clay content, which will result in a generally weaker structured brick. The high level of silica would require considerable care during the cooling stage of the firing process to avoid cracking due to thermal shock during the isothermal transition of alpha and beta quartz at 573°C.

The laboratory samples and briquettes show a good textured brick with a suitable fired colour. There is no evidence of efflorescence or residual chalk particles that would result in lime blow. The briquettes are vitrified but due to the relatively low clay content are relatively weak.

Bricks produced from this clay would be of relatively low strength compared to currently commercially available products.

APPENDIX A - Test Certificates

INORGANIC ANALYSIS REPORT

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UKAS TESTING
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FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH1 B1, 1.2 - 2.2m

Lucideon Reference: UK22106-704

Date Reported: 24-Jan-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 19-Jan-2022 **to** 19-Jan-2022

Determination of Total Carbon and Total Sulphur

Method C45

Result(s)		Units	
Total Carbon	C	%	0.29
Sulphur, Total	S	%	0.02
Sulphur, Total as Sulphur Trioxide		%	0.05
Mean of Duplicate Determinations			Yes
Sample Basis			Dried 110 deg C
UKAS Accredited			Yes

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

End of Test Report

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FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH2 B1, 1.0 - 1.7m

Lucideon Reference: UK22106-705

Date Reported: 24-Jan-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 19-Jan-2022 **to** 19-Jan-2022

Determination of Total Carbon and Total Sulphur

Method C45

Result(s)		Units	
Total Carbon	C	%	0.26
Sulphur, Total	S	%	0.03
Sulphur, Total as Sulphur Trioxide		%	0.07
Mean of Duplicate Determinations			Yes
Sample Basis			Dried 110 deg C
UKAS Accredited			Yes

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End of Test Report

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FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH3 B1, 0.5 - 1.2m

Lucideon Reference: UK22106-706

Date Reported: 24-Jan-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 19-Jan-2022 **to** 19-Jan-2022

Determination of Total Carbon and Total Sulphur

Method C45

Result(s)		Units	
Total Carbon	C	%	0.36
Sulphur, Total	S	%	0.03
Sulphur, Total as Sulphur Trioxide		%	0.07
Mean of Duplicate Determinations			Yes
Sample Basis			Dried 110 deg C
UKAS Accredited			Yes

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Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH4 B1, 1.0 - 2.0 m

Lucideon Reference: UK22106-707

Date Reported: 24-Jan-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 19-Jan-2022 **to** 19-Jan-2022

Determination of Total Carbon and Total Sulphur

Method C45

Result(s)		Units	
Total Carbon	C	%	0.22
Sulphur, Total	S	%	0.04
Sulphur, Total as Sulphur Trioxide		%	0.1
Mean of Duplicate Determinations			Yes
Sample Basis			Dried 110 deg C
UKAS Accredited			Yes

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End of Test Report

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Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH5 B1, 1.0 - 2.0m

Lucideon Reference: UK22106-708

Date Reported: 24-Jan-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 19-Jan-2022 **to** 19-Jan-2022

Determination of Total Carbon and Total Sulphur

Method C45

Result(s)		Units	
Total Carbon	C	%	0.18
Sulphur, Total	S	%	0.03
Sulphur, Total as Sulphur Trioxide		%	0.07
Mean of Duplicate Determinations			Yes
Sample Basis			Dried 110 deg C
UKAS Accredited			Yes

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Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH1 B1, 1.2 - 2.2m

Lucideon Reference: UK22106-704

Date Reported: 10-Feb-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 17-Jan-2022 **to** 10-Feb-2022

XRF Analysis

Methods C201 based on BSEN ISO 12677:2011

Result(s)		**Units**	
Sample Basis			Dried 110 deg C
Silicon Dioxide	SiO_2	%	76.22
Titanium Dioxide	TiO_2	%	0.82
Aluminium Oxide	Al_2O_3	%	10.42
Iron (III) Oxide	Fe_2O_3	%	4.43
Calcium Oxide	CaO	%	0.65
Magnesium Oxide	MgO	%	0.87
Potassium Oxide	K_2O	%	2.29
Sodium Oxide	Na_2O	%	0.75
Phosphorus Pentoxide	P_2O_5	%	0.10
Chromium (III) Oxide	Cr_2O_3	%	0.02
Manganese (II,III) Oxide	Mn_3O_4	%	0.07
Zirconium Oxide	ZrO_2	%	0.07
Hafnium (IV) Oxide	HfO_2	%	<0.01
Lead Oxide	PbO	%	<0.02
Zinc Oxide	ZnO	%	0.01
Barium Oxide	BaO	%	0.05
Strontium (II) Oxide	SrO	%	<0.01
Tin (IV) Oxide	SnO_2	%	<0.01
Copper Oxide	CuO	%	0.01
Loss on Ignition		%	3.36
Loss on Ignition Temperature		°C	1025
Total		%	100.14
Sulphur Trioxide	SO_3	%	<0.05
UKAS Accredited			Yes

The sulphur trioxide may not be a total sulphur figure but is the sulphur remaining after LOI and fusion. Results are quoted to 2 decimal places but are accurate to 3 significant figures or the number of figures given, whichever is the lesser.

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End of Test Report

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INORGANIC ANALYSIS REPORT

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UKAS TESTING
0013

Wardell Armstrong LLP
Sir Henry Doulton House
Forge Lane, Etruria
Stoke on Trent
Staffs
ST1 5BD

FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH2 B1, 1.0 - 1.7m

Lucideon Reference: UK22106-705

Date Reported: 10-Feb-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 17-Jan-2022 **to** 10-Feb-2022

XRF Analysis

Methods C201 based on BSEN ISO 12677:2011

Result(s)		**Units**	
Sample Basis			Dried 110 deg C
Silicon Dioxide	SiO_2	%	75.06
Titanium Dioxide	TiO_2	%	0.83
Aluminium Oxide	Al_2O_3	%	10.45
Iron (III) Oxide	Fe_2O_3	%	4.70
Calcium Oxide	CaO	%	0.66
Magnesium Oxide	MgO	%	0.90
Potassium Oxide	K_2O	%	2.26
Sodium Oxide	Na_2O	%	0.72
Phosphorus Pentoxide	P_2O_5	%	0.11
Chromium (III) Oxide	Cr_2O_3	%	0.02
Manganese (II,III) Oxide	Mn_3O_4	%	0.07
Zirconium Oxide	ZrO_2	%	0.08
Hafnium (IV) Oxide	HfO_2	%	<0.01
Lead Oxide	PbO	%	<0.02
Zinc Oxide	ZnO	%	0.01
Barium Oxide	BaO	%	0.05
Strontium (II) Oxide	SrO	%	0.01
Tin (IV) Oxide	SnO_2	%	<0.01
Copper Oxide	CuO	%	<0.01
Loss on Ignition		%	3.46
Loss on Ignition Temperature		°C	1025
Total		%	99.39
Sulphur Trioxide	SO_3	%	<0.05
UKAS Accredited			Yes

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FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH3 B1, 0.5 - 1.2m

Lucideon Reference: UK22106-706

Date Reported: 10-Feb-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 17-Jan-2022 **to** 10-Feb-2022

XRF Analysis

Methods C201 based on BSEN ISO 12677:2011

Result(s)		**Units**	
Sample Basis			Dried 110 deg C
Silicon Dioxide	SiO_2	%	78.43
Titanium Dioxide	TiO_2	%	0.69
Aluminium Oxide	Al_2O_3	%	8.80
Iron (III) Oxide	Fe_2O_3	%	4.08
Calcium Oxide	CaO	%	0.61
Magnesium Oxide	MgO	%	0.77
Potassium Oxide	K_2O	%	1.70
Sodium Oxide	Na_2O	%	0.52
Phosphorus Pentoxide	P_2O_5	%	0.05
Chromium (III) Oxide	Cr_2O_3	%	0.02
Manganese (II,III) Oxide	Mn_3O_4	%	0.02
Zirconium Oxide	ZrO_2	%	0.05
Hafnium (IV) Oxide	HfO_2	%	<0.01
Lead Oxide	PbO	%	<0.02
Zinc Oxide	ZnO	%	<0.01
Barium Oxide	BaO	%	0.03
Strontium (II) Oxide	SrO	%	<0.01
Tin (IV) Oxide	SnO_2	%	<0.01
Copper Oxide	CuO	%	<0.01
Loss on Ignition		%	3.92
Loss on Ignition Temperature		°C	1025
Total		%	99.69
Sulphur Trioxide	SO_3	%	<0.05
UKAS Accredited			Yes

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Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH4 B1, 1.0 - 2.0 m

Lucideon Reference: UK22106-707

Date Reported: 10-Feb-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 17-Jan-2022 **to** 10-Feb-2022

XRF Analysis

Methods C201 based on BSEN ISO 12677:2011

Result(s)		**Units**	
Sample Basis			Dried 110 deg C
Silicon Dioxide	SiO_2	%	76.74
Titanium Dioxide	TiO_2	%	0.81
Aluminium Oxide	Al_2O_3	%	10.10
Iron (III) Oxide	Fe_2O_3	%	4.53
Calcium Oxide	CaO	%	0.70
Magnesium Oxide	MgO	%	0.87
Potassium Oxide	K_2O	%	2.23
Sodium Oxide	Na_2O	%	0.71
Phosphorus Pentoxide	P_2O_5	%	0.12
Chromium (III) Oxide	Cr_2O_3	%	0.01
Manganese (II,III) Oxide	Mn_3O_4	%	0.08
Zirconium Oxide	ZrO_2	%	0.08
Hafnium (IV) Oxide	HfO_2	%	<0.01
Lead Oxide	PbO	%	<0.02
Zinc Oxide	ZnO	%	0.01
Barium Oxide	BaO	%	0.05
Strontium (II) Oxide	SrO	%	<0.01
Tin (IV) Oxide	SnO_2	%	<0.01
Copper Oxide	CuO	%	<0.01
Loss on Ignition		%	3.13
Loss on Ignition Temperature		°C	1025
Total		%	100.17
Sulphur Trioxide	SO_3	%	<0.05
UKAS Accredited			Yes

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FAO: Stephen Barry

Report of Tests on: Clay: Sittingbourne MRA, ST18667

Your Reference: BH5 B1, 1.0 - 2.0m

Lucideon Reference: UK22106-708

Date Reported: 10-Feb-2022 **Order Number:** ST28975

Date Logged: 10-Jan-2022 **Date(s) of Test(s):** 17-Jan-2022 **to** 10-Feb-2022

XRF Analysis

Methods C201 based on BSEN ISO 12677:2011

Result(s)		**Units**	
Sample Basis			Dried 110 deg C
Silicon Dioxide	SiO_2	%	75.53
Titanium Dioxide	TiO_2	%	0.85
Aluminium Oxide	Al_2O_3	%	10.77
Iron (III) Oxide	Fe_2O_3	%	4.64
Calcium Oxide	CaO	%	0.74
Magnesium Oxide	MgO	%	0.94
Potassium Oxide	K_2O	%	2.31
Sodium Oxide	Na_2O	%	0.75
Phosphorus Pentoxide	P_2O_5	%	0.12
Chromium (III) Oxide	Cr_2O_3	%	0.01
Manganese (II,III) Oxide	Mn_3O_4	%	0.07
Zirconium Oxide	ZrO_2	%	0.07
Hafnium (IV) Oxide	HfO_2	%	<0.01
Lead Oxide	PbO	%	<0.02
Zinc Oxide	ZnO	%	0.01
Barium Oxide	BaO	%	0.05
Strontium (II) Oxide	SrO	%	<0.01
Tin (IV) Oxide	SnO_2	%	<0.01
Copper Oxide	CuO	%	<0.01
Loss on Ignition		%	3.49
Loss on Ignition Temperature		°C	1025
Total		%	100.35
Sulphur Trioxide	SO_3	%	<0.05
UKAS Accredited			Yes

The sulphur trioxide may not be a total sulphur figure but is the sulphur remaining after LOI and fusion. Results are quoted to 2 decimal places but are accurate to 3 significant figures or the number of figures given, whichever is the lesser.

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End of Test Report

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PHYSICAL TESTING ANALYSIS REPORT

Description: Determination of drying shrinkage and fired shrinkage

Test Method: In House Method

Lucideon Reference: UK22106-704

Client:
Wardell Armstrong LLP
Sir Henry Doulton House
Forge Lane, Etruria
Stoke on Trent
Staffs
ST1 5BD

For the Attention of: Stephen Barry

Date Logged: 10-Jan-2022

Date of Tests: 28-Jan-2022 to 07-Feb-2022

Report Date: 02-Mar-2022

Purchase Order No.: ST28975

Please find attached the results for the sample(s) recently submitted for analysis.

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DETERMINATION OF DRIED SHRINKAGE AND FIRED SHRINKAGE – IN HOUSE METHOD

1 METHOD

The clay was dried, crushed and sieved until it passed through a 2mm sieve. Water was then added and the clay was tempered to a plastic consistency, wedged into clots and pressed to produce two 75 x 37 x 25 mm briquettes.

Each briquette was air dried for 4 days in laboratory conditions and an initial measurement was taken. Following this each briquette was placed into a ventilated oven at 110°C for 24 hours, removed and allowed to cool, then remeasured.

A single briquette (B) was then placed into a kiln and heated at 1060°C for 24 hours, removed and allowed to cool, then a final measurement was taken.

2 RESULTS

Samples	Initial Measurement (mm)	24hrs dried at 110 mm	Difference (mm)	Shrinkage (%)	24hrs in kiln at 1060 mm	Difference (mm)	Shrinkage (%)
BH1 A	70.72	70.48	0.24	0.34	-	-	-
BH1 B	70.46	70.32	0.14	0.20	68.56	1.76	2.50

3 PHOTOS

After drying A

After drying B

After firing B

END OF TEST REPORT

PHYSICAL TESTING ANALYSIS REPORT

Description: Determination of drying shrinkage and fired shrinkage

Test Method: In House Method

Lucideon Reference: UK22106-705

Client:
Wardell Armstrong LLP
Sir Henry Doulton House
Forge Lane, Etruria
Stoke on Trent
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ST1 5BD

For the Attention of: Stephen Barry

Date Logged: 10-Jan-2022

Date of Tests: 28-Jan-2022 to 07-Feb-2022

Report Date: 02-Mar-2022

Purchase Order No.: ST28975

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A single briquette (B) was then placed into a kiln and heated at 1060°C for 24 hours, removed and allowed to cool, then a final measurement was taken.

2 RESULTS

Samples	Initial Measurement (mm)	24hrs dried at 110 mm	Difference (mm)	Shrinkage (%)	24hrs in kiln at 1060 mm	Difference (mm)	Shrinkage (%)
BH2 A	70.18	70.14	0.04	0.06	-	-	-
BH2 B	70.89	70.80	0.09	0.13	68.70	2.10	2.96

3 PHOTOS

After drying A

After drying B

After firing B

END OF TEST REPORT

PHYSICAL TESTING ANALYSIS REPORT

Description:	Determination of drying shrinkage and fired shrinkage
Test Method:	In House Method
Lucideon Reference:	UK22106-706
Client:	Wardell Armstrong LLP Sir Henry Doulton House Forge Lane, Etruria Stoke on Trent Staffs ST1 5BD
For the Attention of:	Stephen Barry
Date Logged:	10-Jan-2022
Date of Tests:	28-Jan-2022 to 07-Feb-2022
Report Date:	02-Mar-2022
Purchase Order No.:	ST28975

Please find attached the results for the sample(s) recently submitted for analysis.

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A single briquette (B) was then placed into a kiln and heated at 1060°C for 24 hours, removed and allowed to cool, then a final measurement was taken.

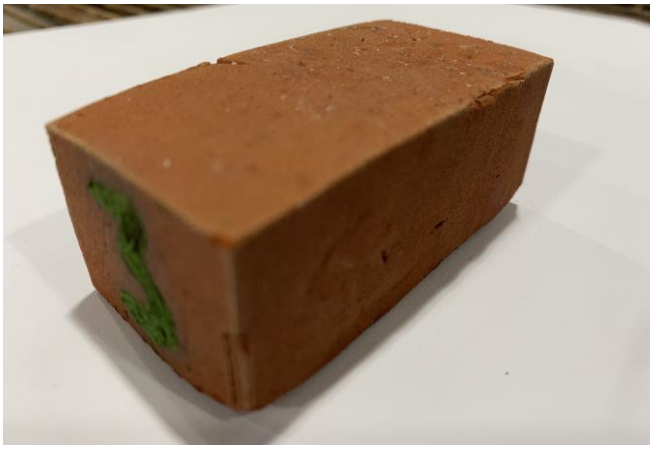
2 RESULTS

Samples	Initial Measurement (mm)	24hrs dried at 110 mm	Difference (mm)	Shrinkage (%)	24hrs in kiln at 1060 mm	Difference (mm)	Shrinkage (%)
BH3 A	71.14	71.07	0.07	0.10	-	-	-
BH3 B	71.19	71.10	0.09	0.13	70.96	0.14	0.20

3 PHOTOS

After drying A

After drying B



After firing B

END OF TEST REPORT

PHYSICAL TESTING ANALYSIS REPORT

Description:	Determination of drying shrinkage and fired shrinkage
Test Method:	In House Method
Lucideon Reference:	UK22106-707
Client:	Wardell Armstrong LLP Sir Henry Doulton House Forge Lane, Etruria Stoke on Trent Staffs ST1 5BD
For the Attention of:	Stephen Barry
Date Logged:	10-Jan-2022
Date of Tests:	28-Jan-2022 to 07-Feb-2022
Report Date:	02-Mar-2022
Purchase Order No.:	ST28975

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A single briquette (B) was then placed into a kiln and heated at 1060°C for 24 hours, removed and allowed to cool, then a final measurement was taken.

2 RESULTS

Samples	Initial Measurement (mm)	24hrs dried at 110 mm	Difference (mm)	Shrinkage (%)	24hrs in kiln at 1060 mm	Difference (mm)	Shrinkage (%)
BH4 A	70.14	70.04	0.10	0.14	-	-	-
BH4 B	70.09	70.01	0.08	0.11	68.46	1.55	2.21

3 PHOTOS

After drying A

After drying B

After firing B

END OF TEST REPORT

PHYSICAL TESTING ANALYSIS REPORT

Description: Determination of drying shrinkage and fired shrinkage

Test Method: In House Method

Lucideon Reference: UK22106-708

Client:
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Date Logged: 10-Jan-2022

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A single briquette (B) was then placed into a kiln and heated at 1060°C for 24 hours, removed and allowed to cool, then a final measurement was taken.

2 RESULTS

Samples	Initial Measurement (mm)	24hrs dried at 110 mm	Difference (mm)	Shrinkage (%)	24hrs in kiln at 1060 mm	Difference (mm)	Shrinkage (%)
BH5 A	70.32	70.29	0.03	0.04	-	-	-
BH5 B	70.39	70.31	0.08	0.11	69.47	0.84	1.31

3 PHOTOS

After drying A

After drying B

After firing B

END OF TEST REPORT