

Our Reference: 4528-G-L004

Date: 15th October 2020

Mr. Andy Davies
Planning Advisor (Sustainable Places)
Environment Agency
Richard Fairclough House
Knutsford Road
Latchford
Warrington
WA4 1HT

North West & Midlands

Caledonian House, Tatton Street,
Knutsford, Cheshire, WA16 6AG
t: 01565 755557

North East & Yorkshire

The Stables, Aske Hall, Richmond
North Yorkshire, DL10 5HG
t: 01748 889010
www.id-gsc.co.uk

Dear Mr Davies,

**RE: EA Letter Ref. SO/2020/119974/01-L01
Discharge of Condition 16 –110179/FO/2015/S1 for Site at Royce Road, Manchester**

Further to our recent discussions relating to your letter (Ref. SO/2020/119974/01-L01) from the EA to Rob Griffin (Principal Planner, Manchester City Council) in which concerns were raised by the EA regarding the decommissioning of boreholes, ID Geoenvironmental Ltd (IDG) have been commissioned by our client (Engie) to prepare the following document for submission in order to provide additional information as requested.

Previous Reports

For reference, the following reports relating to the site have been prepared and previously submitted via planning, and are referred to in this document:

- Subsurface Northwest Ltd
 - Walkover Survey and Desk Study at Royce Road, Hulme, Report No. 6066, dated July 2015.
 - Ground Investigation at Royce Road, Hulme, Report No. 6066B, dated December 2015.
- ID Geoenvironmental Ltd
 - Remediation Strategy for land at Royce Road, Report No 4528-G-R001 dated February 2016.
 - IDG Letter Ref. 4528-G-L003 dated 10th March 2016 - Location of Wells at Royce Road
 - Verification Report for the Remediation and Preparatory works for land at Royce Road, Report No. 4528-G-R002 dated March 2019.
 - Cover Soil Validation Report for Landscaped Areas at Royce Road, Report No. 4528-G-CSV01 dated March 2019.

Aims and Background

This document aims to provide further information to alleviate concerns raised by the EA in relation to the discharge of Condition 16 (Contaminated land), specifically in relation to the presence of well features associated with 3 No. historical 'pumps' identified on a large scale OS map dated 1851 in the SubSurface Desk Study Report (Ref. 6066) dated 2015 and the associated risk posed to the underlying principal aquifer.

A copy of the EA letter Ref. SO/2020/119974/01-L01 dated 13th February 2020 is presented in Appendix A, and states the following:

"We have reviewed the report noted above (IDG Report 4528-G-R002) to assess possible risks to controlled waters from this site and development. The development proposal is located above a Principal Aquifer, supporting a known abstraction.

Our review of CDN/19/0662 as submitted, has identified that whilst the site does not appear to have a history of industrial land use the ground investigation has located three pump features which supported abstraction boreholes. This discovery would suggest activities on site which were not identified during iterative revisions of the OS Map series.

The report noted above has also identified that the boreholes were not decommissioned and that they are likely to still provide a potential contamination migration pathway into the Principal Aquifer. We refer the developer to the Environment Agency guidance in "Good Practice for Decommissioning of Redundant Boreholes & Wells (2012)" for a supported methodology as to how this matter can be addressed.

In light of the above and given the environmental circumstances we are unable to recommend the discharge of Condition 16 of planning permission 110179/FO/2015/S1 as submitted.

We would recommend that no further development continues until these boreholes are decommissioned appropriately or reasons given as to why these features will not, in the future, act as preferential pathways for contamination or pollution into the Principal Aquifer."

IDG welcome the above comments, and acknowledge that our client did not undertake a formal decommissioning of the long-standing historic pump/ well features identified within the boundary of their development site.

On behalf of our client IDG would like to provide the following information and comments in response to the EA's letter, based on review of all available information and relative to the source-pathway-receptor model.

Development Status

IDG note the EA's comment:

"We would recommend that no further development continues until these boreholes are decommissioned appropriately or reasons given as to why these features will not, in the future, act as preferential pathways for contamination or pollution into the Principal Aquifer."

IDG wish to clarify at this point that the development is complete, and it is understood that the newly constructed residential properties are wholly occupied.

IDG's Remediation Strategy was issued in February 2016 and site preparatory works commenced shortly after this in April 2016. The development was largely completed by early 2019, and IDG's Remediation Verification Report prepared and issued in March 2019.

The EA's letter Ref. SO/2020/119974/01-L01 is dated 13th February 2020, and post-dates the completion of the development.

Identification of Pumps

IDG note the EA's comment:

"whilst the site does not appear to have a history of industrial land use the ground investigation has located three pump features which supported abstraction boreholes. This discovery would suggest activities on site which were not identified during iterative revisions of the OS Map series."

The pump features were identified by Subsurface at desk study stage, as noted in Section 2.1, Table 3 of their 2015 report. An extracted copy of the OS maps from 1851 and 1893 is presented in Appendix B for completeness which shows the 3 No. 'pumps' depicted in a residential setting.

IDG have reviewed the historic OS plans along with the desk study report, and confirm the findings presented in the desk study report to be accurate. The available information confirms the site historical use to be wholly residential, with terraced houses being depicted as present from the earliest OS map (1851) through to 1956, with evidence of a phased demolition of the terraced properties between 1932 and 1962, likely to be the result of damage sustained during WWII. The 1969 map then depicts the site to be occupied by 'Oaklands' residential home for the aged, present through to subsequent demolition between 2010 and 2014.

It is considered that the evidence from the historical maps and desk study is robust and conclusive; there is no evidence of industrial use or industrial activities, or activities that were 'not identified'.

The 'pumps' indicated on the 1951 OS plans are determined to be small-scale local abstractions associated with providing water supply to the surrounding residential properties, and do not appear to relate to any unidentified industrial use or processes.

Site Contamination Assessment (Source)

The initial conceptual model presented in Section 2.4 of the desk study identified the only on-site source of contaminants to be Made Ground resulting from previous phases of development, demolition and landscaping.

Section 4.8 of the 2015 Sub Surface ground investigation Report (Report 6066B) details the findings of their contamination assessment.

The chemical analysis and assessment of soil samples identifies elevated concentrations of arsenic, lead and PAH determinants (benzo(b)fluoranthene, benzo(a)pyrene and dibenz(a,h)anthracene) in Made Ground. These elevated concentrations are elevated against S4UL/ C4SL human health assessment criteria and relate to solid phase soil source contaminants.

Sub Surface detail that the concentrations of contaminants identified are most likely derived from building materials (lead flashing, sash window weights, pipework and lead based paint) and coal fire ash in Made Ground, which had been distributed across the site during demolition of the previous residential properties.

The chemical analysis and assessment of 2 No. water samples identified a marginally elevated concentration of arsenic in 1 sample at 12ug/l compared to the UK DWS of 10ug/l. No exceedances of the EA EQS criteria were identified. In relation to the arsenic concentration at 12ug/l, Sub Surface state that *"the UK DWS is a post-treatment standard and as such is very stringent. In our opinion the very slight exceedance of arsenic does not warrant any further consideration"*.

This indicates that the contaminants on site do not pose a risk to controlled waters, and no recommendations or requirements for further investigation were outlined.

IDG have reviewed the data presented and note in addition that concentrations of PAH's in groundwater samples were all below the laboratory limit of detection. This is indicative that whilst concentrations of arsenic, lead and PAH were identified in Made Ground at the site, with the exception of arsenic, these contaminants generally did not appear to be readily partitioning to groundwater via dissolution as a result of groundwater contact or infiltration of surface water through the Made Ground.

It is understood that the Sub Surface Desk Study and Intrusive Investigation Reports, including the contamination assessment (summarised above) were submitted and approved by planning. IDG are unaware as to whether the EA were consulted via the planning at this time, or had the opportunity to comment on the suitability of the assessment.

Overall however, from a contamination source perspective, in consideration of all the information and data available, IDG are satisfied that the relatively low-levels of residual contaminants within the Made Ground have been present on the site for an extended period of time in excess of 50 years, (dating back to demolition of the previous terraced houses around mid-1900's) and are largely bound-in to their source material. Despite extended exposure to infiltration processes and groundwater, the contaminants identified do not appear to have been readily partitioning to groundwater or contributing a significant contaminant burden to the local shallow or deeper groundwater regime. IDG therefore consider that the residual contamination source (Made Ground) at the site poses a negligible risk to controlled waters within the underlying Principal Aquifer.

Failure to Formally Decommission Historic Wells and Implications of the Development (Pathways)

As outlined in IDG's Letter Ref. 4528-G-L003 – 'Location of Wells at Royce Road', and subsequently in Sections 6.1 of IDG's Remediation Verification Report (4528-G-R002), works to locate and identify the nature of the historic wells were undertaken.

The nature of the backfill in the identified wells was determined to represent a potential pathway for contaminants to the underlying Principal Aquifer, and recommendations made for decommissioning in accordance with the Remediation Strategy for the site.

As stated in Section 7.1 of IDG's Remediation Verification Report (4528-G-R002), IDG were not informed of any formal decommissioning of the wells being undertaken, and our client was unable to provide any evidence of formal decommissioning being completed. As a result IDG were unable to verify this element of the Remediation Strategy.

Section 7.1 of the Remediation Verification Report details that IDG were informed by the client that during the site excavation and turnover, a clay cap/seal was placed over the relict well positions. It is understood that this was completed using natural site-won clay, placed and compacted via an excavator.

IDG consider that the placement and compaction of a compacted clay capping horizon over the well positions would provide a low porosity low permeability aquitard, reducing the ability for infiltration of water through the underlying granular backfill of the well reducing potential for vertical migration into the underlying aquifer.

Whilst IDG agree that this does not meet the standard of formal decommissioning, the placement of a clay capping is considered to offer a considerable degree of additional protection to the underlying aquifer compared to the long-standing pre-development condition of the site where surface water could infiltrate throughout the granular Made Ground into the well backfill in direct continuity with the Principal Aquifer, and represents a significant betterment.

In addition to the above points reiterated from the Remediation Verification Report, IDG wish to consider the following additional implications of the newly constructed development relative to the associated groundwater regime and contaminant pathways.

To further review the significance of the historic wells as potential pathways, IDG have also considered the indicative positions of the three pumps/wells relative to the layout of the new development. The new development comprises 3 'blocks' of apartments, with associated carparking, hard and soft landscaping and new drainage infrastructure. The development layout is shown relative to the three pump/well positions on IDG Drawing Ref. 4528-G-D002, a copy of which is presented in Appendix C. From this drawing, it is apparent that Pump 1 is located beneath the footprint of the northwesterly apartment block, Pump 3 is located beneath the southerly apartment block, and Pump 2 is located beneath hard landscaping on the edge of the northeasterly apartment block.

IDG consider the implication of the above positioning is that the direct localities of the wells are afforded significant protection from direct vertical infiltration by the overlying buildings and hard landscaping. This will significantly reduce the amount of surface water permeation and infiltration into the subsurface in the immediate vicinity of the wells, in turn further reducing the potential for the dissolution of residual contaminants in the Made Ground and mobilisation into groundwater (which as discussed in previous sections is already considered to be a negligible risk).

IDG also consider that the construction of the new development has resulted in approximately 50% of the total site area being occupied by buildings, car parking and hard landscaping. As a result, a significant proportion of rainfall will now be falling onto roofs, hard landscaping and car parking areas, and diverted into the new surface water drainage infrastructure at the development rather than onto permeable surfaces. This again is considered to reduce the volume of water able to infiltrate into the subsurface, further reducing opportunity for dissolution of residual contaminants into groundwater.

The above sections present considerations relating to potential contaminant sources and pathways, and overall provide assurance that the contaminant source represents a negligible risk, and that the potential pathways for mobilisation and migration of contaminants are significantly reduced as a result of works undertaken and as a result of the constructed development and infrastructure.

In consideration of the potential pathways, the above focus has remained on demonstrating a reduction in potential pathways for mobilisation and migration of contaminants.

IDG also note on balance that the approved construction methods for the new development included a piled foundation design. The client has provided IDG with copies of the pile logs, a copy of which is presented in Appendix D. From the as-constructed pile log/ schedule, it is evident that 192 No. CFA (Continuous Flight Auger) piles have been advanced into the subsurface to natural strata capable of providing sufficient lateral restraint and bearing capacity to support the pile loads. The records indicate an average pile depth of 16.02m, with minimum and maximum depths of 14m and 17m respectively. This indicates that all 192 piles have been advanced through the Made Ground and superficial deposits into the underlying sandstone bedrock (Principal Aquifer). It is understood that the piled foundation solutions were recommended in the Sub Surface Investigation Report 6066B dated 2015, which was subsequently submitted and approved via planning.

Aquifer sensitivity and Abstractions (Receptor)

IDG concur that the development site is located over a Principal Aquifer, relating to the Triassic Sandstone of the Chester Formation.

The EA note that the Aquifer supports a known abstraction. With reference to abstractions from the Principal Aquifer, IDG have reviewed all available information presented in the Subsurface Desk Study and incorporated Groundsure 'EnviroInsight' report dated 2015, and confirm the following abstractions:

- No potable groundwater abstractions within 2000m of the site
- 6 No. groundwater abstractions within 501m to 1000m of the site (the nearest of which is 740m East of the site, and relates to a heat pump at Manchester University).
- 22 No. groundwater abstractions within 1000m to 2000m of the site.

In addition, it is noted that the site does not fall within, or within 500m of a groundwater source protection zone.

With reference to the above IDG consider that whilst the site overlies a Principal Aquifer, the absence of a potable water abstraction or groundwater protection zone within proximity to the site, and relatively large distance to and use of the nearest non-potable abstraction reduces the 'typical' sensitivity of the receptor relative to the position and size of the site, and would consider that the Principal Aquifer as a controlled waters receptor is of moderate sensitivity.

Conclusions

In the preceding sections of this document, IDG have presented a summary, review and discussion of the available information relative to the presence of the historic pump wells and the source-pathway-receptor model for the site.

In summary, IDG consider that the model for the site comprises the following:

SOURCE – Residual contaminants bound into near-surface Made Ground represent a very low contaminant burden – ***Negligible Risk***

PATHWAY – The three pump wells represent a ***very low potential for migration*** as a result of low permeability clay capping, and significantly reduced infiltration of surface water as a result of the new development. A ***significant betterment of the pre-development condition*** of the wells has been achieved. When considering the betterment achieved, in conjunction with the piled foundation solution of the development, the wells are ***no longer considered to provide a preferential pathway***.

RECEPTOR – The sensitivity of the receptor has been discussed and is considered to remain ***moderately sensitive*** given the geological setting of the site.

In evaluating the above model, IDG consider that whilst the sensitivity of the receptor remains, the contaminant source is negligible and the potential for migration via the identified pathway is significantly inhibited.

In order for a risk to be represented to the receptor, a clear source and pathway must also be present. IDG consider that this document demonstrates that a significant source is not present, and that the potential pathway is not significant. It is that any residual risk to the underlying aquifer following the remediation and redevelopment of the site is extremely low.

With reference to the development now being completed and occupied, the opportunity and practicality for any meaningful post-construction works to further investigate or remediate in relation to the wells is unlikely to be feasible. The cost of any such work is likely to be extremely costly, and potentially disruptive to the residents, along with posing significant risks to the integrity of the newly constructed buildings and infrastructure. Relative to the low risk considered to be posed to the Principal Aquifer, IDG consider that the cost-benefit to any such work render the option to do so unviable.

IDG trust that this document provides sufficient additional information and evaluation to alleviate the concerns of the EA regarding protection of the Principal Aquifer, and to allow reconsideration of the recommendations relating to discharge of the associated Contaminated Land Condition 16.

We look forward to your review and response to the above and attached information. If however in the meantime you require any further information or clarification, please do not hesitate to contact the undersigned.

Yours sincerely,



Liam Murphy
Senior Geoenvironmental Engineer
BSc (Hons) FGS
for and on behalf of
iD GEOENVIRONMENTAL LIMITED

Enclosed Appendices

Appendix A – EA Letter Ref. SO/2020/119974/01-L01

Appendix B – Historic OS Maps

Appendix C – IDG Drawing Ref. 4528-G-D002

Appendix D – Pile log records

Appendix A

Manchester City Council
Development Control
PO Box 488
Manchester
Lancashire
M60 2JT

Our ref: SO/2020/119974/01-L01
Your ref: CDN/19/0662
Date: 13 February 2020

FAO: Robert Griffin

Dear Sir

DISCHARGE OF CONDITION NUMBERS 8 (LANDSCAPING), 16 (CONTAMINATED LAND), 18 (EXTERNAL PLANT EQUIPMENT), 19 (ACOUSTIC INSULATION), 21 (HIGHWAY DETAILS) AND 24 (CYCLE STORAGE FROM PLANNING APPROVAL REFERENCE 110179/FO/2015/S1.

LAND BOUND BY ROYCE ROAD, CITY ROAD AND CHORLTON ROAD, HULME MANCHESTER , M15 5LY

Thank you for consulting the Agency on the above development proposal. This referral was received in office on the 10th January 2019.

Documentation reviewed:

- Remediation and Preparatory works for land at Royce Road, Manchester by iGeo Ltd. Dated March 2019.

Environment Agency Position [Condition 16 – Contaminated Land]

We are unable to recommend the discharge of condition 16 on planning permission 110179/FO/2015/S1 as submitted. Please see outlined below an explanation our rationale for this determination.

Groundwater / Contaminated Land

We have reviewed the report noted above to assess possible risks to controlled waters from this site and development. The development proposal is located above a Principal Aquifer, supporting a known abstraction.

Our review of CDN/19/0662 as submitted, has identified that whilst the site does not appear to have a history of industrial land use the ground investigation has located three pump features which supported abstraction boreholes. This discovery would suggests activities on site which were not identified during iterative revisions of the OS Map series.

The report noted above has also identified that the boreholes were not decommissioned and that they are likely to still provide a potential contamination migration pathway into the Principal Aquifer. We refer the developer to the Environment Agency guidance in “Good Practice for Decommissioning of Redundant Boreholes & Wells (2012)” for a supported methodology as to how this matter can be addressed.

In light of the above and given the environmental circumstances were **are unable to** recommend the discharge of Condition 16 of planning permission 110179/FO/2015/S1 as submitted.

We would recommend that no further development continues until these boreholes are decommissioned appropriately or reasons given as to why these features will not, in the future, act as preferential pathways for contamination or pollution into the Principal Aquifer.

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Please forward a copy of this letter to the applicant / agent. Should you have any queries regarding this response, then please do not hesitate to contact me.

Yours faithfully

Mr Andy Davies
Sustainable Places Advisor

Direct dial 02077140640

Direct e-mail andy.davies1@environment-agency.gov.uk

Appendix B

Ordnance Survey® Historical Mapping Extract

www.centremapslive.com

Site Details:

Royce Road, Hulme, Manchester

Client Ref: 4199
Report Ref: CMAPS-CM-442782-4199-010715HIS
Grid Ref: 382936, 396864

Map Name: 1056 Scale Town Plan

Map date: 1851

Scale: 1:1,056

Printed at: 1:1,056



Surveyed 1849
Revised N/A
Edition 1851
Copyright N/A
Landed N/A



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Groundsure Insights
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Production date: 01 July 2015

To view map legend click here [Legend](#)



Ordnance Survey® Historical Mapping Extract

www.centremapslive.com

Site Details:

Royce Road, Hulme, Manchester

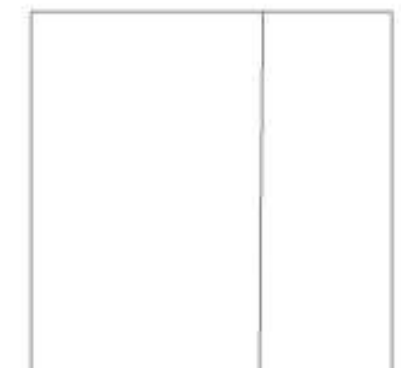
Client Ref: 4199
Report Ref: CMAPS-CM-442782-4199-010715HIS
Grid Ref: 382936, 396864

Map Name: County Series Town Plan

Map date: 1891

Scale: 1:500

Printed at: 1:1,000



Surveyed 1891
Revised N/A
Edition N/A
Copyright N/A
Levelling N/A



Produced by
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Production date: 01 July 2015

To view map legend click here [Legend](#)



Ordnance Survey® Historical Mapping Extract

www.centremapslive.com

Site Details:

Royce Road, Hulme, Manchester

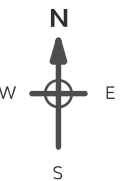
Client Ref: 4199
Report Ref: CMAPS-CM-442782-4199-010715HIS
Grid Ref: 382936, 396864

Map Name: County Series

Map date: 1889-1893

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1893
Revised 1893
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1889
Revised 1889
Edition N/A
Copyright N/A
Levelled N/A



Produced by
Groundsure Insights
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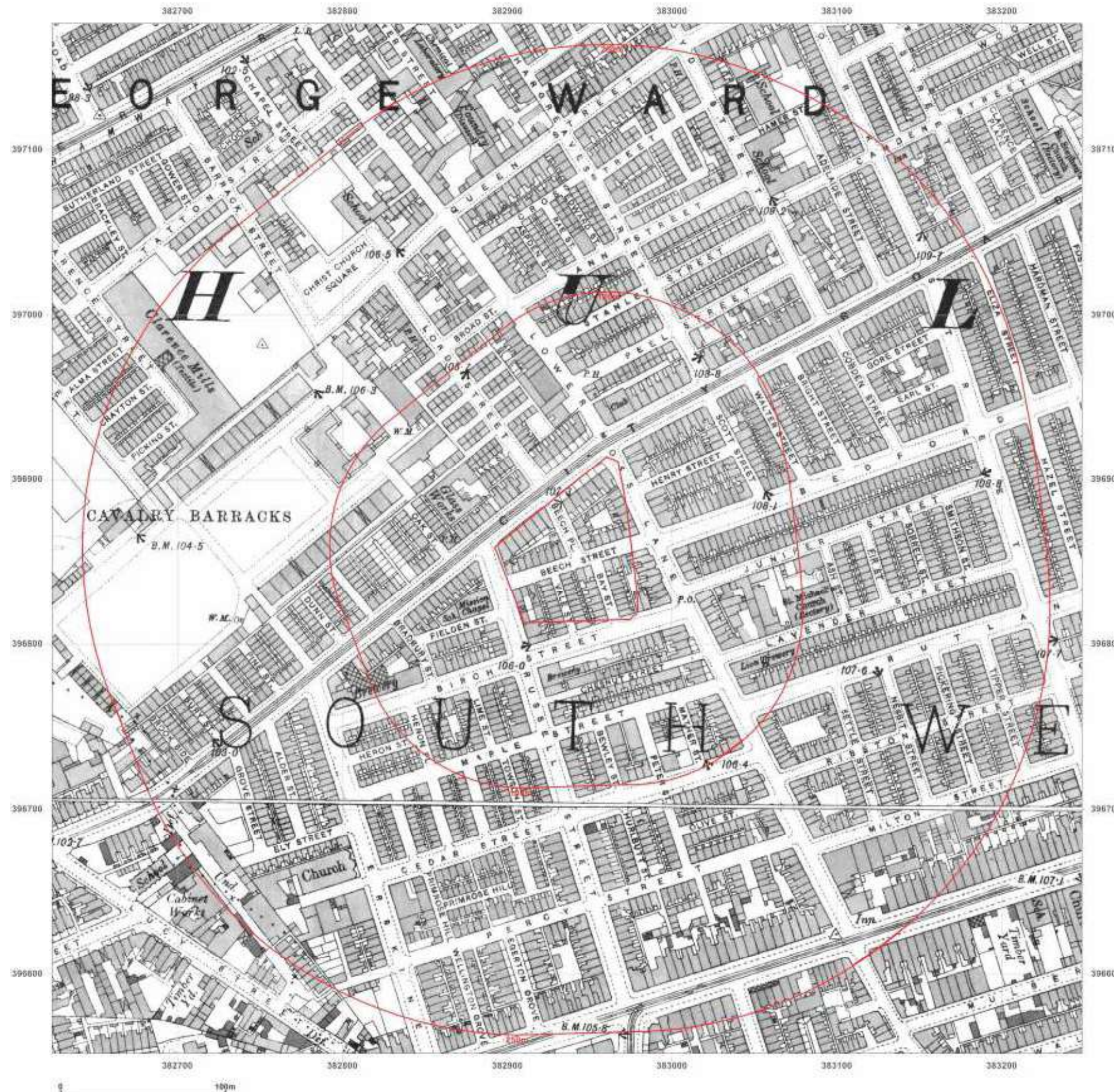


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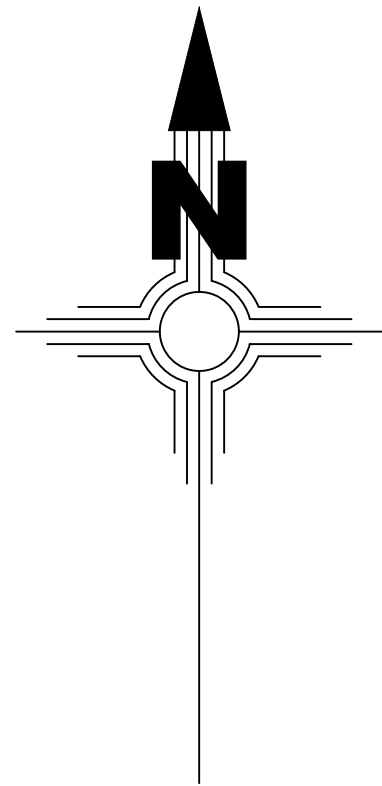
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Production date: 01 July 2015

To view map legend click here [Legend](#)



Appendix C



BURIED FEATURE FOUND
USING RADAR



The Employer must not amend any drawing, design or other intellectual property produced by IDG, without permission in writing from IDG in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, IDG shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or other intellectual property.

- TP CCG Trial Pit Location
- BH CCG Borehole Location
- WS CCG Window Sample Borehole Location
- Site Boundary
- Landscaped Area 450mm clean cover
- Private Garden Area 600mm clean cover
- Approximate Location of Possible Well

Revision	Description	Date
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Geo
Structures
Civils

ID GeoEnvironmental
Consulting Engineers

North West & Midlands:
Caledonian House
Tatton Street
Knutsford, Cheshire
WA16 6AG
Tel: 01565 755557
Fax: 01565 740263

North East & Yorkshire:
The Stables, Aske Hall
Aske, Richmond
Yorkshire, DL10 5HG
Tel: 01748 889015
Fax: 01565 740263

Keepmoat Regeneration (Bramall) Limited

Royce Road, Hulme, Manchester

Remediation Requirements Plan

STATUS DRAFT		
DRAWN BY BRB	SIGNATURE	DATE 18-2-16
APPROVED NW	SIGNATURE	DATE 18-2-16
SCALE 1:500@A1	DRG No. 4528-G-D002	

Appendix D



Piled Foundations & Underpinning

Cohesion Piling Company Ltd

Globe House Business Centre
Moss Bridge Road
Rochdale
OL16 5EB

T: 01706 714555

F: 01706 641041

info@cohesionpiling.co.uk

www.cohesionpiling.co.uk

PILE DESIGN CALCULATIONS CONTINUOUS FLIGHT AUGER BORED PILING

**Proposed site at
Royce Road, Manchester, M15 5LA
for Keepmoat Ltd.**

Project No: 11320

Revision: 0

Prepared by: Gary Kime

Date Prepared: 23/05/2016

Approved by: John Robins

Date Approved: 23/05/2016

Documentation

Pile layout drawing No's S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3- 081 rev A.

Pile Schedule drawing No's C-1-081 rev C01, C-2-081 revC01, C-3-081 rev C01.

Scope

To install approximately 192 No CFA bored piles of 450mm diameter to support 3No apartment blocks (B1, B2, & B3) -

Pile compression loading of 500 – 1100kN.

Pile horizontal (shear) loading of 50kN.

There are no tension or moment loads, applied to the piles.

Soil Profile

The soil profile has been taken from the Sub Surface site investigation report reference 6066B dated December 2015.

Piling levels

Piling platform levels are as informed below, of –

B1 = 32.175m

B2 = 32.275m

B3 = 32.175m

Generally these levels are at existing ground / top of borehole level i.e. no cut or fill operation has taken place. Although referring to the borehole levels, some cut has taken place on block B3.

Pile reinforcement will be left at ground level which we assume provides sufficient pile steel projection above the cut off levels.

No allowance has been made for de bonding of the pile reinforcement.

Pile Type

Propose 450mm diameter Continuous Flight Auger (CFA) Bored Piles where;

As, surface Area = 1.414m^2 (per metre length)

Ab, base area = 0.159m^2

Concrete strength = 35N/mm^2

Concrete sulphate class = DC- 2 in accordance with BRE Special Digest SD1.

Pile reinforcement = 5 H16 bars x 5.0m long with T8 helical reinforcement @ 200mm pitch.

Concrete cover to pile reinforcement of 75mm.

Please refer to the enclosed compressive & horizontal design calculations.



Piled Foundations & Underpinning

CFA CONTRACT REF: Hulme - Royce Road

ENGINEER

GDK

DATE

23/05/2016

F of S shaft = 2.5

F of S base = 2.5

F of S NSF = 1.0

30-13

Depth	Soil Description	Bulk Unit Weight	Submerged Unit Weight	N.S.F. Beta Value	Cohesive soil input parameters		Granular soils input parameters					Chalk input parameters		Rock Socket input parameters		Effective o'burden pressure	Unit Friction	Unit Base Resistance	C.F.A. Piles		0.450	Diameter (m)
		γ kN/m ³	γ' kN/m ³	β	Cu	Alpha	N Value	Ks	tan δ	D/B Ratio	Nq	SPT	PG6 Method q_s	PR 86 Method β	SPT	UCS	kN/m ²	kN/m ²	UR Shaft	UR Base	UR N.S.F.	
0.0 - 0.5	Made Ground / pile cut off level	19							0.000	1							5	0	0	0	0	0
0.5 - 1.0	Made Ground / pile cut off level	19							0.000	2							14	0	0	0	0	0
1.0 - 1.5	Made Ground / sewer	17							0.000	3							23	0	0	0	0	0
1.5 - 2.0	Made Ground / sewer	17							0.000	4							32	0	0	0	0	0
2.0 - 2.5	Made Ground / sewer	17							0.000	6							40	0	0	0	0	0
2.5 - 3.0	Made Ground / sewer	17							0.000	7							49	0	0	0	0	0
3.0 - 3.5	Made Ground / sewer	17							0.000	8							57	0	0	0	0	0
3.5 - 4.0	Made Ground / sewer	17							0.000	9							66	0	0	0	0	0
4.0 - 4.5	Made Ground / sewer	17							0.000	10							74	0	0	0	0	0
4.5 - 5.0	Made Ground / sewer	17							0.000	11							83	0	0	0	0	0
5.0 - 5.5	Made Ground / sewer	17							0.000	12							91	0	0	0	0	0
5.5 - 6.0	Made Ground / sewer	17							0.000	13							100	0	0	0	0	0
6.0 - 6.5	Made Ground / sewer	17							0.000	14							108	0	0	0	0	0
6.5 - 7.0	Made Ground / sewer	17							0.000	16							117	0	0	0	0	0
7.0 - 7.5	Made Ground / sewer	17							0.000	17							125	0	0	0	0	0
7.5 - 8.0	Made Ground / sewer	17							0.000	18							134	0	0	0	0	0
8.0 - 8.5	Made Ground / sewer	17							0.000	19							142	0	0	0	0	0
8.5 - 9.0	Made Ground / sewer	17							0.000	20							151	0	0	0	0	0
9.0 - 9.5	Made Ground / sewer	17							0.000	21							159	0	0	0	0	0
9.5 - 10.0	Made Ground / sewer	17							0.000	22							168	0	0	0	0	0
10.0 - 10.5	Made Ground / sewer		7						0.000	23							174	0	0	0	0	0
10.5 - 11.0	Made Ground / sewer		7						0.000	24							177	0	0	0	0	0
11.0 - 11.5	Made Ground / sewer		7						0.000	26							181	0	0	0	0	0
11.5 - 12.0	Glacial Clay		10		150	0.5			0.000	27							185	75	1350	53	215	0
12.0 - 12.5	Glacial Clay		10		150	0.5			0.000	28							190	75	1350	106	215	0
12.5 - 13.0	Glacial Clay		10		150	0.5			0.000	29							195	75	1350	159	215	0
13.0 - 13.5	Sandstone		10		888	0.3			0.000	30							200	250	7992	336	1270	0
13.5 - 14.0	Sandstone		10		888	0.3			0.000	31							205	250	7992	512	1270	0
14.0 - 14.5	Sandstone		10		888	0.3			0.000	32							210	250	7992	689	1270	0
14.5 - 15.0	Sandstone		10		888	0.3			0.000	33							215	250	7992	865	1270	0
15.0 - 15.5	Sandstone		10		888	0.3			0.000	34							220	250	7992	1042	1270	0
15.5 - 16.0	Sandstone		10		888	0.3			0.000	36							225	250	7992	1219	1270	0
16.0 - 16.5	Sandstone		10		888	0.3			0.000	37							230	250	7992	1395	1270	0
16.5 - 17.0	Sandstone		10		888	0.3			0.000	38							235	250	7992	1572	1270	0
17.0 - 17.5	Sandstone		10		888	0.3			0.000	39							240	250	7992	1749	1270	0
17.5 - 18.0	Sandstone		10		888	0.3			0.000	40							245	250	7992	1925	1270	0
18.0 - 18.5																						
18.5 - 19.0																						
19.0 - 19.5																						
19.5 - 20.0																						
20.0 - 20.5																						
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28.0 - 28.5																						
28.5 - 29.0																						
29.0 - 29.5																						
29.5 - 30.0																						

CHALK PILE DESIGN FOR SPT VALUES UP TO 34

Ultimate Bearing Capacities - kN/m²

For $N < 30$, $q_b = 0.24MN/m^2$ (i.e. $240 \times N$)

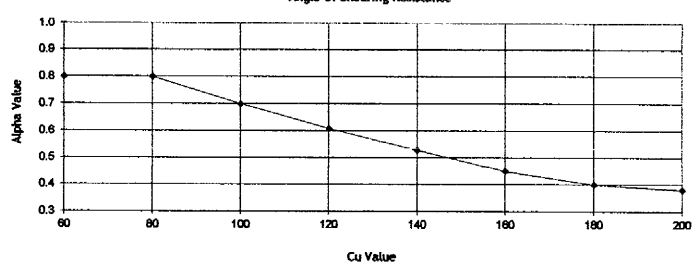
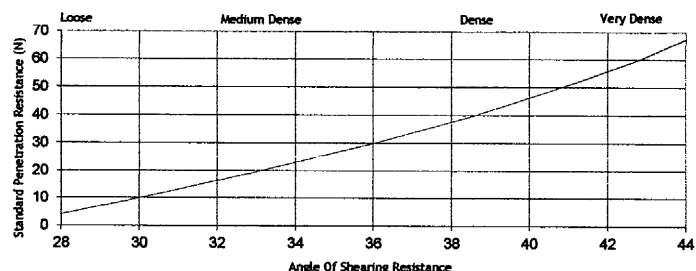
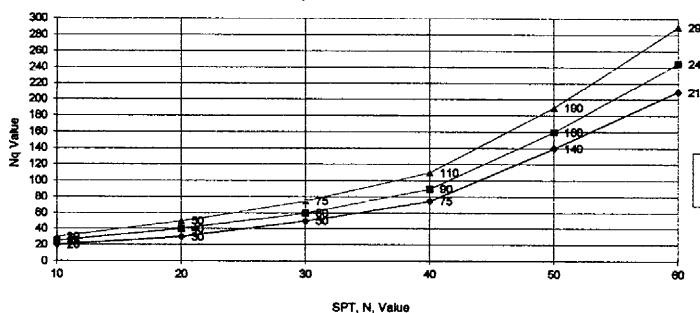
For $N > 40$, $q_b = 0.20MN/m^2$ (i.e. $200 \times N$)

(Pro rata for Bond Stress's between SPT N values)

Ultimate Bond Stress's - kN/m²

N	qs	N	qs	N	qs
6	23	16	77	26	186
8	29	18	91	28	218
10	35	20	105	30	250
12	49	22	144	32	250
14	63	24	157	34	250

Nq Values after Beresantsov



4 of 13

Project : Royce Road, Manchester

Project No :

Revision :



BROMS ANALYSIS

Input by : GDK

Revised By :

Approved For

Construction : JR

Date : 23-May-16

Date :

Date : 23-May-16

LAYER	LEVEL OF TOP OF STRATUM (m)	SOIL DESCRIPTION	BULK UNIT WEIGHT (kN/m ³)	Cu (kN/m ²)	Phi (°)
1 2 3 4	0.0	Made Ground	17	42	

Water Level :-

-10.0 m

Pile Size :-

450 mm

Unfactored Lateral Load at Top :-

50 kN

Unfactored Moment Applied to Top :-

0 kNm

Overburden Pressure on Ground at Top of Pile Level :-

0.0 kN/m²

F.O.S. on Lateral Pressure :-

3

Summary

Unfactored max.

moment in pile

assuming

FREE

head conditions.

(kNm)

Level of max
moment below
cut off level.

(m)

-1.5

Level of bottom
of reinforcement
below cut off level.

(m)

-3.3

Maximum
shear load in
pile.

(kN)

51.030

Level
(m)Factored Lateral
Resisting Pressure
(kN/m²)Shear
in Pile
(kN)Moment
in Pile
(kNm)

0.0

28.000

50.000

0.000

-0.1

35.259

48.577

4.932

-0.2

42.519

46.827

9.704

-0.3

49.778

44.750

14.286

-0.4

57.037

42.347

18.844

-0.5

64.296

39.617

22.744

-0.6

71.556

36.560

26.556

-0.7

78.815

33.177

30.046

-0.8

86.074

29.467

33.180

-0.9

93.333

25.430

35.928

-1.0

100.593

21.067

38.256

-1.1

107.852

16.377

40.130

-1.2

115.111

11.360

41.520

-1.3

122.370

6.017

42.392

-1.4

126.000

0.428

42.715

-1.5

126.000

0.000

42.475

-1.6

126.000

-5.670

42.191

-1.7

126.000

-11.340

41.341

-1.8

126.000

-17.010

39.923

-1.9

126.000

-22.680

37.939

-2.0

126.000

-28.350

35.387

-2.1

126.000

-34.020

32.269

-2.2

126.000

-39.690

28.583

-2.3

126.000

-45.360

24.331

-2.4

126.000

-51.030

19.511

-2.5

126.000

-45.360

14.692

-2.6

126.000

-39.690

10.439

-2.7

126.000

-34.020

6.753

-2.8

126.000

-28.350

3.635

-2.9

126.000

-22.680

1.083

-3.0

126.000

-17.010

-0.901

-3.1

126.000

-11.340

-2.319

Project : Royce Road, Manchester

Project No :

File :

Revision :

Based On :

BROMS ANALYSIS (CONTINUED)



Piled Foundations & Underpinning

-3.2	126.000	-5.670	-3.169
-3.3	126.000	0.000	-3.453

Project : Royce Road, Manchester

Project No : 11320

File :

Revision :



CIRCULAR COLUMN DESIGN SHEET

Input by : GDK

Revised By :

Chkd By : JR

Date : 23-May-16

Date :

Date : 23-May-16

Structural Design For Laterally Loaded In-situ Pile

Maximum Working Vertical Load	=	1100 kN	Max. Design Vertical Load	=	1650 kN
Minimum Working Vertical Load	=	500 kN	Min. Design Vertical Load	=	750 kN
Max. Working Horizontal Load	=	50.0 kN	Max. Design Horizontal Load	=	75 kN
Max. Working Moment	=	43.0 kNm	Design Moment	=	64.5 kNm
Pile Diameter	=	450 mm			
Cover	=	75 mm			
Concrete Strength, f_{cu}	=	35 N/mm ²			
Main Bar Strength, f_y	=	500 N/mm ²			
Link Bar Strength, f_{yv}	=	500 N/mm ²			

Assuming 8 mm links & 16 mm main bars :- = 268

therefore $\frac{h_s}{h} = 0.55$ **Main Bars**

Use BCA "Charts for the Design of Circular Columns to BS8110" CHART 8 b

$$\frac{M}{h^3} = 0.71 \text{ N/mm}^2$$

$$\text{Maximum } \frac{N}{h^2} = 5.43 \text{ N/mm}^2$$

$$\text{Minimum } \frac{N}{h^2} = 3.70 \text{ N/mm}^2$$

$$\text{Area of Steel (As)} = 0.4 \%$$

$$\text{Therefore, As} = 636 \text{ mm}^2$$

Bar size	T10	T12	T14	T16	T20	T25	T32
No of bars	9	6	6	6	6	6	6
(As Provided)	(707)	(679)	(924)	(1206)	(1885)	(2945)	(4825)

Use 5 x T 16 Bars (1005mm²) x 5m**Links**

Consider pile to be square with an equivalent area.

$$b = 399 \text{ mm}$$

$$d = 308 \text{ mm}$$

$$v = \frac{V}{b_v d} = 0.611 \text{ N/mm}^2$$

$$\frac{100 A_s}{b_v d} = 0.409$$

Therefore, from B.S.8110 Table 3.8 :-

$$v_c = 0.56 \quad (\text{Note that } v_c \text{ is enhanced when } f_{cu} < 40 \text{ N/mm}^2)$$

$$v_c' \text{ at Max. Compression} = 2.57$$

$$v_c' \text{ at Min. Compression} = 1.47 \text{ (WORST CASE)}$$

 $v < 0.5 v_c'$, therefore, Links Required for Fabrication Purposes Only

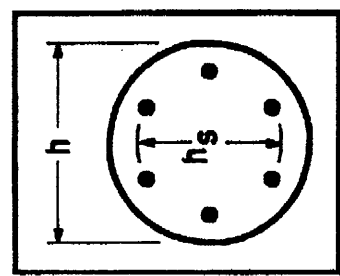
Link bar size	T 6	T 8	T 10	T 12	T 16
Spacing	N/A	N/A	N/A	N/A	N/A
(As Prov per m)	N/A	N/A	N/A	N/A	N/A

Links to be T 8 @ 200 mm centres

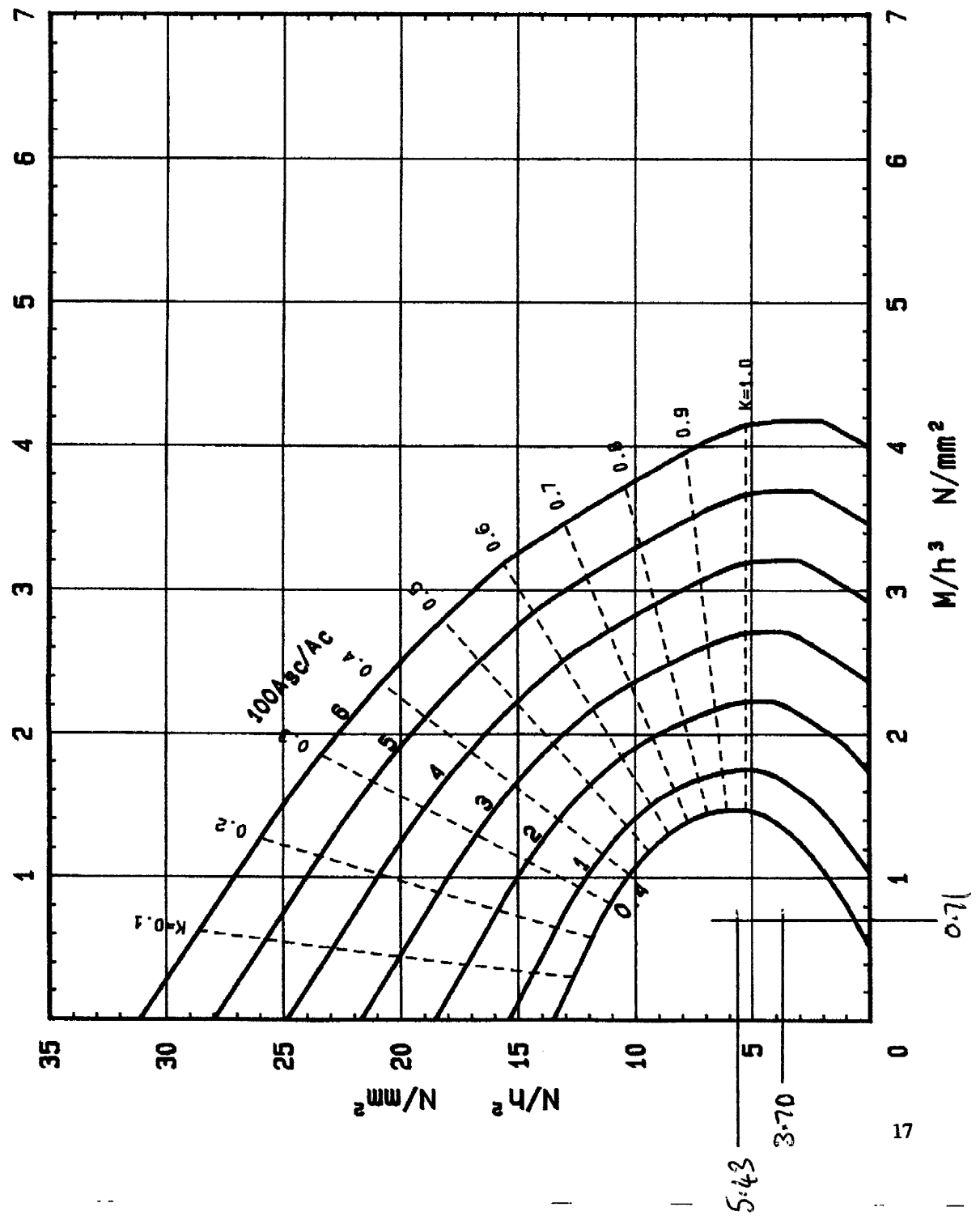
Chart 9

$$A_c = \frac{\pi h^2}{4}$$

A_{sc} = total area
of reinforcement



f_{cu}	35
f_y	460
h_s/h	0.60





CFA PILING SCHEDULE

Drawing No: - S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3-081 rev A

Schedule No: C-1-081 rev C01, C-2-081 rev C01, C-3-081 rev C01

Piled Foundations & Underpinning

CFA PILE SUMMARY TABLE

Pile numbers	Total Depth	Av Depth
192	3075.5	16.02

Factor of safety 2.5

Pile diameter (m) 0.45

Minimum Pile Depth Override

14

AREA / NOTES	PILE REF	PILE V SWL (kN)	TENSION LOAD (kN)	HORIZONTAL LOAD (kN)	PILE DIA (m)	PILE DEPTH (m)	PILE LEVEL	PILE CUT OFF LEVEL	PPL-COL	MAIN REINFORCEMENT	HELICAL REINFORCEMENT
B1	1	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	2	850	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	3	850	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	4	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	5	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	6	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	7	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	8	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	9	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	10	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	11	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	12	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	13	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	14	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	15	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	16	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	17	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	18	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	19	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	20	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	21	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	22	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	23	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	24	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	25	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	26	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	27	1100	0	50	0.45	17.0	32.175	30.950	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	28	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	29	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	30	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	31	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	32	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	33	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	34	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	35	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	36	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	37	1100	0	50	0.45	17.0	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B1	38	1100	0	50	0.45	17.0	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B1	39	1000	0	50	0.45	16.5	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B1	40	1100	0	50	0.45	17.0	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch

CFA PILING SCHEDULE

Drawing No: - S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3-081 rev A

Schedule No: C-1-081 rev C01, C-2-081 revC01, C-3-081 rev C01

CFA PILE SUMMARY TABLE

Pile numbers	Total Depth	Av Depth
192	3075.5	18.02

AREA / NOTES	PILE REF	PILE V SWL (kN)	TENSION LOAD (kN)	HORIZONTAL LOAD (kN)	PILE DIA (m)	PILE DEPTH (m)	PILE LEVEL	PILE CUT OFF LEVEL	PPL-COL	MAIN REINFORCEMENT	HELICAL REINFORCEMENT
B1	41	850	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	42	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	43	850	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	44	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	45	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	46	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	47	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	48	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	49	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	50	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	51	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	52	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	53	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	54	1100	0	50	0.45	17.0	32.175	30.850	1.225	5 H 16 x 5m	8mm @ 200mm pitch
B1	55	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B1	56	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B2	1	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	2	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	3	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	4	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	5	800	0	50	0.45	15.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	6	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	7	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	8	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	9	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	10	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	11	500	0	50	0.45	14.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	12	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	13	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	14	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	15	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	16	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	17	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	18	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	19	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	20	800	0	50	0.45	15.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	21	1000	0	50	0.45	16.5	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	22	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	23	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	24	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch



CFA PILING SCHEDULE

Drawing No: - S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3-081 rev A

Schedule No: C-1-081 rev C01, C-2-081 revC01, C-3-081 rev C01

CFA PILE SUMMARY TABLE

Pile numbers	Total Depth	Av Depth
182	3075.5	16.02

AREA / NOTES	PILE REF	PILE V SWL (kN)	TENSION LOAD (kN)	HORIZONTAL LOAD (kN)	PILE DIA (m)	PILE DEPTH (m)	PILE LEVEL	PILE CUT OFF LEVEL	PPL COL	MAIN REINFORCEMENT	HELICAL REINFORCEMENT
B2	25	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	26	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	27	500	0	50	0.45	14.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	28	800	0	50	0.45	15.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	29	800	0	50	0.45	15.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	30	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	31	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	32	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	33	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	34	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	35	500	0	50	0.45	14.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	36	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	37	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	38	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	39	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	40	1100	0	50	0.45	17.0	32.275	31.025	1.250	5 H 16 x 5m	8mm @ 200mm pitch
B2	41	1100	0	50	0.45	17.0	32.275	31.025	1.250	5 H 16 x 5m	8mm @ 200mm pitch
B2	42	1100	0	50	0.45	17.0	32.275	31.025	1.250	5 H 16 x 5m	8mm @ 200mm pitch
B2	43	1100	0	50	0.45	17.0	32.275	31.025	1.250	5 H 16 x 5m	8mm @ 200mm pitch
B2	44	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	45	1000	0	50	0.45	16.5	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	46	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	47	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	48	1100	0	50	0.45	17.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	49	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	50	500	0	50	0.45	14.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	51	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	52	950	0	50	0.45	16.0	32.275	31.250	1.025	5 H 16 x 5m	8mm @ 200mm pitch
B2	53	800	0	50	0.45	15.0	32.275	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	2	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	3	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	4	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	5	1025	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	6	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	7	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	8	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	9	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	10	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	11	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch



CFA PILING SCHEDULE

Drawing No: - S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3-081 rev A

Schedule No: C-1-081 rev C01, C-2-081 rev C01, C-3-081 rev C01

Piled Foundations & Underpinning

CFA PILE SUMMARY TABLE

Pile numbers	Total Depth	Av Depth
192	3075.5	16.02

AREA / PILE	REF	PILE V SWL (kN)	TENSION LOAD (kN)	HORIZONTAL LOAD (kN)	PILE DIA (m)	PILE DEPTH (m)	PILE LEVEL	PIPING OFF LEVEL	PPL-COL	MAIN REINFORCEMENT	HELICAL REINFORCEMENT
B3	12	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	13	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	14	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	15	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	16	1000	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	17	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	18	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	19	1000	0	50	0.45	16.5	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B3	20	1000	0	50	0.45	16.5	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B3	21	1000	0	50	0.45	16.5	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B3	22	1000	0	50	0.45	16.5	32.175	30.875	1.300	5 H 16 x 5m	8mm @ 200mm pitch
B3	23	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	24	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	25	1000	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	26	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	27	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	28	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	29	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	30	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	31	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	32	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	33	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	34	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	35	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	36	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	37	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	38	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	39	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	40	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	41	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	42	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	43	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	44	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	45	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	46	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	47	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	48	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	49	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	50	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	51	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch



CFA PILING SCHEDULE

Drawing No: - S-1-080 Rev B, S-2-080 rev B, S-3-080 rev B, S-3-081 rev A

Schedule No: C-1-081 rev C01, C-2-081 rev C01, C-3-081 rev C01

Piled Foundations & Underpinning

CFA PILE SUMMARY TABLE

Pile numbers	Total Depth	Av Depth
192	3075.5	16.02

AREA / NOTES	PILE REF	PILE V SWL (kN)	TENSION LOAD (kN)	HORIZONTAL LOAD (kN)	PILE DIA (m)	PILE DEPTH (m)	PILE LEVEL	PILE CUT OFF LEVEL	PPL-COL	MAIN REINFORCEMENT	HELICAL REINFORCEMENT
B3	52	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	53	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	54	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	55	1100	0	50	0.45	17.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	56	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	57	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	58	1000	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	59	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	60	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	61	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	62	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	63	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	64	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	65	1000	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	66	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	67	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	68	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	69	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	70	1025	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	71	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	72	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	73	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	74	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	75	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	76	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	77	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	78	950	0	50	0.45	16.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	79	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	80	500	0	50	0.45	14.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	81	1025	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	82	1025	0	50	0.45	16.5	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch
B3	83	800	0	50	0.45	15.0	32.175	31.100	1.075	5 H 16 x 5m	8mm @ 200mm pitch

Design notes & summary

- 1) All piles to be designed using a minimum overall factor of safety of 2.5. There are two working pile tests required, as the Renaissance piling specification.
- 2) Integrity testing is required to 100% of piles. Concrete identity cube testing is required at a rate of 4 cubes per day of concreting.
- 3) No allowance has been made for positive or negative pile shaft friction (nsf) in the superficial deposits to a depth of 11.5m when calculating the compressive pile length.
- 4) The piles have been designed to the industry standard soil settlement of 10mm at pile safe working load, excluding elastic shortening of the pile element.
- 5) Soil profile to be checked on site prior to pile installation using trial boring with the piling rig. The rock depth range is expected in the range of 11.5 to 14.2m depth. Pile lengths will vary in sympathy with the rock levels encountered on site. Piles will be installed to a designed rock socket or practical rig refusal whichever occurs first.