

Factory Theatre

Foundation Works Risk Assessment

034933

2 October 2018

Revision 00

Revision	Description	Issued by	Date	Checked
00	Foundation Works Risk Assessment	GM	02/10/18	COH

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date **2nd October 2018**

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signature



date **2nd October 2018**

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1 Introduction

This foundation works risk assessment has been prepared in order to assess risks to human health and controlled water receptors from proposed piling works associated with the development at The Factory, Manchester. It has been prepared in direct response to the Environment Agency's Statutory Consultee response to Planning Application 114294/VO/2016, which is reproduced below:

"Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the local planning authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.

Reason

Piling or any other foundation using penetrative methods can result in risks to potable supplies. It should be demonstrated that any proposed piling will not result in contamination of groundwater."

The risk assessment has been produced in general accordance with Environment Agency guidance^{1 2}.

¹ Environment Agency (2001) 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention'. NC/99/73.

² Environment Agency (National Groundwater and Contaminated Land Centre) (2002) 'Piling into contaminated sites'.

2 Site Setting

2.1 The Site

The site is located in Manchester City Centre, approximately 550 m northwest of Deansgate Railway Station, and forms the southwestern part of the St. John's Masterplan area. The National Grid Reference is ³82990 E, ³97960 N. The majority of the site is currently occupied by surface car parking with the western extent currently occupied by Network Rail / Skanska as a construction site compound. A number of structures and buildings are present, including the 5 storey 19th century Bonded Warehouse, Water Street (running centrally through the Site (oriented SW-NE)), a Grade II Listed Colonnaded Railway Viaduct (in part), which was in use by ITV for filming and storage, and the Starlight Theatre (overlying the railway arches). For the purposes of this report the two sets of adjacent railway arches present on / near site are referred to as the 'St John's arches' (northern) and the 'Museum of Science and Industry (MoSI) arches' (offsite, adjacent to the southern boundary). A site location plan and red line boundary plan are included as Appendix A and Appendix B respectively.

The current proposed end use will comprise a new cultural venue comprising flexible auditorium spaces and associated facilities including retail, restaurant, office and educational uses with areas of external landscaping.

A desk study has been completed by Buro Happold³ with a subsequent Ground Investigation (GI) commissioned and undertaken by ESG (since rebranded Socotec). The first phase of GI (east of Water Street) was undertaken between June and October 2016. The second phase of GI (west of Water Street) was undertaken in January 2017. A third phase of GI, comprising trial pits on top of the St John's arches, was undertaken in December 2017. A summary of the relevant findings of all phases of GI is outlined in subsequent sections, however, the associated final ESG / Socotec reports should be fully read in conjunction with this report:

- 'The Factory Factual Report on Ground Investigation', dated October 2016. (Report No.: A6053-16);
- 'The Factory Site, Manchester. Factual Report on Additional Ground Investigation', dated May 2017. (Report No.: A60131-16).
- 'Factual Letter Report for Additional Works at The Factory, Manchester', dated March 2018. (Ref.: A7064-17).

2.2 Ground Conditions

The ground conditions beneath the site have been assessed on the basis of the available information. The general sequence of strata encountered based on all 3 No. phases of the ESG / Socotec GI is summarised in Table 2-1. The ground conditions comprise Made Ground (MG) which is underlain by superficial deposits: Alluvium (both cohesive and granular), and Glaciofluvial Deposits (granular material – recorded in BH02 only). The cohesive Alluvium was encountered sporadically, within 10 No. exploratory holes out of 28.

The Chester Formation bedrock underlies the superficial deposits. Rockhead was recorded between 21.60 and 23.10 m AOD during the GI.

Exploratory hole location plans are included as Appendix C.

³ Buro Happold Engineering (2016) 'Factory, Manchester: Ground Engineering Desk Study Report Revision 01'. (Ref: MF-BHE-XX-XX-RP-CG-0001-PO1).

Table 2-1: Summary of ground conditions encountered on site.

Depth to Top of Strata (m BGL)	Typical Thickness (m)	Generalized Description
0.00	0.80 – 2.50 (3.75 in BH05)	MACADAM or CONCRETE OVER Grey, yellow, brown and black sandy/very sandy gravel and very gravelly sand of sandstone, limestone, mudstone, coal, slate, brick, concrete clinker and glass, with occasional cobble content of sandstone and brick AND Soft to firm brown and black, sandy, gravelly, clay with localised silt and sand of ash. Gravel of fine to coarse brick, coal, quartzite, limestone, mudstone, slate and timber with occasional cobbles of brick. [MADE GROUND]
1.60 – 1.80 (HTP09 & HTP10)	0.10 – 0.60	Soft yellowish brown and brown slightly sandy, slightly gravelly CLAY. Gravel of sandstone and mudstone. [POSSIBLE MADE GROUND]
0.80 – 2.50 (Sporadic)	0.50 – 1.30	Soft to firm brownish yellow mottled grey, slightly sandy, slightly gravelly CLAY. Gravel of sandstone and mudstone. [ALLUVIUM – COHESIVE]
1.50 – 2.50	1.40 – 3.10	Medium dense to very dense dark brown, orange brown and occasionally grey slightly gravelly to gravelly SAND and sandy, silty GRAVEL. Gravel of sandstone and mudstone with occasional limestone, quartzite and siltstone. [ALLUVIUM – GRANULAR]
3.20 (Encountered in BH02 only)	1.20	Brownish grey, becoming yellowish grey, gravelly SAND and sandy GRAVEL. Gravel of sandstone, quartzite and siltstone. [GLACIOFLUVIAL DEPOSITS]
3.40 – 4.60	>25.60	Reddish brown slightly gravelly silty SAND. AND Extremely weak to weak reddish brown to greenish grey medium grained SANDSTONE. Discontinuities are: 1. Subhorizontal, closely to medium spaced, rough, planar, undulating, smooth. 2. Subvertical, widely spaced, tight, planar, smooth with sand smearing and local clay smearing. [CHESTER FORMATION – SHERWOOD SANDSTONE GROUP]

2.3 Hydrology

The nearest surface water feature to the site is the River Irwell, located approximately 30 m northwest of the proposed building footprint. The river flows to the southwest.

A disused branch of the Manchester & Salford Junction Canal is located approximately 50 m to the north, to the west of Water Street. Historically, the canal continued further east, beyond Water Street, and entered a tunnel approximately 100 m east of the site. Section 2.11 and Drawing ES01 S1 (Figure 4 refers) within the RoC Desk Study for the wider St Johns masterplan development⁴ states that the canal basin to the east of Water Street was infilled in the 1950s, and *'several historic tunnels are known to remain further to the east'*.

2.4 Hydrogeology

The Buro Happold Desk Study³ states that the site is underlain by a *'Principal Aquifer'* (formerly termed a *'Major Aquifer'*) defined as *'highly permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public water supply and other purposes.'* This is considered to refer to the Chester Formation (Sherwood Sandstone Group). The desk study also records that the site is underlain by a *'Secondary A Aquifer'*. This is considered to refer to the Alluvial Deposits recorded in close proximity.

2.5 Groundwater

During the ground investigation, groundwater was struck between 2.20 and 3.10 m BGL within several exploratory holes within the granular Alluvium.

Post fieldwork groundwater levels have been recorded between 23.13 and 23.51 m AOD (~2.80 to 3.30 m BGL) within the granular Alluvium, and between 22.87 and 23.63 m AOD (~2.80 to 3.80 m BGL) within the Chester Formation bedrock. It is therefore considered that the two strata are in hydraulic continuity. Perched water was recorded in 2 No. of the 4 No. wells installed within the Made Ground, between 1.80 and 3.05 m BGL.

Groundwater monitoring results are included as Appendix D.

2.6 Geoenvironmental Assessment

Chemical testing was carried out during all 3 No. phases of the ESG / Socotec GI in respect of end use, health and safety considerations in addition to waste disposal categorization. Testing undertaken across the entire site is detailed below:

- Buro Happold Soil General Suite – 20 No. samples (17 Made Ground, 3 Alluvium).
- Buro Happold Leachate General Suite – 2 No. samples (both Made Ground).
- Buro Happold Groundwater Suite – 2 No. samples.
- Waste Acceptance Criteria (WAC) with 2 stage leachate – 8 No. samples (7 Made Ground, 1 Alluvium).

The results are included as Appendix E.

Soil Results and Risk to Human Health

In total, 20 No. soil samples (Made Ground: 17 No. and natural material: 3 No.) were tested and assessed against the relevant CLEA model thresholds (commercial / industrial, S4SLs and C4SLs derived for 1% SOM).

⁴ RoC Consulting (2015) 'Phase 1 Desktop Study on St Johns' Core Development Sites, Manchester for Manchester Quays Limited'.

Commercial criteria are considered suitable for the proposed end use as a theatre / public realm space due to the following reasons:

- End users will be transient;
- The vast majority of the proposed development area will be covered by the building, with the remainder covered by hard or soft landscaping; and
- Floor slabs and landscaped areas will be underlain by a clean capping layer.

No exceedances of the CLEA model commercial / industrial thresholds for the analysed determinands were recorded. No Asbestos Containing Material (ACM) was identified in the 20 No. samples analysed.

Several chemical exceedances were recorded above the more sensitive CLEA model residential without plant uptake thresholds, including TPH, lead, arsenic and PAHs.

Visual / olfactory evidence of contamination was recorded during the first phase of the ground investigation in 2 No. exploratory holes, namely WS09, 3.30 to >3.85 m BGL (maximum depth drilled with a 'strong diesel odour – hydrocarbon') and MTP05, 0.30 to >3.10 m BGL (maximum depth drilled; 'slight hydrocarbon odour').

Samples of these materials were sent to a laboratory to be analysed for a suite of potential contaminants. Soil analysis results recorded concentrations of TPH, lead and PAH above residential without plant uptake thresholds. The highest TPH value recorded onsite was within HTP11 at 1.00 m BGL (1920 mg/kg TPH), despite no visual / olfactory evidence of contamination being noted; this material represents historic backfilling on top of the St John's arches.

Buro Happold have produced a 'Land Contamination Summary and Outline Remediation Strategy'⁵ (herein referred to as the REM Strat) and an 'Excavation and Filling Specification'⁶ (herein referred to as the E&F Spec), and the procedure for dealing with any unexpected hotspots is outlined therein.

Leachate

Eleven leachate tests undertaken as part of the ground investigation recorded sporadic minor exceedances of the UK DWS of antimony, barium, benzo[a]pyrene and fluoride, and minor exceedances of the Freshwater EQS of pH and sulphate (Note: PAHs and TPH only tested in two of the eleven samples). Several other determinands (lead, copper, zinc and chromium) recorded concentrations between the two assessment criteria used (above the Freshwater EQS but below the UK DWS).

Based on the minor exceedances of the Freshwater EQS and UK DWS, the potential for leaching of contaminants from site soils into controlled waters is considered to be low. Furthermore, the groundwater concentrations are also low (see next section) giving a further line of evidence to the low leachability of soils.

Groundwater

Two groundwater samples were collected on one occasion by bailer during post-fieldwork monitoring and tested in the laboratory. The two samples were taken from different wells (BH01 and BH05), both with response zones within the Chester Formation bedrock (i.e. deeper groundwater). One exceedance was recorded in BH01: benzo[a]pyrene exceeding the UK DWS by 17 times. In BH05, a substantial concentration of TPH was recorded (14,000 µg/m³); however, no visual or olfactory signs of contamination were reported during groundwater sampling.

⁵ Buro Happold Engineering (2018) 'Land Contamination Summary and Outline Remediation Strategy' (Ref: MF-BHE-XX-XX-RP-CG-0002).

⁶ Buro Happold Engineering (2016) 'Factory Theatre: Excavation and Filling Specification – Employers Requirements, Revision 02 Draft' (Ref: MF-BHE-XX-XX-SP-CG-00-0001).

The monitoring undertaken suggests some hydrocarbon impact to groundwater within the Chester Formation aquifer; however, there is no evidence to suggest that this impact originates from the Site:

- Onsite processes unlikely to have resulted in such contamination;
- The origin of the TPH impacts recorded at BH05 is unclear and may be from an offsite source (engineering works and timber yard are recorded off Site on historical maps);
- Chemical analysis of soils in the location of BH05 recorded low TPH concentrations (58 and 40 mg/kg at 1 and 3 m BGL respectively);
- Within the upper strata of both BH01 and BH05, no visual / olfactory evidence of contamination was noted, and no elevated TPH was recorded during soil chemical testing. This suggests migration of contamination within the groundwater;
- No CLEA commercial threshold exceedances were recorded in the site soils; and
- Soil leachability tests reported low leachability.

Ground Gas

6 No. ground gas monitoring events were undertaken on the 8 No. monitoring wells as part of the post fieldwork monitoring visits between 28 July and 20 October 2016. The findings of the monitoring events undertaken are outlined below and a summary of the monitoring results obtained is included in Appendix F:

- The maximum concentration of carbon dioxide recorded during the monitoring events was 3.7% in 1 No. installation, namely BH04 on the 22.03.2017 (response zone 1.00 to 3.00 m BGL in Glaciofluvial Deposits);
- The maximum concentration of methane was recorded to be <0.1% for the installations; and
- The maximum flow rate was recorded to be 0.1%.

On the basis of this information, the site is classified as Characteristic Situation 1 (CS1).

Conclusion

Concentrations in soil were recorded below the relevant CLEA commercial thresholds and are therefore considered suitable for use for the proposed development. The soils data indicates that some contaminants are present within site Made Ground; however, the maximum concentrations recorded do not indicate that the site is substantially impacted by contamination. Impacts within the Made Ground are therefore not considered to pose a risk either to future end users of the development or environmental receptors.

Suitable and appropriate health and safety measures / procedures will need to be implemented to protect the construction workforce from an associated risk. The procedure for dealing with unexpected contamination 'hotspots' is outlined in both the REM Strat and the E&F Spec.

The evidence from leachate and groundwater results suggests that there is a low potential for impacts to controlled waters originating from the site.

The future development will introduce impermeable surfaces over the proposed development and sealed drainage discharging to the River Irwell. This will substantially reduce infiltration through site Made Ground and so will further reduce potential impacts to controlled waters.

The site is classified as Characteristic Situation 1 (CS1), suggesting that "no special precautions" are required, in accordance with CIRIA C665⁷ and the British Standard BS8485:2015⁸.

⁷ CIRIA C665 (2007) 'Assessing risks posed by hazardous ground gases to buildings'. Construction Industry Research and Information Association.

3 Proposed Piling Methodology

The new theatre building is currently proposed to be founded on a combination of conventional Continuous Flight Auger (CFA) piles and mini piles within the St John's arches.

There are currently ~403 No. CFA piles scheduled in total, both 600 mm and 750 mm in diameter (238 and 165 piles respectively). Pile lengths are envisaged to be between 13.40 and 15.00 m, although this is subject to detailed design. Piling platform level is currently assumed to be 26.87 m AOD. Based on the foregoing, the toe level of the piles is expected to be between approximately 11.80 and 13.50 m AOD. This equates to approximately 6 to 10 m rock sockets into the Chester Formation (rockhead recorded between 21.60 and 23.10 m AOD – Section 2.2 refers).

Mini piling is proposed to be undertaken inside the Grade II Listed St John's arches. The methodology for installing the mini piles will be a Sectional Flight Auger (SFA) system due to limited access and headroom restrictions. There are currently ~46 No. piles at 450 mm diameter scheduled to be installed to lengths of approximately 9.5 to 11 m, although this is subject to detailed design. Piling platform level is yet to be decided due to constraints within the arches however the mini piles will be rock socketed into the Chester Formation as above.

⁸ BS8485 (2015) 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. British Standard Institution.

4 Identification of Potential Adverse Environmental Impacts

Potential adverse environmental impacts are assessed using the source pathway receptor linkage model; these elements are discussed below.

4.1 Sources of Contaminants

The following are considered sources of contamination for The Factory development site:

- Leachable contaminants in the Made Ground
- Perched water within the Made Ground
- Isolated hydrocarbon hotspots within the Alluvium (encountered in MTP05 and WS09 during the GI).

4.2 Contaminant Receptors

Groundwater

The Chester Formation bedrock is classified by the EA as a Principal Aquifer. Superficial deposits beneath the site (Alluvium) are designated as a Secondary A Aquifer.

Surface waters

The River Irwell is situated approximately 30 m northwest of the proposed building footprint. There are no other surface water features in the immediate vicinity.

Human Health

Human health receptors include construction workers and end users of both the development itself and neighbouring properties.

5 Site Specific Risk Assessment

5.1 General

The risk assessment methodology presented below follows the recommendations of CIRIA C552⁹. The C552 guidance on consequences to controlled waters is based on the Water Resources 1991 which contains no scope for considering significance of pollution. The consequence classification has therefore been modified to reflect the consequence to controlled waters compared to their existing condition.

5.2 Consequence

In terms of controlled waters, the following consequence designations have been adopted:

Minor:	Remote possibility of degradation of controlled waters.
Mild:	Short-term degradation of controlled waters.
Medium:	Long-term degradation of controlled waters.
Severe:	Permanent degradation of controlled waters.

The severity of consequences to human health receptors have been derived qualitatively based on the contaminants considered likely to be present, the sensitivity of the receptor, and the envisaged exposure time.

5.3 Probability

Unlikely:	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.
Low likelihood:	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Likely:	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
High Likelihood:	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.

5.4 Risk

Once the consequence and probability have been classified, these can then be compared to produce a risk category, as per Table 5-1 overleaf.

⁹ Rudland, D.J., Lancefield, R.M. & Mayell, P.N. (2001) 'Contaminated land risk assessment, a guide to good practice'. Construction Industry Research and Information Association.

Table 5-1 Comparison of consequence against probability.

		CONSEQUENCE			
		Severe	Medium	Mild	Minor
PROBABILITY	High likelihood	Very high risk	High risk	Moderate risk	Moderate/low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Very high risk: There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.

High risk: Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.

Moderate risk: It is possible that harm could arise to a designated receptor from an identified hazard. However, if is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.

Low risk: It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.

Very low risk: There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

5.5 Summary

The likelihood, severity and risks discussed above are summarised in Table 5-2 and discussed overleaf.

Table 5-2 Summary of pollutant linkages in relation to piling works.

Pile Type	Receptor	Consequence	Probability	Risk	Comments and Required Mitigation (if any)	After Mitigation Action:		
						Consequence	Probability	Risk
Pollution Scenario 1: Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer.								
CFA SFA (mini piling)	Chester Formation Principal Aquifer Alluvium Secondary A Aquifer	Mild	Low Likelihood	Low	Hydrocarbon impact was recorded in soils in WS09 and MTP05, however chemical testing in these localities recorded concentrations below the relevant commercial / industrial thresholds. Any visual / olfactory contamination 'hotspots' that are discovered during the enabling works will be removed as per the Buro Happold Excavation and Filling Specification ⁶ . Leachable concentrations of contaminants were discovered to be low during leachate testing. There should be no formation of preferential pathways, as the concrete is cast in intimate contact with the surrounding soil in the case of CFA / SFA piles. Cohesive alluvium (which would act as an aquitard) is sporadic and, where present, relatively thin (0.50 to 1.30 m thickness). Furthermore, groundwater data indicates that the Alluvium and Chester Formation aquifers are in hydraulic continuity. It is therefore considered that there is no barrier between the Made Ground and underlying Chester Formation Principal Aquifer in the existing situation, thus it is not considered that piling will increase the level of risk from the current situation. The Main Contractor will be required to control the permeation of water through the ground during construction. Any potential impact is short term, because the future development will introduce impermeable surfaces over the site area and sealed drainage discharging directly to the River Irwell.	Mild	Unlikely	Very Low
Pollution Scenario 2: Creation of preferential pathways through a low permeability surface layer, allowing migration of landfill gas, soil gas or contaminant vapours to the surface.								
CFA SFA (mini piling)	End Users Construction Workers	Severe	Unlikely	Low	Based on gas monitoring data, the site is classified as Characteristic Situation 1 (CS1), suggesting that “no special precautions” are required, in accordance with CIRIA C665 and the British Standard BS8485:2015.	No Mitigation Required		
Pollution Scenario 3: Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface; runoff to surface waters.								
CFA SFA (mini piling)	Construction Workers	Medium	Low Likelihood	Low to Moderate	Good working practice, health and safety and use of PPE (if necessary) to be implemented to protect workforce. For any potentially contaminated arisings, stockpile management, protective measures and working methods will be put in place to control potential runoff to the River Irwell (as per the Buro Happold Excavation and Filling Specification ⁶ , Clauses 395 and 405). It should be noted that piling will be undertaken at least 30 m away from the river. Runoff to River Irwell not considered a risk in internal areas (mini piling).	Mild to Medium	Unlikely	Very Low to Low
	River Irwell (external CFA piling only)	Mild	Low Likelihood	Low		Mild	Unlikely	Very Low
Pollution Scenario 4: Direct contact of the piles or engineered structures with contaminated soils or leachate causing degradation of materials.								
CFA SFA (mini piling)	Proposed Structure Aquifers (if piles are degraded and pathways created)	Medium	Low Likelihood	Low to Moderate	Piles will be designed to be resistant to aggressive ground conditions in accordance with BRE guidance ¹⁰ (DS2-AC2, based on pH and sulphate testing undertaken as part of the GI – Appendix G refers).	Medium	Unlikely	Low
Pollution Scenario 5: The pushing of solid contaminants down into an aquifer during pile driving.								
CFA SFA (mini piling)	Chester Formation Principal Aquifer Alluvium Secondary A Aquifer	Not Applicable – driven piling methods not used.						
Pollution Scenario 6: Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.								
CFA SFA (mini piling)	Chester Formation Principal Aquifer Alluvium Secondary A Aquifer River Irwell	Mild	Low Likelihood	Low	Piles will be cast in situ within both the Alluvium and the Chester Formation, with concrete in direct contact with the ground. Experience from other projects in Manchester with rock socketed piles into the Chester Formation suggests that significant concrete loss is extremely unlikely to occur. Records from an example project are included as Appendix H. In this example, concrete oversupply typically does not exceed 35%. Concrete installation is measured in real time during piling, thus any excess oversupply will be spotted and action be taken accordingly. It is recommended that the piling contractor’s method statements include an explicit plan for the management of surplus concrete e.g. stockpile locations and provisions to prevent concrete entering the watercourse. The migration of concrete into factures within the sandstone is likely to be limited due to the viscosity of the concrete. The concrete will typically solidify in a few hours after installation thus the ability of concrete to travel within the aquifer will be limited to this time period only. Piling activities will be undertaken at least 30 m from the River Irwell. It is considered unlikely that concrete will migrate in excess of that distance.	Mild	Unlikely	Very low

¹⁰ BRE Special Digest 1:2005 Third Edition, 'Concrete in aggressive ground'.

6 Conclusion and Recommendations

6.1 Piling Works Risk Summary

A Conceptual Site Model has been determined and a piling works risk assessment with respect to ground contamination has been conducted for the site.

A Low to Moderate risk with respect to Pollution Scenarios 3 and 4 for installation of the CFA and SFA piles has been identified, as follows:

- Direct contact of site workers with contaminated soil arisings;
- Direct contact of piles with contaminated soils or leachate causing degradation of materials.

The risks can be mitigated by adoption of the measures listed in Section **Error! Reference source not found.**

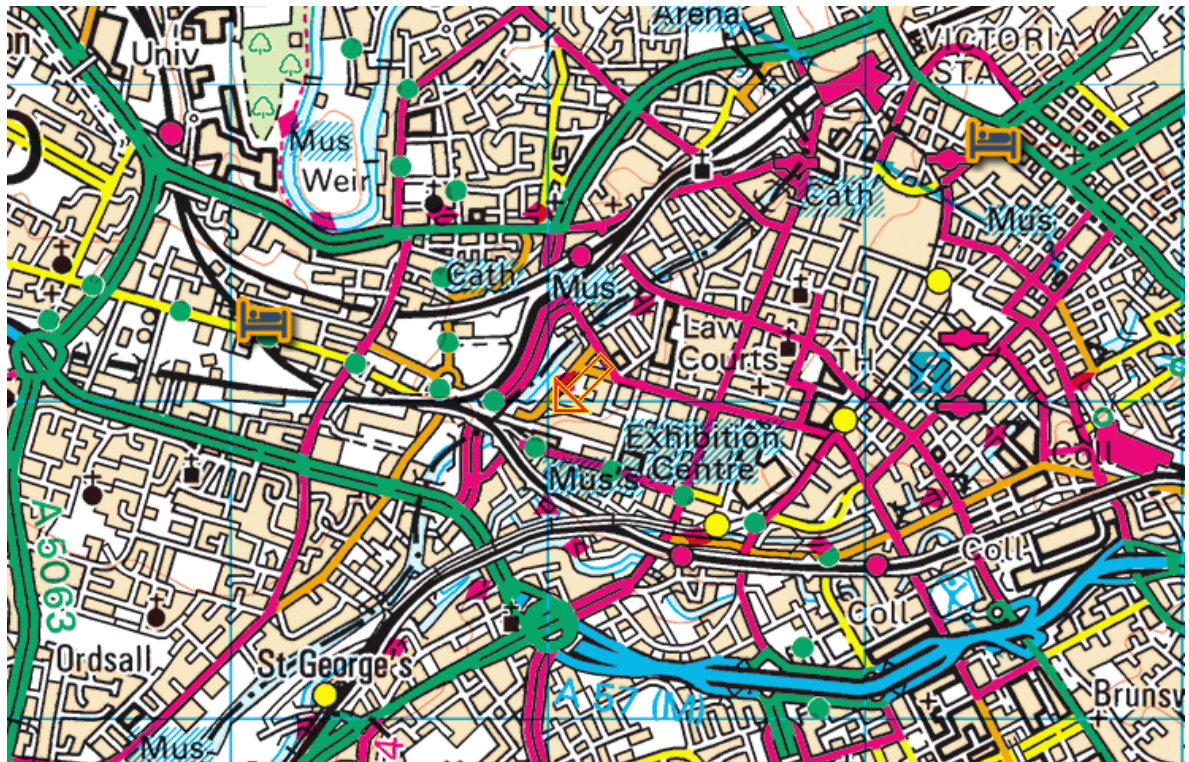
No other risks greater than low have been identified, however it is recommended that the mitigation measures outlined in Section **Error! Reference source not found.** are put in place to ensure the minimum level of risk.

6.2 Proposed Mitigation Measures

In order to ensure the low level of risk, the following mitigation measures should be followed:

- Pollution Scenario 1 – The Main Contractor will be required to control the permeation of water through the ground during construction;
- Pollution Scenario 3 – Good working practice, health and safety procedures and use of PPE (if necessary) will be implemented to protect the workforce from potentially contaminated arisings. This will need to be reflected in the contractor's method statements;
- Pollution Scenario 3 – For any potentially contaminated arisings, stockpile management, protective measures and working methods will be put in place to control potential runoff to the River Irwell. This will need to be reflected in the contractor's method statements for CFA piling in external areas;
- Pollution Scenario 4 – Piles will be designed to be resistant to aggressive ground conditions in accordance with BRE guidance (DS2-AC2, based on pH and sulphate testing undertaken as part of the GI);
- Pollution Scenario 6 – Method statements for piling should include an explicit plan for management of surplus concrete e.g. stockpile locations and provisions to prevent concrete entering the River Irwell.

Appendix A – Site Location Plan



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Project Name : Factory Theatre

Report Title : Foundation Works Risk Assessment

Figure Title : Site Location Plan

Scale: NTS

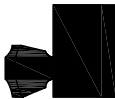
Date: Sept 2018

Job No: 034933

Enclosure: 2

**BUROHAPPOLD
ENGINEERING**

Appendix B – Red Line Boundary Plan



FACTORY MANCHESTER

CLIENT

ARCHITECT

LOCAL ARCHITECT

ENGINEER

LOCAL ENGINEER

COST CONSULTANT

ACOUSTIC ENGINEER

LANDSCAPE ARCHITECT

SCENOGRAPHY

Area including
indicative area for
construction

Building Footprint
at Roof

Building Footprint
at GF

Total area:
1.45ha

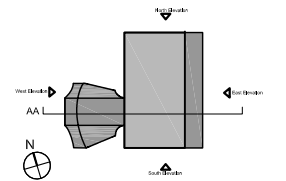
Footprint at GF:
3528m2

Footprint at Roof:
5479m2

Overall Height (AOD):
62320mm

01	08-04-2019	STAGE 2 SUBMISSION
00	25-03-2019	STAGE 2 DESIGN FREEZE
REVISION	DATE	DESCRIPTION

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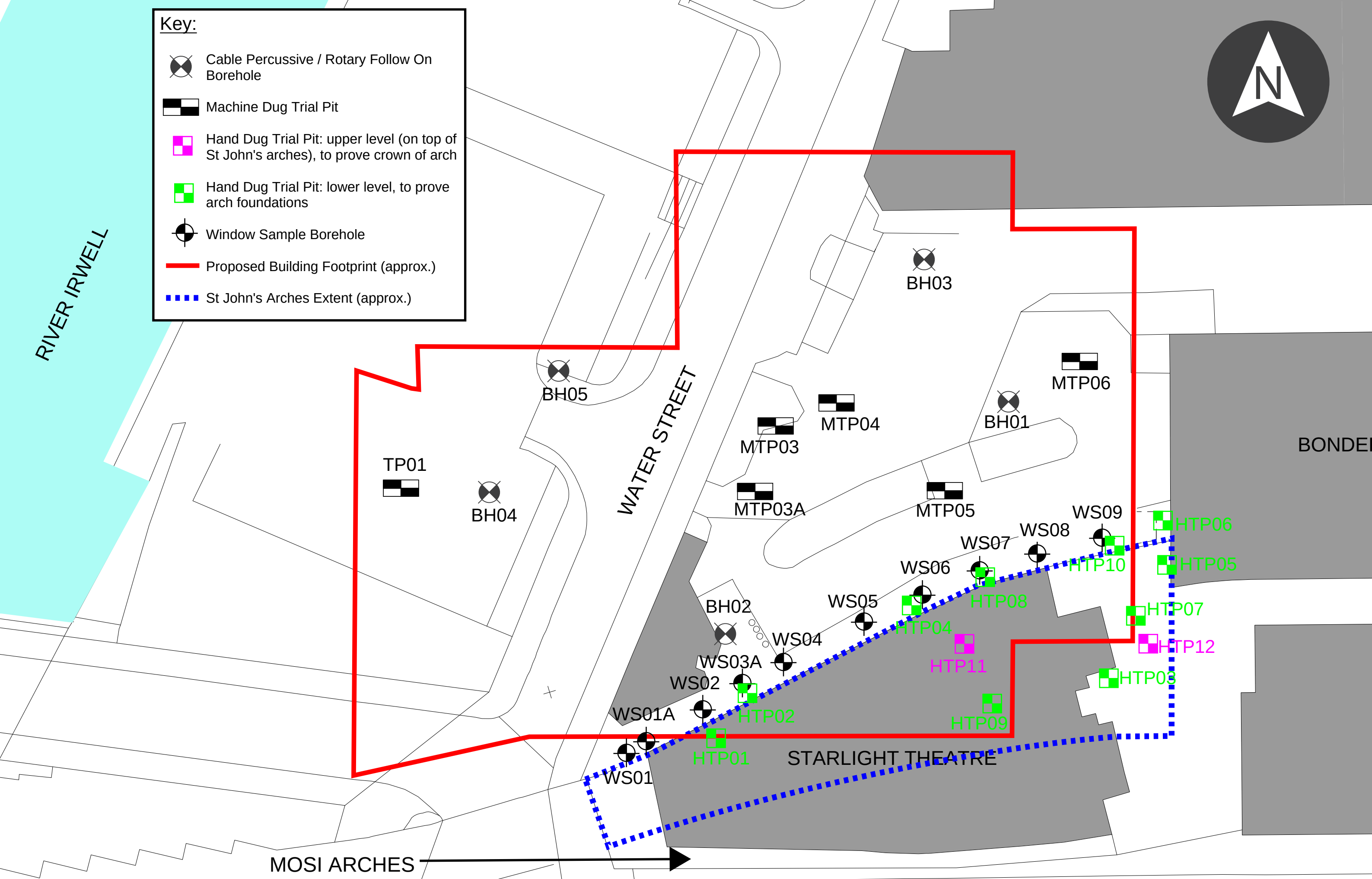
TITLE
Red Line Boundary for Planning

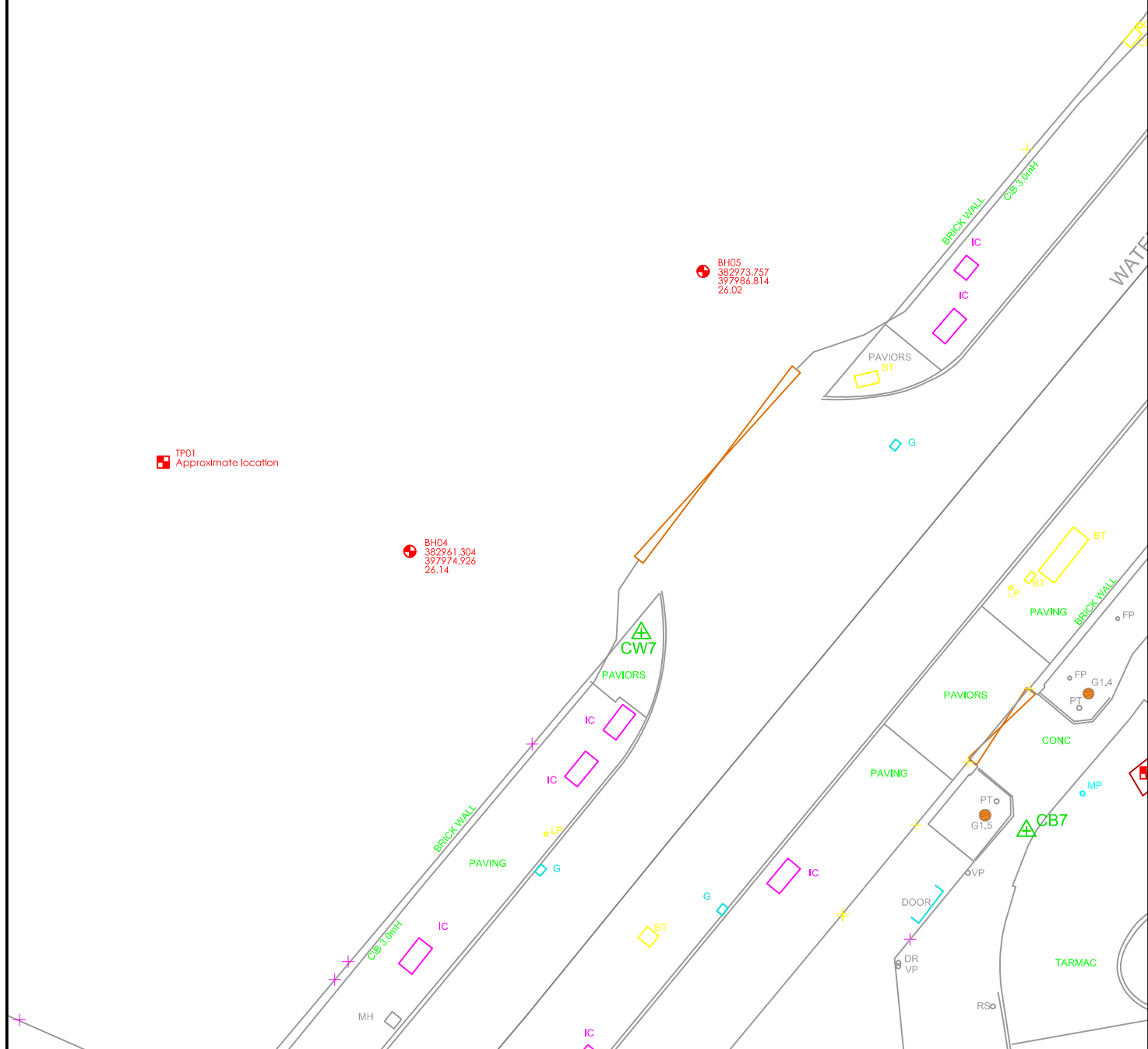
STATUS	REVISION
PROJ. NR.	1 : 1250 A3 01
SCALE	FORMAT

Appendix C – Exploratory Hole Location Plans

Key:

-  Cable Percussive / Rotary Follow On Borehole
-  Machine Dug Trial Pit
-  Hand Dug Trial Pit: upper level (on top of St John's arches), to prove crown of arch
-  Hand Dug Trial Pit: lower level, to prove arch foundations
-  Window Sample Borehole
-  Proposed Building Footprint (approx.)
-  St John's Arches Extent (approx.)





LEGEND TO SYMBOLS  Borehole Location Scale: 1:250 	Title SITE PLAN	Date 15/03/17	Drawn By AW
	Project THE FACTORY ADDITIONAL GI	Scale 1:250	Approv. By TC
	Client Buro Happold Limited	Sheet Size A4	Project No A6136-17
		Figure No A2	Rev 0

Appendix D – Groundwater Monitoring Results

Site: The Factory, Manchester
Monitoring well data

STRIKE DURING GI

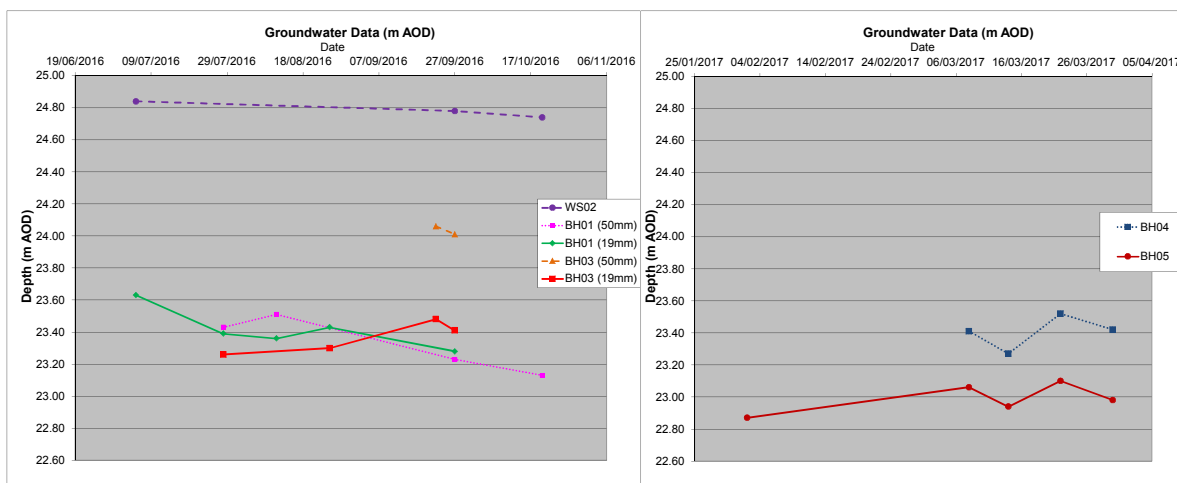
BH	GL	BASE DEPTH	WATER DEPTH (mBGL) :								
			Date	24-Jun-16	05-Jul-16	28-Jul-16	11-Aug-16	25-Aug-16	22-Sep-16	27-Sep-16	20-Oct-16
WS02	26.64	2.10	3.10	1.80	DAMP	DAMP	DRY	NO ACCESS	1.86	1.90	
WS04	26.54	NA	2.20	NOT INSTALLED							
WS05	26.52	NA	3.10	NOT INSTALLED							
WS06	26.53	1.87	NA	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
WS08	26.52	3.25	2.80	3.12	DRY	DRY	DRY	DRY	DRY	DRY	
WS09	26.45	NA	2.90	NOT INSTALLED							
BH01 (50mm)	26.43	4.34	NA	2.35	3.00	2.92	2.13	NO ACCESS	3.20	3.30	
BH01 (19mm)	26.43	11.85	NA	2.80	3.04	3.07	3.00	NO ACCESS	3.15	DRY	
BH02 (50mm)	26.61	1.50	NA	NA	DRY	DRY	DRY	NO ACCESS	DRY	DRY	
BH02 (19mm)	26.61	3.20	NA	NA	DRY	DRY	DRY	NO ACCESS	DRY	DRY	
BH03 (50mm)	27.06	3.60	NA	NA	DRY	NO DATA	DRY	3.00	3.05	DRY	
BH03 (19mm)	27.06	4.00	NA	NA	3.80	NO DATA	3.76	3.58	3.65	NA	
BH	GL	BASE DEPTH	WATER DEPTH (m BGL) :								
			Date	Strike during GI	02-Feb-17	08-Mar-17	14-Mar-17	22-Mar-17	30-Mar-17		
BH04	26.14	3.00	2.59	No Data	2.73	2.87	2.62	2.72			
BH05	26.02	10.00	3.14	3.15	2.96	3.08	2.92	3.04			

Max	Min	RESPONSE ZONES (approx. m BGL)		Geology
From	To	From	To	
3.10	1.80	1.00	2.00	MG
Dry	Dry	1.00	2.00	MG
3.12	2.80	2.00	3.50	Sand
3.30	2.13	2.00	4.00	Sand
3.15	2.80	10.00	12.50	Sandstone
Dry	Dry	1.00	1.50	MG
Dry	Dry	2.50	3.50	Sand
3.05	3.00	1.50	3.00	MG / Sand
3.80	3.58	4.00	4.50	Sandstone
Max	Min	RESPONSE ZONES (approx. m BGL)		Geology
From	To	From	To	
2.87	2.59	1.00	3.00	Sand / Gravel / Clay
3.15	2.92	4.00	10.00	Sandstone

BH	GL	BASE DEPTH	WATER DEPTH (mAOD) :								
			Date	24-Jun-16	05-Jul-16	28-Jul-16	11-Aug-16	25-Aug-16	22-Sep-16	27-Sep-16	20-Oct-16
WS02	26.64	24.54	23.54	24.84	DAMP	DAMP	DRY	NO ACCESS	24.78	24.74	
WS04	26.54	NA	24.34	NOT INSTALLED							
WS05	26.52	NA	23.42	NOT INSTALLED							
WS06	26.53	24.66	NA	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
WS08	26.52	23.27	23.72	23.40	DRY	DRY	DRY	DRY	DRY	DRY	
WS09	26.45	NA	23.55	NOT INSTALLED							
BH01 (50mm)	26.43	22.09	NA	24.08	23.43	23.51	24.30	NO ACCESS	23.23	23.13	
BH01 (19mm)	26.43	14.58	NA	23.63	23.39	23.36	23.43	NO ACCESS	23.28	DRY	
BH02 (50mm)	26.61	25.11	NA	NA	DRY	DRY	DRY	NO ACCESS	DRY	DRY	
BH02 (19mm)	26.61	23.41	NA	NA	DRY	DRY	DRY	NO ACCESS	DRY	DRY	
BH03 (50mm)	27.06	24.06	NA	NA	DRY	NO DATA	DRY	24.06	24.01	DRY	
BH03 (19mm)	27.06	23.06	NA	NA	23.26	NO DATA	23.30	23.48	23.41	NA	
BH	GL	BASE DEPTH	WATER DEPTH (m AOD) :								
			Date	Strike during GI	02-Feb-17	08-Mar-17	14-Mar-17	22-Mar-17	30-Mar-17		
BH04	26.14	23.14	23.55	No Data	23.41	23.27	23.52	23.42			
BH05	26.02	16.02	22.88	22.87	23.06	22.94	23.10	22.98			

Max	Min	RESPONSE ZONES (approx. m BGL)		Geology
From	To	From	To	
24.84	23.54	25.64	24.64	MG
Dry	Dry	25.53	24.53	MG
23.72	23.40	24.52	23.02	Sand
24.30	23.13	24.43	22.43	Sand
23.63	23.28	16.43	13.93	Sandstone
Dry	Dry	25.61	25.11	MG
Dry	Dry	24.11	23.11	Sand
24.06	24.01	25.56	24.06	MG / Sand
23.48	23.26	23.06	22.56	Sandstone
Max	Min	RESPONSE ZONES (approx. m AOD)		Geology
From	To	From	To	
23.55	23.27	25.14	23.14	Sand / Gravel / Clay
23.10	22.87	22.02	16.02	Sandstone

Anomalous reading - not included on graph



Dashed line: Response zone in Made Ground
Dotted line: Response zone in Superficial Deposits
Solid line: Response zone in Chester Formation bedrock

Project Name: Factory Theatre		
Report Title: Foundation Works Risk Assessment		
Figure Title: Groundwater Data Summary		
Date: September 2016	Job No: 034933	Enclosure 4

BUROHAPPOLD
ENGINEERING

Appendix E – Chemical Results

Soil Results Summary

Number of samples exceeding	Residential with Uptake	12
	Residential without Uptake	11
	Commercial	0

No. samples exceeding

Residential with uptake	Residential without Uptake	Commercial
1	1	
6	3	
1	1	
7	7	
2	2	
2	2	
1		
6	5	
6	5	
6	6	
1	1	
7	7	

No Tests	No <LOD	Min	Max	Location of Maximum
20	13	0.50	1.50	HTP12 0.8mbgl
20		1.90	49.00	HTP11 1mbgl
20	2	0.50	2.00	MTP03 0.9mbgl
20	3	0.21	1.15	HTP11 1mbgl
20		7.96	45.00	MTP04 0.5mbgl
14		0.30	0.30	MTP05 2.5mbgl
20		8.00	735.10	HTP11 1mbgl
20		17.30	577.20	HTP12 0.8mbgl
14	9	0.33	1.92	HTP12 0.8mbgl
6		0.50	0.52	BH05 1mbgl
20		7.05	52.20	MTP04 0.5mbgl
20	3	0.50	1.10	MTP03 0.5mbgl
20		38.61	358.10	WS9 2mbgl
20		15.00	1920.00	HTP11 1mbgl
19	19			
19	19			
19	18	0.01	0.01	MTP05 2.5mbgl
19	18	0.06	0.06	MTP05 2.5mbgl
19	19			
17	17			
20	20			
20	7	0.09	3.78	WS9 2mbgl
20	10	0.08	1.43	MTP03 0.5mbgl
20	6	0.09	6.20	HTP11 1mbgl
20	7	0.09	4.06	MTP03 0.5mbgl
20	3	0.10	33.50	HTP11 1mbgl
20	3	0.09	8.57	HTP11 1mbgl
20	2	0.10	52.60	HTP11 1mbgl
20	2	0.10	45.90	HTP11 1mbgl
20	6	0.09	27.70	HTP11 1mbgl
20	6	0.09	22.90	HTP11 1mbgl
20	4	0.10	25.70	HTP11 1mbgl
20	5	0.09	8.57	HTP11 1mbgl
20	5	0.09	23.00	HTP11 1mbgl
20	5	0.09	16.60	HTP11 1mbgl
20	7	0.09	3.10	HTP11 1mbgl
20	5	0.09	10.80	HTP11 1mbgl
20	10	1.57	287.82	HTP11 1mbgl
2	2			
2	2			
14	6	1.20	29.20	WS9 3.3mbgl
14	7	2.00	67.20	WS9 3.3mbgl
14	4	2.00	199.00	WS9 3.3mbgl
14	3	2.49	108.80	WS9 3.3mbgl
14	2	11.20	396.00	BH04 0.2mbgl
8	3	102.00	496.00	WS9 3.3mbgl
8	8			
8	7	5.74	5.74	WS9 2mbgl
8	3	7.90	23.40	WS9 3.3mbgl
8	3	13.00	136.00	MTP05 1mbgl
8	3	25.00	286.00	MTP05 1mbgl
8	3	89.50	443.00	MTP05 1mbgl
20		15.00	1920.00	HTP11 1mbgl

calculated SOM

8.178 Project: Factory Theatre

SOM used for threshold

1% Project Number034933

Date:

Aug-2018

N/A = no screening criteria available

Screening criteria: C4SL/S4UL

		Residential with	Residential with	Commercial
Cyanide	mg/kg	4.6	760	16000
Arsenic	mg/kg	37	40	640
Barium	mg/kg	N/A	N/A	N/A
Beryllium	mg/kg	1.7	1.7	12
Boron	mg/kg	290	11000	240000
Cadmium	mg/kg	26	149	410
Chromium	mg/kg	910	910	8600
Chromium VI	mg/kg	21	21	49
Copper	mg/kg	2400	7100	68000
Lead	mg/kg	200	310	2330
Mercury (elemental)	mg/kg	1.2	1.2	58
Mercury (inorganic)	mg/kg	40	56	58
Nickel	mg/kg	130	180	980
Selenium	mg/kg	250	430	12000
Vanadium	mg/kg	410	1200	9000
Zinc	mg/kg	3700	40000	730000
TPH	mg/kg	490	490	38000
Benzene	mg/kg	0.087	0.38	27
Toluene	mg/kg	130	869	869
Ethyl Benzene	mg/kg	47	83	518
m/p Xylenes	mg/kg	56	79	576
o Xylenes	mg/kg	60	88	478
Xylenes	mg/kg	56	79	576
MTBE	mg/kg	N/A	N/A	N/A
Naphthalene	mg/kg	2.3	2.3	190
Acenaphthylene	mg/kg	170	2900	83000
Acenaphthene	mg/kg	210	3000	84000
Fluorene	mg/kg	170	2800	63000
Phenanthrene	mg/kg	95	1300	22000
Anthracene	mg/kg	2400	31000	520000
Fluoranthene	mg/kg	280	1500	23000
Pyrene	mg/kg	620	3700	54000
Benzo[a]anthracene	mg/kg	7.2	11	170
Chrysene	mg/kg	15	30	350
Benzo[b]fluoranthene	mg/kg	2.6	3.9	44
Benzo[k]fluoranthene	mg/kg	77	110	1200
Benzo[a]pyrene	mg/kg	2.2	3.2	35
Indeno[123-cd]pyrene	mg/kg	27	45	500
Dibenzo[ah]anthracene	mg/kg	0.24	0.31	3.5
Benzo[ghi]perylene	mg/kg	320	360	3900
Total USEPA 16 PAHs	mg/kg	N/A	N/A	N/A
Aliphatic C5 - C7	mg/kg	42	42	3200
Aliphatic C7 - C8	mg/kg	100	100	7800
Aliphatic C8 - C10	mg/kg	27	27	2000
Aliphatic C10 - C12	mg/kg	130	130	9700
Aliphatic C12 - C16	mg/kg	1100	1100	59000
Aliphatic C16 - C21	mg/kg	65000	65000	1600000
Aliphatic C21 - C35	mg/kg	65000	64000	1600000
Total Aliphatic	mg/kg	N/A	N/A	N/A
Aromatic C5 - C7	mg/kg	70	370	26000
Aromatic C7 - C8	mg/kg	130	860	56000
Aromatic C8 - C10	mg/kg	34	47	3500
Aromatic C10 - C12	mg/kg	74	250	16000
Aromatic C12 - C16	mg/kg	140	1800	36000
Aromatic C16 - C21	mg/kg	260	1900	28000
Aromatic C21 - C35	mg/kg	1100	1900	28000
Total Aromatic	mg/kg	1100	1900	28000
Total Aliphatic and Aromatic	mg/kg	490	490	38000

	MG / NG	MG	NG	MG	MG	MG	MG	MG	MG	MG	NG	MG	NG	MG	MG	MG	MG	MG	MG	MG	MG
	Sample ID	MTP05	MTP05	MTP03	MTP03	MTP04	BH01	WS1	WS6	WS7	WS8	WS9	WS9	HTP12	HTP11	BH04	BH04	BH05	BH05	TP01	TP01
	Depth	1	2.5	0.5	0.9	0.5	2.1	0.5	0.5	1.1	1.2	2	3.3	0.8	1	0.2	1	1	3	0	0.8
	Units																				
pH	pH units	7.6	7.6	8.6	8.5	8.7	8.5	11.8	11.1	9.3	8.3	7.7	7.8	8.5	8.1	8.8	8.4	8.6	8.6	9.8	8.8
SOM	%	8.59	1.24	21.8	14.9	17	25.9	0.72	0.31	2.44	2.58	4	0.9	25.9	25.2	1.75	1.41	5.41	0.64	2.2	0.67
Moisture	%	23.3	15.6	9.4	17.9	22.8	16.1	15.4	9.9	3.1	22.5	24.8	8.3	21.9	12.8	5.6	19	22.1	12.1	6.2	22
TOC	%	4.98	0.72	12.7	8.7	9.8	15	0.42	0.18	1.41	1.5	2.32	0.53	15	14.6	1.01	0.82	3.14	0.37	1.28	0.39
Asbestos Screen	D/ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Asbestos Quantification	%																				
Cyanide	mg/kg	<0.7	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.5	<0.6	<0.7	<0.6	1.5	<0.5	0.53	0.6	0.6	0.57	0.5	0.6
Arsenic	mg/kg	13	8.1	24.4	28.5	29.8	15	2.5	1.9	6.3	9.7	12.5	9.8	31.8	49	3	6.8	14.8	4.72	4.3	11.6
Barium	mg/kg																				
Beryllium	mg/kg																				
Boron	mg/kg	1.4	1.2	0.8	2	0.9	1.4	0.5	<0.5	<0.5	0.8	1	0.6	1.5	1.4	0.51	0.5	0.5	0.51	0.5	0.5
Cadmium	mg/kg	<0.21	<0.2	0.84	0.24	0.48	0.77	0.74	0.44	0.53	<0.2	0.89	0.22	0.42	1.15	0.582	0.21	0.4	0.205	0.54	0.25
Chromium	mg/kg	19.4	19.2	18	19.4	45	14.8	20.4	22.1	11.8	24.4	28.1	22.3	18.2	18.2	7.96	16	13	19.1	12.6	16.3
Chromium VI	mg/kg	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1						
Copper	mg/kg	124.8	27	133.4	68.4	108.4	69	10.1	8	38.9	29	130.4	24.7	249	735.1	15	16.9	44	15.81	26.1	18.1
Lead	mg/kg	127	24.9	253.8	169.1	267.7	178.1	39	21.3	99	318	359.7	32.4	577.2	235.1	187.59	39.7	140.4	20	40.4	17.3
Mercury (elemental)	mg/kg	<0.53	<0.53	0.65	0.64	0.73	<0.50	<0.5	<0.5	<0.5	<0.5	<0.53	<0.5	1.92	0.33						
Mercury (inorganic)	mg/kg															0.51	0.5	0.52	0.51	0.5	0.5
Nickel	mg/kg	23.9	15.4	42.1	33	52.2	32.5	16.7	18.3	9.6	15.3	23.5	25.3	36.4	46	7.05	10.9	17.5	19.1	12.4	16
Selenium	mg/kg	0.8	1	1.1	1	1	1.1	<0.5	<0.5	0.7	0.8	0.8	<0.5	0.6	1	0.51	0.5	0.6	0.51	0.5	0.7
Vanadium	mg/kg																				
Zinc	mg/kg	80	43	219.6	89.4	167.5	293.7	57	41.9	160.5	77.9	358.1	61.7	177	340.4	42.38	46.9	72.4	38.61	43.8	77.6
TPH	mg/kg	915	704	1140	74	109	411	22	16	513	15	315	561	387	1920	576	20	58	40	339	17
Benzene	mg/kg	<0.013	<0.013	<0.011	<0.012	<0.013	<0.012	<0.012	<0.011	<0.01	<0.013	<0.013		<10	<10	<0.011	<0.012	<0.013	<0.011	<0.011	<0.013
Toluene	mg/kg	<0.013	<0.013	<0.011	<0.012	<0.013	<0.012	<0.012	<0.011	<0.01	<0.013	<0.013		<10	<10	<0.011	<0.012	<0.013	<0.011	<0.011	<0.013
Ethyl Benzene	mg/kg	<0.013	0.01	<0.011	<0.012	<0.013	<0.012	<0.012	<0.011	<0.01	<0.013	<0.013		<10	<10	<0.011	<0.012	<0.013	<0.011	<0.011	<0.013
m/p Xylenes	mg/kg	<0.013	0.057	<0.023	<0.024	<0.026	<0.024	<0.024	<0.022	<0.021	<0.026	<0.027		<20	<20	<0.021	<0.025	<0.026	<0.023	<0.021	<0.026
o Xylenes	mg/kg	<0.013	<0.013	<0.011	<0.012	<0.013	<0.012	<0.012	<0.011	<0.01	<0.013	<0.013		<10	<10	<0.011	<0.012	<0.013	<0.011	<0.011	<0.013
Xylenes	mg/kg			<0.034	<0.037	<0.039	<0.036	<0.035	<0.033	<0.031	<0.039	<0.04		<30	<30	<0.032	<0.037	<0.039	<0.034	<0.032	<0.038
MTBE	mg/kg	<0.026	<0.025	<0.023	<0.024	<0.026	<0.024	<0.024	<0.022	<0.021	<0.026	<0.027	<0.022	<20	<20	<0.021	<0.025	<0.026	<0.023	<0.021	<0.026
Naphthalene	mg/kg	0.22	<0.10	2.81	<0.10	<0.10	<0.10	<0.09	<0.09	0.7	<0.10	3.78	0.36	1.11	0.87	1.29	0.1	0.1	0.09	1.51	0.1
Acenaphthylene	mg/kg	<0.10	<0.10	1.43	<0.10	<0.10	<0.10	<0.09	<0.09	0.12	<0.10	<0.11	<0.09	0.43	0.32	0.08	0.1	0.1	0.09	0.09	0.1
Acenaphthene	mg/kg	1.51	1.4	2.59	<0.10	<0.10	<0.10	<0.09	<0.09	1.31	<0.10	0.15	1.62	0.74	6.2	1.37	0.1	0.1	0.09	1.34	0.1
Fluorene	mg/kg	1.92	1	4.06	<0.10	<0.10	<0.10	<0.09	<0.09	1.5	<0.10	<0.11	0.41	0.82	3.58	1.21	0.1	0.1	0.09	1.06	0.1
Phenanthrene	mg/kg	10.9	5.38	29.6	0.3	0.58	1.11	<0.09	<0.09	11.2	<0.10	1.81	0.53	8.29	33.5	7.87	0.1	0.19	0.13	7.47	0.1
Anthracene	mg/kg	0.8	0.68	7.21	0.11	0.19	0.3	<0.09	<0.09	2.78	<0.10	0.43	0.38	2.01	8.57	2.55	0.1	0.1	0.09	1.74	0.1
Fluoranthene	mg/kg	4.26	2.75	24.2	0.76	0.87	1.13	<0.09	<0.09	9.93	0.1	1.22	1.81	9.44	52.6	8.39	0.1	0.3	0.13	6.71	0.1
Pyrene	mg/kg	2.82	2.08	24.5	1.01	1.05	1.3	<0.09	<0.09	9.55	0.1	1.14	3.16	9.68	45.9	7.87	0.1	0.28	0.13	6.2	0.1
Benzo[a]anthracene	mg/kg	<0.10	0.37	12.7	0.6	0.8	<0.10	<0.09	<0.09	5.31	<0.10	0.65	<0.09	5.68	27.7	3.67	0.1	0.17	0.09	2.91	0.1
Chrysene	mg/kg	<0.10	0.28	9.9	0.54	0.71	<0.10	<0.09	<0.09	4.53	<0.10	0.6	<0.09	4.4	22.9	4.05	0.1	0.18	0.09	3.25	0.1
Benzo[b]fluoranthene	mg/kg	0.12	<0.10	12.3	0.82	1.2	1.13	<0.09	<0.09	4.94	<0.10	0.9	0.26	5.1	25.7	4.06	0.1	0.21	0.1	3.06	0.1
Benzo[k]fluoranthene	mg/kg	<0.10	<0.10	3.62	0.35	0.49	0.43	<0.09	<0.09	1.52	<0.10	0.36	0.1	1.76	8.57	1.61	0.1	0.1	0.09	1.11	0.1
Benzo[a]pyrene	mg/kg	<0.10	<0.10	10.4	0.76	1.05	0.97	<0.09	<0.09	4.5	<0.10	0.85	0.21	5.35	23	3.65	0.1	0.17	0.09	2.62	0.1
Indeno[123-cd]pyrene	mg/kg	<0.10	<0.10	7.1	0.6	0.9	0.77	<0.09	<0.09	3.04	<0.10	0.92	0.1	2.98	16.6	2.57	0.1	0.1	0.09	1.73	0.1
Dibenzo[ah]anthracene	mg/kg	<0.10	<0.10	1.68	<0.10	0.16	0.17	<0.09	<0.09	0.73	<0.10	0.15	<0.09	0.64	3.1	0.58	0.1	0.1	0.09	0.41	0.1
Benzo[ghi]perylene	mg/kg	<0.10	<0.10	5.58	0.52	0.88	0.7	<0.09	<0.09	2.4	<0.10	0.92	0.1	2.15	10.8	2.2	0.1	0.12	0.09	1.57	0.1
Total USEPA 16 PAHs	mg/kg	<23.38	<14.76	159.67	<6.86	<9.27	<8.59	<1.51	<1.42	64.12	<1.70	<14.08	<9.42	60.15	287.82	53.05	1.58	2.41	1.57	42.8	1.64
Aliphatic C5 - C7	mg/kg	<0.3	<0.3																		
Aliphatic C7 - C8	mg/kg	<0.3	<0.3																		
Aliphatic C8 - C10	mg/kg	<5	1.2					<5	<4	<4	<5.21	<5	29.2			2	2	3	2	2	3
Aliphatic C10 - C12	mg/kg	<5	<5					<5	<4	<4	<5.21	<5	67.2			3.13	2	3	2	3.25	3
Aliphatic C12 - C16	mg/kg	27.2	29					<5	<4	10	<5.21	<5	199			21	2	4.44	2	17.5	3
Aliphatic C16 - C21	mg/kg	104.7	107.5					<5	<4	23	<5.21	31	108.8			77.1	2.49	14	5.42	66	3
Aliphatic C21 - C35	mg/kg	233	157					11.2	<9.72	88.2	<11.42	68.4	88.9			396	14.6	35.7	30.4	232	11.8
Total Aliphatic	mg/kg	369	297					<24	<22	128	<26.1	102	496								
Aromatic C5 - C7	mg/kg																				
Aromatic C7 - C8	mg/kg																				
Aromatic C8 - C10	mg/kg	<5	<5					<5	<4	<4	<5	<5	<4					</			

The Factory, Manchester : Leachate contamination testing results assessment

		Sample Identity	MTP03	MTP05	WS09	HTP 12	HTP11	BH04	BH04	BH05	BH05	TP01	TP01	Minimum values	Maximum values	UK Drinking Water Standards (The Water Supply (Water Quality) Regulations 2000	Other Thresholds
			Depth	1.00	3.30	0.80	1.00	0.20	1.00	1.00	3.00	0.00	0.80				
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL				
			Material	MG	MG	SAND	MG	MG	MG	MG	MG	MG	MG				
Determinand	Method	Units															
Metals																	
Arsenic		µg/l	5	3	<1	4	2	1	1	1	1	1	1	1	5	10	50 ⁽¹⁾
Cadmium		µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5	-
Chromium		µg/l	12	1	<1	<1	<1	6	1	1	1	9	1	1	12	50	5 ⁽¹⁾
Copper		µg/l	7	15	30	13	3	15	5	2	3	8	2	2	30	2000	1 ⁽¹⁾
Lead		µg/l	1	11	<1	18	<1	1	3	2	1	1	1	1	18	25	4 ⁽¹⁾
Mercury		µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1	1 ⁽¹⁾
Nickel		µg/l	<1	1	<1	1	1	1	1	1	1	2	5	1	5	20	50 ⁽¹⁾
Selenium		µg/l	1	1	<1	1	<1	2	1	1	1	2	1	1	2	10	-
Zinc		µg/l	34	107	66	12	4	4	61	43	24	9	90	4	107	3000 **	8 ⁽¹⁾
Barium		µg/l	130	170	130	20	20	50	70	70	60	60	<10	20	170	100 **	-
Antimony		µg/l	13	2	1	1	4	<1	<1	<1	<1	<1	<1	1	13	5	-
Molybdenum		µg/l	70	6	4	16	11	60	1	38	29	65	1	1	70	-	-
Boron (w)		µg/l														1000	2000 ⁽¹⁾
Other Determinands																	
Sulphate as SO4		mg/l	77.3	78.9	542	73	134	62	34	14	12	67	16	12	542	250	400 *
Phenol Index		mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.28	<0.05	0.28	0.28	1 **	30 *
pH (pH Units)		pH units	7.8	7.7	7.6	7.5	7.4	9.3	7.8	7.6	7.6	10.4	7.9	7.4	10.4	-	6<pH<9 ⁽¹⁾
Cyanide (total) (w)		µg/l														50	-
Sulphide (w)		µg/l														-	-
Petroluem Hydrocarbons																	
TPH (C10-C40)		µg/l	30	250										30	250	-	-
Polycyclic Aromatic Hydrocarbons																	
Naphthalene		µg/l	0.051	<0.02										0.051	0.051	-	10 ⁽¹⁾
Acenaphthylene		µg/l	<0.01	0.127										0.127	0.127	-	-
Acenaphthene		µg/l	0.036	0.322										0.036	0.322	-	-
Fluorene		µg/l	<0.01	0.027										0.027	0.027	-	-
Phenanthrene		µg/l	0.035	0.062										0.035	0.062	-	-
Anthracene		µg/l	<0.01	0.06										0.06	0.06	-	-
Fluoranthene		µg/l	0.024	0.273										0.024	0.273	-	-
Pyrene		µg/l	0.018	0.16										0.018	0.16	-	-
Benzo [a] anthracene		µg/l	0.017	0.055										0.017	0.055	-	-
Chrysene		µg/l	<0.01	0.045										0.045	0.045	-	-
Benzo [a] pyrene		µg/l	0.01	0.014										0.01	0.014	0.01	-
Dibenzo [ah] anthracene		µg/l	0.01	<0.01										0.01	0.01	-	-
Benzo [b] fluoranthene		µg/l	0.015	0.025										0.015	0.025	-	-
Benzo [k] fluoranthene		µg/l	<0.01	<0.01										0	0	-	-
Indeno [123-cd] pyrene		µg/l	0.01	<0.01										0.01	0.01	-	-
Benzo [ghi] perylene		µg/l	0.014	<0.01										0.014	0.014	-	-
Total PAH		µg/l	<0.29	<1.23										0	0	-	10 ⁽¹⁾
Classification Tests																	
Total Dissolved Solids		mg/l	306	367	787	308	415	200	300	300	300	300	200	200	787	-	400000 ⁽²⁾
Dissolved Organic Carbon		mg/l	9.9	22	10	2.5	2.8	12	20	4.9	4.8	6.7	6.4	2.5	22	-	50000 ⁽²⁾
Conductivity (µS/cm)		µS/cm	392	471	1010	395	532	300	400	300	300	400	300	300	1010	2500	-
Chloride		mg/l	8	32	26	5	6	14	9	32	33	40	5	5	40	250	-
Fluoride		mg/l	2	0.4	0.5	0.5	0.7	0.4	0.1	0.7	0.7	0.3	0.1	0.1	2	1.5	-

Between criteria - No further consideration

GENERAL NOTES:

(1) Freshwater Environmental Quality Standard. For hardness-related determinands, worse-case hardness band adopted 0 - 50 mg/l CaCO3

(2) Based on Environment Agency 'Guidance on Sampling and Testing of Wastes to meet Landfill Acceptance Procedures' (2005, version 1) Inert waste criteria.

*EA non-statutory

(operational)

**From The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 (DW-1)

2:1 Leachate results used

Project name	The Factory, Manchester
Report title	Foundation Works Risk Assessment
Table title	Contamination End Use Assessment - Leachate results
Date: September 2018	Job No: 034933

The Factory, Manchester : Groundwater contamination testing results assessment

		Sample Identity		Minimum values	Maximum values	UK Drinking Water Standards (The Water Supply (Water Quality) Regulations 2000	Other Thresholds
		Depth					
		Sample Type					
		Sampling Date					
Determinand	Method	Units					
Metals							
Arsenic		µg/l	<1	1	1	10	50 ⁽¹⁾
Cadmium		µg/l	0.1	<0.1	0.1	5	-
Chromium		µg/l	<1	9	9	50	5 ⁽¹⁾
Copper		µg/l	9	3	3	2000	1 ⁽¹⁾
Lead		µg/l	4	<1	4	25	4 ⁽¹⁾
Mercury		µg/l	<0.1	0.6	0.6	1	1 ⁽¹⁾
Nickel		µg/l	3	12	3	20	50 ⁽¹⁾
Selenium		µg/l	<1	2	2	10	-
Zinc		µg/l	22	3	3	3000 **	8 ⁽¹⁾
Barium		µg/l				100 **	-
Antimony		µg/l	<1	1	1	5	-
Molybdenum		µg/l				-	-
Boron (w)		µg/l	20	20	20	1000	2000 ⁽¹⁾
Other Determinands							
Sulphate as SO4		µg/l	23100	56000	23100	250000	400000 *
Phenol Index		µg/l	<0.5	0.9	0.9	1 **	30 *
pH (pH Units)		pH units	7.2	7.4	7.2	-	6<pH<9 ⁽¹⁾
Cyanide (total) (w)		µg/l	<20	<20		50	-
Sulphide (w)		µg/l	<20	<0.02		-	-
Petroleum Hydrocarbons							
TPH (C10-C40)		µg/l	590	14000	590	-	-
Polycyclic Aromatic Hydrocarbons							
Naphthalene		µg/l	<0.02	<0.400	0	-	10 ⁽¹⁾
Acenaphthylene		µg/l	<0.01	<0.200	0	-	-
Acenaphthene		µg/l	0.057	<0.200	0.057	-	-
Fluorene		µg/l	0.019	<0.200	0.019	-	-
Phenanthrene		µg/l	0.155	<0.200	0.155	-	-
Anthracene		µg/l	0.032	<0.200	0.032	-	-
Fluoranthene		µg/l	0.334	<0.200	0.334	-	-
Pyrene		µg/l	0.326	<0.200	0.326	-	-
Benzo [a] anthracene		µg/l	0.164	<0.200	0.164	-	-
Chrysene		µg/l	0.225	<0.200	0.225	-	-
Benzo [a] pyrene		µg/l	0.178	<0.200	0.178	0.01	-
Dibenzo [ah] anthracene		µg/l	0.033	<0.200	0.033	-	-
Benzo [b] fluoranthene		µg/l	0.243	<0.200	0.243	-	-
Benzo [k] fluoranthene		µg/l	0.086	<0.200	0.086	-	-
Indeno [123-cd] pyrene		µg/l	0.137	<0.200	0.137	-	-
Benzo [ghi] perylene		µg/l	0.13	<0.200	0.13	-	-
Total PAH		µg/l	<2.149	<3.400	0	-	10 ⁽¹⁾
Classification Tests							
Total Dissolved Solids		mg/l			0	-	400000 ⁽²⁾
Dissolved Organic Carbon		mg/l	11	65	11	-	50000 ⁽²⁾
Conductivity (µS/cm)		µS/cm	249	500	249	2500	-
Chloride		mg/l	10	42	10	250	-
Fluoride		mg/l	0.1	0.4	0.1	1.5	-

Between criteria - No further consideration

GENERAL NOTES:
(1) Freshwater Environmental Quality Standard. For hardness-related determinands, worse-case hardness band adopted 0 - 50 mg/l CaCO3
(2) Based on Environment Agency 'Guidance on Sampling and Testing of Wastes to meet Landfill Acceptance Procedures' (2005, version 1) Inert waste criteria.
*EA non-statutory (operational)
**From The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 (DW-1)

Project name	The Factory, Manchester
Report title	Foundation Works Risk Assessment
Table title	Contamination End Use Assessment - Groundwater results
Date: September 2018	Job No: 034933

Appendix F – Ground Gas Monitoring Results

GUIDANCE:

Assessment based on guidance published in CIRIA C665 (2007) 'Assessing risks posed by hazardous ground gases to buildings.'

Information from Table 8.5 of CIRIA C665

Characteristic Situation 1 conditions

Gas screening value (CH4 or CO2) < 0.07 l/h

Typically methane < 1 % by volume

Typically carbon dioxide < 5% by volume

Characteristic Situation 2 conditions

Gas screening value (CH4 or CO2) < 0.7 l/h

Borehole air flow rate < 70 l/h

Characteristic Situation 3 conditions

Gas screening value (CH4 or CO2) < 3.5 l/h

Key for shading

	CO ₂ > 5% in air
	CH ₄ > 1 % in air
	Gas screening value > or = 0.07 l/h
	Gas screening value > or = 0.7 l/h

NOTES:

Maximum concentration and flow values are assessed below, using peak values for CO2 % (minimum values for oxygen).

Where no detectable flow is recorded the limit of detection of the instrument is used, following Note 5 of Table 8.5. CIRIA C665

Exploratory Hole	Location	Installation response zone stratum	Depth range (m BGL)	Monitored by	Date	Gas measurements						CO ₂ analysis		CH ₄ analysis		Characteristic
						Flow Rate (l/hr)	Atmos Pres (mb)	O ₂ (%) air	CO ₂ (%) air	CH ₄ (%) air	H ₂ S (ppm)	CO ₂ as fraction	Gas screening value CO ₂ (l/hr)	CH ₄ as fraction	Gas screening value CH ₄ (l/hr)	Situation
BH01 (50 mm)		SAND	2.00 - 4.00	ESG	28.7.16	No Data - damage to installation						No Data - damage to installation				
					11.8.16											
					25.8.16											
					22.9.16	No Access (parked vehicles)						No Access (parked vehicles)				
					27.9.16	0.1	1008	20.9	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					20.10.16	0.0	1021	20.1	0.2	0.0	0.0	0.002	0.000	0.000	0.000	1
BH02 (50 mm)		MG	1.00 - 1.50	ESG	28.7.16	0.0	1008	20.8	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					11.8.16	0.0	1017	20.9	0.2	0.0	0.0	0.002	0.000	0.000	0.000	1
					25.8.16	0.0	1014	20.8	0.1	0.0	0.0	0.001	0.000	0.000	0.000	1
					22.9.16	No Access (parked vehicles)						No Access (parked vehicles)				
					27.9.16	0.0	1008	20.2	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					20.10.16	0.0	1020	20.7	0.1	0.0	0.0	0.001	0.000	0.000	0.000	1
BH03 (50 mm)		MG	1.50 - 3.00	ESG	28.7.16	0.0	1008	21.2	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					11.8.16	No Data						No Data				
					25.8.16	0.0	1014	21.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					22.9.16	0.0	1015	20.6	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					27.9.16	0.0	1008	20.6	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					20.10.16	0.0	1021	20.5	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
BH04	NR Investigation	Sand / Gravel / Clay	1.00 - 3.00	ESG	2.2.17	No Data						No Data				
					8.3.17	0	1011	21.1	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					14.3.17	0.0	1030	21.4	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					22.3.17	0.0	1004	6.1	3.7	0.0	0.0	0.037	0.004	0.000	0.000	1
					30.3.17	0.0	1014	19.0	0.1	0.0	0.0	0.001	0.000	0.000	0.000	1
BH05	NR Investigation	Sandstone	4.00 - 10.00	ESG	2.2.17	0.1	985	21.4	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					8.3.17	0	1011	21.1	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					14.3.17	0	1030	21.3	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					22.3.17	0.0	1004	21.6	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					30.3.17	0.0	1014	21.2	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
												0.000	0.000	0.000	0.000	1
WS02		MG	1.00 - 2.00	ESG	28.7.16	0.1	1008	20.0	0.3	0.0	0.0	0.003	0.000	0.000	0.000	1
					11.8.16	0.0	1017	21.2	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					25.8.16	0.0	1014	21.1	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					22.9.16	No Access (parked vehicles)						No Access (parked vehicles)				
					27.9.16	-0.1	1008	20.8	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
WS06		MG	1.00 - 2.00	ESG	20.10.16	0.0	1020	20.7	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					28.7.16	0.1	1008	19.7	0.6	0.0	0.0	0.006	0.001	0.000	0.000	1
					11.8.16	0.0	1017	20.9	0.1	0.0	0.0	0.001	0.000	0.000	0.000	1
					25.8.16	0.1	1014	19.7	0.8	0.0	0.0	0.008	0.001	0.000	0.000	1
					22.9.16	0.0	1015	19.6	1.1	0.0	0.0	0.011	0.001	0.000	0.000	1
					27.9.16	0.0	1008	20.9	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
WS08		SAND	2.00 - 3.50	ESG	20.10.16	0.0	10212	20.2	0.2	0.0	0.0	0.002	0.000	0.000	0.000	1
					28.7.16	0.0	1008	20.7	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					11.8.16	0.0	1017	21.1	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					25.8.16	0.0	1014	21.2	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					22.9.16	0.0	1015	20.7	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					27.9.16	0.0	1008	20.8	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					20.10.16	0.0	1021	20.6	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1
					Max reading	0.1	10212	21.6	3.7	0.0	0.0	0.037	0.004	0.000	0.000	1
					Min reading	-0.1	985	6.1	0.0	0.0	0.0	0.000	0.000	0.000	0.000	1

Appendix G – pH and Sulphate Assessment

Job Name: Factory Theatre

	Location	Depth (mBGL)	Material	SO4 (2:1 extract) mg/l	SO4 (2:1 extract) g/l	pH
SOIL	MTP03	0.50	MG	90	0.090	8.6
	MTP03	0.90	MG	129	0.129	8.5
	MTP04	0.50	MG	120	0.120	8.7
	BH01	1.00	MG	276	0.276	8.5
	WS1	0.50	MG	56	0.056	11.8
	WS6	0.50	MG	141	0.141	11.1
	WS7	1.10	MG	129	0.129	9.3
	WS8	1.20	CLAY	205	0.205	8.3
	WS9	2.00	MG	265	0.265	7.7
	WS9	3.30	SAND	1260	1.260	7.8
	BH01	3.20	SAND	50	0.050	8.4
	BH01	9.28	SANDSTONE	50	0.050	8.8
	BH01	12.11	SANDSTONE	20	0.020	8.9
	BH02	6.44	SANDSTONE	20	0.020	8.9
	BH02	8.30	SANDSTONE	50	0.050	8.5
	BH03	6.00	SANDSTONE	50	0.050	8.2
	BH03	6.96	SANDSTONE	50	0.050	8.5
	MTP06	0.20	MG	60	0.060	9.2
	MTP06	1.50	CLAY	90	0.090	7.8
	WS02	2.30	SAND	40	0.040	8.2
	WS03A	1.20	MG	790	0.790	9.6
	WS04	2.00	SAND	30	0.030	7.9
	WS05	1.20	MG	130	0.130	8.0
	WS08	0.50	MG	250	0.250	8.5
	WS08	1.20	CLAY	150	0.150	7.7
WATER	BH01	3.00	WATER	23.1	0.023	7.2

MG	Max	790	0.79	11.8
	Min	56	0.056	7.7
Clay	Max	205	0.21	8.3
	Min	90	0.090	7.7
Sand	Max	1260	1.26	8.4
	Min	30	0.030	7.8
Sandstone	Max	50	0.050	8.9
	Min	20	0.020	8.2
TOTAL SOIL	Max	1260	1.260	11.8
	Min	20	0.020	7.7
WATER	Max	23	0.023	7.2
	Min	23	0.023	7.2

Natural Ground				Made Ground					
Design Sulphate Class	SO4 mg/l (2:1 water/soil)	Groundwater (SO4 mg/l)	SO4 %	Design Sulphate Class	SO4 mg/l (2:1 water/soil)	Mg mg/l (soil)	SO4 mg/l (Groundwater)	Mg mg/l (groundwater)	SO4 %
DS1	<500	<400		DS1	<500		<400		<0.24
DS2	500 - 1500	400 - 1400		DS2	500 - 1500		400 - 1400		0.24 - 0.6
DS3	1500 - 3000	1500 - 3000		DS3	1600 - 3000		1500 - 3000		0.7 - 1.2
DS4	3100 - 6000	3100 - 6000		DS4	3100 - 6000	<1200	3100 - 6000	<1000	1.3 - 2.4
DS5	>6000	>6000		DS4m	3100 - 6000	>1200	3100 - 6000	>1000	1.3 - 2.4
				DS5	>6000	<1200	>6000	<1000	>2.4
				DS5m	>6000	>1200	>6000	>1000	>2.4

Project Name: Factory Theatre		
Report Title: Foundation Works Risk Assessment		
Figure Title: pH and Sulphate Classification		
Date: September 2018	Job No: 034933	Enclosure 7

SOIL SULPHATE							
Number of samples	SO4 (2:1 extract) mg/l	Mean of top 20%		Number of samples	pH	Mean of lowest 20%	
1	1260	568	Round to nearest 100 = 600	1	7.7	7.8	
2	790			2	7.7		
3	276			3	7.8		
4	265			4	7.8		
5	250			5	7.9		
6	205			6	8.0		
7	150			7	8.2		
8	141			8	8.2		
9	130			9	8.3		
10	129			10	8.4		
11	129			11	8.5		
12	120			12	8.5		
13	90			13	8.5		
14	90			14	8.5		
15	60			15	8.5		
16	56			16	8.6		
17	50			17	8.7		
18	50			18	8.8		
19	50			19	8.9		
20	50			20	8.9		
21	50			21	9.2		
22	40			22	9.3		
23	30			23	9.6		
24	20			24	11.1		
25	20			25	11.8		
Number of samples	SO4 (2:1 extract) mg/l	Top value		Number of samples	pH	Top value	
1	23.1	23.1	Round to nearest 100 = 0	1	7.2	7.2	

OVERALL CATAGORIZATION=				Sulphate	pH	Class
				600	7.2	DS2-AC2

BUROHAPPOLD
ENGINEERING

Appendix H – Example Piling Records

Form No.

Daily Piling Log Sheet

MAIN CONTRACTOR

CONTRACT ADDRESS

CONCRETE SUPPLIER

CONCRETE MIX

JOB NO

JCE025

MACHINE &
PILE TYPEMP 25 CFA /
RBA
(circle appropriate type)

FOREMAN

DATE

25/07/17

Plot/Block No.	Pile No.	Pile Diameter (mm)	Pile length from PPL (m)	Cage Type	PPL (m OD)	Obstructions/Delays (min)
C	PC182	600	17.11	A1	41.100	
C	PC170	600	17.10	A1	41.100	
C	PC168	600	17.11	A1	41.100	
C	PC180	600	17.11	A1	41.100	
C	PC178	600	17.10	A1	41.100	

DRAWINGS

NUMBER

REV

KAM-BHE-BC-F01-DR-S-0090

C03

JRL CE SCHEDULE

NUMBER

REV

JCE025

A

TOTAL CONCRETE VOLUME

m3

SETTING OUT BY JRL CE

Y / N

AS BUILTS

Y / N

TOTAL PILES THIS SHEET

5

TOTAL PILES TO DATE

5

COMMENTS

	Form No. _____
Daily Piling Log Sheet	

MAIN CONTRACTOR	JOB NO	JCE025
CONTRACT ADDRESS	MACHINE & PILE TYPE	MP 25 CFA / RBA (circle appropriate type)
CONCRETE SUPPLIER	FOREMAN	
CONCRETE MIX	DATE	26/07/17

Plot/Block No.	Pile No.	Pile Diameter (mm)	Pile length from PPL (m)	Cage Type	PPL (m OD)	Obstructions/Delays (min)
C	PC166	600	17.51	A1	41.100	
C	PC164	600	17.10	A1	41.100	
C	PC144	600	17.10	A1	41.100	
C	PC142	600	17.10	A1	41.100	
C	PC117	600	17.10	A1	41.100	
C	PC115	600	17.12	A1	41.100	
C	PC113	600	17.11	A1	41.100	
C	PC094	600	17.11	A1	41.100	
C	PC061	600	17.10	A1	41.100	
C	PC077	600	17.11	A1	41.100	

DRAWINGS	REV
NUMBER	
KAM-BHE-BC-F01-DR-S-0090	C03

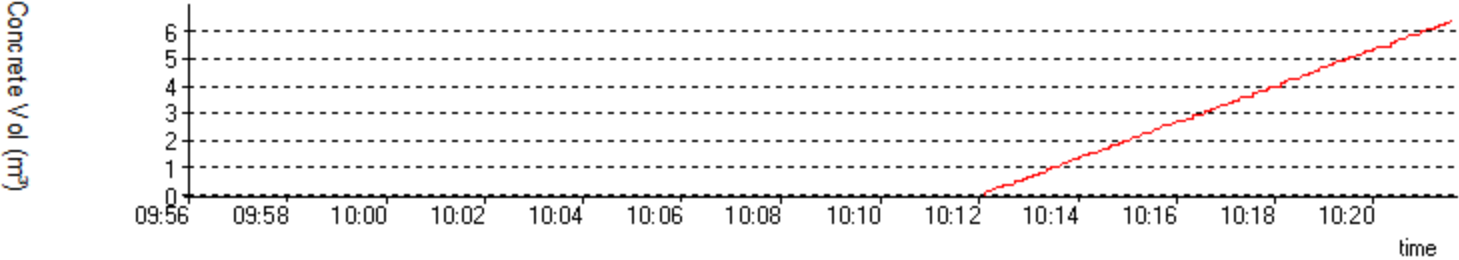
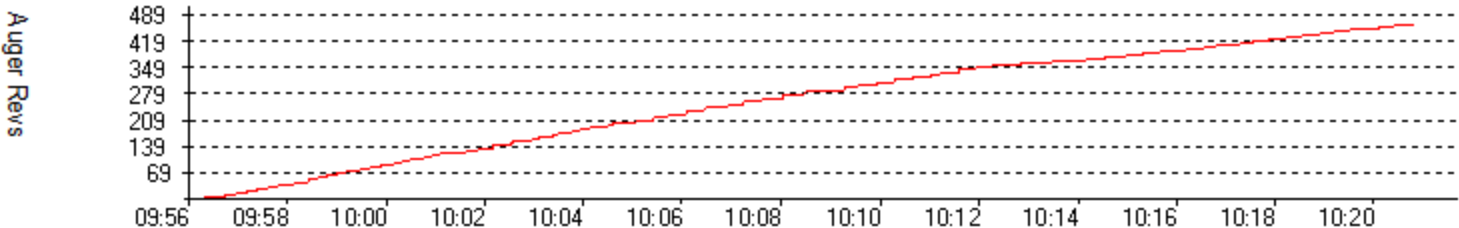
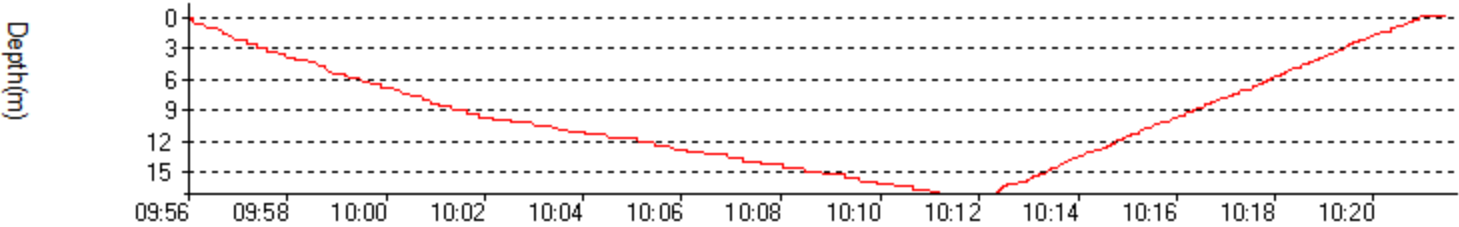
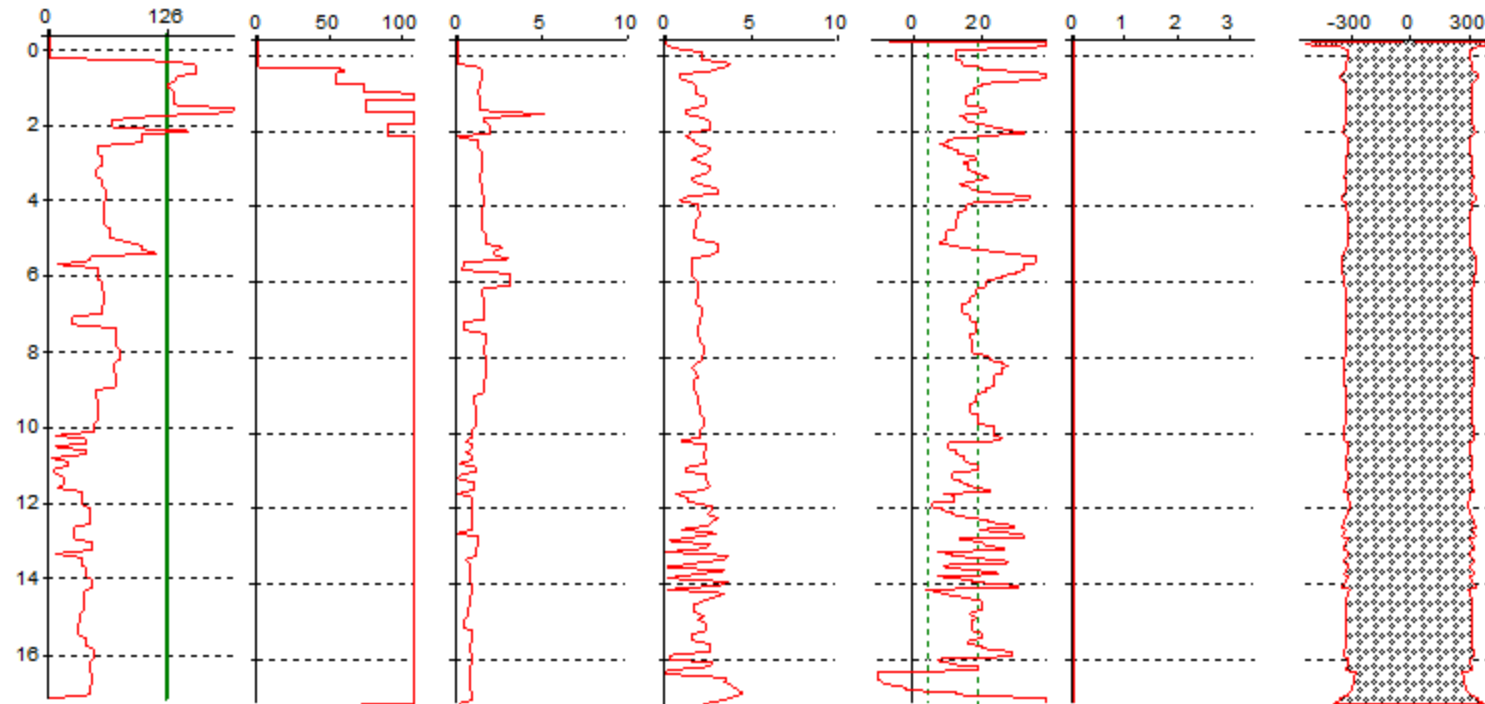
JRL CE SCHEDULE	REV
NUMBER	
JCE025	B
TOTAL CONCRETE VOLUME	m3
	58.5

SETTING OUT BY JRL CE	Y / N
AS BUILT	Y / N
TOTAL PILES THIS SHEET	10
TOTAL PILES TO DATE	15

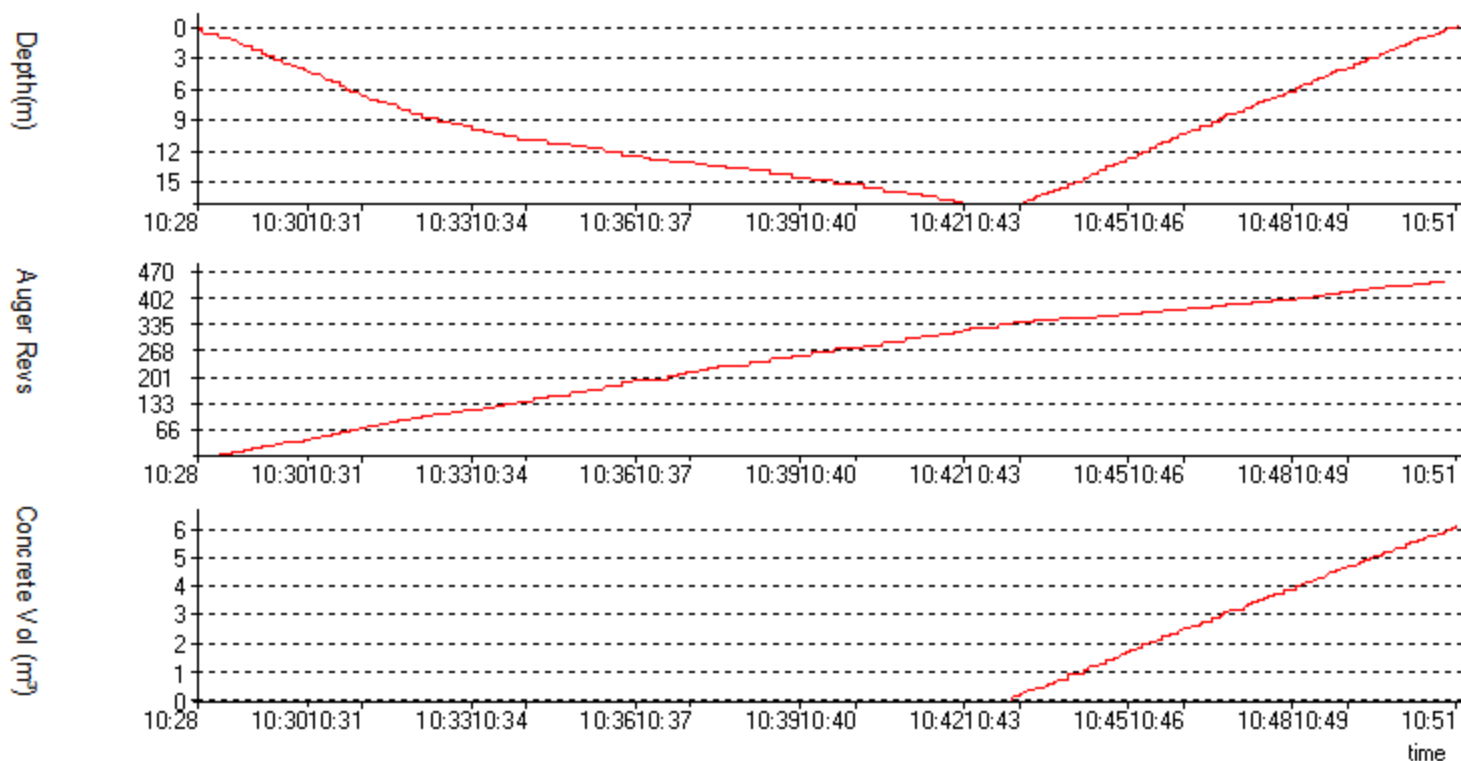
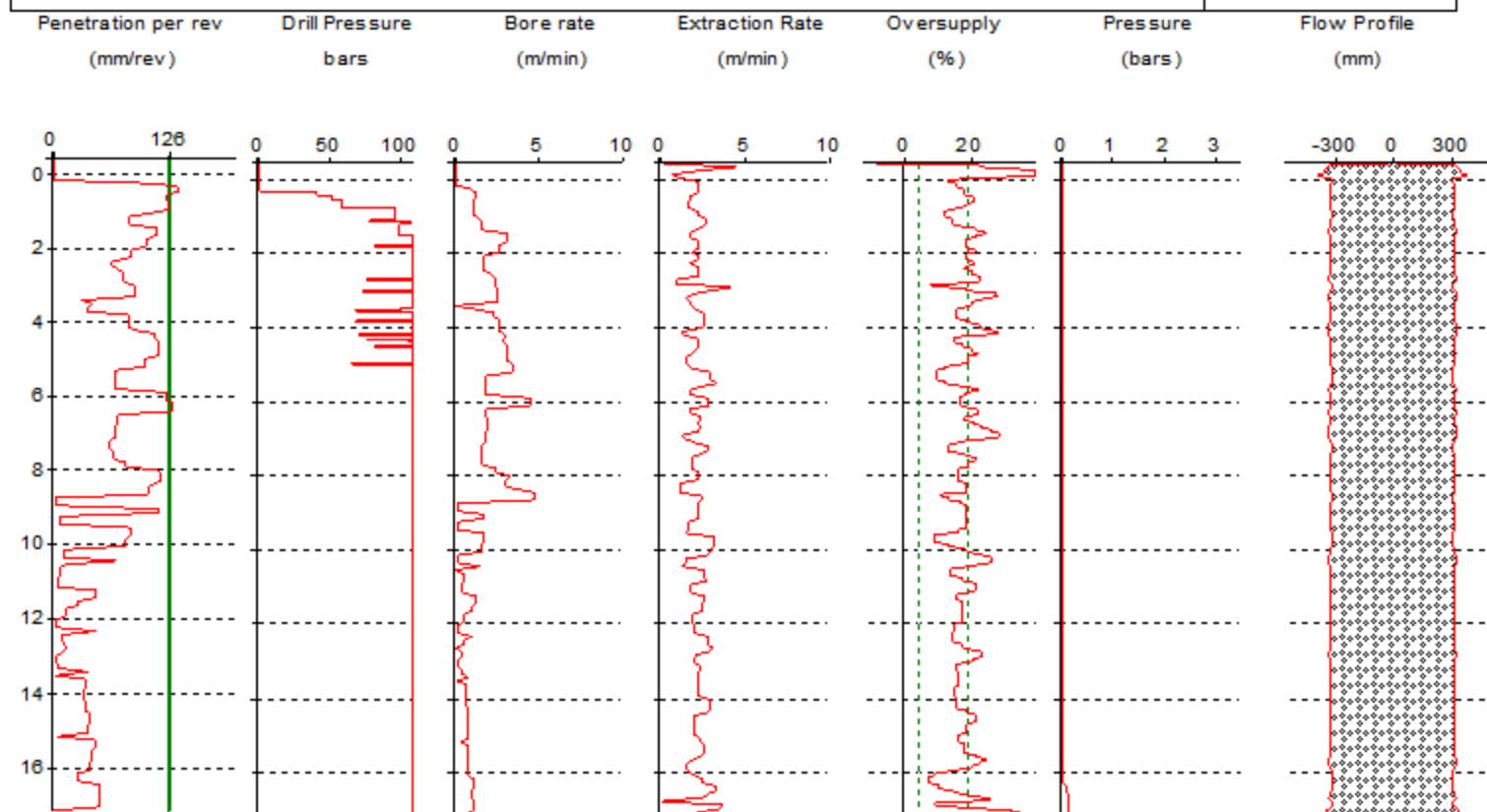
COMMENTS

						PC182 BLOCK C		
Length	17.11 m	Revs	472.1	Vol :	6.47 m	Rig :	JCE25	25/07/2017
600 mm		Energy	0 MJ	Excess :	33.77 %	Operator :	NICL	
5 inch NUB								

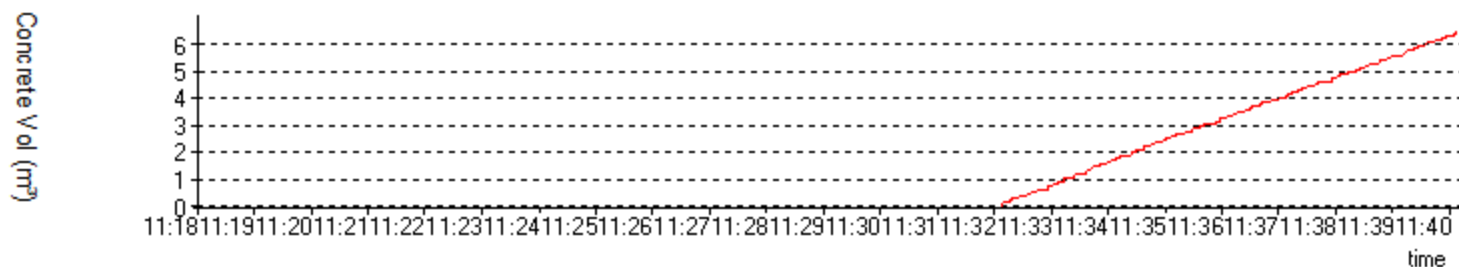
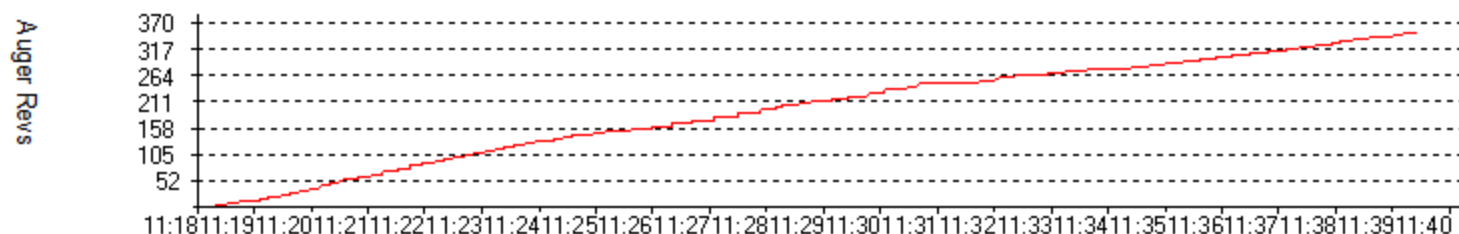
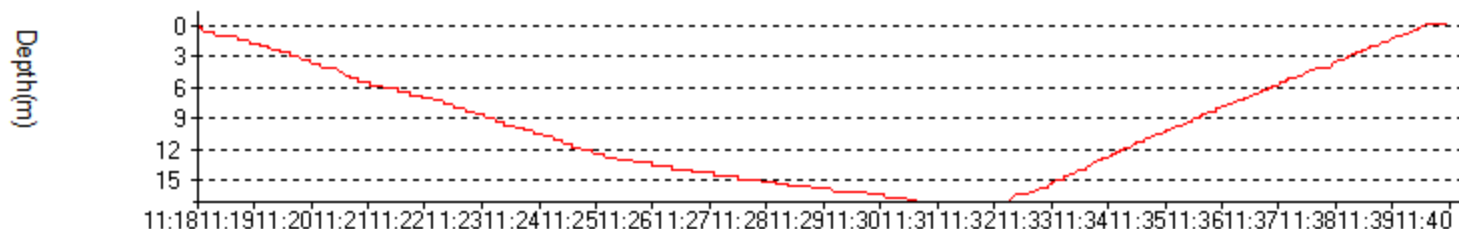
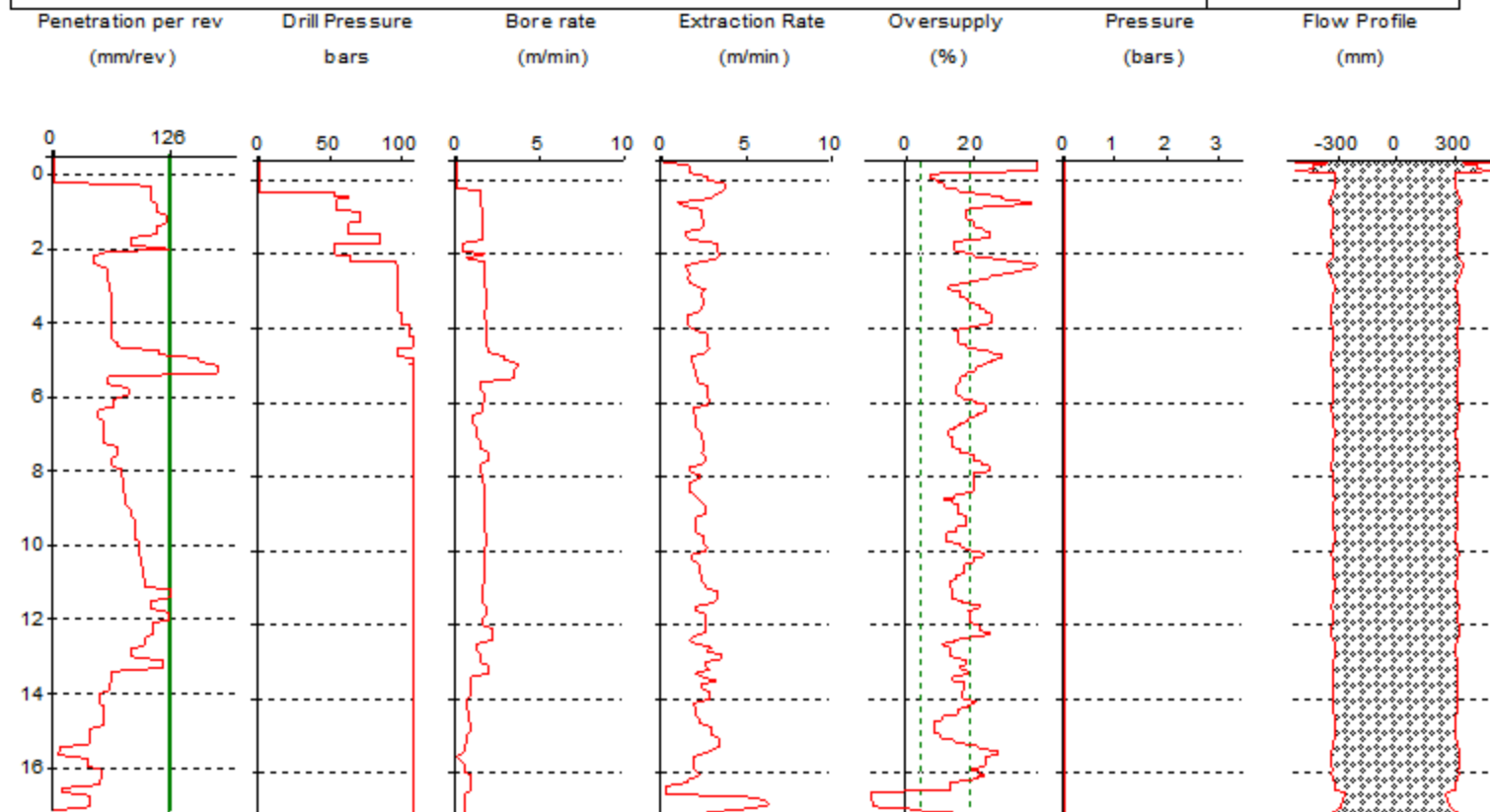
Penetration per rev (mm/rev)	Drill Pressure bars	Bore rate (m/min)	Extraction Rate (m/min)	Oversupply (%)	Pressure (bars)	Flow Profile (mm)
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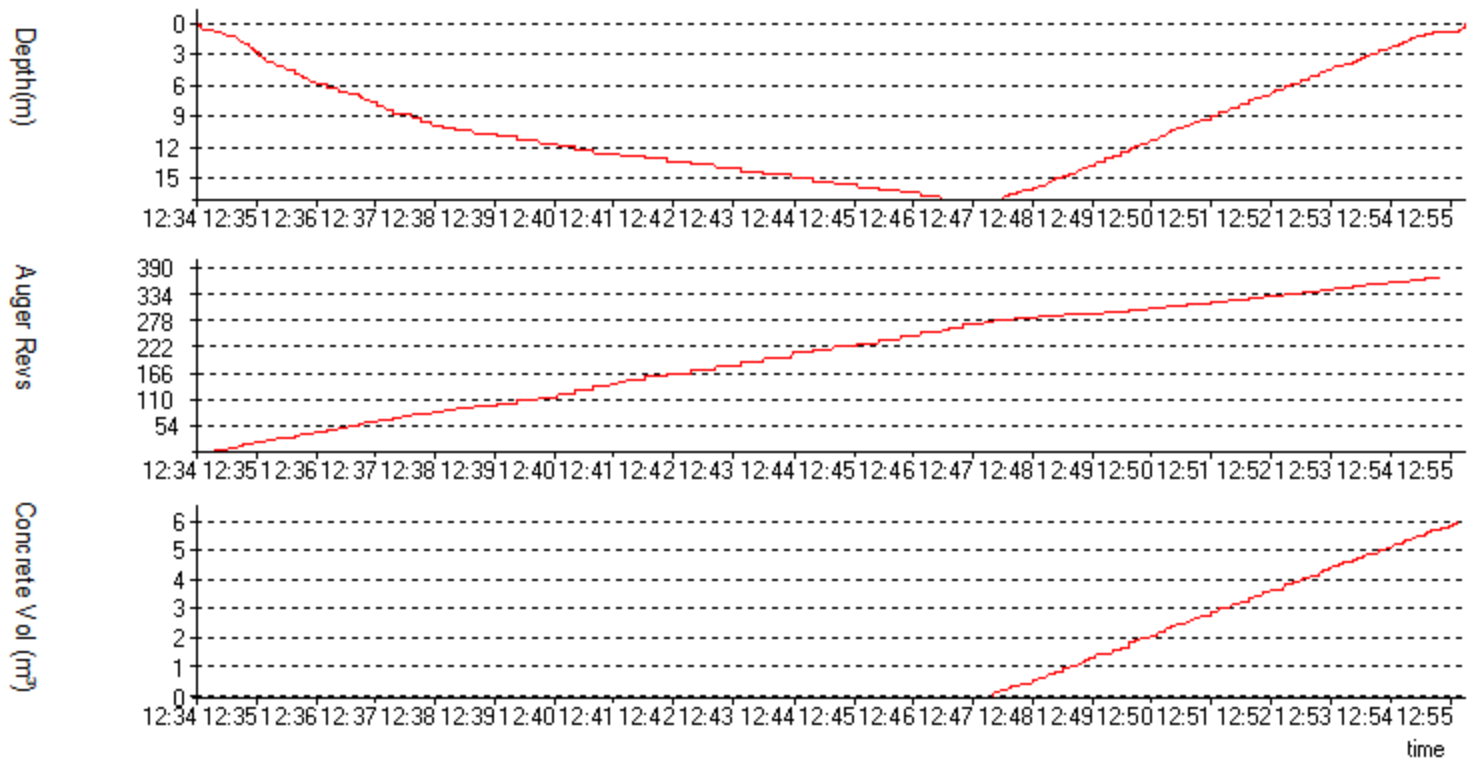
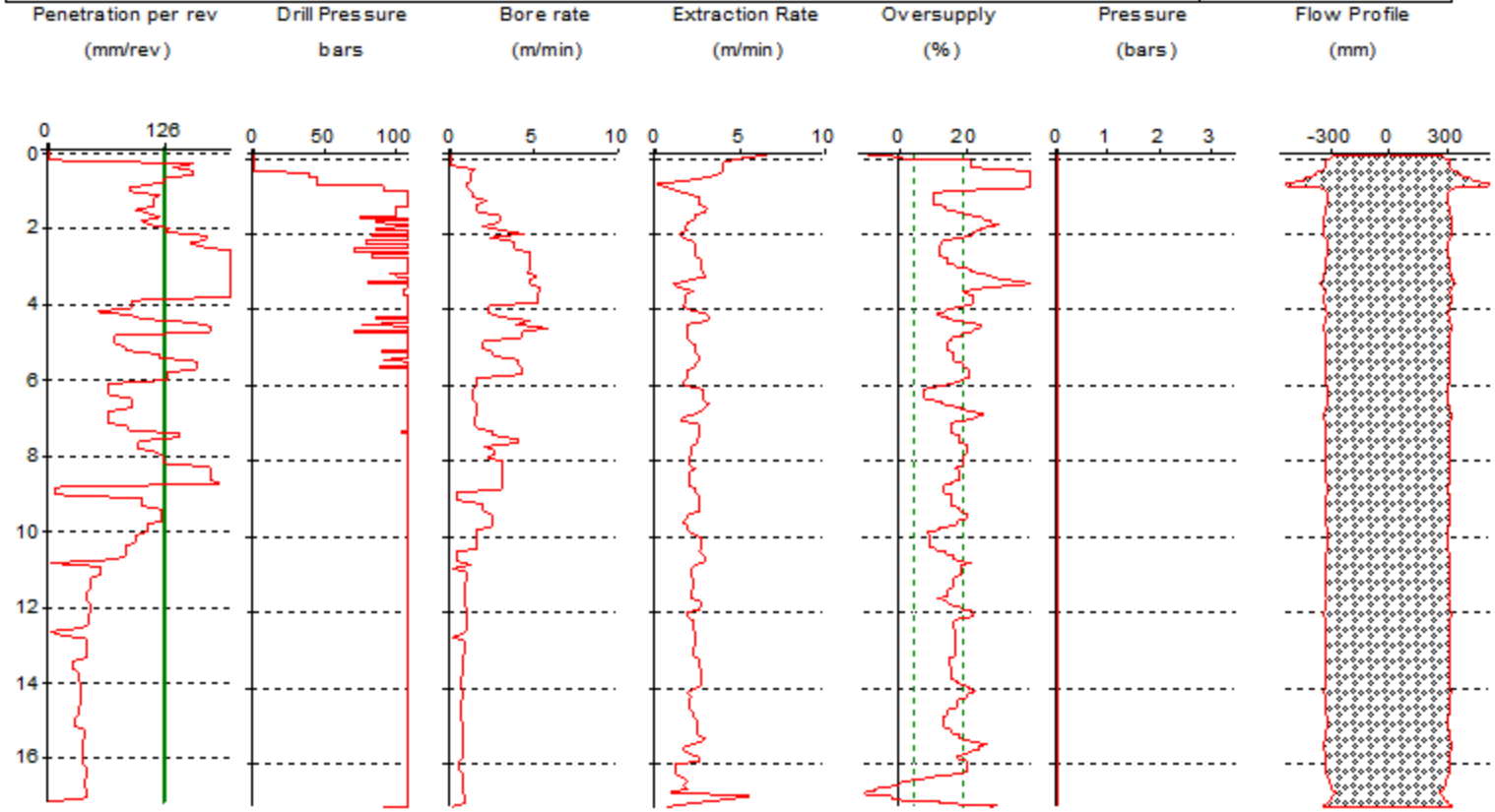
						180 BLOCK C
Length 17.11 m 600 mm 5 inch NUB	Revs 453.2 Energy 0 MJ	Vol : 6.16 m Excess : 27.25 %	Rig : JCE25 Operator : NICL	25/07/2017		



						178 BLOCK C
Length 17.1 m	Revs 356.5	Vol : 6.52 m	Rig : JCE25			25/07/2017
600 mm	Energy 0 MJ	Excess : 34.79 %	Operator : NICL			
5 inch NUB						

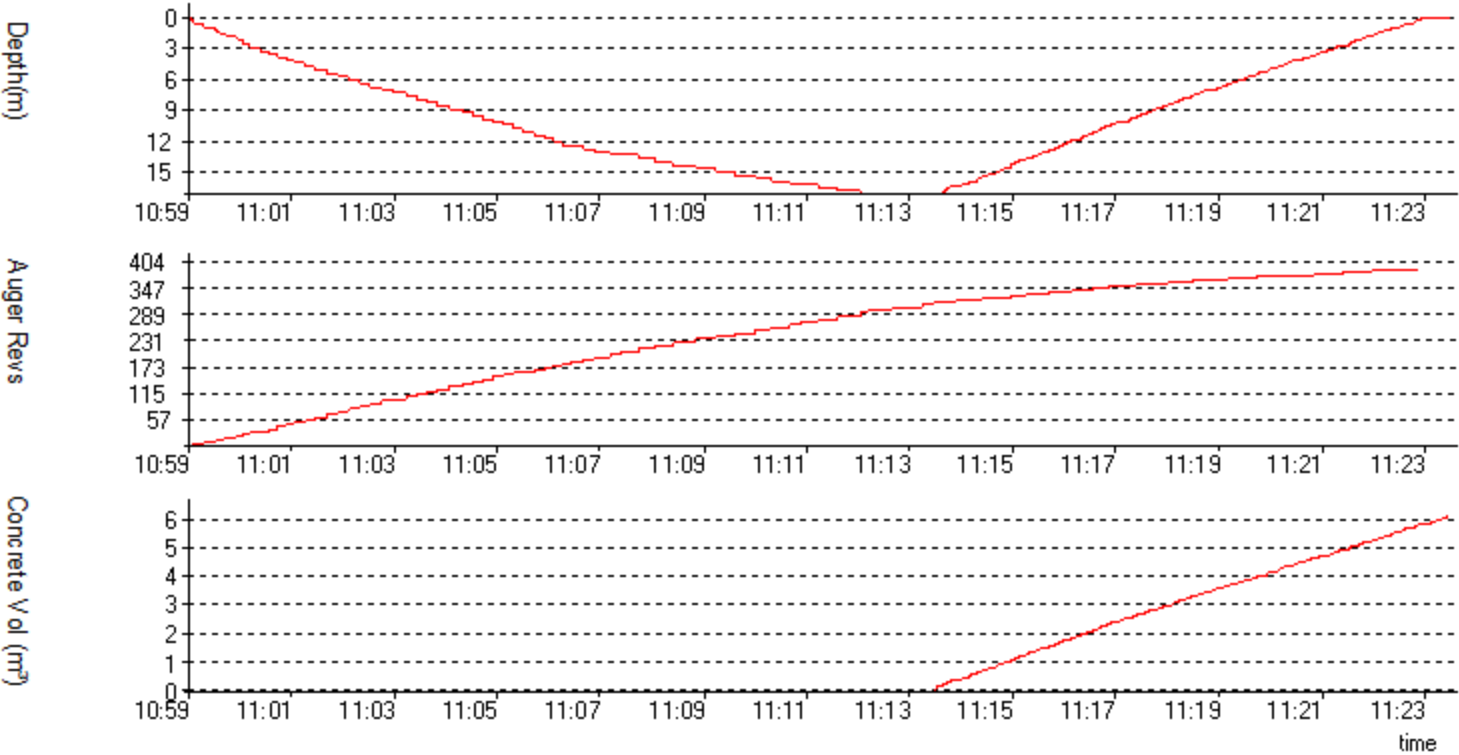
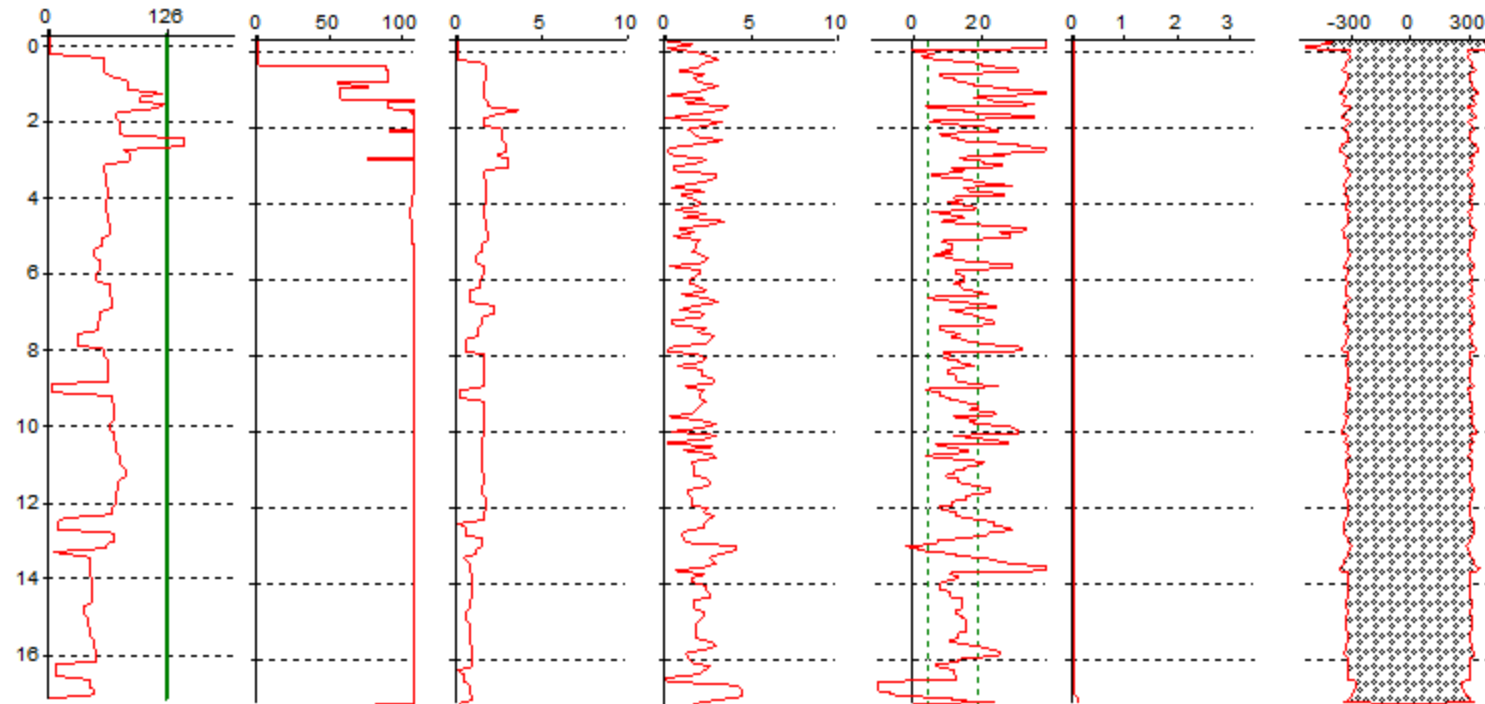


						PC168 BLOCK C		
Length	17.11 m	Revs	376.1	Vol :	6.06 m		Rig :	JCE25
600 mm		Energy	0 MJ	Excess :	25.35 %		Operator :	NICL
5 inch NUB								

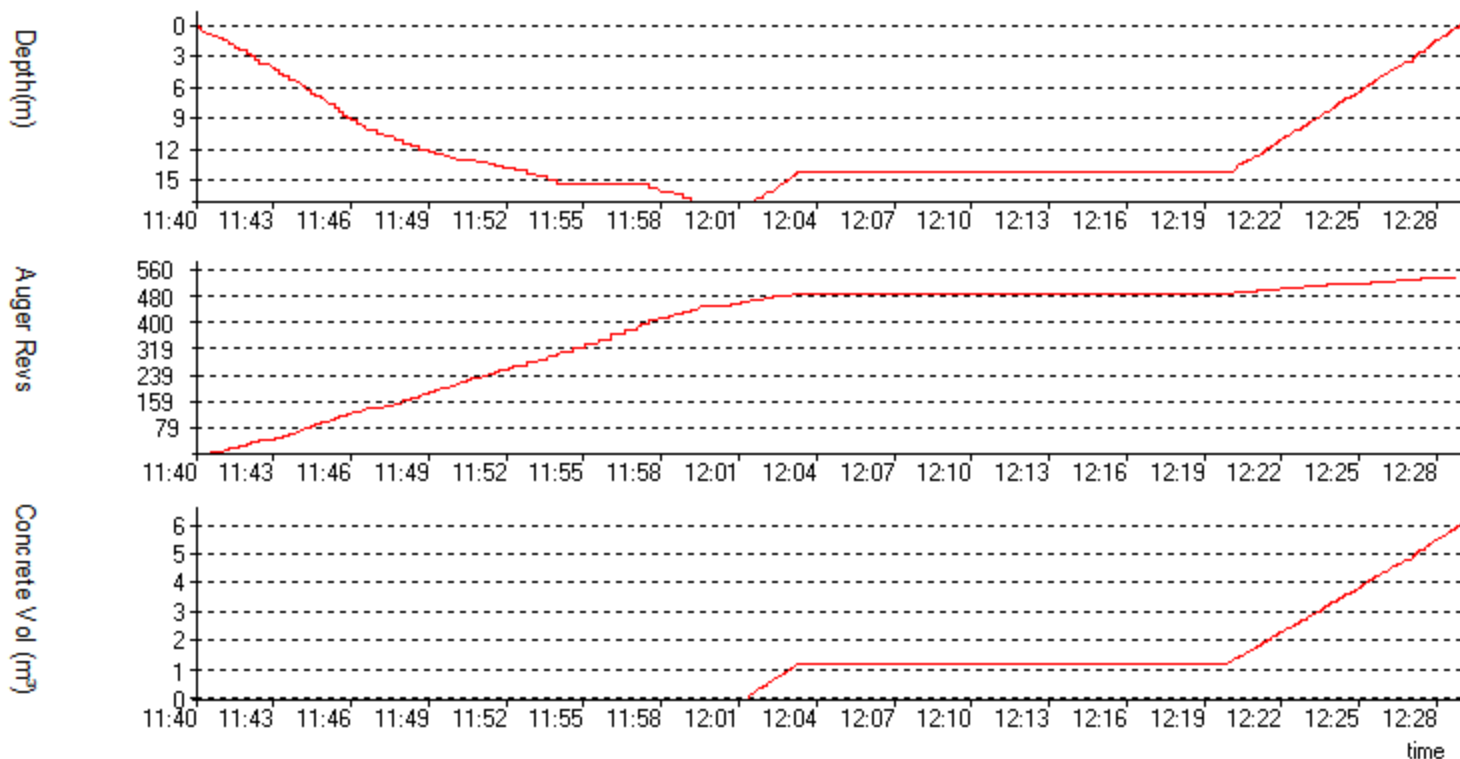
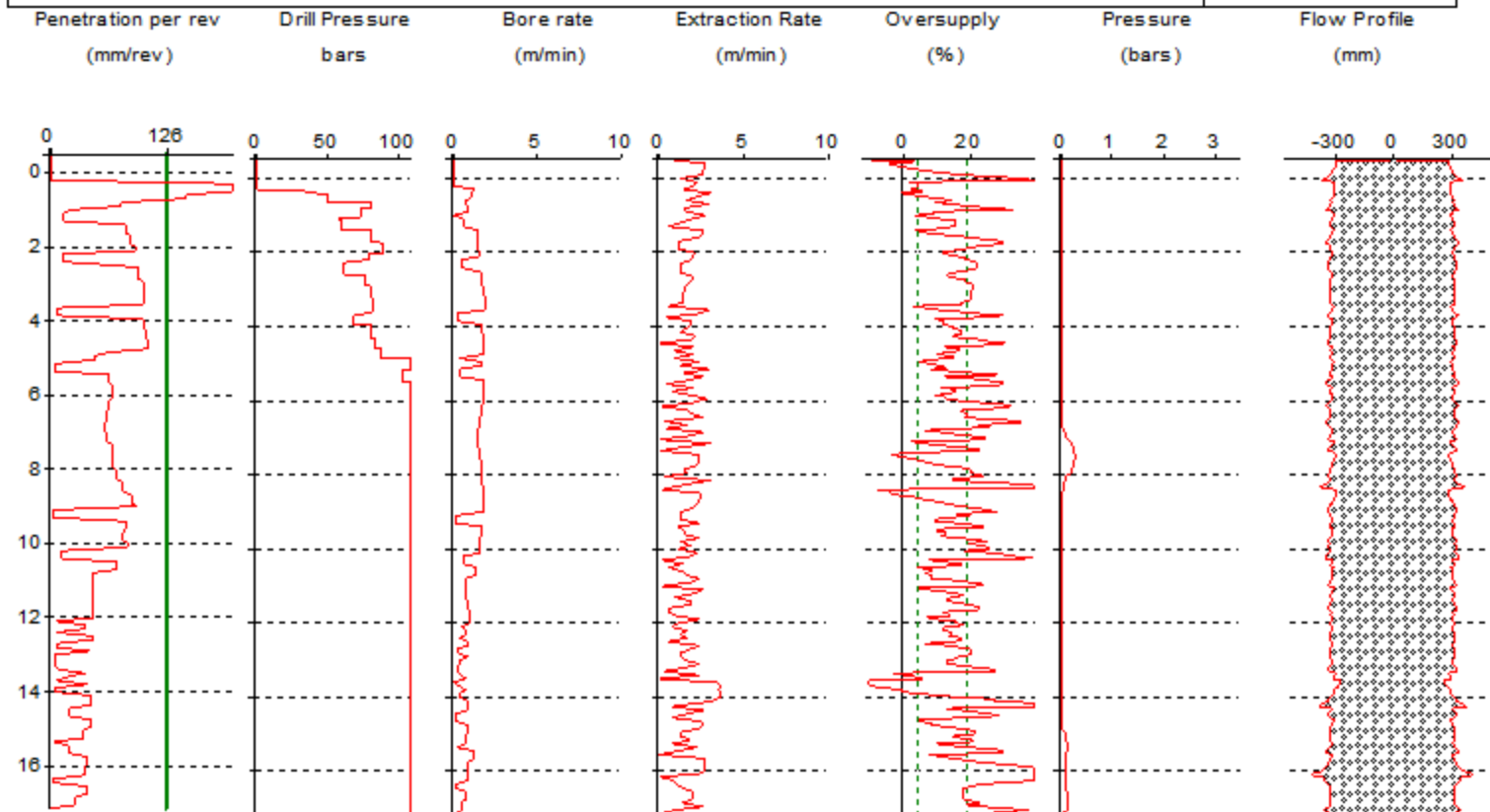


						PC164 BLOCK C
Length 17.1 m	Revs 389.7	Vol : 6.16 m	Rig : JCE25			26/07/2017
600 mm	Energy 0 MJ	Excess : 27.3 %	Operator : NICK			
5 inch NUB						

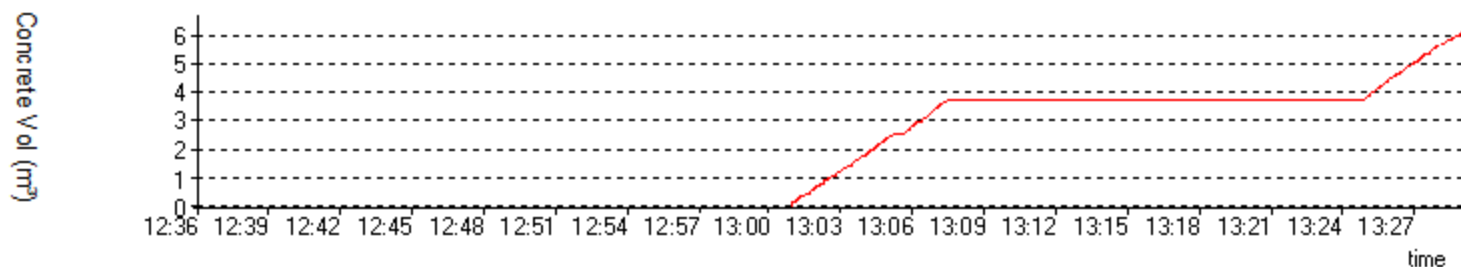
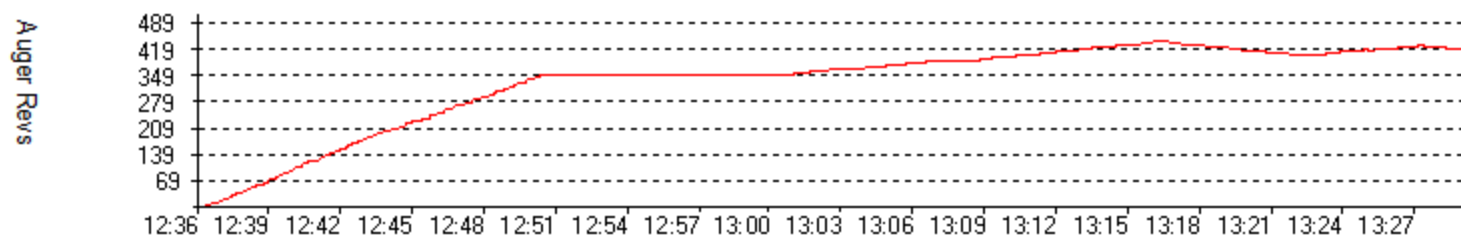
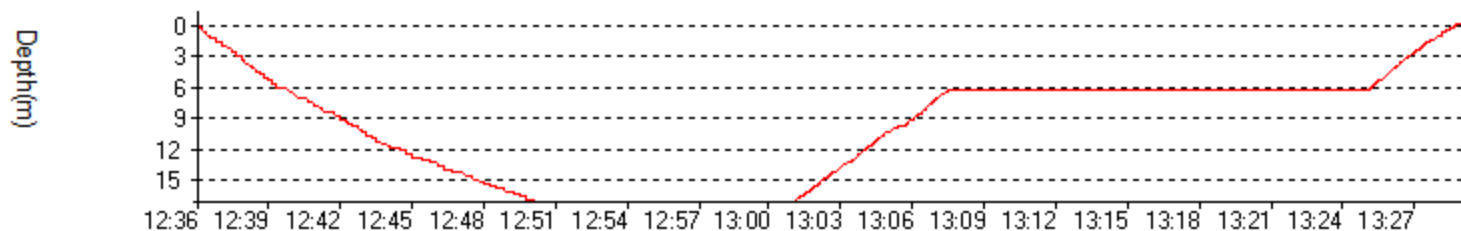
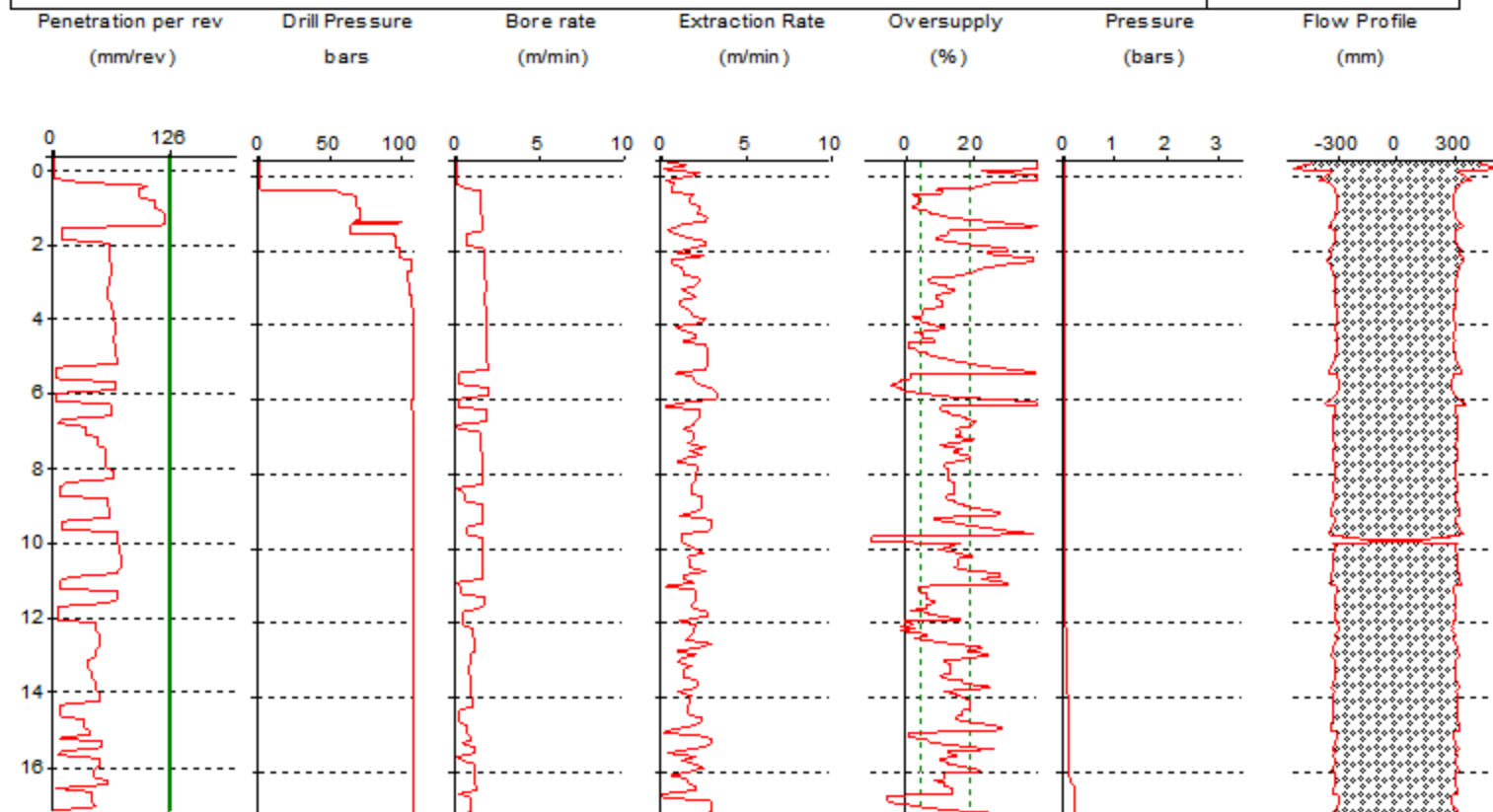
Penetration per rev (mm/rev)	Drill Pressure bars	Bore rate (m/min)	Extraction Rate (m/min)	Oversupply (%)	Pressure (bars)	Flow Profile (mm)
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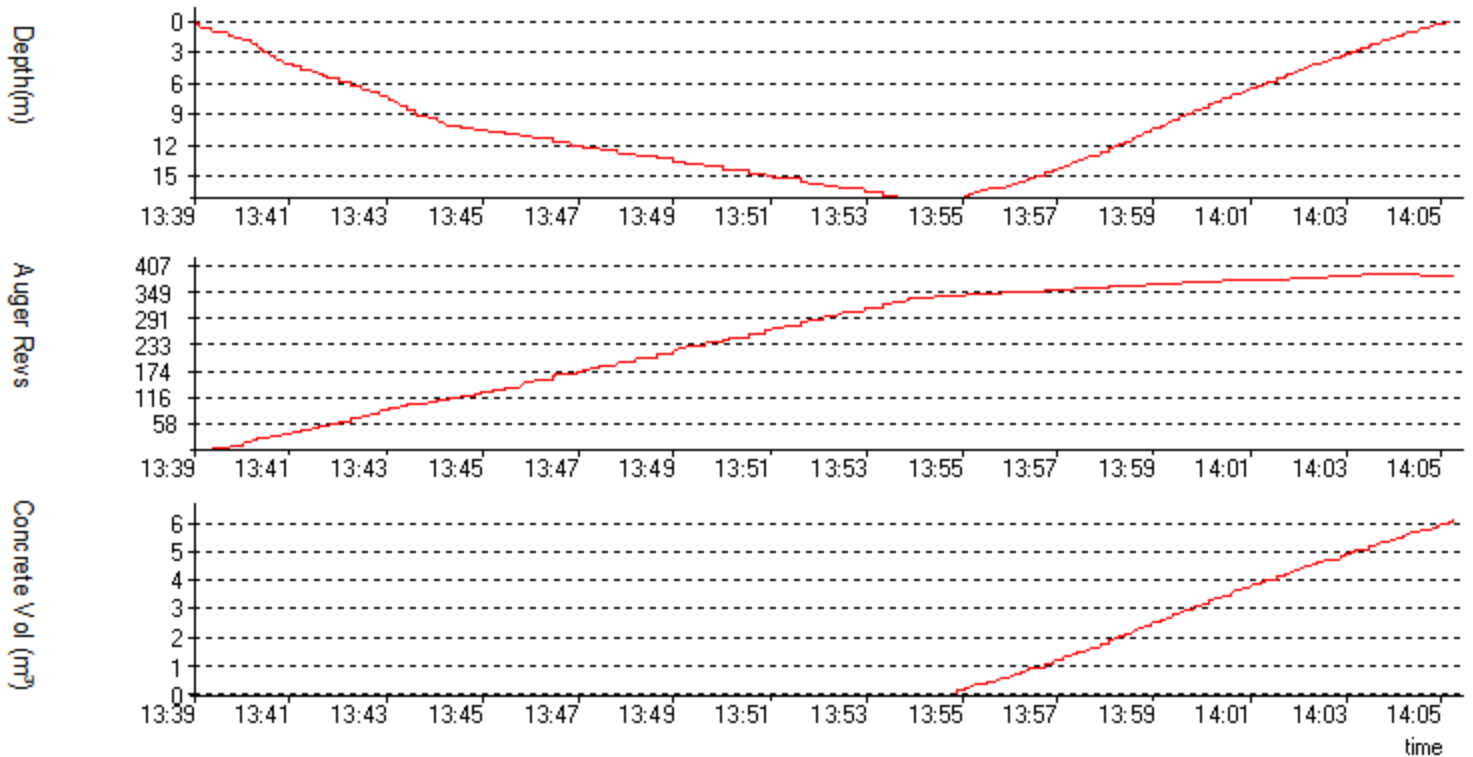
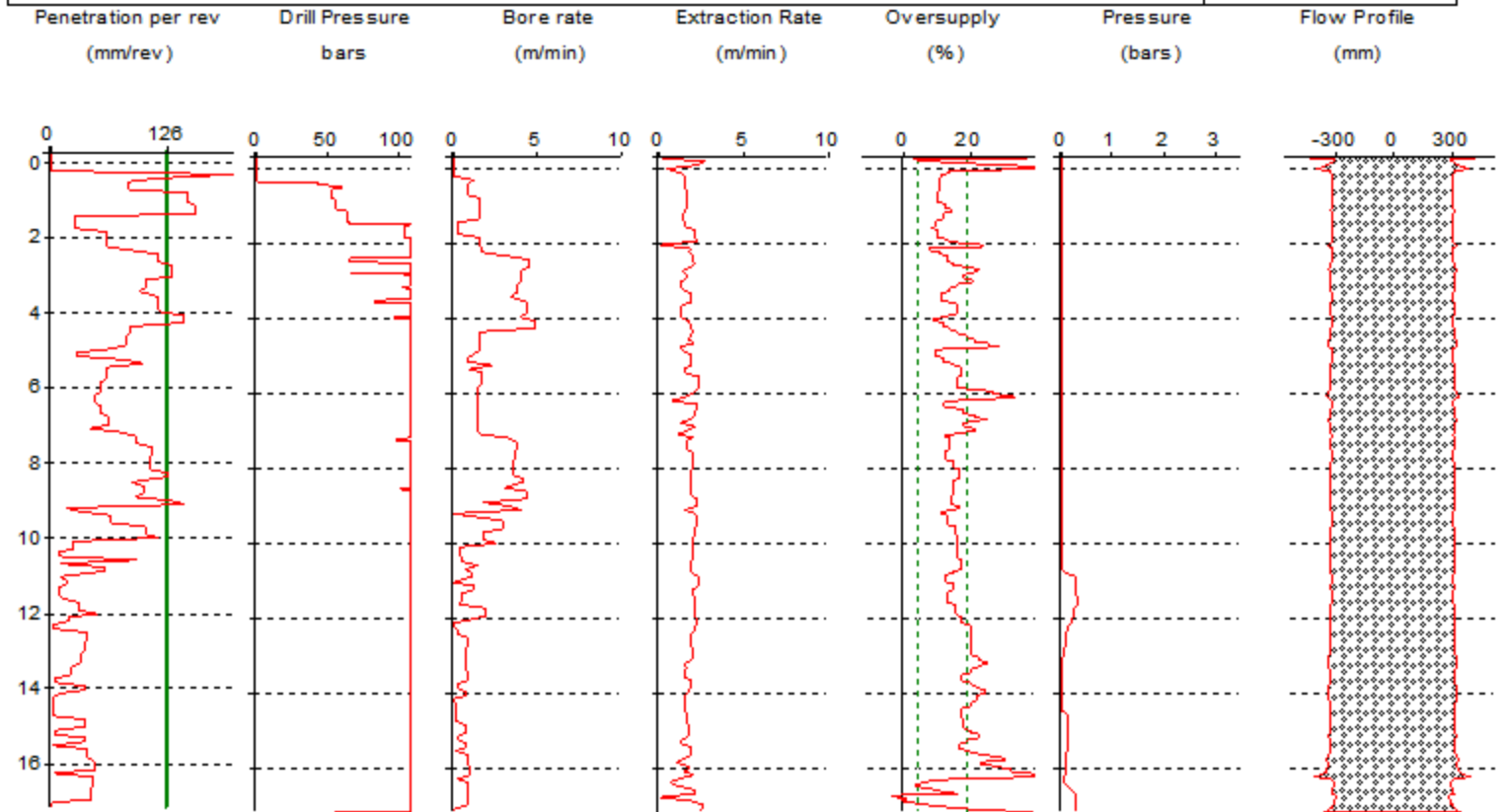
						PC144 BLOCK C		
Length	17.1 m	Revs	539.5	Vol :	6.11 m	Rig :	JCE25	26/07/2017
600 mm		Energy	0 MJ	Excess :	26.37 %	Operator :	NICK	
5 inch NUB								



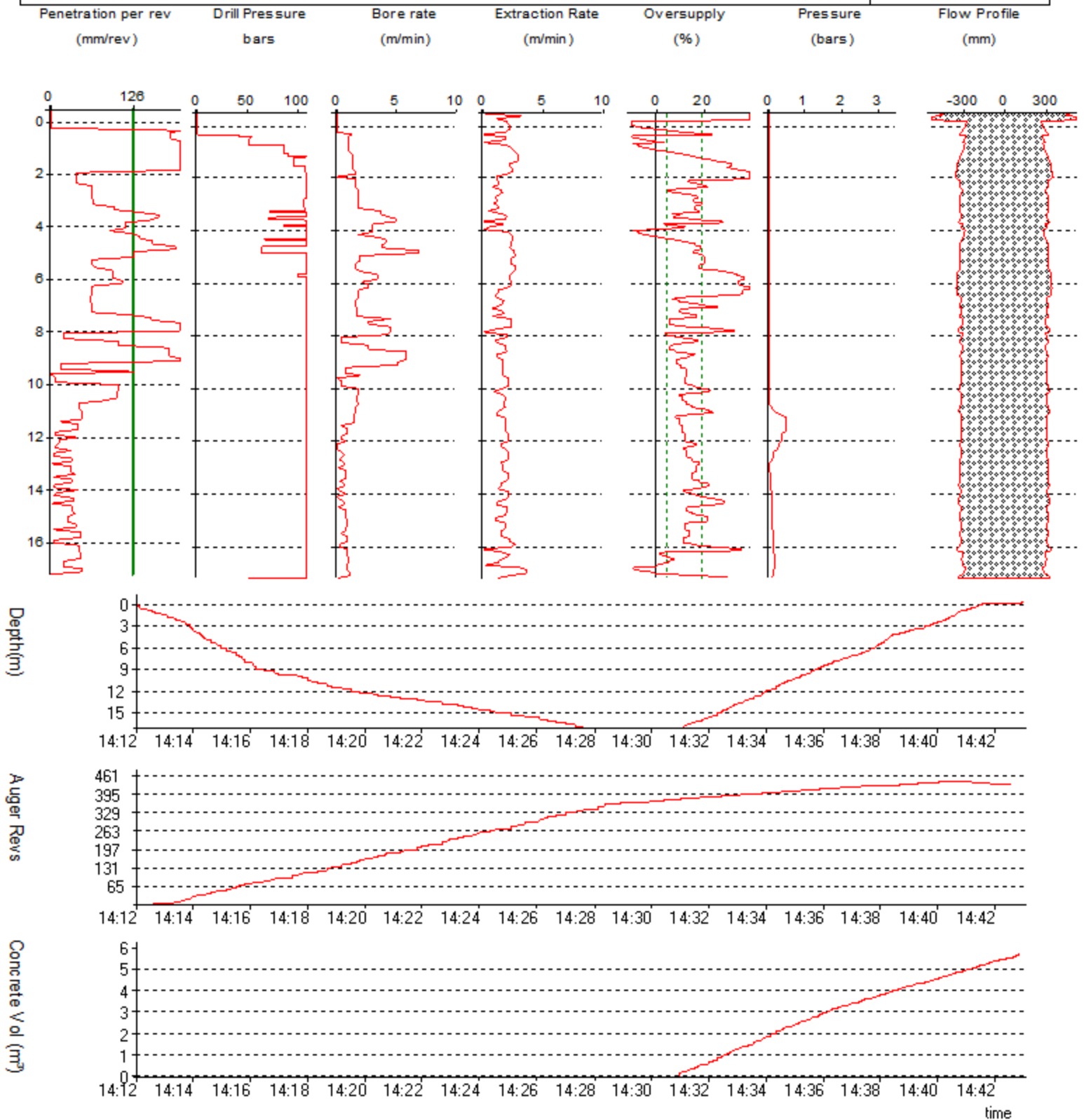
						PC42 BLOCK C		
Length	17.1 m	Revs	471.4	Vol :	6.16 m	Rig :	JCE25	26/07/2017
600 mm		Energy	0 MJ	Excess :	27.28 %	Operator :	NICK	
5 inch NUB								



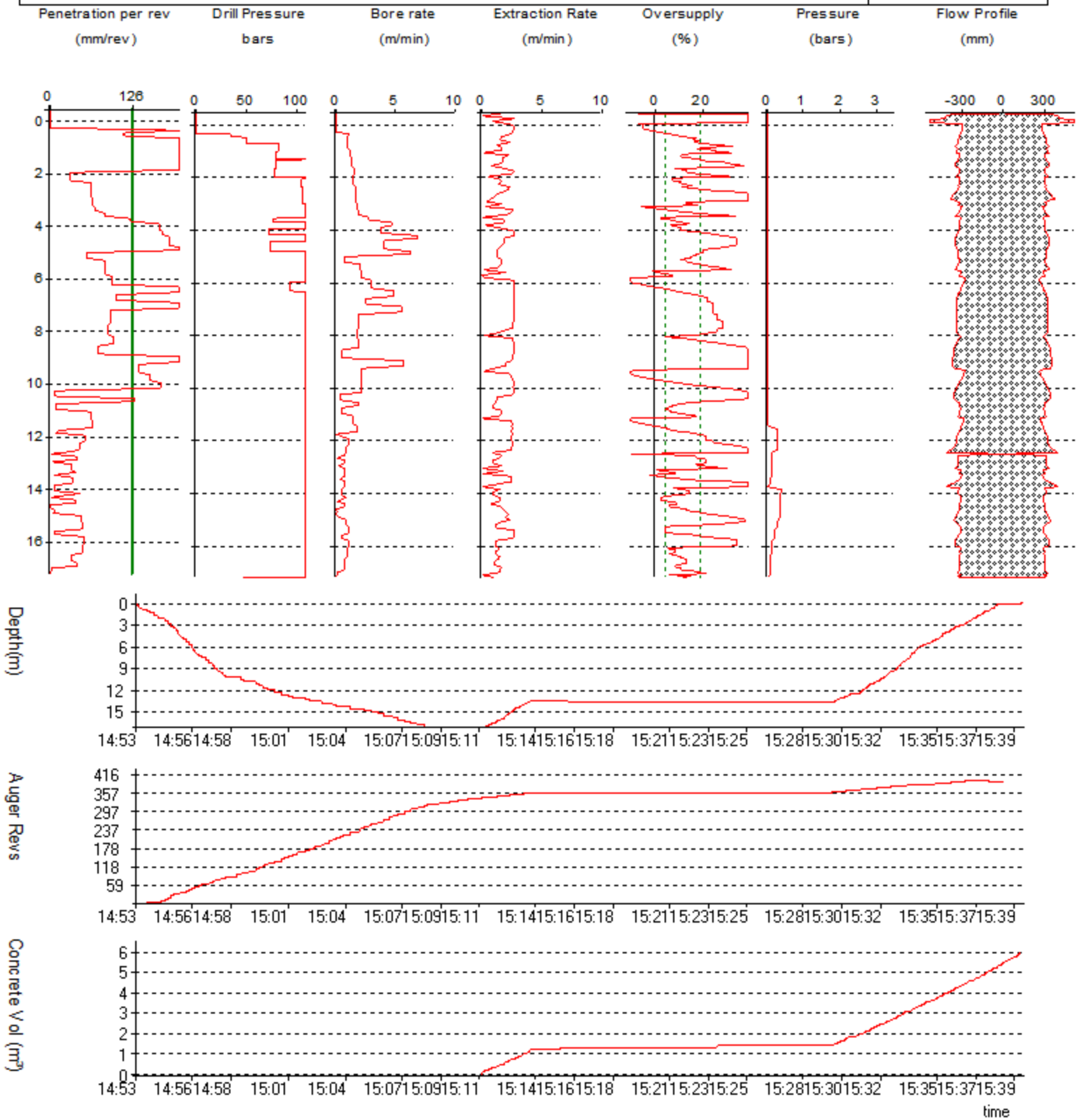
						PC117 BLOCK C		
Length	17.1 m	Revs	392.4	Vol :	6.16 m	Rig :	JCE25	26/07/2017
600 mm		Energy	0 MJ	Excess :	27.3 %	Operator :	NICK	
5 inch NUB								



						PC115 BLOCK C		
Length	17.12 m	Revs	444.4	Vol :	5.79 m	Rig :	JCE25	26/07/2017
600 mm		Energy	0 MJ	Excess :	19.71 %	Operator :	NICK	
5 inch NUB								



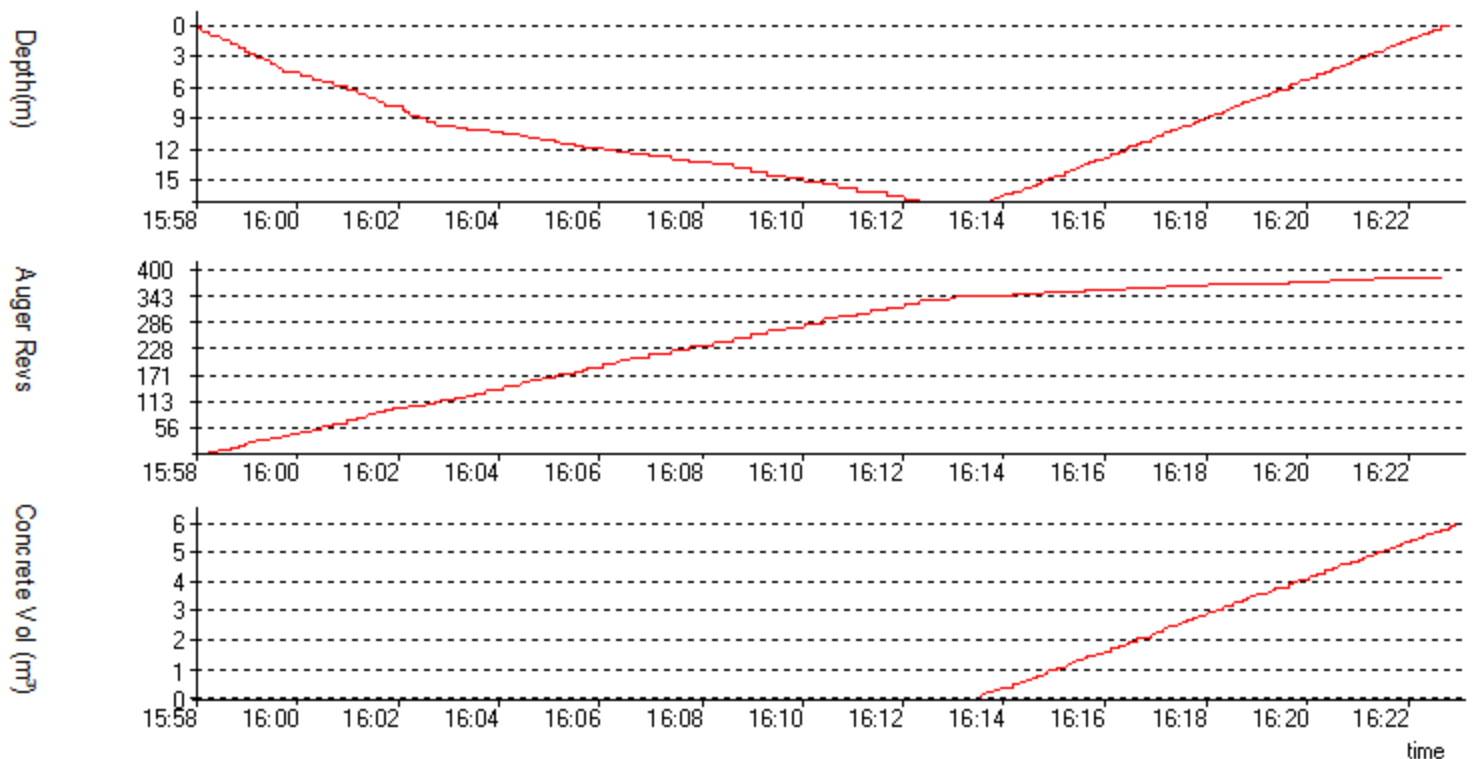
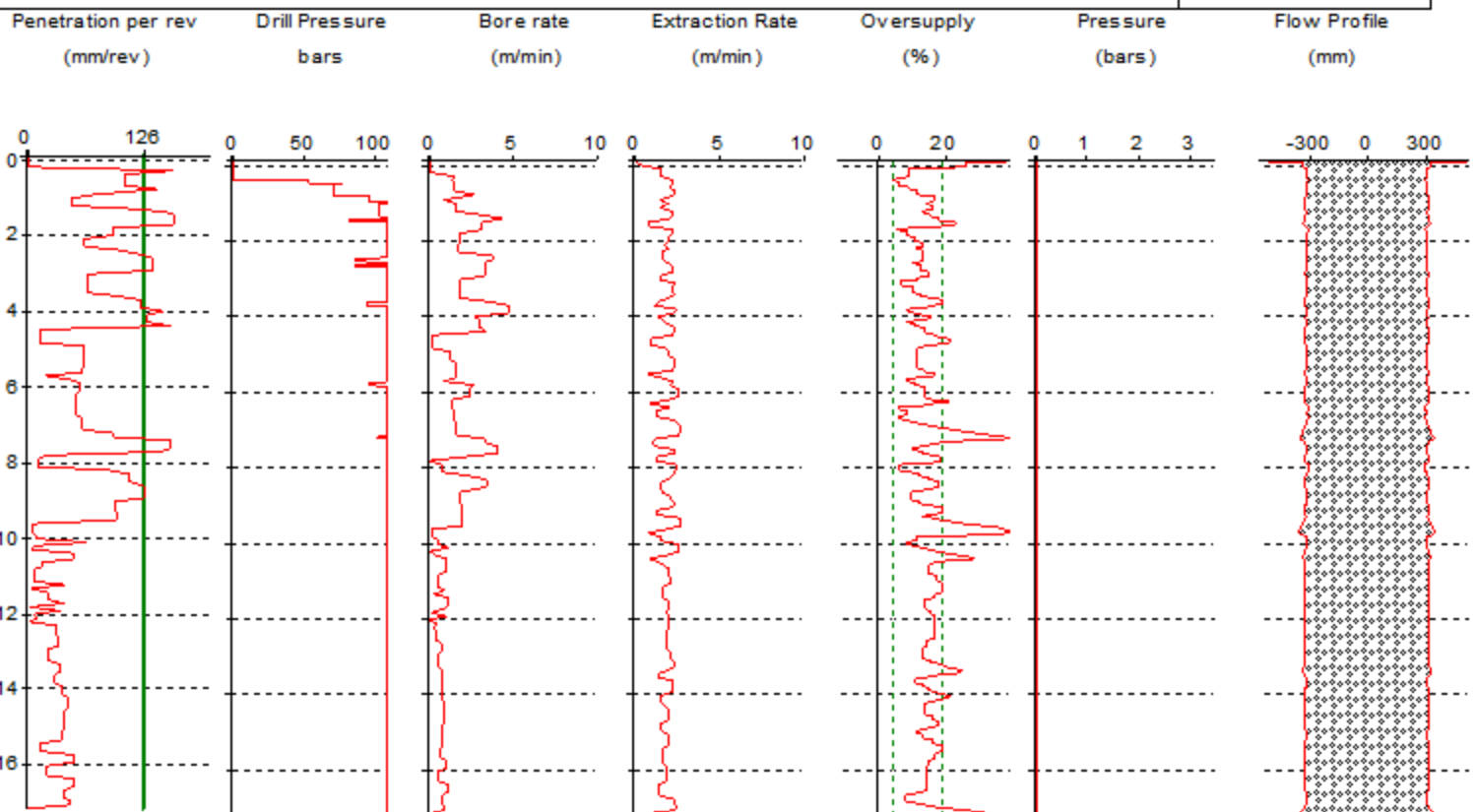
						PC113 BLOCK C		
Length	17.11 m	Revs	401.3	Vol :	6.06 m	Rig :	JCE25	26/07/2017
600 mm		Energy	0 MJ	Excess :	25.38 %	Operator :	NICK	
5 inch NUB								



PC094
BLOCK C

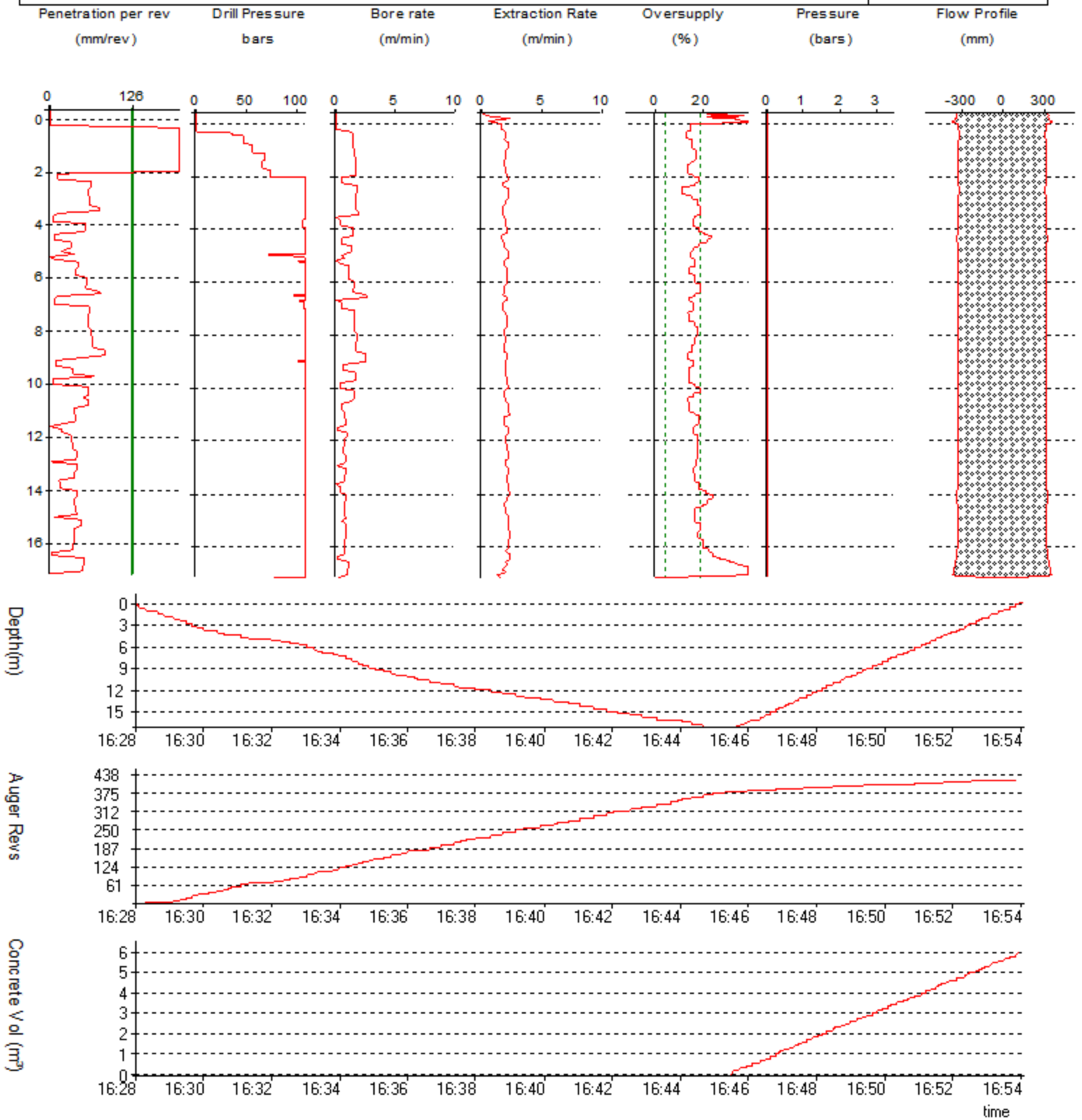
26/07/2017

Length 17.11 m Revs 386.5 Vol : 6.02 m Rig : JCE25
600 mm Energy 0 MJ Excess : 24.44 % Operator : NICK
5 inch NUB



PL3000/CFA Piling Instrumentation Monitoring & Control System

						PC61 BLOCK C
Length 17.1 m 600 mm 5 inch NUB	Revs 422.7 Energy 0 MJ	Vol : 6.06 m Excess : 25.41 %	Rig : JCE25 Operator : NICK	26/07/2017		

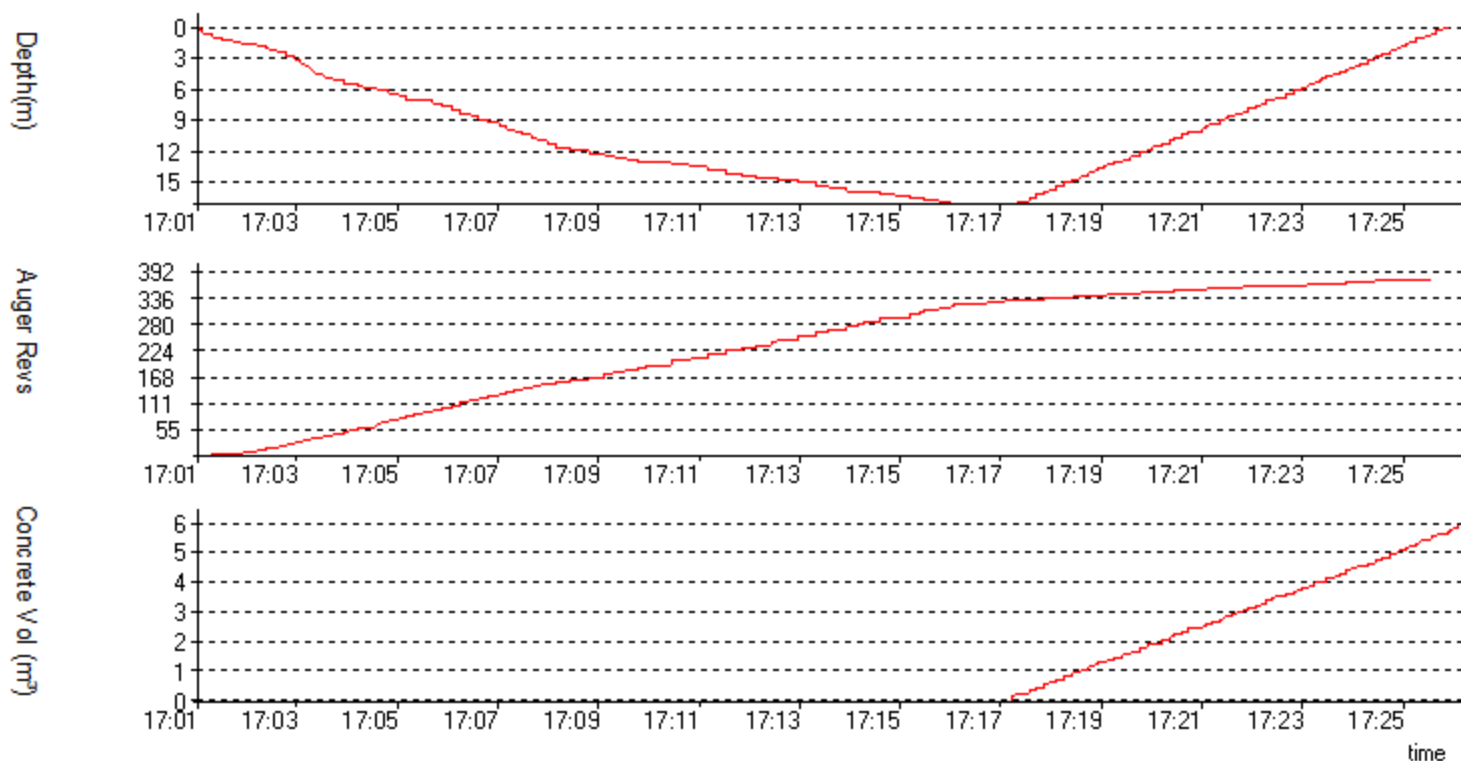
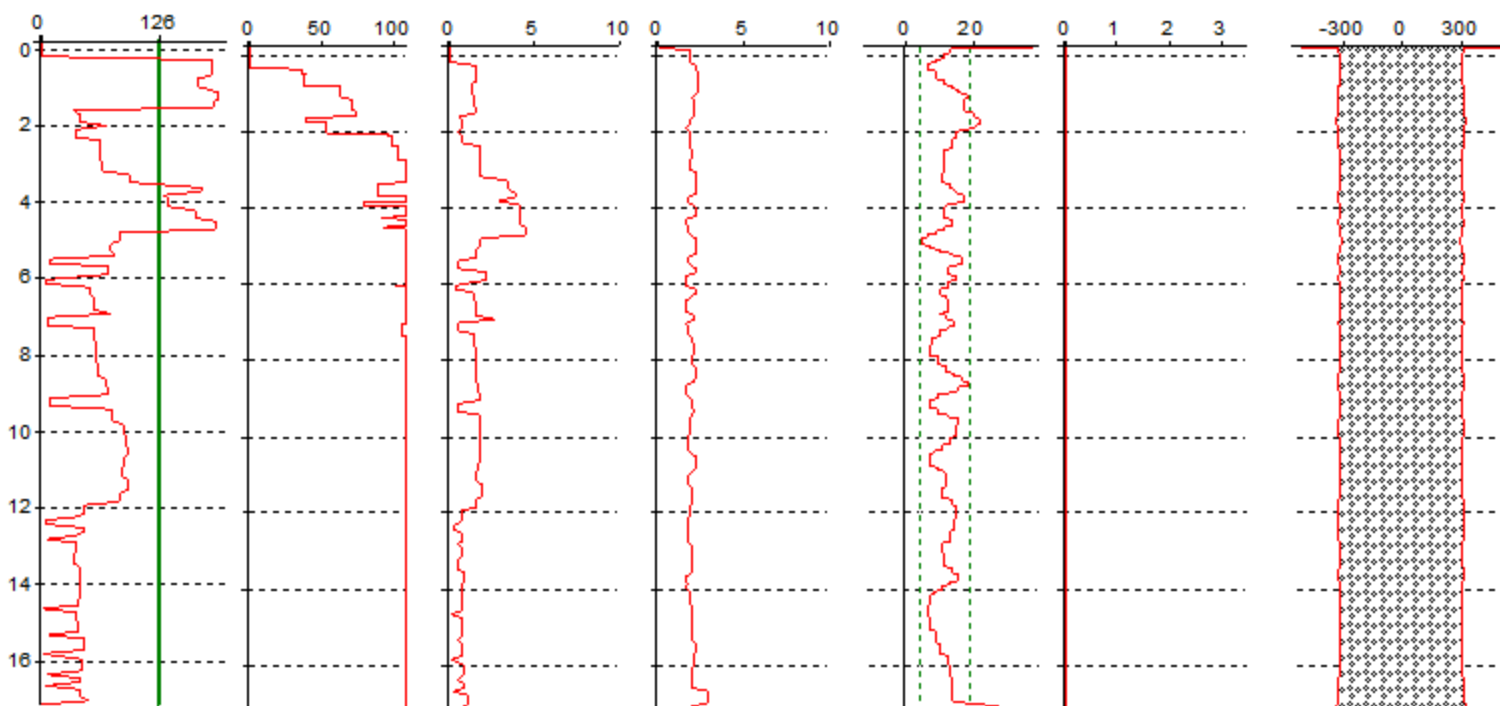


PC077
BLOCK C

26/07/2017

Length 17.11 m Revs 378.7 Vol : 5.97 m Rig : JCE25
600 mm Energy 0 MJ Excess : 23.48 % Operator : NICK
5 inch NUB

Penetration per rev (mm/rev) Drill Pressure bars Bore rate (m/min) Extraction Rate (m/min) Oversupply (%) Pressure (bars) Flow Profile (mm)



PL3000/CFA Piling Instrumentation Monitoring & Control System

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