



Document Ref: C14459/G002/002

11th August, 2014

For the attention of Simon Spencer

Bericote Properties
8 Hamilton Terrace
Leamington Spa
CV32 4LY

Dear Simon

Re: Piling Risk Assessment for Proposed Employment Development on Land at Oldlands Farm Site, Bognor Regis (ADC ref. BE/73/14/PL)

1.0 Introduction

It is proposed to construct 2no. industrial/warehouse units on Land at Oldlands Farm, Bognor Regis totalling approximately 38,099m². Hydrock has been commissioned by Bericote Properties to prepare a piling risk assessment with regards to the installation of piles for the support of foundations and ground floors.

The assessment has been carried out with reference to National Groundwater & Contaminated Land Centre Report NC/99/73, "Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention".

2.0 The Site

The site is located adjacent to the A29 Shripney Road/Rowan Way, on the northern edge of Bognor Regis, West Sussex. The nearest postcode is PO22 9ST and the approximate National Grid Reference 494263E, 101433N.

The main development site covers 9.43 ha and is currently arable farmland. The ground investigation included investigation of a separate area to the northwest of the development site to be used as a flood compensation area. The flood compensation area totals approximately 6.59 ha in area.

The proposed development is to comprise warehousing, with associated access, car parking, waste storage and landscaping to the south of the Northern Relief Road (A259) and a flood compensation area north of the road. The first phase of the development is shown on the Bericote Properties drawing, "Site Layout Plan", reference 99603-PL-101D, dated June 2014 which is presented in Appendix A.

A Site Location Plan (MSA drawing 99603-PL-100B) and Topographic Survey Plan (Hydrock drawing 14459/002) are attached.

3.0 Background Information

The site is occupied by a number of relatively flat arable fields. The topography gently slopes downward from west to east with levels ranging between approximately 3.10m OD and 1.20m OD respectively. The western and southern sections of the site slope gentle downwards to the north. The northeastern section is relatively flat. There are no significant breaks in slope with the exception of the drainage ditches.

Historical mapping suggest the site has not been developed, although it is known there were two ponds on the site which have been subsequently infilled with construction materials. There is an industrial estate adjacent to the southern site boundary.

There are numerous drains on the site which are classified as Tertiary and Secondary Rivers. The nearest Primary River is the Ryebank Rife which is located 135m to the east of the site boundary and flows to the south, and the English Channel (2km to the south).



Historically there have been two ponds in the south of the main site. There is also a well located on site which does not appear to be in current use.

There is a surface water abstraction license for the use in spray irrigation.

There are no recorded pollution incidents at, or in the vicinity of, the site. However, sewage was once discharged into the site drainage but this practise ceased in 1963 and no further consideration is given.

The site is underlain by Raised Marine Deposits in the west and River Terrace Deposits in the east. These deposits overlie Undifferentiated Chalk. Made Ground is anticipated where the former ponds have been backfilled.

The following reports on the site have been prepared previously by Hydrock and have been used in the preparation of this report:

- Hydrock. June 2014 “Oldlands Farm, Bognor Regis - Ground Conditions Desk Study Report”, reference R/14459/002/Rev002.
- Hydrock. July 2014 “Oldlands Farm, Bognor Regis - Ground Investigation”, reference R/14459/003/Rev002a.

For full details reference should be made to these reports.

4.0 **Ground Conditions**

The ground conditions on site are described in detail in the Hydrock report R/14459/003/Rev002a which includes cross-sections illustrating the geological sequence across the site (attached for reference).

The deposition of soils is reflected in the topography of the site with Raised Marine Deposits in the east and River Terrace Deposits occupying the higher ground in the centre and west. The flood compensation area lies a considerable distance beyond the northwestern extent of the Raised Marine Deposits.

A thin surface cover of Made Ground (reworked topsoil) is present across the entire site. Locally in the south and southwest of the main site, deeper areas of Made Ground were encountered which are consistent with the location of former ponds identified in the desk study.

The spatial distribution of the geology on the main development site is indicated on the attached Site Zonation Plan (Hydrock drawing 14459/D006) and summarised in Table 1. No piling is proposed in the Flood Compensation Area to the north of the main site.

Table 1: Strata Encountered below the Main Site

Stratum Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Made Ground – reworked topsoil consisting of sandy clay and clayey sand.	0.00	0.10 – 0.80	0.10 – 0.80
Made Ground – refuse materials present in former pond areas consisting of variable sandy gravelly clay, clayey sandy gravel and gravelly sand with some cobbles and occasional boulder sized particles. Gravel is flint and ash, metal, glass concrete, brick and asbestos containing materials.	0.00	0.30 – 1.70	0.30 – 1.70
Subsoil – locally present underlying topsoil consisting of soft sandy clay.	0.20 – 0.40	0.25 – 1.20	0.00 – 0.90
Raised Marine Deposits – present in the east of the site and consisting of very soft organic clay, sandy silt, silty sand and sand, locally with plant remains.	0.10 – 1.20	2.00 – 8.70	0.00 – 8.40
River Terrace Deposits – present in the west and centre of the site and locally underlying the Raised Marine Deposits, typically consisting of soft to firm sandy clay and clayey sandy gravel. Gravel is predominantly of flint and chalk.	0.20 – 4.10	1.90 – 5.20	0.00 – 4.60



Stratum Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
White Chalk Subgroup – comprising clayey slightly sandy gravel sized fragments of weak, low density chalk and with occasional flint gravel. (Grade Dc)	1.90 – 8.70	unproven	unproven

A buried concrete obstruction was encountered in the southern end of trial pit TP38. The nature and origin of the obstruction is not known. However, the location is coincident with the easternmost of the backfilled ponds.

There were no specific indications of contamination other than the presence of man-made materials and refuse within the ponds. The evidence of potentially contaminated soils occurred only within the ponds in the main site area and there was no evidence of contamination in the flood compensation area.

5.0 Hydrogeology

The aquifer designations given in Table 2 and are based on the Environment Agency interactive aquifer designation map.

Table 2: Hydraulic Characteristics of Strata

Stratum	Aquifer Designation	Hydraulic Characteristics
Raised Marine Deposits	Secondary A Aquifer	Moderate to high porosity because of unconsolidated nature, but permeability likely to be constrained to low or low to moderate because of poor sorting and clay content.
River Terrace Deposits		
Undifferentiated Chalk.	Principal Aquifer	Possible large storage capacity both from fractures and porosity. Permeability likely to be controlled by fracture flow. An important strategic aquifer.

A number of groundwater strikes were recorded during the investigation at between 0.0m bgl and 4.6m bgl. Monitoring data has indicated that the groundwater table is standing at approximately 0.00m AOD. Groundwater flow is to the southeast and groundwater on the site is in hydraulic continuity with the surface waters.

The site is not within a Source Protection Zone (SPZ) and there are no groundwater abstraction licenses within 1km of it although there is a well present on the site.

6.0 Summary of Soils and Ground Gas Contamination

Within soils in the vicinity of the historical ponds (now backfilled), there are elevated PAH and asbestos containing materials. Across the remainder of the site, there are no elevated Chemicals of Concern.

The source of these substances is ash which forms a significant constituent of the backfill materials within the ponds. Whilst the ponds are located predominantly outside of the footprint of the proposed buildings, piling works in relation to the southernmost of the buildings may encounter some of the contaminated soils. This eventuality is the subject of the risk assessment presented herein.

Ground gas monitoring indicates:

- no methane has been detected in any borehole on any of the visits;
- carbon dioxide has been detected at concentrations of up to 4.9% v/v in one instance but typically ranging between 0.0 to 2.0% v/v;
- oxygen concentrations of between 19.3% v/v and 21.2% v/v; and
- gas flow measurements indicated emission rates of between -0.1/hr and 0.2/hr.



7.0 Summary of Groundwater Contamination

The ground investigation report has presented an assessment of the risk posed to Controlled Waters. The risks to groundwater and surface water from contaminants on site have been assessed according to the Environment Agency (2006) Remedial Targets Methodology (RTM). Pollutants from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) and as such are regulated under the Agency's 'limit' pollution objective.

Acceptable Water Quality Targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)). The following have been considered in the risk assessment:

- the White Chalk Subgroup is a Principal Aquifer;
- the Raised Marine Deposits and River Terrace Deposits are Secondary Aquifers;
- there are surface water drains on site; and
- there is hydraulic continuity between all groundwater and surface water bodies.

There have been exceedances of the DWS and/or EQS for sodium, chloride, nitrate, manganese and silver. In the case of sodium and chloride, it is likely the exceedances are caused by brackish waters given the proximity to the English Channel and therefore these are considered to be of natural origin. Similarly, there is no evidence of a source of silver or manganese on site and therefore these contaminants are believed to be sourced from the underlying geology.

In the case of nitrite, the sources are likely to be agricultural both on site and within the wider area. It is not known whether fertilisers have been applied to the crops sown at the time of the investigation. Hydrock believes that no specific action is necessary because the site is not within a Source Protection Zone, and furthermore, upon development, agriculture will cease and therefore the development process will achieve betterment from the perspective of protection of Controlled Waters.

Hydrock does not believe the site presents a risk to Controlled Waters and no remedial actions are proposed. However, specifically in relation to the piling risk assessment, there is no evidence of PAH contamination within the groundwater and therefore under current conditions the former ponds are not influencing the groundwater quality at the site.

8.0 Proposed Remediation

A Remediation Strategy is presented for the site in Hydrock report R/14459/004. Given the proposals involve raising of ground levels within the vicinity of the ponds it is proposed to leave the backfill material within the ponds as placed. Therefore, from the perspective of groundwater quality no specific remediation is proposed.

9.0 Selection of Foundations

Based on the poor load bearing characteristics of the Raised Marine Deposits and River Terrace Deposits, coupled with the relatively high groundwater table, it is envisaged that shallow foundations will not be suitable for the development and it will be necessary to adopt piled foundations for the buildings and internal floor slabs at the site.

Piled foundations will need to be designed to extend through the Raised Marine and River Terrace Deposits and carry their load in the White Chalk strata in skin friction or a combination of skin friction and end bearing.

A number of piled solutions could be given consideration at the site, including:

- continuous flight auger (CFA) piles or similar bored and cast in situ techniques; or
- driven piles.

Advice is required from piling contractors on the application of their proprietary system in view of the ground conditions present. Where a bored and cast in-situ piling methodology is considered, there may be practical difficulties in casing pile bores to their base prior to placement of concrete because of the groundwater conditions. Where a driven piling methodology is adopted, it will be necessary to take into account the tendency of the pile to macerate chalk around the annulus of the pile without a corresponding mobilisation of skin friction when driving piles.



At this stage, it is uncertain as to the proposed piling technique and either CFA piles (or similar bored and cast in situ techniques), or driven piles may be used.

10.0 Site Specific Risk Assessment

In accordance with the six scenarios defined in Report NC/99/73, the following risk assessment relates to consideration of additional pollutant pathways created by the piling operations. The risk to Controlled Waters via other pathways is addressed as part of the flood risk and drainage strategy.

The assessment has been carried out for both CFA piled and driven piles, using the risk assessment flowchart from National Groundwater & Contaminated Land Centre Report NC/99/73 (Figure 6.1). The five of the six pollution scenarios suggested in Report NC/99/73 will be considered in terms of their potential Source - Pathway - Receptor linkages on this site.

Pollution Scenario 1 - Creation of Preferential Pathways

Investigations have identified contaminated soils within the pond area of the site. The contaminated soil is in direct continuity with the Secondary Aquifer (river Terrace Deposits). With regard to the creation of further preferential pathways by piling, the following potential pollutant linkage has been assessed:

- Source – Contaminated soil material / perched water.
- Pathway – Pile / soil interface.
- Receptor – Groundwater in White Chalk (Principal Aquifer).

In terms of pollutant linkage the following factors have been considered:

- i. Contaminated soil is present within the Made Ground;
- ii. There is no evidence of PAH contamination impacting the groundwater;
- iii. There will be a limited period in which the pathway will be open prior to concreting of the augered bores to form the piles (not relevant to driven piles);
- iv. There is already direct continuity between the potentially contaminated soils in the backfilled ponds and the Secondary Aquifer and the Principal Aquifer.

CFA Assessment

Upon consideration of the above, it is considered unlikely that the piling works will create a new pathway for the downward migration of nitrate impacted groundwater as there is already hydraulic continuity between the River Terrace and the White Chalk. There is no evidence of PAH impacting groundwater at the site.

Upon casting of the piles, there will be no pathway for the downward migration of contaminants as the concrete will be in direct contact with the surrounding soil.

It is therefore considered that the risk of CFA piling creating an additional Source - Pathway - Receptor link is negligible.

Driven Assessment

Driven piles will likely be of square section as opposed to steel column ("H" section) piles. Due to the ground conditions present at the site, during driving of piles, soils will be displaced radially as opposed to vertically downwards. This will increase the pore water pressure. Upon completion due to dissipation of the excess pore water pressure, the effective stress in the clay and the macerated Chalk and in the soil/pile interface will increase; this will lead to sealing of the soils around the annulus of the pile.

Therefore, in addition to there not being a viable source, a pathway for contaminant migration will not present itself during pile installation or upon completion. It is therefore considered that the risk of piling creating an additional Source - Pathway - Receptor link is negligible.



Pollution Scenario 2 – Creation of Preferential Pathways to Allow Upward Migration of Ground Gas

The following potential pollutant linkage has been assessed:

- Source – natural soils (Raised Marine Deposits).
- Pathway – migration of gas upward around pile shaft.
- Receptor – building air-space and end users.

The risk posed by ground gas has been addressed in the ground investigation report reference R/14459/003. Currently, the gas monitoring programme is continuing to provide an adequate dataset on which to base the design of any protection measures required. However, data gathered to date suggests Characteristic Situation 1 in accordance with CIRIA document C665 in which case no remedial measures will be necessary.

For both CFA and driven piles, based on the gas data available to date, which indicates very low gas flow rates and very low gas flows, it is considered unlikely that a significant increase in gas flow would occur as a result of pile installation. Therefore, notwithstanding the outcome of the final ground gas risk assessment upon completion of the necessary monitoring, Hydrock believes that no additional preferential pathway will be created by the piling works.

Pollution Scenario 3 - Direct Contact of Site Workers

The following potential pollutant linkage has been assessed:

- Source – Contaminated soil.
- Pathway – Direct contact with excavated arisings.
- Receptor – Construction workers.

CFA Assessment

The former ponds are located predominantly outside of the building footprint. However, there is the potential for the creation of some contaminated pile arisings in relation to the southernmost of the proposed buildings if CFA piles are utilised. However, this is not an additional pollutant pathway as it is possible that excavation of the pond Made Ground may be required during the earthworks. This pollution scenario is to be addressed by materials management and site working practices as detailed in the Remediation Strategy reference R/14459/004. In summary, measures will include segregation and disposal of contaminated materials, along with appropriate PPE for site workers handling such material. It is therefore considered that the risk of CFA piling creating an additional risk to site workers is negligible.

Driven Assessment

For driven piles there is no removal of soil, and consequently there is no risk from this linkage scenario.

Pollution Scenario 4 - Degradation of Pile Materials

The following potential pollutant linkage has been assessed:

- Source – Elevated concentrations of contaminants in soil / groundwater.
- Pathway – Direct contact with pile.
- Receptor – Built development – piles.

With regards to both a CFA pile or a driven pile, testing has been undertaken in accordance with BRE SD1 to ensure buried concrete is capable of withstanding the aggressive chemical environment present at the site. The results of the testing are presented in the Ground Investigation Report and indicate that that a DS-2, AC-2 specification is required for buried concrete at the site.

The concrete piles proposed will be designed to be capable of resisting the levels of contamination indicated and concrete will be designed to resist sulphate attack, and so no significant risk exists.

Upon the adoption of the above mitigation the risks in relation to Pollution Scenario 4 are low.



Pollution Scenario 5 - Driving Down Solid Contaminants

The following potential pollutant linkage has been assessed:

- Source – Contamination in the Made Ground.
- Pathway – Soil driven down with pile.
- Receptor – White Chalk (Principal Aquifer).

CFA Assessment

As the proposed piles are CFA, spoil will be augered upward and removed from the pile bore, therefore there is considered to be no risk of driving contaminated soil downward. Therefore, pollution scenario 5 can be discounted.

Driven Assessment

During pile installation, soil will be displaced laterally as opposed to vertically. There is a significant thickness of Alluvial clay (Raised Marine Deposits) separating the small amount of Made Ground present at the site and the receptor.

The near surface soils are Alluvium and these soils are soft and plastic hence unlikely to be displaced via punching shear upon pile installation. The soil will therefore be displaced horizontally. Therefore, the risk associated with vertical displacement of contaminants is considered negligible.

Pollution Scenario 6 - Contamination by Concrete, Cement or Grout

The following potential pollutant linkage has been assessed:

- Source – Concrete, cement paste or grout.
- Pathway – Flow within highly permeable or fractured strata.
- Receptor – Groundwater and abstractions.

CFA Assessment

The ground investigation has generally found the Drift and the White Chalk at the site to be highly weathered and clayey, therefore there is limited potential for driving concrete into the surrounding strata.

During the installation of CFA piles, concrete pressure, the rate of extraction of the auger and the total volume on concrete used are monitored as part of the installation process. It is essential that piles do not “waist” for the purposes of constructing a stable pile capable of supporting the design loads. If it is found during installation that concrete is being lost into the surrounding ground, corrective action will be taken. This will involve either changes in the pressure and/or rate of concreting or the use of sleeving to contain concrete within the pile shaft. Therefore, with the adoption of sound piling practice, Hydrock does not believe this pollution scenario will occur.

Driven Assessment

With regards to driven piles, the risk is negligible as precast concrete piles are cured prior to driving.

11.0 Conclusions

Piling is proposed on Land at Oldlands Farm, Bognor Regis in relation to two proposed industrial/warehouse buildings.

At this stage, either CFA piles or driven piles may be used.

With regards to the risks from piling, the above assessment, undertaken in general accordance with the risk assessment flowchart from National Groundwater & Contaminated Land Centre Report NC/99/73 (figure 6.1), no additional Source - Pathway - Receptor pollutant pathways will be created by the piling operations. As a result, subject to agreement of the above assessment by the regulators, either CFA piles or driven piles can be utilised at the site, dependant on specialist technical advice with regards to the installation of piling.

Cont.....



Should you require any further information, please do not hesitate to contact me.

Yours sincerely,
for **Hydrock Consultants Ltd**



Richard Brown
Senior Geotechnical Consultant





NOTES:

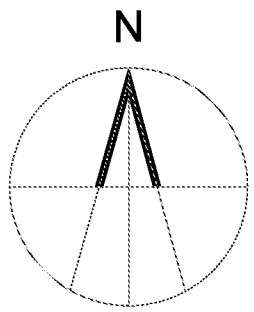
SUBJECT TO STATUTORY CONSENTS

BASED ON MALCOLM HUGHES LAND SURVEYOR'S
TOPOGRAPHICAL SURVEY (DRAWING No. 16473 / 1)

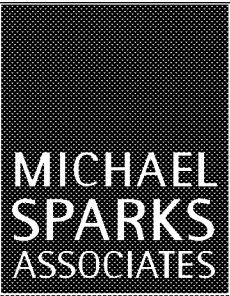
BASED ON OS MAP REPRODUCED BY PERMISSION OF
CONTROLLER OF HM STATIONARY OFFICE (c) CROWN
COPYRIGHT

COPYRIGHT RESERVED
DO NOT USE ELECTRONIC VERSIONS OF THIS DRAWING TO
DETERMINE DIMENSIONS UNLESS SPECIFICALLY
AUTHORISED BY MICHAEL SPARKS ASSOCIATES

IF USING AN ELECTRONIC VERSION OF THIS DRAWING
FIGURED DIMENSIONS TAKE PRECEDENCE AND NOTIFY
MICHAEL SPARKS ASSOCIATES OF ANY DISCREPANCIES



B	23.06.14	GENERAL AMENDMENTS	PF	NSC
A	20.06.14	GENERAL AMENDMENTS	PF	NSC
REV	DATE	NOTE	DRAW	CHK



REGISTERED ARCHITECTS
11, AUSTIN ROAD
SUTTONS ROAD
LUTON LUK 4EJ
TELEPHONE 01297 7726 8153
FAX 01297 7726 8154
www.msparks.co.uk

TITLE
OLDLANDS FARM, BOGNOR REGIS
DRAWING
SITE LOCATION PLAN

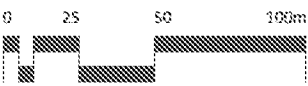
CLIENT
BERICOTE PROPERTIES LTD

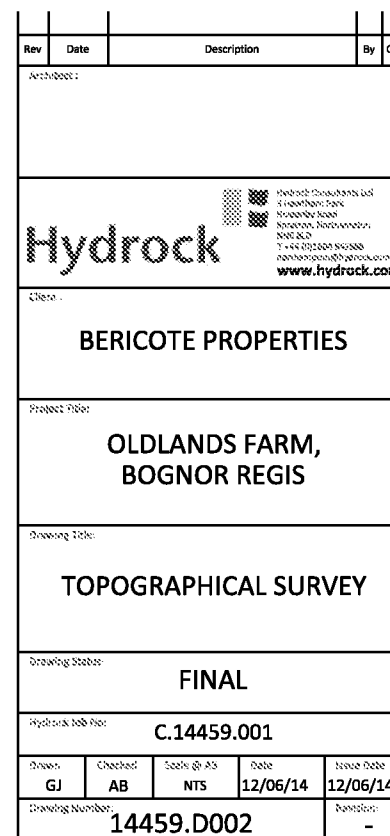
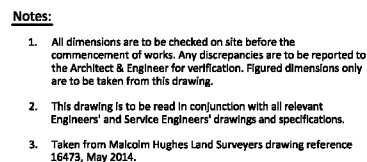
DATE JUNE 2014	SCALE 1:2500@A1	DRAWN PF
	STATUS PLANNING	CHECKED NSC

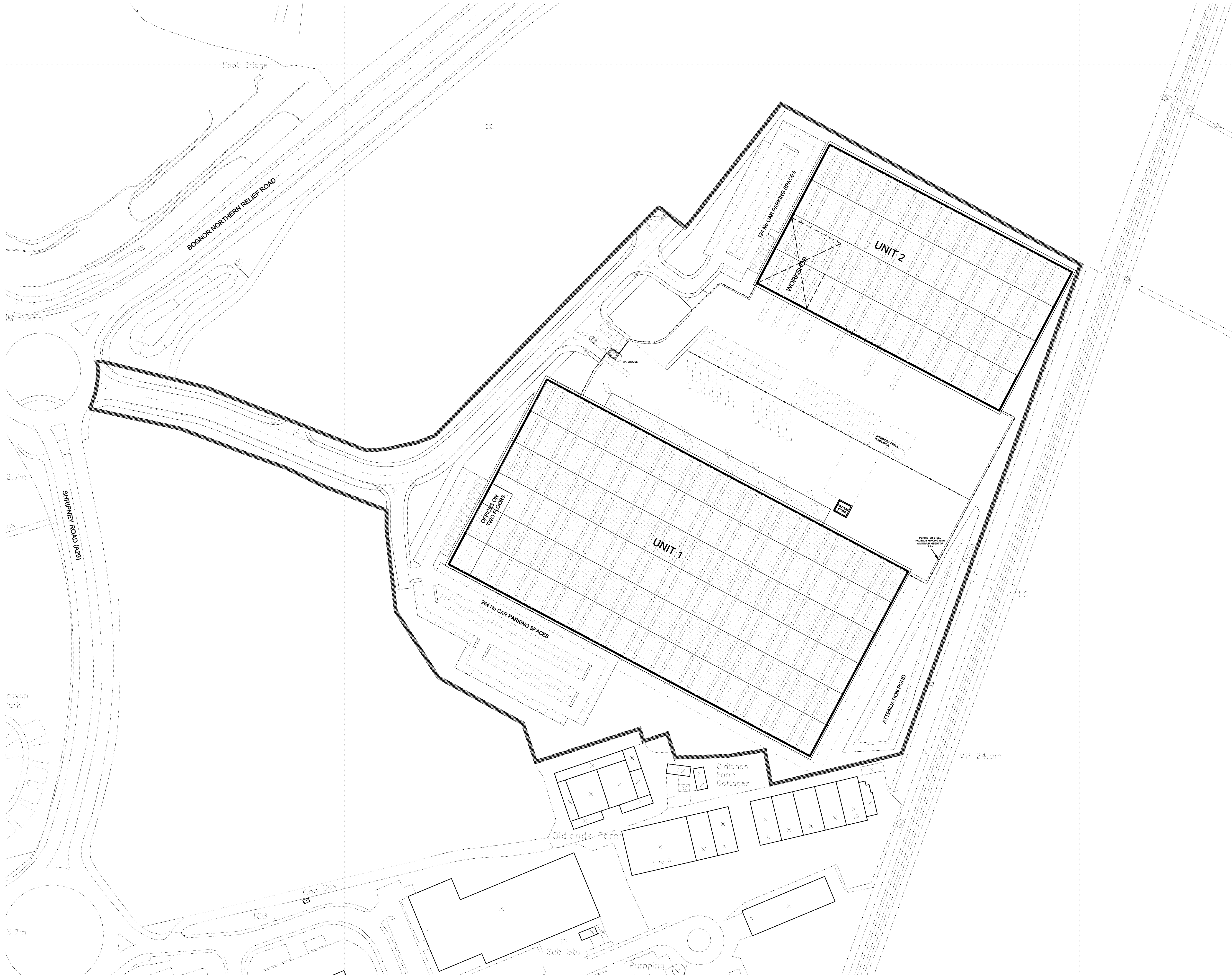
DRAWING NUMBER
30699-PL-100B

01
100

SITE LOCATION
1:2500







NOTES:

SUBJECT TO STATUTORY CONSENTS

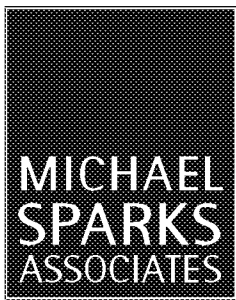
BASED ON MALCOLM HUGHES LAND SURVEYOR'S
TOPOGRAPHICAL SURVEY (DRAWING No: 16473 / 1)

BASED ON OS MAP REPRODUCED BY PERMISSION OF
CONTROLLER OF HM STATIONARY OFFICE (c) CROWN
COPYRIGHT

COPYRIGHT RESERVED
DO NOT USE ELECTRONIC VERSIONS OF THIS DRAWING TO
DETERMINE DIMENSIONS UNLESS SPECIFICALLY
AUTHORISED BY MICHAEL SPARKS ASSOCIATES

IF USING AN ELECTRONIC VERSION OF THIS DRAWING
FIGURED DIMENSIONS TAKE PRECEDENCE AND NOTIFY
MICHAEL SPARKS ASSOCIATES OF ANY DISCREPANCIES

A	20.06.14	GENERAL AMENDMENTS	PF	NSC
B	23.07.14	NEW ROAD LAYOUT ADDED	PF	NSC
C	24.07.14	BOUNDARY AND SERVICE AREA UPDATED	PF	NSC
D	28.07.14	BATTERY STORE REPOSITIONED	PF	NSC
REV	DATE	NOTE	DRAW	CHK



CHARTERED ARCHITECTS
11 PLATO PLACE
STUDIOS ROAD
LONDON SW6 4TU
TELEPHONE 020 7736 8162
FAX 020 7736 3696
www.mso-architects.co.uk

TITLE
OLDLANDS FARM, BOGNOR REGIS
DRAWING
SITE LAYOUT PLAN

CLIENT
BERICOTE PROPERTIES LTD

DATE JUNE 2014	SCALE 1:1000@A1	DRAWN PF
STATUS PLANNING		CHECKED NSC

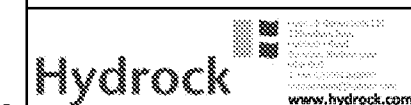
DRAWING NUMBER
30699-PL-101D



2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

- | | |
|---|----------------------------------|
|  | TRIAL PIT |
|  | TRIAL PIT SOAKAWAY |
|  | BOREHOLE |
|  | STATIC CONE PENETRATION TEST |
|  | MONITORING WELL |
|  | EXTENT OF RAISED MARINE DEPOSITS |
|  | BACKFILLED FORMER PONDS |
|  | SITE BOUNDARIES (APPROXIMATE) |
|  | PROPOSED BUILDINGS |
|  | EXISTING GAS MAIN |
|  | LOCATION OF WELL |

A	13-08-14	Site Boundary updated	SD	Al
Rev	Date	Description	By	Chk



OLDLANDS FARM
BOGNOR REGIS

Site Zonation Plan

INFORMATION

C/14459

Nome	Cognome	data di N.	data	data fine
AB	CV	1:1500	23/05/14	13/08/14
Numero Protocollo				Sezione
14459/D006				A