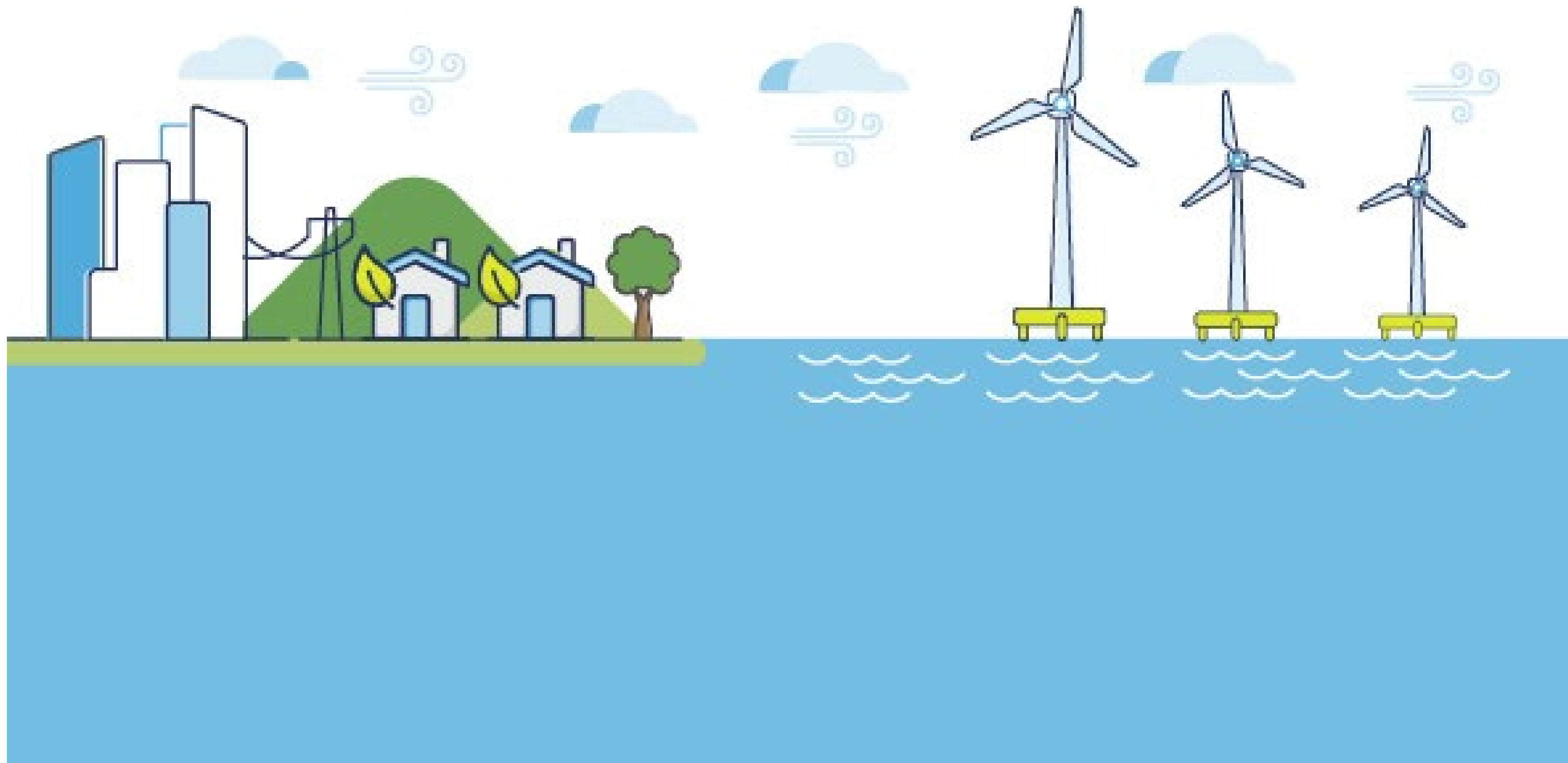
White Cross Offshore Windfarm Bentonite Management Plan

Technical Information Note – HDD Drilling Fluids



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TECHNICAL INFORMATION NOTE – HDD DRILLING FLUIDS

SIGNATURE:					
B03	27.03.24	Final	Chris Hobman Project Manager	S Stephens Specialist Project Director	Gearoid O'Connell Director
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CONTENTS

1 INTRODUCTION

Please read the entirety of this document to assist with any potential questions related to "drilling fluid".

Further this is a technical note and does not negate or allow Stockton's to abscond from developing appropriate site-specific designs, method statements and risk assessments.

This document is written to provide the reader with a high-level overview of 'Bentonite' in the trenchless environment.

This Technical Information Note (TIN) is to summarise bentonite drilling fluid, potential risks and subsequent mitigation measures for the major trenchless crossings.

1.1 EXECUTIVE SUMMARY

The risk of bentonite break out at the major trenchless crossings is classed as a remote possibility with a minor severity (see section 8 Risk assessment matrix for definitions) due to the following reasons:

1. Preliminary design of the directional drills will be conducted to identify suitable depths of the HDD bore path using a mixture of desk top studies and onsite surveys.
2. Routes which pose a high risk of bentonite break out will be eliminated
3. The route will be designed at a suitable depth to ensure it is in a competent homogenous geological layer.
4. Weaker un-cohesive layers are being cased through to prevent a breakout during the initial shallow stages of the drill or removed ensuring drilling commences from rockhead.

The remainder of the document addresses how the summary points raised within the 'Executive Summary' were reached.

2 BENTONITE

2.1 WHAT IS BENTONITE

The drilling fluid used during trenchless crossings including HDD (Horizontal Directional Drilling) comprises of bentonite as the primary base (a mined clay) which is delivered to site as a dried and finely ground powder. This is rehydrated in the temporary mix tank with potable water. In addition to the bentonite, the drilling fluid contains carefully chosen additives to control its rheological properties (See 2.3 for further information).

2.2 BENTONITE USES

Drilling fluid, a composite made of Bentonite and water has the following functions:

- To remove cuttings from in front of the drill bit
- Power the mud motor
- To transport cuttings from the drill face through the annular space towards the surface
- Lubricate the drill string during drilling phases and HDPE strings during pullback

- Cooling the reamers (cutting tools)
- Hole stabilization
- Creation of a filter cake against the wall of the hole to minimize the risk of loss of drilling fluid or influx of groundwater penetration into the borehole.

2.3 BENTONITE CONCENTRATIONS

The characteristics of drilling fluid, especially the viscosity can be adjusted during the drilling phases by changing the structure of the composite.

The drilling fluid consists of a low concentration bentonite – water mixture. Depending on the formation to be drilled through, the typical concentration is between 13 litres (30kg) and 35 litres (80kg) of dry bentonite clay per m^3 of water.

The use of bentonite has a number of benefits:

- It is a natural material, and chemically inert
- It is recyclable
- It is on the PLONOR[1] list, so discharge onshore or offshore is not toxic to the environment[2]

An example of a bentonite Materials Safety Data Sheet (MSDS) is presented in section 6

There is little to no valuable guidance from onshore government bodies regarding the use of bentonite due to the materials non-hazardous label, we therefore reference PLONOR within this document as the list is maintained by CEFAS[3] which is an executive agency of the United Kingdom government Department for Environment, Food and Rural Affairs. This confirms the 'non-hazardous' rating of the product as demonstrated by the MSDS within section 6

2.4 OTHER DRILLING MATERIALS

The Offshore Chemical Notification Scheme (OCNS) applies to chemicals that are intended for use and discharge in the exploration, exploitation and associated offshore processing of petroleum in the UK and Netherlands.

The scheme is regulated in the UK by the Department for Business, Energy & Industrial Strategy (BEIS) using scientific and environmental advice from CEFAS.

Stockton will ensure that all drilling materials used are CEFAS or OCNS (Centre for Environment, Fisheries and Aquaculture Science) rated.

[1] PLONOR Poses Little Or No Risk
[2] Discharge is not planned for this project
[3] CEFAS The Centre for Environment, Fisheries and Aquaculture Science

2.5 DRILLING FLUIDS SYSTEM, VOLUMES AND DISPOSAL

The drilling fluids system consists of a generator, mix and recycling units, high pressure mud pump, 150mm slurry pumps (for drilling fluid), holding tanks, mud reception pits. The fluids handling system is typically bunded to mitigate any drilling fluid releases. Stockton equipment is relatively new and is maintained to a high standard by our plant department. If hired equipment is required, then Stockton only hire from reputable suppliers that it has long standing relationships with.

SDL will arrange for fresh water to be delivered to the drilling location. This will be either from a nearby river or provider of water and stored in holding tanks to be used for mixing. The fresh water will be mixed with Bentonite until the desired values for the composite are reached. From there, the drilling fluid will be transported by the high-pressure mud pump, which is connected to the rig. Normally a capacity of 3 to 4m^3 per hour is needed during drilling phases. In case of drilling fluid loss, a capacity of 60 to 120m^3 per hour is required. The pumps are sized to meet this requirement.

A mud reception pit, situated at the entry point of the HDD, creates a first “holding” possibility for drilling fluid. From there, the drilling fluid will be transported by slurry pumps to the recycling unit to separate drilling fluid from cuttings. Recycled drilling fluid will be stored in tanks to be used in each drilling/reaming phase. The mix, settling and holding tanks typically have a total capacity of 80m^3.

Parameters of drilling fluid will be monitored and registered on a regular base throughout the drilling phases.

Monitoring includes:

- Registering amount of Bentonite added to the drilling fluid;
- Measuring viscosity of drilling fluid;
- Measuring percentage of sand in drilling fluid;
- Measuring specific gravity of drilling fluid.

Results will be registered in Bentonite reports.

At the feasibility stage, the 3 major crossings volumes of the crossings are calculated on the reaming diameters from the hydrofracture calculations as follows.

- River Taw 24” diameter ~ 357m^3
- Golf Course 24” diameter ~ 345m^3
- Landfall (included for completeness although option is now dropped) 44” diameter ~ 1805m^3

These volumes are converted to the “Bulked” volumes that are needed to be disposed of. These are at feasibility stage:

- River Taw ~ 536m^3
- Golf Course ~ 517m^3
- Landfall (included for completeness although option is now dropped) = 2707m^3

The feasibility stage volumes of drilling fluid to be disposed of are:

- River Taw ~ 160m^3

- Golf Course ~ 158m^3
- Landfall (included for completeness although option is now dropped) ~ 50m^3 due to there being no internal duct.

These volumes could significantly reduce at detail design stage as reamed diameter is defined.

Please note that the volumes to be disposed of are removed over the period of the drilling programme, not all at the end of the drilling campaign.

The usual method of disposal for the cuttings is to landfill. The drilling fluid has two options to be considered. First option is to dispose of to landfill. However, the bentonite in the drilling fluid is nutritious to plants. Consequently, this has often been offered to farmers as a topdressing for their fields and spread by them in a similar manner to animal slurry.

3 RISK OF BENTONITE BREAKOUT

3.1 BENTONITE LOSS TO SURFACE

Surface breakout most commonly occurs within the first 30m from entry and a competent contractor will avoid this on 90% (Subjective, based on industry experience) of projects. This is due to the drill being shallow and not yet at the optimum drill depth as identified within the cross-section drawings and in detail design. Document FLO-WHI-TEC-013 Rev 02 a Feasibility Stage HDD Hydrofracture Assessment has been completed for the major HDD routes. In order to remain conservative and to mitigate any unseen permeable ground, the geotechnical parameters have been selected to represent a coarse gravel with some cohesion, to best represent a highly fractured rock, as this is considered the worst-case scenario in terms of hydrofracture, owing to the additional voids through which drill fluids could migrate.

The River Taw crossing as detailed in Section 2.2.1 says "The rock encountered in BH14 (located north of the River Taw) typically encountered very weak to weak siltstone or mudstone and was recovered predominantly as non-intact angular gravel and gravelly clay. The rock encountered in BH15 (located south of the River Taw) typically encountered medium strong to strong, locally weak, siltstone, with very close to medium spaced fracturing. Locally recovered as a gravelly clay in places. On this basis, in order to remain conservative, the selected geotechnical parameters have been selected to represent a coarse gravel as this is the worst-case scenario in terms of hydrofracture." The Golf Course Crossing Section 2.2.2 says "The rock encountered in all relevant boreholes was typically siltstone and was recovered as predominately competent rock, with closely to medium spaced fractures".

This feasibility stage hydrofracture assessment demonstrates that there is no significant risk of frac-out along both bore profiles except for at the entry and exit points of the Taw and Golf Course crossings as is expected as the cover depth is low at the entry and exit points. There is Mitigation measures (Casing, bunding) to ensure the risk is reduced to ALARP will be part of the detail design. Updates to the calculations in the hydrofracture document need to be carried out as the project design progresses.

Stockton will have a person walking the drill alignment as far as reasonably practicable (Within agreed site boundaries) checking for breakout. If detected the drilling is stopped immediately and the spill contained and removed.

We will maintain a stock of ready filled sandbags on site to contain a breakout if it occurs and a small pump with flexible hose to pump the bentonite back to the entry pit.

Drilling fluid (bentonite) can sometimes break out of the bore in case of highly fissured clay, gravels or where there are large, interconnected fissures in the ground.

Breakouts may also occur where man made features are present (e.g. old SI boreholes). In the event of egress of drilling fluid from the bore it is only likely to reach ground level where there is a continuous path available to the surface.

The risk of a bentonite breakout during drilling cannot be fully assessed beforehand[4] however any decrease in the mud volume returning to the entry pit will trigger the need for suitably experience personnel to closely monitor the area around the drilling head.

For this reason, a close watching brief during drilling activities and a detailed contingency and communication plan is essential to ensure that any drilling fluid breakout is contained, bunded and pumped back to the entry pit with minimum disturbance to the surrounding environment.

Specific mitigations and control measures to mitigate the risk of bentonite breakout are further detailed in Sections 4 and 6 of this document. Post consent, a construction methodology will be developed. This methodology will further detail the methods needed to mitigate and assess the risks of any bentonite breakout or spill.

3.2 BENTONITE LOSS TO VOIDS

During drilling in ground with high permeability (e.g. peat) or voids (e.g. chalk) drilling fluid can be lost to the ground. Good ground investigations and good design are the main tools in mitigating this risk for the project. If fluid is lost to the ground the mud man (drilling fluids engineer) will quickly identify the losses because of the falling fluid levels within the mud tanks. Generally, the mud man will identify any losses greater than 2m^3 in volume. Pumping will then be stopped, and action taken to seal the area of loss using the protocol that will be detailed in the project CEMP. Communication of any losses to voids will be reported to the Stockton Drilling Ltd drilling/site manager and they will inform the client's representative. The communication protocol is typically detailed in the clients CEMP.

4 BENTONITE BREAKOUT MITIGATION

4.1 DRILLING PROCEDURE

A key component of avoiding breakout is effective removal of the cuttings from the borehole. If cuttings are not removed they form cuttings beds on the base of the borehole, decreasing the cross sectional area of the borehole. This causes an increase in annular pressure and therefore increases the risk of breakout. Cuttings in the borehole also lead to increased drilling forces and can eventually cause equipment to be lost or stuck downhole.

[4] Mitigation measures discussed in the following pages

Stockton's will be proactive in ensuring that cuttings are effectively removed and will spend additional time and effort to reduce the risk of both breakout and stuck equipment.

An additional tool that is recommended by the hydrofracture feasibility study to assist in monitoring the state of the borehole is Downhole Annular Pressure Monitoring. Supplied as a standard add-on to the guidance equipment the tool measures the pressure in the borehole annulus in real-time. The actual value can be compared to limit values calculated from hydro fracture analysis to avoid damaging the ground surrounding the HDD during hole drilling. By avoiding any over-pressuring of the surrounding ground, the risk of surface breakout is greatly reduced.

Minimising breakout / Frac out impact	
Risk	**Mitigation Measures**
Breakout of drilling fluid to the surface during drilling	Detail design of the cable landfall, showing geological layers and intended drill path
	HDD design has sufficient depth below surface for the expected ground conditions
	Hydro fracture analysis and calculation
	Monitoring of drilling fluid returns and volumes to warn of inadequate hole cleaning
	Drilling fluid to be of sufficient viscosity and properties for the ground being drilled
	Real time downhole annular pressure monitoring to warn of over pressurising by drilling fluid (Pressure set by hydro fracture calculation)
	Have lost circulation materials on site to seal and contain any breakout. This will include sandbags and silt fencing to minimise any ground suffocation.

4.2 SITE MONITORING AND COMMUNICATION

During the construction phase the following onsite communication modes shall be adopted:

Project Communication Modes			
Project Level	**Site Project Meetings (including relevant stakeholders)**		
Work-gang	Daily Toolbox Talks	Health & Safety Inductions	Method Statement Briefings
Individuals	Directly with each employee		'Open door policy'

Drilling mud breakouts are only likely to happen when the fluid is under pressure, so during drilling, site monitoring will be carried out by dedicated, competent and suitably experienced personnel.

The site to be monitored[5] will include an area of 100m in front or behind the drill head and 30m either side of the centre line of the drill route.

[5] Area based on high level information, subject to detail design

The site will be divided into areas which will be checked regularly. Records shall be maintained of inspections.

In addition, a downhole annular pressure sensor will be used during drilling. The maximum allowable annular pressure according to the design calculations will be plotted on the screen within the drilling control cabin with an alarm sounding if we get to 90% of that allowable limit.

If the allowable pressure is exceeded, We shall stop drilling and retract the drilling assembly until the blockage has been cleared before continuing to drill.

4.2.1 ANNULAR PRESSURE MONITORING

In addition to the Feasibility stage hydrofracture assessment document Stockton's detail design will include Hydrofracture calculations that will be carried out by suitably qualified personnel using the factual geotechnical / Interpretive report to ascertain actual pressures required to cause an inadvertent drill fluid release. This calculation is graphed against chainage (Distance) and vertical elevation. The graph will include plotted lines representing the following parameters:

- The topographic surface;
- The vertical bore hole alignment;
- The minimum pressure required to create fluid returns in the entry pit (P_{min});
- The maximum allowable pressure ground could withstand without hydrofracturing (P_{max});
- The design must prove that P_{min} will remain lower than P_{max} There will then be a safety factor applied and a downhole pressure sensor utilised to ensure that the pressures are not exceed.

During the drilling of the pilot hole the onsite project team must plot the actual annular pressure on to the theoretical graph mentioned above in real time. The Contractor is to act accordingly if P_{min} approaches P_{max}. Measures such as cleaning the hole, reducing the fluid pressure, reducing the rate of penetration (ROP) should be implemented.

Evidence of calibration of the pressure sub tool shall be submitted to the Clients Representative prior to commencement of the pilot bore or before re-entering the pilot bore if removed.

4.3 SITE REPORTING

The following table provides a list of recommended documents that are to be completed during directional drilling, they all play a role in ensuring we follow best practices which further minimises the risk of bentonite break out.

Detail design shall dictate which documents become a requirement and the contract shall dictate the handover / frequency of reporting details

HDD Record / Report	Included Information	Handover Frequency / Details
Rig Log (Pilot, Reaming and Conditioning)	Rod time, torque and carriage forces. Geology and fluid comments (returns / losses).	By noon the next day.
Steering Log	Azimuth, length and inclination. 3 & 10 joint checks. Position to be referenced to the designed alignment.	By noon the next day.
Rate of Penetration Chart (ROP)	Rod cutting time. Face time. Rig gear / forces. Bit size.	By noon the next day.
Annular Pressure Graph	P_{min}, P_{max} and P_{actual}. Bore profile, ground level.	By noon the next day.
Pipe Pull Back Logs (Casing and Carrier)	Rod time, torque and carriage forces. Fluid comments.	By noon the next day.
Filling and Pre-Hydro Test Logs	Water quantity, times and pressure.	By noon the next day.
Grouting Logs (If Rqd')	Grout quantity, times and pressure.	By noon the next day.
Plotted Pilot Hole AsBuilt (real time)	Plotted as-built bore path relative to the designed and planned bore path.	By noon the next day.
Welding Logs	Welder, weld type, number, date, if tested and rods used.	By noon the next day.
Resources	Details of plant materials and labour	By noon the next day.
Settlement Logs (If Rqd')	Details of settlement or heave along the HDD alignment.	Weekly

5 LOST CIRCULATION MATERIALS

Lost circulation is the loss of drilling fluid from the borehole through cracks, crevices, or porous formations to surface or voids and is referred to in the industry as a 'breakout' It can be partial or complete, depending on the conditions. Lost circulation is sometimes referred to as lost returns, either partial or complete, because part or all of the fluid fails to return to the surface. When circulation is lost, the drilling fluid is not performing one of its major functions, that of transporting the cuttings up the hole where they can be released in the mud tank or pit. If the cuttings are not removed from the hole, they will pack around the drill string above the bit, resulting in stuck pipe and possible loss of the bit, collars, part of the string and perhaps, the hole.

If the geological formation being drilled through has large cracks or crevices, the fluid may carry the cuttings into the formation and away where they cannot pack around the drill string, but there is no way of being assured that this is the case. Drilling without circulation is known as drilling blind. Complete loss of circulation usually results in the fluid level dropping to considerably below the surface with the resultant complete or partial loss of fluid pressure stabilizing the hole walls.

Lost circulation is probably the most important problem encountered in drilling. It results in:

1. loss of expensive fluid components,
2. loss of drilling time
3. use of potentially expensive lost circulation materials (inert organic polymers such as Guar gum or materials such as crushed walnut shells). This will be defined at the detail design stage.

Despite the severity of the problems, most industry experts agree that probably one-half the lost circulation problems can be avoided, and many are driller induced. Proper planning and rig operation are important.

The route of all the directional drills will be carefully selected to ensure it is suitable for the trenchless methodology of directional drilling.

Calculations will be conducted at detail design stage to select a rig size that minimises the annular pressure. Thereby reducing the risk of frac outs at the surface.

At this stage, potential leakage volumes have been considered for the major crossings and the shore approach.

Potential leakage volumes during drilling will be as per section 3.2 (2m^3) this is where when pressures and returns are seen to be out with the detail design parameters. Note that this is loss of mud, not pure bentonite. The concentration of bentonite at this stage is calculated to be ~17.5Kgm^3. However, all of the volumes above will be refined during detail design.

6 BENTONITE BREAKOUT CLEANUP

Stocktons shall develop and produce a detailed bentonite breakout plan / methodology to be included in the Project CEMP. A typical outline of materials and method is included below. For the major trenchless crossing a detailed breakout plan and methodology will be developed as part of detailed design. The following outlines the materials and method/sequence of mitigating contamination by any breakout.

We shall have available at all times:

1. Silt fencing
2. 4" mobile suction pump, or similar
3. Seal pups (Industry brand name for large sausage shaped containment and absorption pad) or similar
4. Straw bales or similar
5. Timber stakes or similar
6. Sand bags or similar
7. Small tools for erecting temporary bunds (silt fencing).

The following sequence shall be followed following a breakout[6]:

1. Once the break out / frac out location has been identified the priority is personal safety and then containment.
2. The drilling activity will be immediately stopped – therefore the fluid decreases in pressure, stopping further fluids migrating to surface.
3. Locate the frac out / break out (15 to 30 minutes)
4. Most surface breakouts are quantifiable in litres of fluid and contained using straw bales and silt fencing to contain the fluid (15 to 30 minutes)
5. The drill fluid is then covered with absorbent granules to increase the viscosity to enable the drilling fluid to become a thick clay that can be removed from surface (15 minutes)
6. All of the drilling fluid at surface level can and will be removed back to the drilling compound (60 minutes)
7. In the extremely unlikely (Due to prior planning as identified above) event of a larger break out quantifiable by cubic metres of fluid the priority is always containment.
8. Containment is by the use of silt fencing and straw bales (30 to 60 minutes)
9. Due to the larger volume of fluid to recover a vacuum tanker, or suction pump and hose may be utilised to remove the fluid off the ground. (8 hrs)
10. Remaining deposits would be cleaned and removed from site by hand (60 minutes)

[6] Durations provided in this section are based on information currently available and existing high-level design

7 EXAMPLE BENTONITE MATERIALS SAFETY DATA SHEET

MSDS

CLEAR SOLUTIONS
Performance Drilling Products
The Earth Can Trust

PRODUCT NAME: Ultrabore®

Safety Data Sheet No: 5002EC

1. Identification of the Substances and Details of the Company

Product Description: Drilling Fluid Additive
Company Name and Address:
Clear Solutions International Ltd
Unit B3, Wem Industrial Estate
Soulton Road
Wem
Shropshire SY4 5SD
UK

Date Prepared: August 2009
Issue No: 3
Date Reviewed: March 2016

Tel: +44 (0) 1939 235754
Fax: +44 (0) 1939 232399
Email: info@drilling-products.com

2. Hazards Identification

Classification of the substance
Classification Regulation (EC) No 1272/2008: not hazardous
Classification Directive 67/548/EEC, 1999/45/EC: not classified

Label elements
Labeling Regulation (EC) No 1272/2008: not classified

Other hazards
Not applicable

3. Composition/Information on Ingredients

Substances
Chemical nature: Naturally occurring mineral
CAS No. 1302-78-9
Consists mainly of montmorillinite with < 10% accessory minerals (quartz, feldspar, mica and calcite). Respirable Crystalline Silica (<7.1µ) may be present at <1% and therefore not classified as hazardous.

4. First Aid Measures

Skin Contact: Rinse thoroughly with cold water and seek medical attention if symptoms persist.
Eye Contact: Rinse thoroughly with cold water and seek medical attention if symptoms persist.
Inhalation: Remove person to fresh air, and if symptoms persist seek medical attention.
Ingestion: Drink several glasses of water or milk. If large quantities are ingested seek medical attention.

5. Fire Fighting Measures

Non combustible - when extinguishing fires bear in mind product becomes slippery when wet.

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MSDS

PRODUCT NAME: Ultrabore®
Safety Data Sheet No: 5002EC

6. Accidental Release Measures

Personal precautions: Do not breathe dust – see section 8. Becomes slippery when wet.
Environmental risk: Non-toxic.
Cleaning up: Sweep or vacuum up and dispose of as non-toxic waste.

7. Handling and Storage

Handling: Avoid the creation of dust, and ensure adequate ventilation at point of use. See section 8.
Storage: Store in clean, dry environment.

8. Exposure Controls/Personal Protection

Hand Protection: Use barrier creams and rubber gloves as required.
Skin Protection: Normal work wear.
Respiratory Protection: Use dust masks. Ensure adequate ventilation and dust control measures to maintain dust levels below OES* limit.
*OES level (Occupational Exposure Standard): Dry bentonite is classed as a nuisance dust with an 8 hour TWA for total dust inhalation of 10mg/m^3 and 5 mg/m^3 for respirable dust. Quartz present in small quantities in this product has a Maximum Exposure Limit (MEL) of 0.4mg/m^3 respirable dust for an 8 hour TWA period. (Respirable dust is that portion with a particle size <7.1µ).
Eye protection: Wear safety glasses.

9. Physical and Chemical Properties

Appearance:	Light grey to off-white powder
Odour:	Odourless
pH – 2% suspension:	7 – 9.5
S.G:	2.5
Solubility:	Forms suspension in water
Decomposition Temperature:	Not Evaluated
Flammability:	Non-flammable
Explosive properties:	None
Vapour pressure:	N/A
Flash point:	N/A
Melting point:	N/A
Boiling point:	N/A

10. Stability and Reactivity

Conditions to avoid: Avoid generation of dust. Slippery when wet.
Materials to avoid: Oxidising agents.
Hazardous Decomposition Products: None.

11. Toxicological Information

Ingestion: Orally non-toxic.

MSDS

PRODUCT NAME: Ultrabore®

Safety Data Sheet No: 5002EC

Eye contact: Causes irritation due to physical abrasion by dust particles.
Eye contact: Causes irritation due to physical abrasion by dust particles.
Skin contact: Non-toxic may cause skin dryness and chapping.
Inhalation: Long term exposure to bentonite dust in excess of the OES limit may result in fibrosis of the lung tissue. The presence of respirable crystalline silica may lead to silicosis if the MEL is persistently exceeded over a long time.

12. Ecological Information

Toxicity
LC_{50} (96hrs) Rainbow Trout: 16000 mg/l
LC_{50} (24hrs) C. dubia and H. limbata: >500 mg/l

13. Disposal Considerations

Dispose of in accordance with local and national regulations using an approved disposal contractor.

14. Transport information

There are no specific transport precautions required as product is classified as not dangerous but product should be kept dry as it becomes slippery when wet and avoid dust creation.

15. Regulatory Information

Dangerous Substances Directive 67/548/EEC and Dangerous Preparations Directive 88/379/EEC do not apply.
Follow safety guidelines S22 – do not breathe dust and use only in well-ventilated areas.
COSHH regulations 2002 apply in the UK.

16. Other Information

Typical uses of this product are civil engineering, oil well drilling, ceramics, foundry applications, land fill barriers, bore hole sealing.

The information herein has been compiled from sources believed to be reliable and is accurate to the best of our knowledge. However, CLEAR SOLUTIONS INTERNATIONAL LTD cannot give guarantees regarding information from other sources, and expressly does not make any warranties, nor assumes any liability, for its use.

8 HIGH LEVEL RISK ASSESSMENT MATRIX

A High-Level Risk Register has been compiled for the directional drills.

The risk assessment method outlines the level of risk, prioritised in accordance with their probability and severity and classified into a risk category.

Probability (P)

Probability of Risk	1. Remote	Unlikely but conceivable
	2. Possible	May occur, could well occur
	3. Probable	May occur several times, occurs frequently

Severity (S)

Severity of Risk	1. Minor	H&S: Injury with short term effect, not reportable under RIDDOR. Environment: Nuisance to fauna and flora. Project: Minor changes required to achieve construction objectives with low cost and/or delivery implications
	2. Severe	H&S: Major injury or disability or ill health with long term effect reportable under RIDDOR, single fatality. Environment: Potentially fatal to fauna and flora for days / weeks. Project: Major changes required to achieve construction objectives with significant cost and/or delivery implications.
	3. Extreme	H&S: Multiple fatalities. Environment: Detrimental to local ecosystem for months / years Project: Catastrophic impact to construction objectives.

Risk Category (R)

Probability/Severity	Minor	Severe	Extreme
Remote	1	2	3
Possible	2	4	6
Probable	3	6	9

1 – 2 > Risk is controlled as far as is reasonably practical, no further control measures necessary
3 – 4 > Risk is controlled as far as is reasonably practical
6 – 9 > Hazard should be avoided

9 HIGH LEVEL RISK ASSESSMENT

Item	Risk	Risk Classification			Mitigation Measures	Reduced Risk Classification		
		P	S	R		P	S	R
1	Breakout of drilling fluid	3	2	6	Monitoring of drilling fluid returns and volumes to warn of inadequate hole cleaning	2	2	4
					Drilling fluid to be of sufficient viscosity and properties for the ground being drilled	2	2	4
					Pilot hole stopped in competent ground before exit point and only advanced to exit when reaming to that point is completed	1	2	2
					Lost Circulation Materials available on site to seal any breakout	2	2	4
					Use of downhole pressure sensor	1	2[7]	2

[7] Score '2' = Severe, A Major bentonite breakout is very unlikely if all the mitigation measures are followed. However, there is always a chance that for example an old borehole was missed providing a 'conduit' for drill fluid to follow easily to surface.

10 MEDIUM LEVEL HDD RISK ASSESSMENT MATRIX

Potential Consequences:					A	B	C	D	E
Harm to People P	Environmental Impact E	Asset Damage A	Reputation Impact R		Never heard of in the industry	Heard of in the industry	Occurs several times per year in industry	Happens several times per year in company	Happens several times per year at location
No injury or damage to health	Zero effect	Zero damage	No impact	**0**	Low	Low	Low	Low	Low
Slight injury or health effects (including FAC and MTC), not affecting work performance, or causing disability	Slight effect; local environmental damage within fence and subsystems	Slight damage: no disruption to process (costs less than £10,000 to repair)	Slight impact: Public awareness but no public concern	**1**	Low	Low	Low	Low	Low
Minor injury or health affects affecting work performance (e.g. RWC or minor LTI < a few days, reversible health effects)	Minor effect: Contamination, single complaint, no permanent effect	Minor damage: Brief process disruption(costs less than £100,000 to repair)	Limited impact: Local public concern (e.g. may include media/political)	**2**	Low	Low	Low	Medium	Medium
Major injury or health effects (e.g. prolonged work absence, irreversible health damage)	Local effect: Limited loss of discharges of known toxicity, beyond fence	Localised damage: Partial shutdown (costs up to £1,000,000 to repair)	Considerable impact: Regional public or slight national media/political attention	**3**	Low	Low	Medium	Medium	High
1 to 3 fatalities or Permanent Total Disability from injury or occupational illness	Major effect: Severe environmental damage	Major damage: Partial operation loss, e.g. 2 weeks shutdown (costs up to £10,000.000	National Impact: National public concern. Mobilisation of action groups	**4**	Low	Medium	Medium	High	High
Multiple fatal injury or occupational illness	Massive effect: Persistent severe environmental damage	Extensive damage: Substantial or total loss of operation (cost in excess of £10,000,000	International impact: extensive negative attention in international media	**5**	Medium	Medium	High	High	High

HOW TO USE THE RAM:

1. For harm to People, select the severity of the consequence that could potentially harm people (0-5)
2. Estimate the likelihood of the potential outcome (A-E) using local knowledge. Likelihood is based upon previous occurrences of that potential consequence due to this type of incident.
3. Repeat steps 1 & 2 for Asset Damage, Environmental Impact and Reputation Impact
4. The “worst case” risk classification is then used in subsequent activities (e.g. selecting investigation owner and level of investigation). The “worst case” is the classification that gives the highest rating of LOW, MEDIUM or HIGH.
5. A “SIGNIFICANT” incident is one with an **actual** severity of 4 to 5

EXAMPLE:

1. An incident is estimated to have a potential severity of “3” under harm to People
2. How often have there been incidents of this type that has led to a severity of “3”? Answer: This happens several per year within company –“D”
3. Risk Classifications for Harm to People is D3 (MEDIUM)
4. Other Classifications estimated as:- Asset Damage=B2 (LOW) Environmental Impact=C3 (MEDIUM) Reputation Impact= A0 (LOW)
5. “Worst case” Risk Classification is: D3 - MEDIUM RISK

11 MEDIUM LEVEL RISK ASSESSMENT

Task & Hazard	Risk	Consequence and Frequency	Controls	Residual Risk Level
Management Management and control on site	Lack of adequate supervision on site, insufficient to control activities. Supervisors and managers not fully trained. Roles and responsibilities not clearly defined.	4B	Managers and supervisors have adequate training and experience. Kick-off meeting for all managers and supervisors. Roles and responsibilities are defined in procedures and method statements	L
Access and Egress Tripping and slipping hazards	Sprains and fractures	3C	Layout plant, equipment to provide safe access ways by routing cables and hoses to eliminate as far as possible the need to cross them. Where crossing unavoidable provide bridging and protection from overrun by plant.	L
	Injury to Third Parties	3C	Housekeeping. Keep footways clear of mud and slurry. Whilst positioning plant (pumps etc) ensure briefing is given to third parties prior to works commencing and banksman to be in attendance at all times when manoeuvring plant & lifting operation	L

Non authorised entry Other contractors and Third Parties	Various minor to serious personal injuries.	3C	Ensure plant is positioned out of the way of third parties and is clearly signed	L
Transport Movement of plant to site and on site.	Persons struck by vehicles, vehicles overturn or fall into excavation. Fatality, serious personal injury, damage.	4B	Relevant parts of Traffic Management Plan be communicated to suppliers and transport agents. Drilling site layout takes account of vehicle and pedestrian safety including: Excavator operating area will be segregated with suitable barriers. Pedestrian walkways will be segregated from vehicle routes where practicable. Plant to be checked upon arrival to site. Operator daily checks to include lights, warning devices and visibility aids. Public not allowed on site	L
Lifting Plant and Equipment Lifting Operations for positioning of clean up equipment	Fatality, Physical Injury property damage	4C	Lifting plan and operation to be controlled by Contractor. Contractor will obtain and forward all necessary information on equipment to allow lifts to be planned.	L

Bentonite Bentonite Spillage (i.e. on site a bag of bentonite splits)	If wet creates slip hazard	3C	Do not wash down spillage area. Contain, shovel up or pump away and bag spillages. Remove all trace from allotments.	L
Bentonite break out of drilling fluid from drill bore	Contamination of groundwater and water courses with bentonite. (Inert but classed as 'polluting matter') Localised effect on flora and fauna if not cleaned up. Unsightly deposits	3B	Precautions to be centred on vigilance, control, containment and clean up. The line of the bore shall be patrolled and inspected regularly for signs of breakout from the drill bore at the surface. The driller shall monitor pumping pressures continuously for signs of breakout. The mud mixing operative will monitor system volumes continually for signs of losses. Drilling to be ceased at first signs of breakout and contingency plans actioned. Contingency plans to be detailed in method statement. The driller, pipe side operators and patrolling crew shall be in radio contact at all times. Drilling shall be stopped immediately on any reports of breakout and contingency plans and emergency response procedures enacted. Drill fluid sourced from PLONOR list	L

Environmental Damage Diesel/Hydraulic oil spillage	Contamination of ground and/or water courses.	3C	Use self bunding diesel bowser and bunds to tanks. In case of spillage contain oil by creating earth bunds and soak up spill with absorbent material and dispose of in accordance with waste management plan. Plant to use Hydraulic BIO Oil	L
Emergencies Inadequate or inappropriate response to situation	Further injury or escalation of situation	4B	All operatives receive Contractor site induction and specific project induction. This covers all precautionary requirements and emergency response situations.	L
Work at Night	Increased risk of injury from other sources due to reduced visibility and operator fatigue	4B	Working to be restricted to daytime working hours. Only in an emergency would night time working be allowed in agreement with all Stakeholders	L
Risk Rating: See attached risk assessment matrix	**TRAINING REQUIREMENTS** Supervisor to advise crew of method statement and risk assessment. Site specific induction as required by host contractor/client or where particular site conditions present different hazards and require precautions additional to those identified in this risk assessment.			

REVIEWS: In line with any on site deviations and following regular discussions with workforce, supply chain and other stakeholders