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SOILS REPORT

Brinsworth Substation

Powercem Soil Stabilisation Trial

Final Report

May 2012

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1.0 BACKGROUND

1.1 The Electricity Alliance West is investigating alternatives to the use of conventional stone roads in providing access to agricultural land for construction of electricity infrastructure.

1.2 A demonstration trial has been undertaken at Brinsworth substation, near Rotherham, to assess the engineering performance and potential agronomic impacts occurring when topsoil is treated with cement and a strengthener/flexibility additive called powercem. The aim of this treatment is to create a temporary track surface for vehicular access to agricultural land during tower construction or maintenance.

1.3 Topsoils were treated at two rates of cement/powercem addition in September 2011. The soils were then compacted to form a temporary running surface which was used for a period of 6-8 weeks. The track was removed, cultivated and seeded with a winter wheat crop during early November 2011.

1.4 LDCL has been asked by The Electricity Alliance to undertake sampling and analysis of the soils at various stages of the trial to assess the impacts of this treatment technology on the agricultural soil resource. This report provides the results of these investigations

2.0 TRIAL PROTOCOL

2.1 Aims and objectives

- To determine whether topsoil could be treated with cement and powercem stabilised to form a temporary track suitable for access by construction traffic.
- Assess the impacts of treatment stabilisation on the agricultural soil resource
- Provide information on potential applications and use of soil stabilisation techniques for electricity infrastructure build and/or maintenance.

2.2 Trial layout

2.2.1 The trial site consisted of 2 plots of topsoil treated with cement and powercem at the following application rates:

- Treatment T1: 1 part powercem to 100 parts cement incorporated into 200mm of topsoil. This was considered to be an optimum treatment.
- Treatment T2 1.4 parts powercem to 140 parts cement incorporated into 200mm of topsoil. This was considered to be a slightly over-specified treatment.

The plot layout is shown schematically in Figure 1.

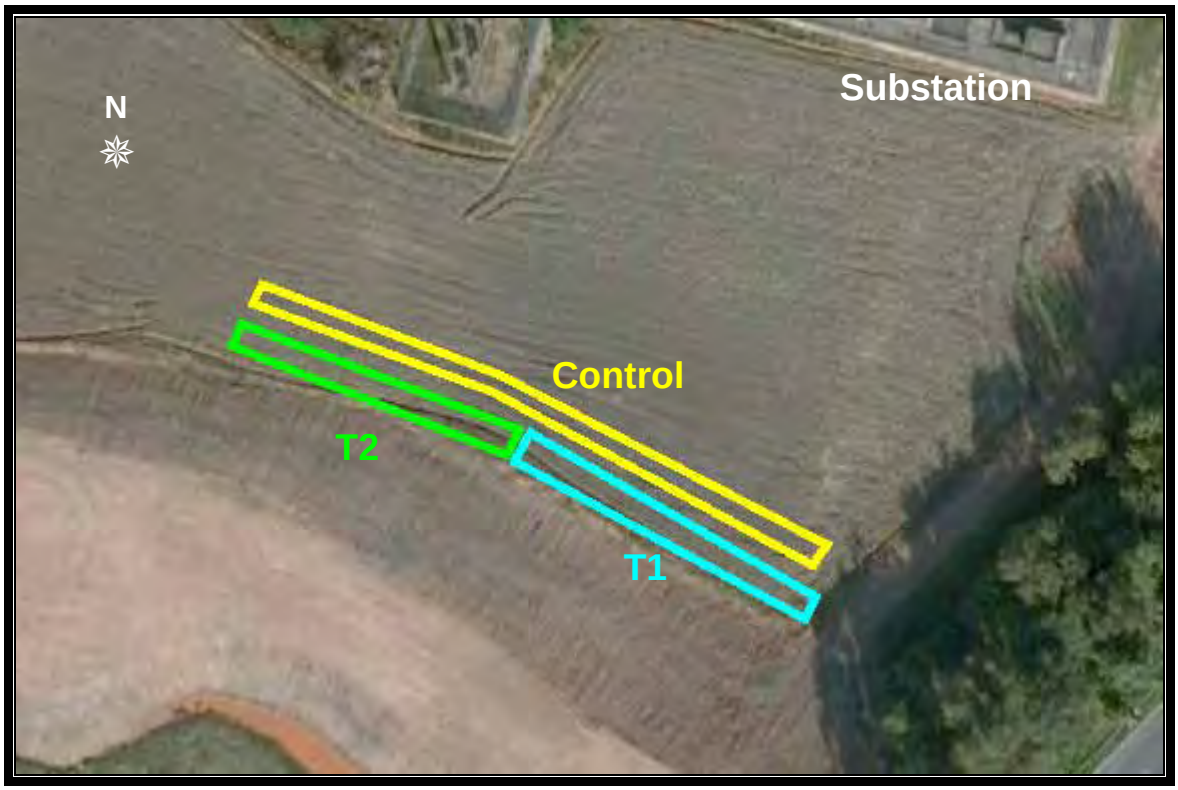
2.2.2 The soils in the field were medium to heavy textured and at the time of trial set up were slightly moist or wet at the field surface following recent rainfall (Plate 1)

2.3 Track installation and removal

2.3.1 Ground preparation, soil amendment, incorporation, compaction and track re-instatement are shown in sequence in the plates at Appendix 1 and summarised below.

- Powercem was applied to the field surface at the required rate using a calibrated manual spreader (Plate 2) on 21st September 2011

Fig 1 Plot layout



- The incorporation equipment, consisting of a lime hopper, applicator and heavy duty rotary cultivator was filled with cement direct from a powder tanker (Plate 3).

- The topsoil, powercem and cement mix was thoroughly mixed to a depth of 200mm by a controlled process of cement addition and complete rotary cultivation (Plates 4-6).

- The track was watered to facilitate curing of the mixed topsoil and cement, levelled and rolled using a heavy duty vibrating roller (Plates 7-11).

- After 8 weeks the track was re-cultivated, levelled and rolled (Plates 12-15).

- The farmer, Mr Brightmore, drilled the treated and adjacent control areas with winter wheat using a disc/power harrow combination drill on 11th November 2011.

2.4 Assessments and measurements

Chemical analysis

2.4.1 A sample of cement collected 21/09/2011 was tested as follows:

- *pH, total and available major plant nutrients (nitrogen, phosphate, potassium, sulphur), Total Neutralising Value, electrical conductivity, total arsenic, cadmium, copper, chromium, fluoride lead, mercury, molybdenum, nickel, selenium, zinc, PAH and TPH.* Analysis results are shown at Appendix 1.

2.4.2 Topsoil samples were taken from the undisturbed areas of the field in August 2011 and from the 1:100 trial plot on 10/11/2011 and tested as follows:

- *pH, organic matter, electrical conductivity, particle size distribution, % carbonate, total and available sulphur, total arsenic, cadmium, copper, chromium, fluoride lead, mercury, molybdenum, nickel, selenium, zinc TPH, PAH and potential microbiological activity.*

Analysis results are shown at Appendix 2.

2.4.3 Topsoil samples were taken from all plots on 21/09/2011, 10/11/2011 and 11/04/2012 and tested as follows:

- *pH, available phosphorus, potassium, magnesium, electrical conductivity and sulphate sulphur*

Analysis results are shown at Appendix 3.

2.4.4 A sample of leaf tissue from the winter wheat crop on the 1:100 treated plots was taken on 11/04/2012 and tested as follows

- *Total nitrogen, phosphate, potassium, sulphur, calcium, magnesium, manganese, iron, copper, zinc and boron*

Analysis results are shown at Appendix 4.

Soil physical assessment

2.4.5 An assessment was made on 21/09/2011, 10/11/2011 and 11/04/2011 of:

- *Texture, structure, drainage status and rooting characteristics.*

2.4.6 Topsoil samples collected from all plots were taken 21/09/2011 and tested as follows:

- *Moisture content, plastic limit, liquid limit and plasticity index.*

Analysis results are shown at Appendix 5.

2.4.7 A topsoil sample collected from the 1:100 plots on 21/11/2011 was tested as follows:

- *Moisture content and bulk density*

Analysis results are shown at Appendix 6.

4.0 RESULTS AND DISCUSSION

4.1 Cement analysis

4.1.1 The cement/powercem amendment had a very high pH of 12.9.

4.1.2 The total neutralising value of 35% in the cement indicates that each tonne of cement applied to the topsoil will add approximately 0.35 tonnes of Calcium Oxide equivalent, which equates to approximately 0.63 tonnes of ground limestone equivalent

4.1.3 The treatment of 200-250mm of topsoil at a rate of 100kg/m^3 in T1 will mean that approximately 250-300 tonnes/ha of cement equivalent will be applied. This equates to around 160-190 tonnes of limestone equivalent per hectare.

4.1.4 The treatment of 250-300mm of topsoil at a rate of 140kg/m^3 in T2 will mean that 350-400 tonnes/ha of cement equivalent will be applied. This equates to around 220-250 tonnes of limestone equivalent per hectare.

4.1.5 For reference, agricultural lime is usually applied at rates of 2-5t/ha to arable soils with a pH of 6.00-6.50, or approximately 50-100 times less than that applied in this trial.

4.1.6 The cement contained low levels of total nitrogen, moderately high levels of total phosphorus and high levels of potassium, magnesium and sulphur.

4.1.7 Water soluble analysis indicated that up to 75% of the potassium and sulphur could be available for plant growth and leads to a very high electrical conductivity in the material. Available phosphorus and nitrogen levels were low.

4.1.8 Concentrations of Potentially Toxic Elements (PTE's) were low to moderate in the cement with zinc and arsenic being only slightly elevated.

4.2 Topsoil - Potentially Toxic Elements (PTE's)

Pre-treatment

4.2.1 Concentrations of arsenic, copper and zinc in the undisturbed topsoil were very slightly elevated above background. None of the levels reported were regarded as contaminated in the context of current contaminated land guidance (CLEA 2009).

4.2.2 All PTE's were within the normal range occurring in UK agricultural soils and fairly typical of this geographical area.

Post treatment

4.2.3 Concentrations of total sulphur increased significantly from 153mg/kg to 951mg/kg but remained at levels where plant toxicity was unlikely to occur. Approximately one third of this sulphur, or 305 mg/l, was in an available sulphate form.

4.2.4 Remaining PTE's were all within the normal range occurring in UK agricultural soils. Variability observed in the results was small and, from an agronomic viewpoint, unlikely to pose any risk to growing crops.

4.2.5 In summary, treatment of the topsoils caused no significant increases in PTE concentrations other than what might be reasonably expected.

4.3 Topsoil pH and major plant nutrients

4.3.1 A summary of the results reported during the sampling period is shown in Table 1.

Table 1 Soil pH and major plant nutrient summary September to April 2011

Parameter	Unit	Treatment and sampling date								
		Control			T1 (1:100)			T2 (1:140)		
		21/09/11	10/11/11	11/04/12	21/09/11	10/11/11	11/04/12	21/09/11	10/11/11	11/04/12
pH	-	7.40	7.10	6.90	12.00	10.20	10.60	11.20	11.10	10.70
Phosphorus	mg/l	28	35	38	118	125	133	171	83	153
Potassium	mg/l	162	118	79	558	237	281	451	281	261
Magnesium	mg/l	213	184	175	76	49	59	95	40	58
Conductivity	µS/cm	2,132	2,011	2,107	5,322	2,145	2,066	2,620	1979	2,258
Nitrate - N	mg/l	29.1	27.5	53.5	1.1	14.5	19.4	1.4	7.20	38.1
Organic matter	%	4.30	-	-	3.10	-	-	-	-	-

4.3.2 Prior to treatment the control had a satisfactory pH (6.90-7.40). Concentrations of available phosphorus were satisfactory whilst soil potassium levels were slightly deficient. Soil magnesium levels were satisfactory (index 4) and the electrical conductivity, nitrate and organic matter levels low. This analysis was typical of a medium textured soil in continuous arable use.

4.3.3 Soil pH increased in T1 and T2 and remained very high for the duration of the trial. The pH in the treated soils was sufficiently alkaline to cause nutrient and trace element lock up or antagonisms. The high pH is a direct result of the lime added to the soil from the cement and, for reference, UK agricultural soils rarely exceed a pH of 8.30 or thereabouts in naturally alkaline soils (e.g. chalky or limestone derived soils).

4.3.4 Available phosphorus concentrations increased in both T1 and T2. This might reflect phosphate added from the cement, but is more probably a result of the increase in soil pH, as phosphorus availability increases at high pH.

4.3.5 Levels of available potassium increased in both T1 and T2 after treatment. This is attributable to the potash added from the cement.

4.3.6 Concentrations of available magnesium decreased in both T1 and T2. This could reflect a nutrient antagonism with potassium or calcium leading to a reduction in magnesium availability.

4.3.7 The electrical conductivity (soil salt concentration) increased in T1 and T2 after treatment but has since fallen over winter. This result is not unexpected as soluble

salts of potassium, sodium and sulphur added from the cement will have leached during the winter months.

4.3.8 Soil nitrate levels fell in T1 and T2 after treatment, possibly at the expense of ammonium nitrogen which increased.

4.4 Topsoil trace elements

4.4.1 A summary of trace element soil analysis undertaken during November 2011 is shown in Table 2

Table 2 Trace element analysis November 2011

Parameter	Unit	Treatment		
		Control	T1 (1:100)	T2 (1:140)
Ammonium - N	mg/l	0.80	11	12
Boron	mg/l	1.40	0.40	0.30
Calcium	mg/l	1,806	7,941	10,914
Chloride	mg/l	30	76	68
Copper	mg/l	20	34	4
Iron	mg/l	68	103	166
Manganese	mg/l	11	1.30	1.00
Sodium	mg/l	17	76	96
Sulphate	mg/l	50	305	153
Zinc	mg/l	15	6	3

4.4.2 Ammonium nitrogen levels increased in the topsoil and were probably affected by the high soil pH together with increased ammonia production from organic matter degradation in the topsoil. The anaerobic conditions caused by increasing bulk density and poor structure will have contributed to this increase.

4.4.3 Boron, copper, manganese and zinc availability fell in T1 and T2 after treatment as a result of increasing pH. Copper, manganese and zinc availability have been lowered to a very deficient status.

4.4.4 Calcium, chloride, sodium and sulphate increased in T1 and T2 and reflect the additions from the cement. These levels are not considered to present a risk of toxicity to the growing crop.

4.5 Soil physical assessment

4.5.1 Topsoil structure was severely affected, and effectively lost, on preparation of the track surface during cement incorporation, rotary cultivation and compaction (Plate 8).

4.5.2 The bulk density of the topsoil was increased to 1.75 tonnes/m^3 in the upper 100mm of the profile and became highly compacted, structureless and platy/laminated during track use (Plate 13).

4.5.3 The plastic limit of the topsoil increased from 26% to 31% in T1 and 35% in T2 after treatment. The plasticity index fell and the moisture content remained broadly unchanged after treatment.

4.5.4 When the track was removed, topsoil structure was again absent due to the heavy cultivation/grinding of the compacted topsoil. The topsoil had remained dry and the engineered surface appeared to have performed well during the trial (Plates 13, 14 and 16)

4.5.5 There remained a strong odour of cement within the topsoil on removal.

4.5.6 Topsoil structure has remained weak throughout the winter months with evidence of standing water at the soil surface and within the seedbed. Below a depth of 100mm topsoil structure has remained very weak with evidence of capping with finer material and slumping at the base of the seedbed (Plate 16). Below this depth the topsoil remained relatively dry, indicating that both water and roots have not begun to explore the lower topsoil layers.

4.6 Crop growth

4.6.1 The winter wheat crop germinated less well on the treated plots than adjacent land and throughout the winter months has performed less well in T2 than T1. Both treatments performed poorly when compared to undisturbed areas with significant yellowing, purpling and stunting of the plants (Plates 17-20).

4.6.2 Root development has been particularly poor on the treated areas, probably due to the poor topsoil structure and wetness overwinter.

4.6.3 The wheat on both treated plots was subject to increased levels of damage from birds with many seedlings being removed by pigeon. This might have been caused by the more open soil surface or an edge effect as the track lies on a headland, both of which can encourage birds to land. The weaker plants will have been easier to lift allowing the birds to access the seed below.

4.6.4 Samples of the wheat were collected with difficulty, due to plant sparseness, in April 2012. An analysis of the leaf tissue is shown in Table 3.

Table 3 Leaf tissue analysis April 2012

Parameter	Unit	Treatment T1 & T2	Comment
Nitrogen	%	2.20	Low
Phosphate	%	0.16	Low
Potassium	%	0.95	Low
Sulphur	%	0.19	Low
Calcium	%	39.5	Very high
Magnesium	%	0.133	Satisfactory
Manganese	mg/kg	449	Very high
Iron	mg/kg	11,860	Very high
Copper	mg/kg	18.4	Very high
Zinc	mg/kg	49.1	Satisfactory
Boron	mg/kg	6.82	Satisfactory

4.6.5 Levels of major plant nutrients in the leaf tissue were very low. Calcium, magnesium, iron and copper were very high and might reflect slight soil contamination from the roots of the samples taken.

4.7 Summary of key results

Soil chemistry

4.7.1 The most significant effect in this trial is the change in topsoil pH which has been increased, and maintained, at a consistently high level of more than pH 10.20 in both T1 and T2. This pH is considered far too high for sustainable agricultural crop production.

4.7.2 Cement contains highly reactive forms of free lime which is very finely divided, meaning that it is highly effective as a liming material. The pH measured might fall slightly in the longer term but is likely to remain unacceptably elevated. It is unlikely that pH reduction, though use of sulphate fertilisers, could be used to reduce this pH due to the quantity of lime that remains in these soils.

4.7.3 Lime application in T1 and T2 has been equivalent to more than 50-100 times the amount normally needed to maintain soil pH at that required for agricultural production.

4.7.4 The pH changes would, regardless of soil type, be common to any soils subject to a similar degree of treatment and may be more significant on less well buffered sandy soils.

4.7.5 For the majority of arable crops/soils in the UK a pH of 6.5 in mineral soils and 5.8 for organic soils is usually recommended. For grassland the optimum pH is 6.0 for mineral soils and 5.30 for organic soils. Within these broad requirements individual crops vary in their critical pH requirements.

4.7.6 Soil pH is a fundamental characteristic, and incredibly important, in all soils and has a significant controlling influence on the behaviour of many essential nutrients and trace elements and their resulting availability to plants. The measured changes in pH at this scale are also likely to adversely affect soil microbiological and invertebrate activity.

4.7.7 At high pH levels, the uptake of most trace elements reduces and results in the poor crop growth and which has been evident in this trial.

4.7.8 Significant changes in available soils phosphorus, potassium and magnesium have been measured following treatment. Whilst increases in phosphorus and potassium levels might be regarded as beneficial, these changes are secondary and offset by the negative effects of high soil pH and trace element deficiency which will be more significant limiting factors.

Soil structure

4.7.9 The technique of powercem/cement stabilisation led to a complete loss of topsoil structure when preparing and removing the track. Soil structure reflects how smaller soil particles of sand, silt and clay (aided by organic matter) aggregate to form larger units of soil. This structure can take many years to form and is essential for soil profile drainage, water infiltration, plant rooting, organic matter and nutrient recycling. A reduction in aggregate size has led to finer particles capping at both the surface and within the cultivated layer leading to impeded drainage and rooting. The wetness caused will further inhibit nutrient and trace element uptake by the growing crop.

Soil biology and microbiology

4.7.10 The chemical and structural changes observed will affect soil fauna and flora. Invertebrate populations (e.g. earthworms, insects, beetles etc) will have been almost completely destroyed during physical and chemical treatment. Changes in soil pH are also likely to change soil microbiological activity, diversity and the soil processes that they control.

Crop growth

4.7.11 Since re-instatement, crop establishment and growth has been very poor in T1 and T2. High soil pH is likely to be the most significant limiting factor interacting with poor soil structure, wetness, soil conductivity and changes in microbiology.

5.0 CONCLUSIONS

5.1 Treatment of topsoil with powercem and cement has enabled an engineered pavement to be formed suitable for temporary access to agricultural land. It is LDCL opinion, however, that the residual impact on soil chemistry, biology and structure are detrimental and outweigh the likely benefits achieved when compared to current agricultural access techniques.

5.2 Acceptance and uptake of this technique by the agricultural community and statutory bodies such as DEFRA, the Environment Agency and Local Planning Authority, as a viable alternative to access roads or soil protection, would require evidence that it will not impact on soil quality in the longer term. The results of this trial do not achieve this aim.

5.3 The use of cement stabilisation in the formation of permanent tracks, or in upgrading existing access features, gateways and permanent storage areas is likely to be viable since this will not impact on crop growth. The use of the technique in non agricultural, non sensitive ecological applications is also likely to be feasible. There may be further applications in strengthening roads/hardstandings constructed using recycled or lower cost aggregates or in reducing the quantity/quality of stone used for conventional access road build.

Plates

Plate 1 Site pre-working

Plate 2 Application of powercem prior to incorporation

Plate 3 Cement collection and filling

Plate 4 Incorporation of powercem and cement into topsoil

Plate 5 Incorporation of powercem and cement into topsoil

Plate 6 Incorporation of powercem and cement into topsoil

Plate 7 Levelling of surface

Plate 8 Soil structure post treatment

Plate 9 Application of water to assist in curing

Plate 10 Prepared surface pre-compaction

Plate 11 Compaction

Plate 12 Decompaction equipment

Plate 13 Track lifting showing compaction in topsoil

Plate 14 Track decompaction and cultivation

Plate 15 Track levelling prior to seeding and cultivation

Plate 16 Soil structure April 2012 – note compaction below seedbed >100mm

Plate 17 Crop growth April 2012 1:100

Plate 18 Crop growth April 2012 1:140

Plate 19 Winter wheat in treated areas	Plate 20 Winter wheat and weed in untreated areas
	

DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE WF10 3HR

J143

Please quote above code for all enquiries

BRINSWORTH

CEMENT

ANALYSIS RESULTS

Laboratory References	
Report Number	45680
Sample Number	36957

Sample Reference :

BRINSWORTH S/STATION

Sample Matrix :CEMENT

Date Received	29-SEP-2011
Date Reported	05-OCT-2011

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept as the dry ground sample for at least 1 month.

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Value	Units
Dry Matter	99.7	%
Total Phenols Index	<1	mg/kg
TPH [C10-C40]	<50	mg/kg
PAH EPA16	<2	mg/kg
Total Cyanide	<1	mg/kg
Conductivity 1:6	13100	uS/cm
Total Nitrogen	<0.01	% w/w
Nitrate Nitrogen	<0.1	mg/kg
Ammonium Nitrogen	<0.1	mg/kg
Total Phosphorus (P)	955	mg/kg

Released by ..... *Andrew Chase* ..... Date ..... *05/10/11* .....

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ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Value	Units
Total Potassium (K)	5971	mg/kg
Total Magnesium (Mg)	5311	mg/kg
Total Copper (Cu)	41.6	mg/kg
Total Zinc (Zn)	242	mg/kg
Total Sulphur (S)	18190	mg/kg
Total Molybdenum (Mo)	3.66	mg/kg
Organic Carbon	0.1	% w/w
Total Lead (Pb)	30.7	mg/kg
Total Cadmium (Cd)	0.82	mg/kg
Total Mercury (Hg)	<0.05	mg/kg

Released by *Andrew Chase* Date *05/10/11*

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ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Value	Units
Total Nickel (Ni)	20.9	mg/kg
Total Chromium (Cr)	51.6	mg/kg
pH	12.9	
Lime Equivalent as CaCO3	62.7	% w/w
Total Arsenic (As)	16.3	mg/kg
Total Selenium (Se)	1.36	mg/kg
Total Sulphate	6314	mg/kg
Total Boron (B)	33.1	mg/kg
Water Soluble Magnesium	0.15	mg/kg
Water Soluble Phosphorus	<0.01	mg/kg

Released by *Andrew Chase* Date *05/10/11*

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ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Value	Units
Water Soluble Potassium	4556	mg/kg
Water Soluble Sulphur	4278	mg/kg
Naphthalene	<0.2	mg/kg
Acenaphthylene	<0.1	mg/kg
Acenaphthene	<0.1	mg/kg
Fluorene	<0.1	mg/kg
Phenanthrene	<0.2	mg/kg
Anthracene	<0.1	mg/kg
Fluoranthene	<0.2	mg/kg
Pyrene	<0.2	mg/kg

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The sample will be kept as the dry ground sample for at least 1 month.

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Value	Units
Benzo[a]anthracene	<0.1	mg/kg
Chrysene	<0.1	mg/kg
Benzo[b]fluoranthene	<0.1	mg/kg
Benzo[k]fluoranthene	<0.1	mg/kg
Benzo[a]pyrene	<0.1	mg/kg
Indeno[1,2,3-cd]pyrene	<0.1	mg/kg
Dibenzo[a,h]anthracene	<0.1	mg/kg
Benzo[g,h,i]perylene	<0.1	mg/kg
Neutralising Value as CaO [TNV]	35.2	% w/w

Released by *Andrew Chase* Date *05/10/11*

Brinsworth Powercem Trial 21.09.2011
Topsoil analysis - pre- treatment

Appendix 2

ANALYTICAL REPORT

Report Number	**41739-11**	**J143**	**DAVID ROYLE**
Date Received	**08-AUG-2011**		**SOIL MATTERS**
Date Reported	**17-AUG-2011**		**35 WOODLANDS AVENUE**
Project	**SOIL**		**TOWNVILLE**
Reference	**BRINSWORTH**		**CASTLEFORD**
Order Number			**WEST YORKSHIRE WF10 3HR**

Laboratory Reference		**MINN69394**
Sample Reference		**BRINSWORTH SUBSTAT.**
Determinand	**Unit**	**SOIL**
pH		7.4
Organic Matter WB	% w/w	4.3
Sand 2.00-0.063mm	% w/w	37
Silt 0.063-0.002mm	% w/w	34
Clay <0.002mm	% w/w	29
Nitrate Nitrogen	mg/kg	13.4
Ammonium Nitrogen	mg/kg	0.58
Dry Matter	%	84.1
Conductivity Sat CaSO4	uS/cm	2169
Available Sulphate	mg/l	62.2
Neutralising Value as CaCO3 eq.	% w/w	3.8
Neutralising Value as CaO eq.	% w/w	2.1
Total Copper	mg/kg	42.5
Total Zinc	mg/kg	124
Total Lead	mg/kg	87.1
Total Arsenic	mg/kg	17.9
Total Cadmium	mg/kg	0.44
Total Nickel	mg/kg	26.2
Total Chromium	mg/kg	35.1
Total Mercury	mg/kg	0.08
Total Selenium	mg/kg	0.59
Total Molybdenum	mg/kg	2.3
Total Sulphur	mg/kg	153
Fluoride	mg/kg	54.0
TPH [C10-C40]	mg/kg	<50

ANALYTICAL REPORT

Report Number	**41739-11**	**J143**	**DAVID ROYLE**
Date Received	**08-AUG-2011**		**SOIL MATTERS**
Date Reported	**17-AUG-2011**		**35 WOODLANDS AVENUE**
Project	**SOIL**		**TOWNVILLE**
Reference	**BRINSWORTH**		**CASTLEFORD**
Order Number			**WEST YORKSHIRE WF10 3HR**

Laboratory Reference		**MINN69394**
Sample Reference		**BRINSWORTH SUBSTAT.**
Determinand	**Unit**	**SOIL**
Naphthalene	mg/kg	<0.2
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	0.8
Anthracene	mg/kg	0.4
Fluoranthene	mg/kg	1.5
Pyrene	mg/kg	1.3
Benzo[a]anthracene	mg/kg	0.6
Chrysene	mg/kg	0.7
Benzo[b]fluoranthene	mg/kg	0.7
Benzo[k]fluoranthene	mg/kg	0.5
Benzo[a]pyrene	mg/kg	0.7
Indeno[1,2,3-cd]pyrene	mg/kg	0.5
Dibenzo[a,h]anthracene	mg/kg	0.1
Benzo[g,h,i]perylene	mg/kg	0.6
PAH EPA16	mg/kg	8.7
Microbial Activity	ug/6g	83.0
Textural Class		Clay Loam

Notes

Analysis Notes

The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

ANALYTICAL NOTES

Report Number	**41739-11**	**J143**	**DAVID ROYLE**
Date Received	**08-AUG-2011**		**SOIL MATTERS**
Date Reported	**17-AUG-2011**		**35 WOODLANDS AVENUE**
Project	**SOIL**		**TOWNVILLE**
Reference	**BRINSWORTH**		**CASTLEFORD**
Order Number			**WEST YORKSHIRE WF10 3HR**

Notes

Reported by

Joe Cherrie

Natural Resource Management Ltd.
Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS
Tel: 01344 886338
Fax: 01344 890972
email: enquiries@nrm.uk.com

ANALYTICAL REPORT

Report Number	**45706-11**	**J143**	**DAVID ROYLE**	**Client**	**BRINSWORTH SUBSTATION**
Date Received	**30-SEP-2011**		**SOIL MATTERS**		
Date Reported	**06-OCT-2011**		**35 WOODLANDS AVENUE**		
Project	**SOILS**		**TOWNVILLE**		
Reference	**BRINSWORTH SUBSTATON**		**CASTLEFORD**		
Order Number			**WEST YORKSHIRE WF10 3HR**		

Laboratory Reference		**SOIL203295**	**SOIL203296**	**SOIL203297**
Sample Reference		**TOPSOIL**	**TOPSOIL P T 1.4:140**	**TOPSOIL P T 1:100**
Determinand	**Unit**	**SOIL**	**SOIL**	**SOIL**
pH		7.4	12.0	11.2
Available Phosphorus (Index)	mg/l	28 (3)	118 (6)	171 (7)
Available Potassium (Index)	mg/l	162 (2-)	558 (4)	451 (4)
Available Magnesium (Index)	mg/l	213 (4)	76 (2)	95 (2)
Conductivity Sat CaSO4	uS/cm	2132	5322	2620
Nitrate Nitrogen	mg/kg	29.7	1.1	1.4
Water Sol Sulphate 1:2	mg/l	<40	<40	<40

Notes

Analysis Notes
The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

Reported by

Andrew Chase

Natural Resource Management Ltd.
Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS
Tel: 01344 886338
Fax: 01344 890972
email: enquiries@nrm.uk.com

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

CHECKING STATUS: **CHECKED**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **25/10/2011 11:16:45**.

Testing reported after this date is not covered by this Verification Certificate.

M. Athorne

Approved Signatory
Mark Athorne (Laboratory Quality Manager)

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Contract: **Brinsworth**

Job No: **780548**

Sheet 1 of 4

AGS

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 780548 R01

Date	25-October-2011	Contract	Brinsworth

Client LDCL (Land Drainage Consultancy Ltd)
Address Cowslip Offices
Fimbar
Driffield
YO25 9LY

For the Attention of David Royle

Samples submitted by client	12/10/2011	Client Reference	
Testing Started	13/10/2011	Client Order No.	
Testing Completed	24/10/2011	Instruction Type	Written

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

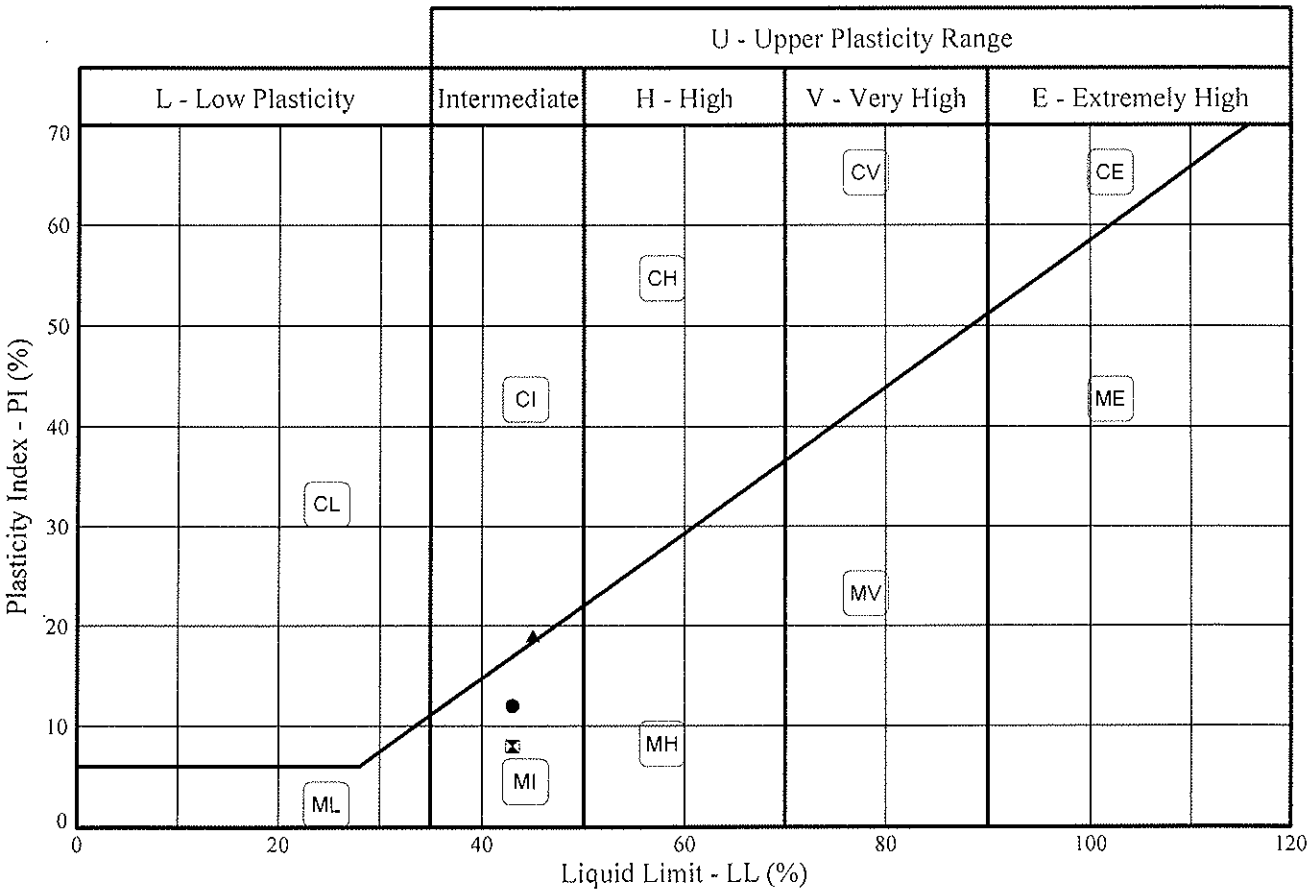
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of

Approved signatories: Mark Athorne (Laboratory Manager) Sean Royle (Senior Technician)

Structural Soils Ltd The Potteries Pottery Street Castleford WF10 1NJ Tel: 01977 552255 e-mail mark.athorne@soils.co.uk

PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1981
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %
	Exploratory Position ID	Sample	Depth (m)							
●	1:100	1B	0.00	3.2/4.3/5.3/5.4	4.2.4	20	43	31	12	65
⊠	Post North	1B	1.40	3.2/4.3/5.3/5.4	4.2.4	16	43	35	8	47
▲	Topsoil	1B	0.00	3.2/4.3/5.3/5.4	4.2.4	18	45	26	19	80

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non standard test, NP = Non plastic.

Approved Signatories: M. ATHORNE S. ROYLE M. FISHER C. COLE

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date
M. Fisher	MAUREEN FISHER	25/10/11

Contract: **Brinsworth**

Contract Ref: **780548**

AGS

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
1:100	1	B	0.00	20	43	31	12	65	Brown slightly sandy slightly gravelly SILT
Post North	1	B	1.40	16	43	35	8	47	Brown slightly sandy slightly gravelly SILT
Topsoil	1	B	0.00	18	45	26	19	80	Brown slightly sandy slightly gravelly CLAY

STRUCTURAL SOILS LTD

Contract: **Brinsworth**

Contract Ref: **780548**

Page 1 of 1

AGS

Contact : DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE
WF10 3HR
Tel. : 01977 555869

J143

Please quote the above code for all enquiries

Client : BRINSWORTH

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 29783/11

Date Received 15-Nov-11
Date Reported 17-Nov-11

Samples will be stored until 15-DEC-2011

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
132011/11	1	**UNDISTURBED** *No cropping details given*	**7.1**	**3**	**1**	**4**	**35.4**	**116**	**184**
132012/11	2	**POST TRT 1.4:140** *No cropping details given*	**11.1**	**5**	**3**	**1**	**83.2**	**281**	**40**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the DEFRA Fertiliser Recommendations RB209 8th Edition (Appendix 4).

Released by *Joe Cherrie* On behalf of NRM Ltd Date *17/11/11*

MICRO NUTRIENT REPORT

Interim Report

DATE **17th November 2011**

SAMPLES FROM **BRINSWORTH**

DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE WF10 3HR
Tel: 01977 555869

Reference: **29783/132011/11-1** Field Name: **UNDISTURBED**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Ammonium Nitrate Extractable Sodium mg/l	16.9	1					
Ammonium Nitrate Extractable Calcium mg/l	1806.0	2					
Estimated Cation Exchange Capacity meq/100g	14.4	3					

Reference: **29783/132012/11-1** Field Name: **POST TRT 1.4:140**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Ammonium Nitrate Extractable Sodium mg/l	95.8	4					
Ammonium Nitrate Extractable Calcium mg/l	10913.8	5					
Estimated Cation Exchange Capacity meq/100g	72.9	6					

Notes (*)

(1) Sodium is a non essential plant nutrient. It is seldom, if ever, deficient except for Sugar Beet and Spinach. No crops show recognisable symptoms of sodium deficiency. This soil is low in potassium and any crop of Sugar Beet, Fodder Beet, Red Beet, Mangels, Turnips or Celery will require extra potassium and will respond to the addition of sodium fertiliser. Sodium has a positive influence on the mineral nutrition of plants, especially those growing on low potassium soil. Response may be seen in Barley, Wheat, Oats, Peas, Cabbage, Kale and Spinach. Sodium can be applied as agricultural salt at 150kg/ha. Kainit may be used at 1t/ha and this will usually supply adequate amounts of sodium and potassium. Sodium levels in mineral soils are usually below 20mg/l available sodium. Sodium is easily leached from nearly all soil types and it is difficult to build up sodium levels over a period of years. The most responsive crops (beets) are usually grown in three or four year rotations and therefore need sodium fertiliser every time they are grown.

(2) Calcium plays an important role in soil fertility and its status is reflected in the pH of the soil. Plants thrive best when the predominant base in the soil is calcium. If other bases, such as magnesium, potassium or sodium are present in amounts equal to or greater than calcium, nutritional disturbances can occur. Correction is by application of a calcium based liming material.

(3) CEC level is Medium (12-25). Pumice soils often in the range 13-18; lower fertility mineral soils in the range 15-25.

(4) Sodium is a non essential plant nutrient. It is seldom, if ever, deficient except for Sugar Beet and Spinach. No crops show recognisable symptoms of sodium deficiency. Some crops can respond to sodium fertiliser when the potassium level is just adequate or low. At the level of sodium and potassium found in this soil, no response to sodium fertiliser would be expected.

(5) High levels of calcium in the soil usually reflect high soil pH. Avoid any applications of liming material.

(6) CEC level is Very High (40+). Values typically found in peat soils. Consolidated peats typically in range 40-65; raw peat may be as high as 100.

Contact : DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE
WF10 3HR
Tel. : 01977 555869

J143

Please quote the above code for all enquiries

Client : BRINSWORTH SUBSTATION

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 29781/11

Date Received 15-Nov-11
Date Reported 17-Nov-11

Samples will be stored until 15-DEC-2011

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
132006/11	1	**POST TRT 1:100** *No cropping details given*	**10.2**	**6**	**2+**	**1**	**124.6**	**237**	**49**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the DEFRA Fertiliser Recommendations RB209 8th Edition (Appendix 4).

Released by ..... *Joe Cherrie* ..... On behalf of NRM Ltd Date ..... *17/11/11* .....

NRM Ltd. Coopers Bridge, Braziers Lane, Bracknell, Berkshire RG42 6NS
Tel: +44 (0) 1344 886338 **Fax:** +44 (0) 1344 890972 **Email:** enquiries@nrm.uk.com **www.**nrm.uk.com

ANALYTICAL REPORT

Report Number	**49028-11**	**J143**	**DAVID ROYLE**	**Client**	**BRINSWORTH SUBSTATION**
Date Received	**14-NOV-2011**		**SOIL MATTERS**		
Date Reported	**22-NOV-2011**		**35 WOODLANDS AVENUE**		
Project	**TOPSOIL**		**TOWNVILLE**		
Reference	**BRINSWORTH SUBSTATIO**		**CASTLEFORD**		
Order Number			**WEST YORKSHIRE WF10 3HR**		

Laboratory Reference		**MINN71237**
Sample Reference		**POST TRT 1:100**
Determinand	**Unit**	**SOIL**
pH		10.2
Organic Matter WB	% w/w	3.1
Available Phosphorus (Index)	mg/l	125 (6)
Available Potassium (Index)	mg/l	237 (2+)
Available Magnesium (Index)	mg/l	49 (1)
Sand 2.00-0.063mm	% w/w	51
Silt 0.063-0.002mm	% w/w	40
Clay <0.002mm	% w/w	9
Nitrate Nitrogen	mg/kg	14.5
Ammonium Nitrogen	mg/kg	10.6
Dry Matter	%	84.8
Conductivity Sat CaSO4	uS/cm	2145
Available Copper EDTA	mg/l	7.6
Available Zinc EDTA	mg/l	6.0
Available Sodium	mg/l	76.3
Available Calcium	mg/l	7941
Available Sulphate	mg/l	305
Neutralising Value as CaCO3 eq.	% w/w	7.7
Hot Water Soluble Boron	mg/l	0.4
Available Manganese	mg/l	1.3
Available Iron	mg/l	103
Total Copper	mg/kg	33.6
Total Zinc	mg/kg	103
Total Lead	mg/kg	93.3
Total Arsenic	mg/kg	18.7

ANALYTICAL REPORT

Report Number	**49028-11**	**J143**	**DAVID ROYLE**	**Client**	**BRINSWORTH SUBSTATION**
Date Received	**14-NOV-2011**		**SOIL MATTERS**		
Date Reported	**22-NOV-2011**		**35 WOODLANDS AVENUE**		
Project	**TOPSOIL**		**TOWNVILLE**		
Reference	**BRINSWORTH SUBSTATIO**		**CASTLEFORD**		
Order Number			**WEST YORKSHIRE WF10 3HR**		

Laboratory Reference		**MINN71237**
Sample Reference		**POST TRT 1:100**
Determinand	**Unit**	**SOIL**
Total Cadmium	mg/kg	0.38
Total Nickel	mg/kg	21.7
Total Chromium	mg/kg	31.6
Total Mercury	mg/kg	0.23
Total Selenium	mg/kg	0.52
Total Molybdenum	mg/kg	2.4
Total Sulphur	mg/kg	951
Water Soluble Chloride	mg/kg	128
Fluoride	mg/kg	71.5
EPH [C10-C40]	mg/kg	39
Naphthalene	mg/kg	0.5
Acenaphthylene	mg/kg	<0.1
Acenaphthene	mg/kg	<0.1
Fluorene	mg/kg	<0.1
Phenanthrene	mg/kg	0.7
Anthracene	mg/kg	0.1
Fluoranthene	mg/kg	0.8
Pyrene	mg/kg	0.7
Benzo[a]anthracene	mg/kg	0.4
Chrysene	mg/kg	0.5
Benzo[b]fluoranthene	mg/kg	0.2
Benzo[k]fluoranthene	mg/kg	0.4
Benzo[a]pyrene	mg/kg	0.4
Indeno[1,2,3-cd]pyrene	mg/kg	0.1
Dibenzo[a,h]anthracene	mg/kg	<0.1

ANALYTICAL REPORT

Report Number	**49028-11**	**J143**	**DAVID ROYLE**	**Client**	**BRINSWORTH SUBSTATION**
Date Received	**14-NOV-2011**		**SOIL MATTERS**		
Date Reported	**22-NOV-2011**		**35 WOODLANDS AVENUE**		
Project	**TOPSOIL**		**TOWNVILLE**		
Reference	**BRINSWORTH SUBSTATIO**		**CASTLEFORD**		
Order Number			**WEST YORKSHIRE WF10 3HR**		

Laboratory Reference		**MINN71237**
Sample Reference		**POST TRT 1:100**
Determinand	**Unit**	**SOIL**
Benzo[g,h,i]perylene	mg/kg	0.2
PAH EPA16	mg/kg	5.0
Microbial Activity	ug/6g	185
Textural Class		Sandy Loam

Notes

Analysis Notes

The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

Document Control

This test report shall not be reproduced, except in full, without the written approval of the laboratory.

Reported by

Andrew Chase

Natural Resource Management Ltd.
Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS
Tel: 01344 886338
Fax: 01344 890972
email: enquiries@nrm.uk.com

MICRO NUTRIENT REPORT

Interim Report

DATE **17th November 2011**

SAMPLES FROM **BRINSWORTH SUBSTATION**

DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE WF10 3HR
Tel: 01977 555869

Reference: **29781/132006/11-1** Field Name: **POST TRT 1:100**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Ammonium Nitrate Extractable Sodium mg/l	76.3	1					
Ammonium Nitrate Extractable Calcium mg/l	7941.3	2					
Estimated Cation Exchange Capacity meq/100g	53.4	3					

Notes (*)

(1) Sodium is a non essential plant nutrient. It is seldom, if ever, deficient except for Sugar Beet and Spinach. No crops show recognisable symptoms of sodium deficiency. This soil is low in potassium and any crop of Sugar Beet, Fodder Beet, Red Beet, Mangels, Turnips or Celery will require extra potassium and will respond to the addition of sodium fertiliser. Sodium has a positive influence on the mineral nutrition of plants, especially those growing on low potassium soil. Response may be seen in Barley, Wheat, Oats, Peas, Cabbage, Kale and Spinach. Sodium can be applied as agricultural salt at 150kg/ha. Kainit may be used at 1t/ha and this will usually supply adequate amounts of sodium and potassium. Sodium levels in mineral soils are usually below 20mg/l available sodium. Sodium is easily leached from nearly all soil types and it is difficult to build up sodium levels over a period of years. The most responsive crops (beets) are usually grown in three or four year rotations and therefore need sodium fertiliser every time they are grown.

(2) High levels of calcium in the soil usually reflect high soil pH. Avoid any applications of liming material.

(3) CEC level is Very High (40+). Values typically found in peat soils. Consolidated peats typically in range 40-65; raw peat may be as high as 100.

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

CHECKING STATUS: **CHECKED**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **13/12/2011 14:07:24**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
Sean Royle (Laboratory Technician)

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Contract:	Job No:
Brinsworth	**780548**
	Sheet 1 of 3

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 780548 R02

Date	13-December-2011	Contract	Brinsworth
Client	LDCL (Land Drainage Consultancy Ltd)		
Address	Cowslip Offices Fimbar Driffield YO25 9LY		
For the Attention of	David Royle		

Samples submitted by client	24/11/2011	Client Reference	
Testing Started	25/11/2011	Client Order No.	
Testing Completed	13/12/2011	Instruction Type	Written

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2

Non UKAS Accredited Tests Undertaken

Density immersion in water method BS1377:Part 2:1990,clause 7.3

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of

Approved signatories: Mark Athorne (Laboratory Manager) Sean Royle (Senior Technician)

Structural Soils Ltd The Potteries Pottery Street Castleford WF10 1NJ Tel: 01977 552255 e-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,7.3,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m³	Dry Density Mg/m³	Particle Density Mg/m³	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
Sample 1	1	B	0.00	9.8	1.75	1.59						Brown slightly sandy slightly gravelly CLAY
Sample 2	2	B	0.00	8.8	1.71	1.57						Brown slightly sandy slightly gravelly CLAY
Sample 3	3	B	0.00	10	1.76	1.60						Brown slightly sandy slightly gravelly CLAY

STRUCTURAL SOILS LTD

Contract: **Brinsworth**

Contract Ref: **780548**

Page 3 of 3

AGS

Brinsworth Powercem Trial
Topsoil analysis - post treatment
11.04.2012

Appendix 7

Contact : DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE
WF10 3HR
Tel. : 01977 555869

J143

Please quote the above code for all enquiries

Client : BRINSWORTH SUBSTATION
11/04/2012

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 12703/12

Date Received 13-Apr-12
Date Reported 19-Apr-12

Samples will be stored until 13-MAY-2012

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
57477/12	1	**TOPSOIL** *No cropping details given*	**6.9**	**3**	**1**	**3**	**38.0**	**79**	**175**
57478/12	2	**POST 1.4:140** *No cropping details given*	**10.6**	**6**	**3**	**2**	**133.2**	**281**	**59**
57479/12	3	**POST 1:100** *No cropping details given*	**10.7**	**7**	**3**	**2**	**153.0**	**261**	**58**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the DEFRA Fertiliser Recommendations RB209 8th Edition (Appendix 4).

Released by ..... *Joe Cherrie* ..... On behalf of NRM Ltd Date ..... *19/04/12* .....

MICRO NUTRIENT REPORT

DATE **19th April 2012**

SAMPLES FROM **BRINSWORTH SUBSTATION, 11/04/2012**

DAVID ROYLE
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE WF10 3HR
Tel: 01977 555869

Reference: **12703/57477/12-1** Field Name: **TOPSOIL**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Available (Phosphate Buffer Soluble) Sulphate mg/l	29.0	1					
Electrical Conductivity (Sat. CaSO4) uS/cm	2107						
Nitrate-Nitrogen mg/kg	53.5						

Reference: **12703/57478/12-1** Field Name: **POST 1.4:140**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Available (Phosphate Buffer Soluble) Sulphate mg/l	349.0	1					
Electrical Conductivity (Sat. CaSO4) uS/cm	2066						
Nitrate-Nitrogen mg/kg	19.4						

Reference: **12703/57479/12-1** Field Name: **POST 1:100**	**Result**	**(*)**	**V Low**	**Low**	**Risk**	**Normal**	**High**
Available (Phosphate Buffer Soluble) Sulphate mg/l	409.4	1					
Electrical Conductivity (Sat. CaSO4) uS/cm	2258						
Nitrate-Nitrogen mg/kg	38.1						

Notes (*)

(1) Plants absorb sulphur as the sulphate ion. Sulphates are not retained in the soil, to any great extent, they are soluble and tend to move with the soil water and are readily leached by high rainfall or irrigation. This is particularly true for low capacity (sandy) soils. Sulphur behaves very much like nitrogen, the largest pool of sulphur is contained within the organic matter. The sulphate sulphur becomes available to the plant via bacterial breakdown of the organic matter, atmospheric sulphur and other forms of reduced sulphur. Intensification of agriculture, improved crop varieties, the use of sulphur free fertilisers and control of atmospheric pollution have aggravated the sulphur deficiency problem. In many UK soils, the distribution of sulphate sulphur may not be consistent throughout the soil profile. A profile test down to 90cm should be considered before using the soil test levels alone to calculate fertiliser sulphur requirements. If the soil has relatively high sulphur levels at lower depths, the amounts can be reduced. The best method of building soil sulphur reserves is by adding organic materials and maintaining an adequate organic matter content. Where satisfactory organic sulphur reserves cannot be maintained, certain fertilisers or amendments have to be used to supply the crop with its sulphur requirement.

PLANT TISSUE ANALYTICAL RESULTS

Client: BRINSWORTH SUBSTATION Contact: DAVID ROYLE (J143)
SOIL MATTERS
35 WOODLANDS AVENUE
TOWNVILLE
CASTLEFORD
WEST YORKSHIRE
WF10 3HR

Lab. Ref: H549/1170
Received: 13/04/12
Reported: 17/04/12

SAMPLE NAME: WHEAT ON EASEMENT **CROP: WHEAT**

ANALYSIS	RESULT	INTERPRETATION					COMMENTS
		Deficient	Low	Normal	High	Excessive	
Nitrogen (N)	2.20 %	2.20	2.70	5.00	7.00		N is deficient. Possible causes: low N application, low soil available-N, low soil P.
Phosphate (P)	0.161 %	0.23	0.30	0.56	0.95		P is deficient. Possible causes: low soil P, low P application wet soils, low soil pH (<5.5) or high pH (>7.2).
Potassium (K)	0.952 %	2.50	2.80	5.00	8.00		K is deficient. Possible causes: low soil K, low K application excessive N applied, cold wet spots.
Sulphur (S)	0.188 %	0.28	0.32	0.36	0.50		S is deficient. Possible causes: low soil Sulphate, excess soil N on low organic matter soils, low S fertilisation, high leaching.
Calcium (Ca)	39.5 %	0.16	0.25	0.80	1.40		Ca is excessive. Possible causes: diseased or dead tissue sampled old plant tissue sampled.
Magnesium (Mg)	0.133 %	0.10	0.13	0.18	0.40		Nutrient status satisfactory.
Manganese (Mn)	449 mg/kg	20	26	60	100		Mn is excessive. Possible causes: high N/P applications on low pH or low OM soils, low soil pH, soil or fungicide contamination .
Iron (Fe)	11860 mg/kg	10	25	250	350		Fe is excessive. Possible causes: poor soil conditions, very wet or flooded soils. Zn deficiency. Soil contamination of tissue sample.
Copper (Cu)	18.4 mg/kg	3.00	4.00	10	15		Cu is excessive. Possible causes: high soil Cu, can be caused by a previous pesticide application now residual in the soil.
Zinc (Zn)	49.1 mg/kg	20	29	50	70		Nutrient status satisfactory.
Boron (B)	6.82 mg/kg	4.00	6.00	10	15		Nutrient status satisfactory.

The points summarised above are only meant as a guide to the likely cause of a nutrient problem. It is beyond the scope of this report to consider trace element interactions, lock up etc.