Soil & Nutrient Network

FARM ADVISORY SERVICE

Welcome

Midgarth, Stronsay
20 August 2018

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Soil Management & Nutrient Network Farms

Funded by Scottish Government under the Farm Advisory Service and delivered by SAC Consulting

- One of a network of 12 farms across Scotland taking a before and after look at how to protect and improve soils
- The aim is to improve farm profitability through improved soil and nutrient use, lower carbon footprints and reduce diffuse pollution risk.
- Series of 3 meetings
- Topics for meetings 2 & 3 to be decided by you
- Opportunity to link up with the other network farms to share information

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Agenda

- Welcome & Introduction to Midgarth Soil Nutrient Network Farm
- Midgarth soil, slurry & FYM results (G Scott)
- Importance of Soil analyses and addressing deficiencies (Dr Bill Crooks)
- Soil structure, drainage and alleviating compaction (Gavin Elrick)
- Field visit and machinery demonstration
- Topics for meeting 2 & 3. Feedback forms

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Midgarth Slurry Analysis

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	Determination	Result	Units
*	Dry Matter	7.29	%
*	Total Nitrogen (Kjeldahl)	0.235	%
	Aqua Regia Phosphorus	0.869	%DM
*	Total Phosphate (P2O5)	1.45	kg/tonne
	Aqua Regia Potassium	4.92	%DM
*	Total Potash (K20)	4.3	kg/tonne
	Aqua Regia Magnesium	0.670	%DM
	Aqua Regia Calcium	1.30	%DM
	Aqua Regia Sodium	1.11	%DM
	Aqua Regia Copper	84.0	mg/kgDM
	Aqua Regia Zinc	247	mg/kgDM
	Aqua Regia Iron	1450	mg/kgDM
	Aqua Regia Sulphur	5110	mg/kgDM
	Aqua Regia Manganese	521	mg/kgDM
*	pH	7.1	
*	Ammonia Nitrogen	0.0796	%
*	Nitrate Nitrogen	<0.00100	%

* Not UKAS accredited

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Nutrients in cattle slurry

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	Typical cattle Slurry	Midgarth Slurry
Dry Matter (DM) %	6%	7.29%
Total Nitrogen	2.6 kg/m^3	2.35kg/m^3
Total Phosphate (P_2O_5)	1.2 kg/m^3	1.45 kg/m^3
Total Potash (K_2O)	3.2 kg/m^3	4.3 kg/m^3

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Phosphate in Midgarth slurry

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- 1.45kg P_2O_5/m^3 (4.54m^3 = 1000 gallons)
- 6.58kg P_2O_5 in 1000 gallons
- 13.16 units P_2O_5 in 1000 gallons

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Potash in Midgarth Slurry

- 4.3kg K_2O/m^3 (4.54 m^3 = 1000 gallons)
- 19.52kg K_2O in 1000 gallons
- 39 units of K_2O in 1000 gallons

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Nitrogen in Midgarth Slurry

- 2.35kg N/m³ (4.54m³ = 1000 gallons)
- 10.67kg N in 1000 gallons
- 21.34* units of N in 1000 gallons

- * available nitrogen can vary from 5 to 55% depending on various factors

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Unit value of Midgarth Slurry

- 1000 gallon/acre of Midgarth slurry is equivalent to applying a 50kg bag of 6:13:39

£ Value of Midgarth Slurry

- Nitram (34.5% N) = £262/tonne (£0.76/kgN)
- TSP (46% P) = £324/tonne (£0.70/kgP)
- MOP (60% K) =£303/tonne (£0.50/kgK)
- 1000 gallons of Midgarth slurry contains:-
- 3.2kg of N = £2.43
- 6.58kg of P = £4.61
- 19.52kg K = £9.46
- 1000 gallons Midgarth Slurry = £16.80

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Midgarth FYM Analysis

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	Determination	Result	Units
*	Dry Matter	16.4	%
*	Total Nitrogen (Kjeldahl)	0.398	%
	Aqua Regia Phosphorus	0.750	%DM
*	Total Phosphate (P2O5)	2.82	kg/tonne
	Aqua Regia Potassium	1.46	%DM
*	Total Potash (K20)	2.9	kg/tonne
	Aqua Regia Magnesium	0.250	%DM
	Aqua Regia Calcium	1.12	%DM
	Aqua Regia Sodium	1.42	%DM
	Aqua Regia Copper	103	mg/kgDM
	Aqua Regia Zinc	103	mg/kgDM
	Aqua Regia Iron	489	mg/kgDM
	Aqua Regia Sulphur	5000	mg/kgDM
	Aqua Regia Manganese	28.3	mg/kgDM

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Nutrients in FYM

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Nutrient content on farm yard manure (kg/t of solid manure)		
	Cattle FYM (Fresh)	Midgarth FYM
Dry Matter %	25	16.4
N (kg)	6	3.98
Readily available N (kg)	1.2	0.6
Total phosphateP_2O_5 (kg)	3.2	2.82
Total potash K_2O (kg)	8.0	2.9

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Nutrients in FYM

Total nutrients (kg/t fresh weight) in different Farm Yard Manures Application Rate 10 tonnes per acre		
	Cattle FYM (Fresh)	Midgarth FYM
Readily available N (kg)	12	6 (12 units)
Total phosphate P_2O_5 (kg)	32	28 (56 units)
Total potash K_2O (kg)	80	29 (58 units)

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Midgarth FYM nutrients

- Application rate at 10t/acre of Midgarth FYM is equivalent to spreading 1 x 50kg bag of 12:56:58

£ Value of Midgarth FYM

- Nitram (34.5% N) = £262/tonne (£0.76/kg N)
- TSP (46% P) = £324/tonne (0.70/kg P)
- MOP (60% K) = £303/tonne (0.50kg K)
- 10t/acre of Midgarth FYM supplies
- 6kg N = £4.56
- 28kg P = £19.60
- 29kg K = £14.5
- 10t/acre of Midgarth FYM = £38.66

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Shell sand v Granulated Lime

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- Granulime = £173/tonne delivered*
- Shell sand =£18/t delivered & spread*

- Granulime at 54% CaO = £3.20 per 1% CaO
- Shell sand at 32% CaO = £0.56 per 1% CaO

- *Orkney Mainland price

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Shell sand v Granulated lime

SAC soil reports assume lime with 50% CaO

1 tonne of lime (as per SAC soil report) = 0.92t of granulime (50/54) costing £161.92

1 tonne of lime (as per SAC soil report) = 1.56t of shell sand with NV 32% CaO (50/32) costing £28.08

However, Granulime is quicker acting and can be applied using conventional fert. spreaders

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Stronsay Sand

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Stronsay

ORKNEY KW17 2AN

Your reference:	G07127
Farm Sampled:	
Client Sample ID:	1

Lab sample no:	16500015
Case no:	ASD-2016-3127
Date received:	16/06/2016
Date reported:	22/06/2016

Determination	Result	Units
Neutralising Value	36.9	%CaO

* Not UKAS accredited

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Stronsay Sand

- Stronsay Sand NV = 36.9% CaO
- 50/36.9 = 1.35
- 1 tonne of lime – 1.35 tonne of Stronsay shell sand

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Summary of Results

FINAL REPORT

Internal LIMS Client
n/a
n/a

Farm Sampled:

Batch Number: ASD-2018-3614

Report Date: 20/06/2018

SAC	SAC Status	Extractable Phosphorus	Extractable Potassium	Extractable Magnesium
Scales of Interpretation, results in mg/l	VL	0 – 1.7	0 – 39	0 – 19
	L	1.8 – 4.4	40 – 75	20 - 60
	M-	4.5 – 9.4	76- 140	61 – 200
	M+	9.50 - 13.4	141 - 200	61 – 200
	H	13.5 – 30.0	201 – 400	201 – 1000
	VH	> 30.0	> 400	> 1000

			Lime Required		Extractables		
			Arable	Grass	P	K	Mg
ASD Ref	Field Name/Ref	pH	t/ha		mg/l	mg/l	mg/l
18006933	Hill Field	5.7	5.0	2.1	4.58 (M-)	126.0 (M-)	158.0 (M)
18006934	Greeni Spot	5.7	4.7	2.0	2.64 (L)	56.80 (L)	104.0 (M)
18006935	Stursy's Brother	5.7	5.4	2.3	3.79 (L)	57.20 (L)	131.0 (M)
18006936	Rosebank	5.7	5.0	2.2	5.84 (M-)	129.0 (M-)	128.0 (M)
18006937	Millfield Silage Field	6.3	0.0	0.0	10.4 (M+	149.0 (M+)	130.0 (M)
18006938	Cott	5.9	3.8	0.0	16.9 (H)	242.0 (H)	189.0 (M)
18006939	Quoy of dale next cleat	5.7	5.1	2.2	15.5 (H)	221.0 (H)	174.0 (M)
18006940	Millfield Ley field	5.4	6.6	4.0	14.7 (H)	151.0 (M+)	192.0 (M)
18006941	Harrowdale next sunnydale	6.0	2.9	0.0	13.5 (H)	180.0 (M+)	179.0 (M)
18006942	Millfield next harrowdale	6.1	2.0	0.0	15.8 (H)	160.0 (M+)	140.0 (M)
18006943	Waterside	6.1	0.0	0.0	3.15 (L)	134.0 (M-)	182.0 (M)
18006944	Deepdale	5.6	5.3	2.7	4.66 (M-)	165.0 (M+)	172.0 (M)
18006945	Quoy of dale middle	5.7	4.9	2.1	16.3 (H)	212.0 (H)	199.0 (M)
18006946	Hillihoose	5.6	5.6	2.8	1.78 (L)	193.0 (M+)	163.0 (M)
18006947	Waterside Next Windbreck	7.4	0.0	0.0	50.9 (VH)	404.0 (VH)	185.0 (M)

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Farm Sampled:	
Your reference:	S615
Last Crop:	Grass - grazing
Next Crop:	Grass - grazing
Soil Type:	Mineral

Sample ID :	Stursy's Brother
Lab sample no:	18006935
Case no:	ASD-2018-3614
Date received:	12/06/2018
Date reported:	20/06/2018

Determination	Result	Units	Status
pH	5.7		
Lime req (Arable)	5.4	t/ha	
Lime req (Grass)	2.3	t/ha	
Extractable Phosphorus	3.79	mg/l	Low
Extractable Potassium	57.20	mg/l	Low
Extractable Magnesium	131.0	mg/l	Mod
Extractable Calcium	870	mg/l	
Extractable Sodium	93.70	mg/l	

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Blinkbonny pH

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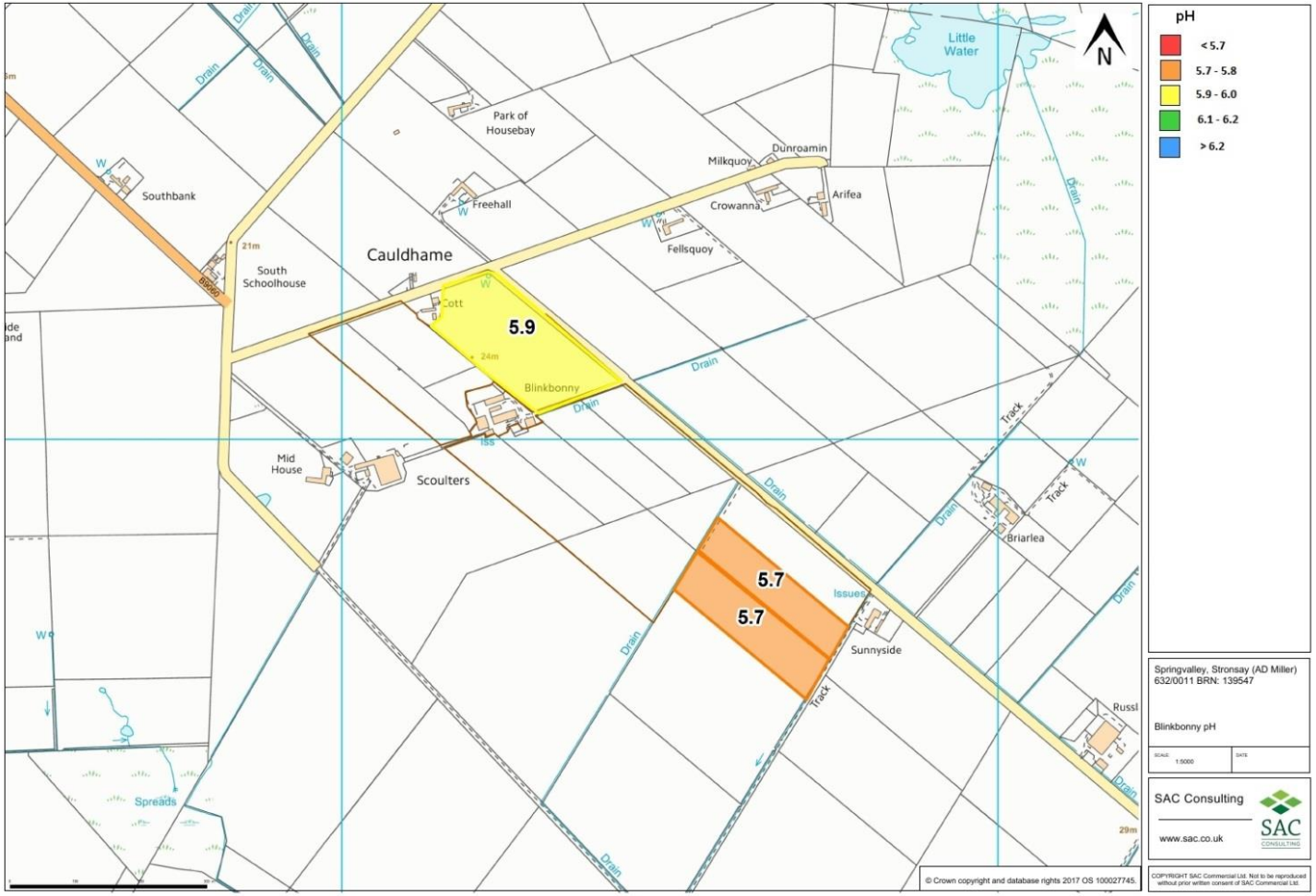

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Harradale pH

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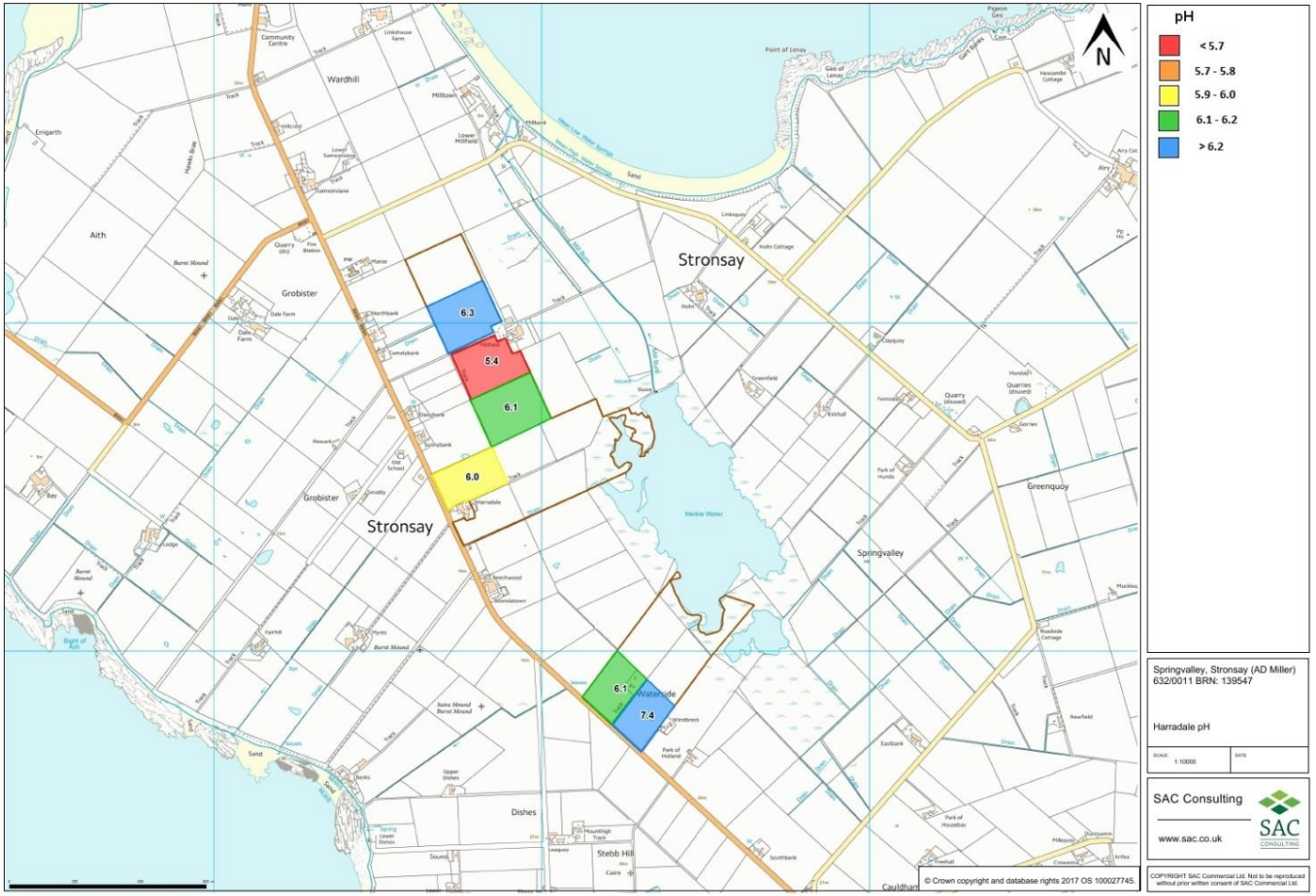

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Midgarth pH

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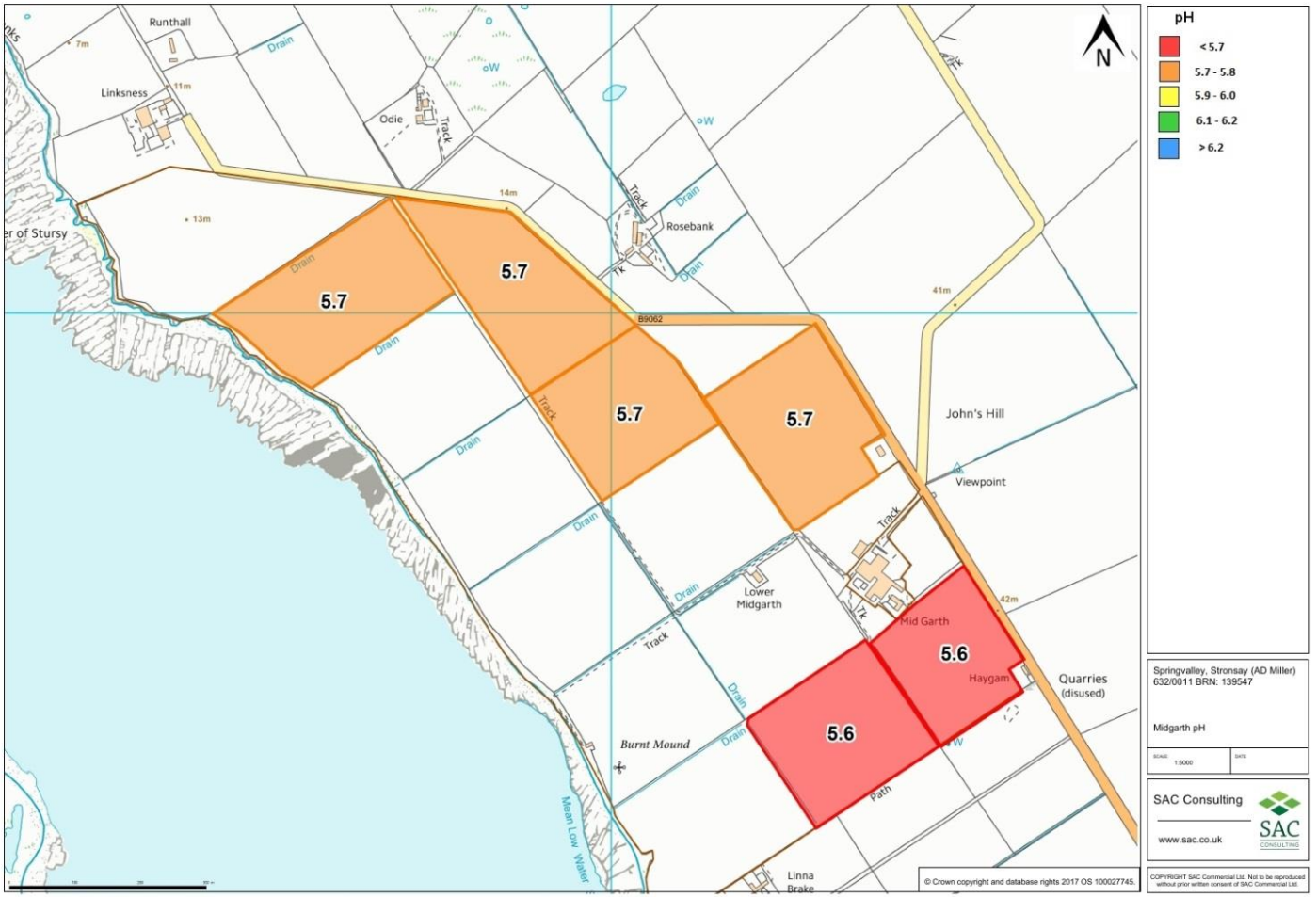

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Blinkbonny P

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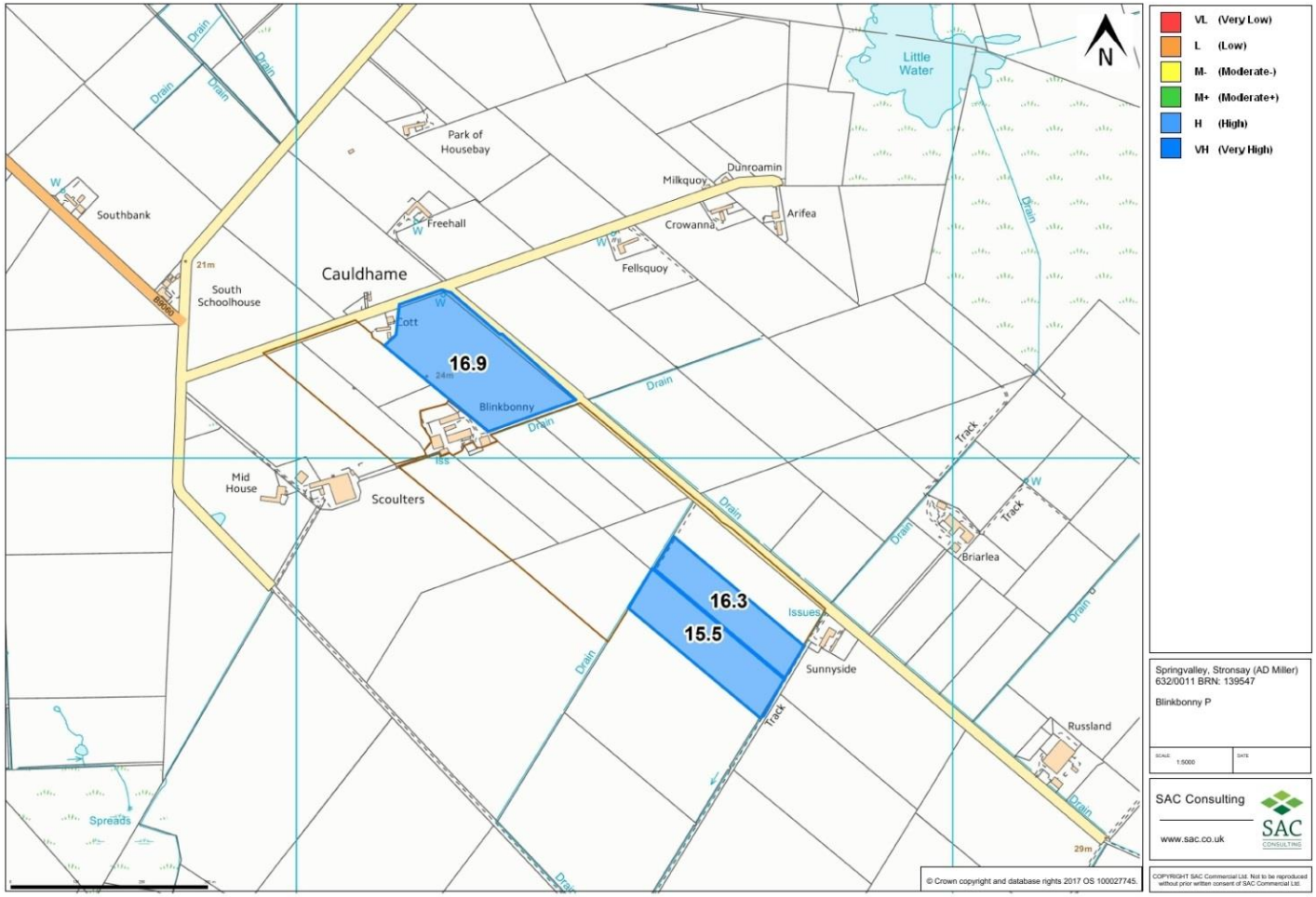

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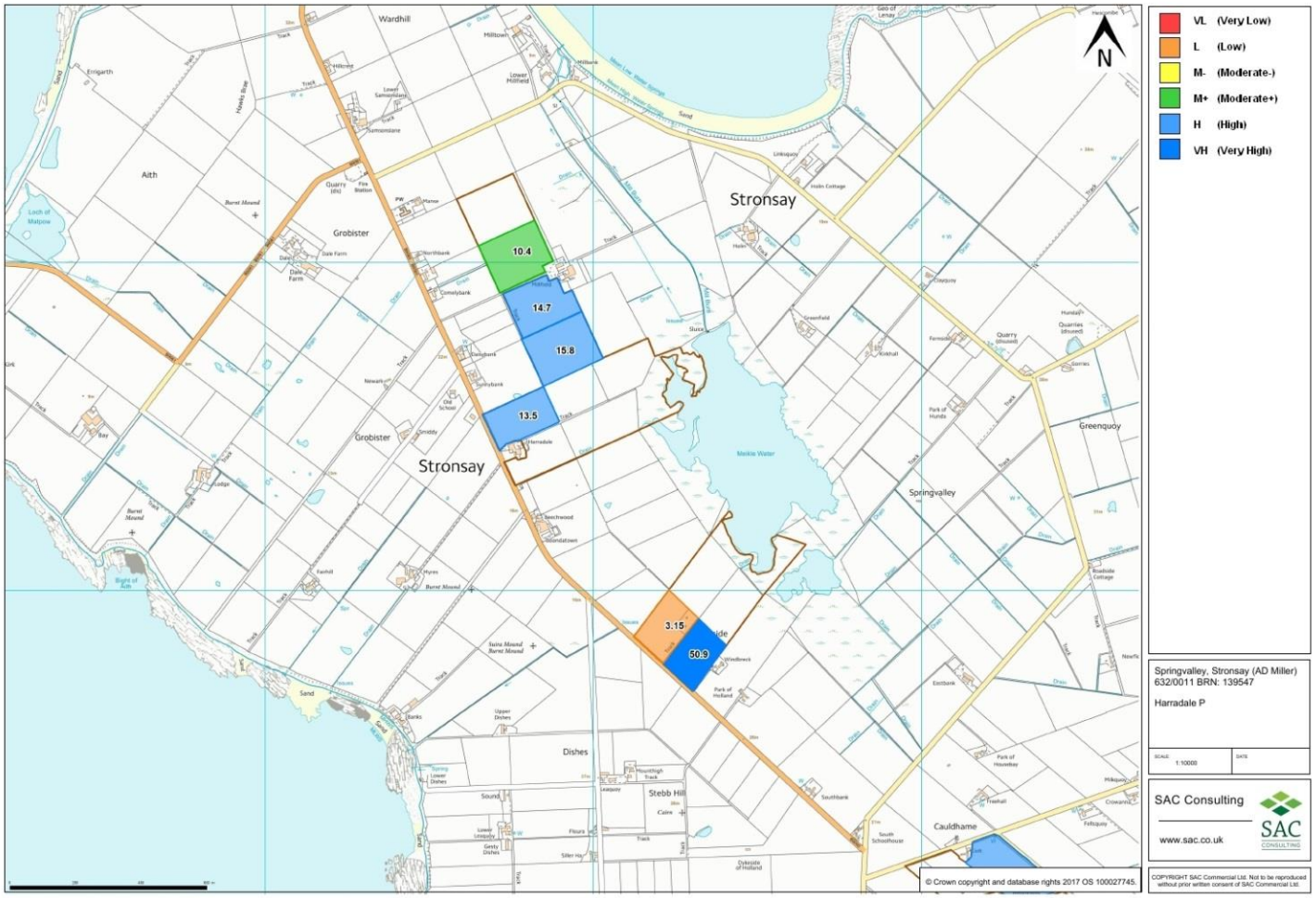

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Midgarth P

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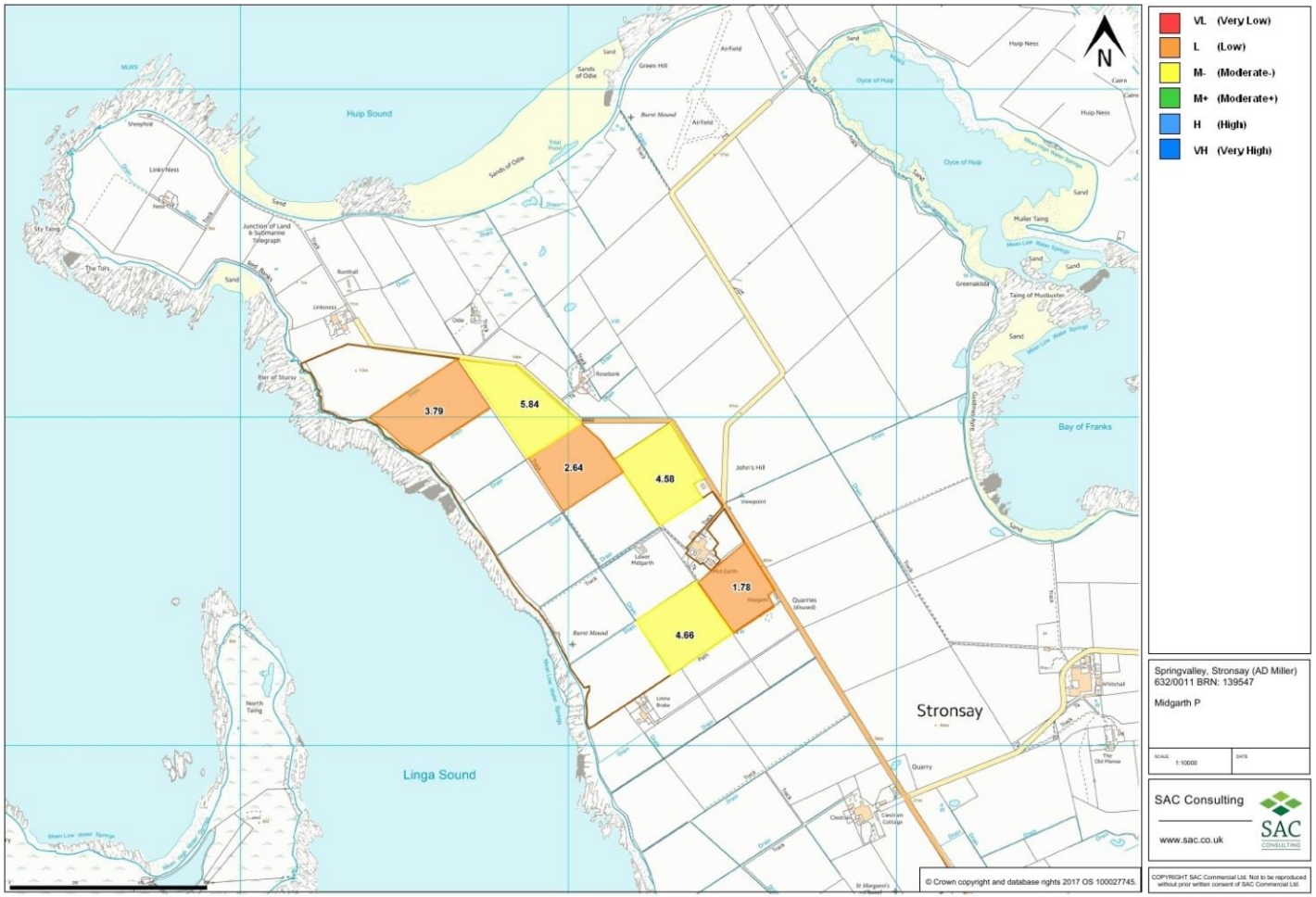

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Blinkbonny K

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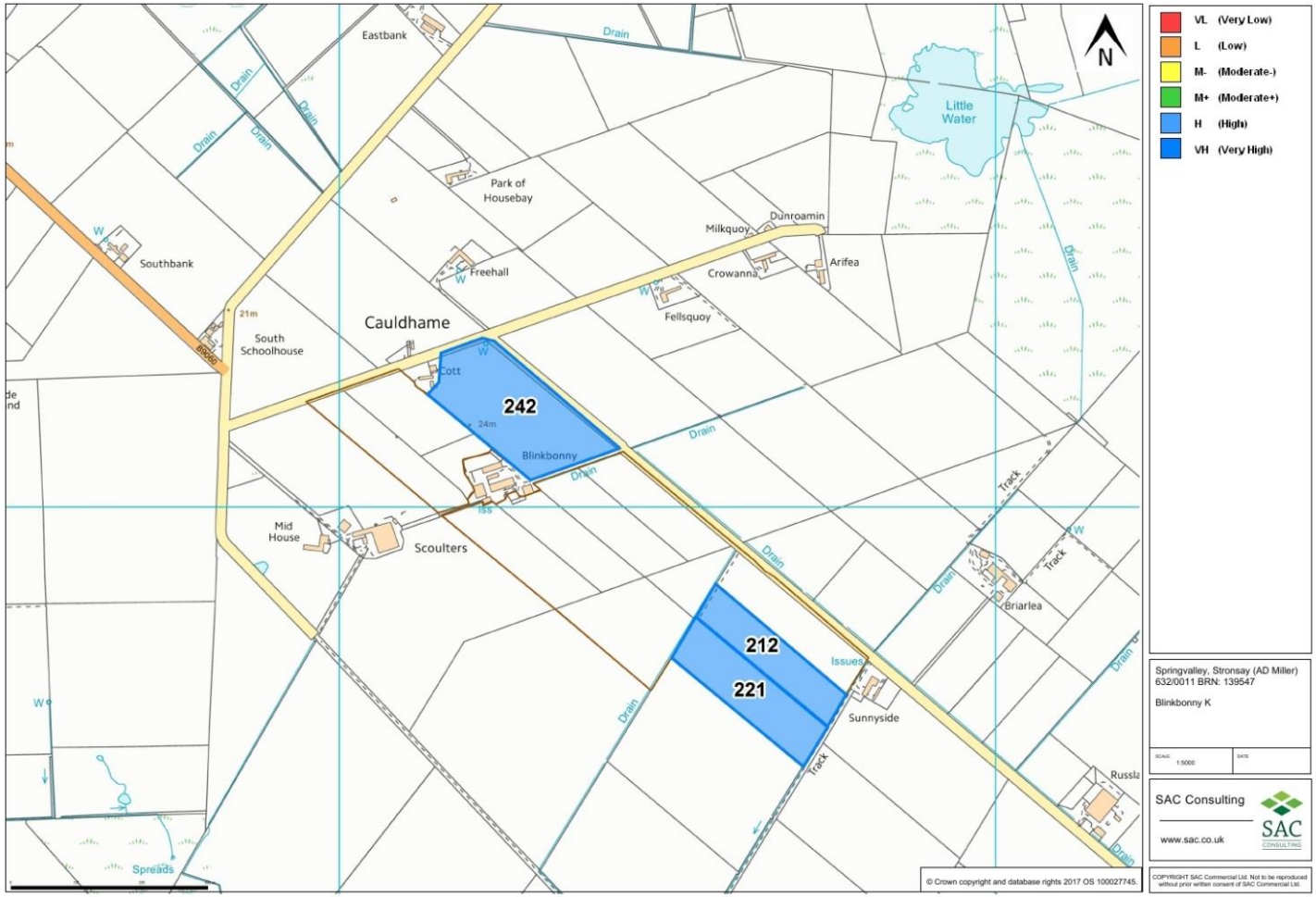

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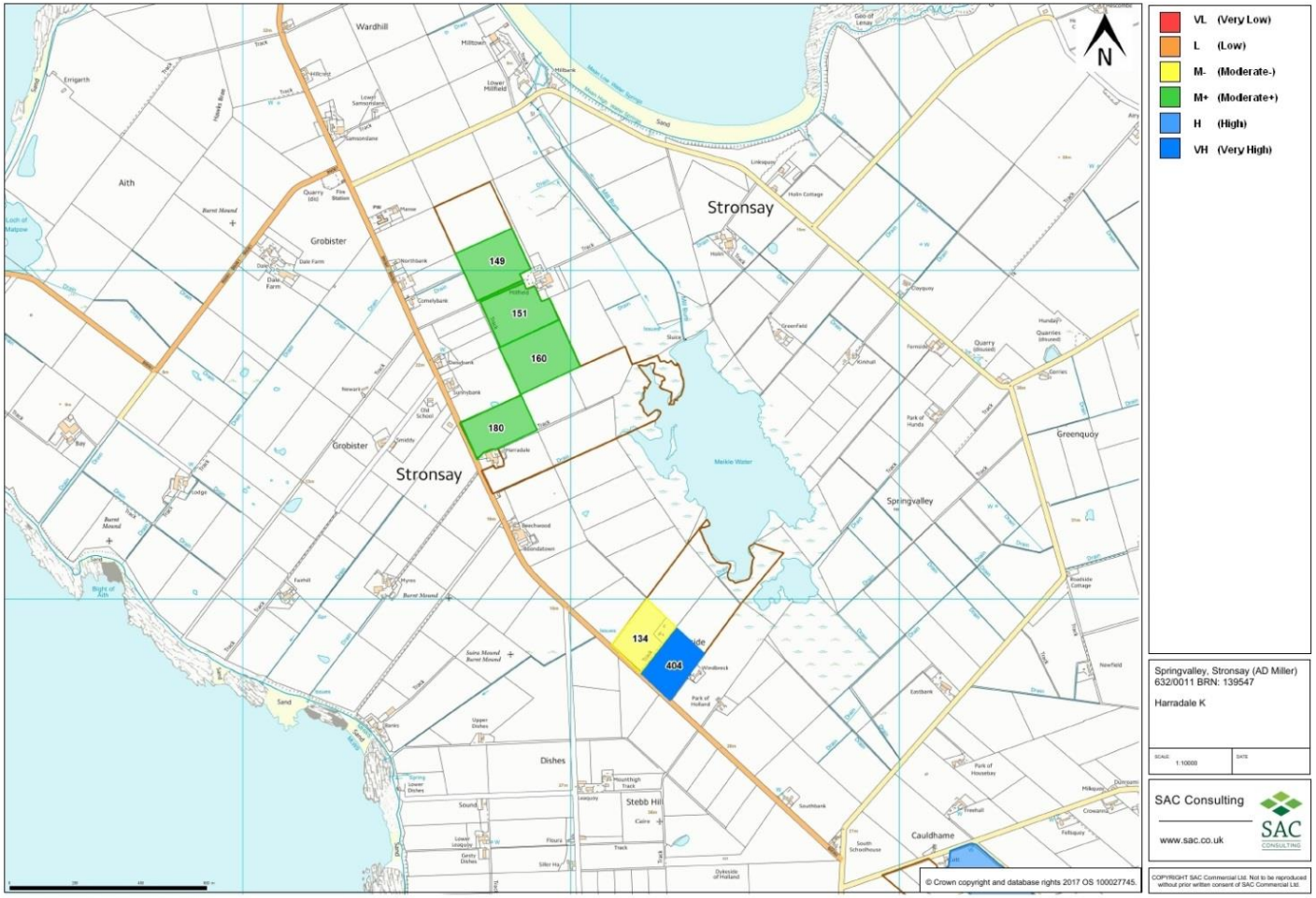

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Midgarth K

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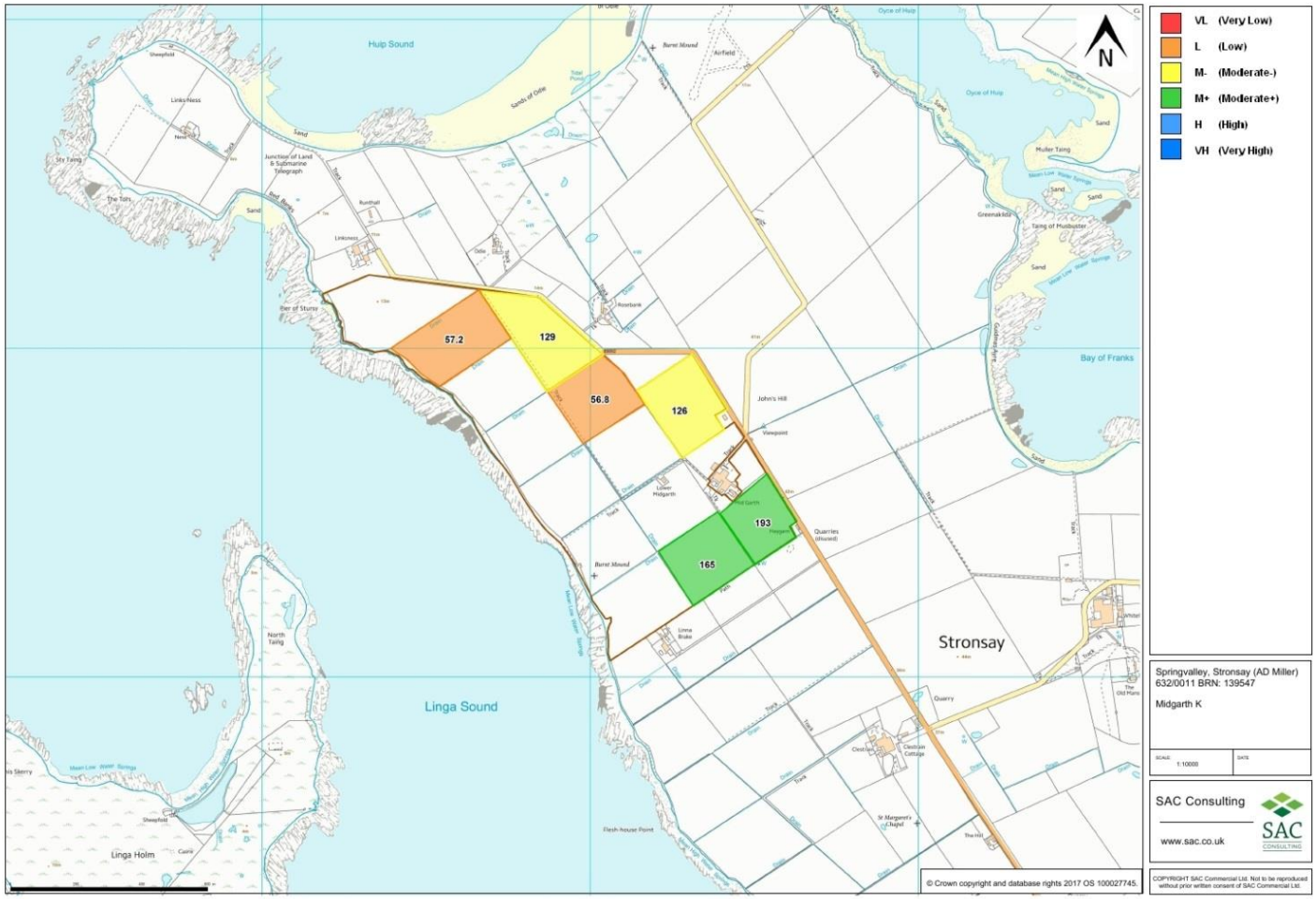

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Soil Acidity

- The pH of soils declines due to the build up of hydrogen ions (H^+)
- In Scotland this is a natural process but all productive farming practices will accelerate the process
  - Use of bagged fertiliser
  - Crop Harvest

Soil Acidity: Liming

- Liming process is a fixed chemical reaction

Calcium lime

$$CaCO_3 + 2H^+ = Ca_2^+ + CO_2 + H_2O$$

Magnesium Lime

$$MgCO_3 + 2H^+ = Mg_2^+ + CO_2 + H_2O$$

Soil Acidity: Liming

- Liming value is determined by:
  - Neutralising value - how much CO_3
  - Purity
  - Reactivity – how fast it works
    - Fine powder is the best (large surface area)

Soil Acidity: Liming

- Granulated Lime
- Finely ground lime processed into an easily managed granule

=

=

$$CaCO_3 + 2H^+ = Ca_2^+ + CO_2 + H_2O$$

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Soil Acidity: Liming

- Granulated Lime
  - Easy to use and fast reacting
  - No more effective than other materials over the medium term (5 years)
- Once you are on target the best liming material is the cheapest.

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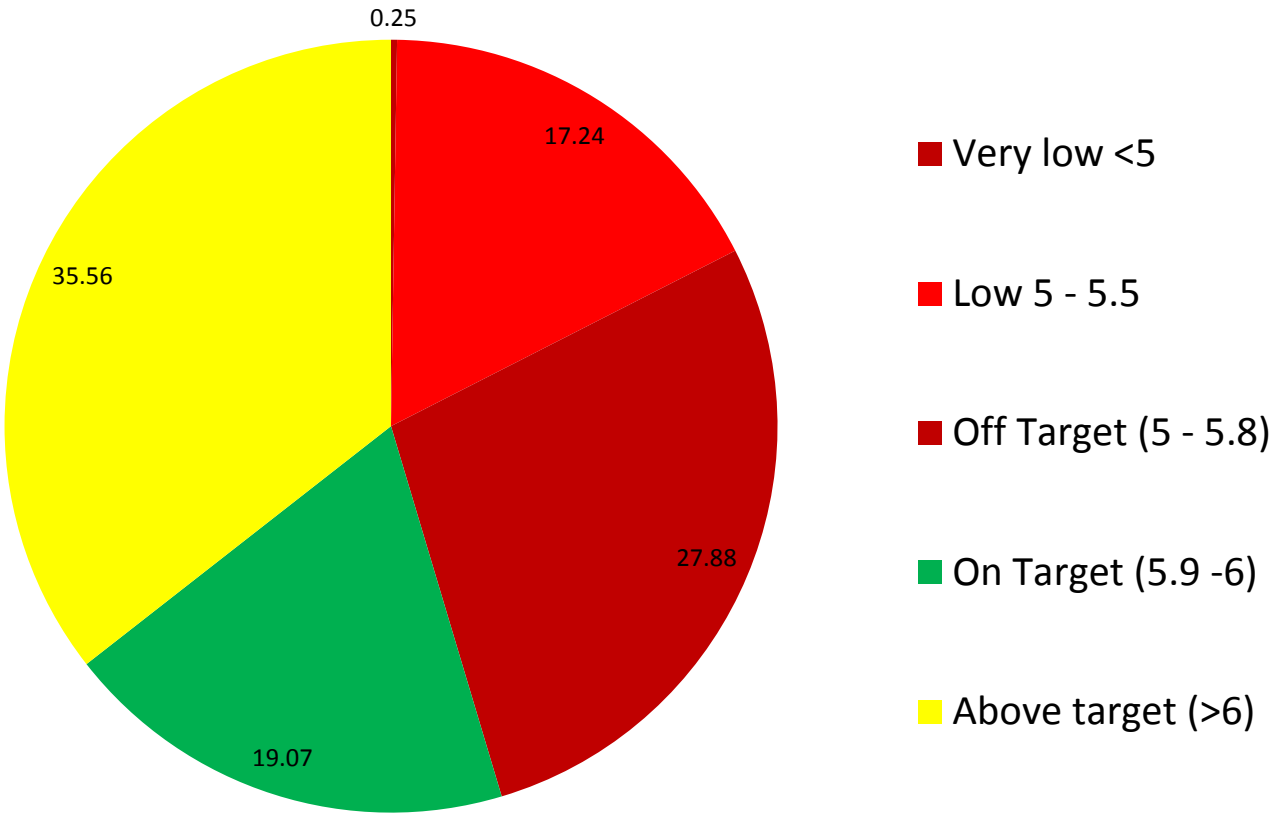
pH status across Orkney (2015 – 18)



pH - Nutrient Availability

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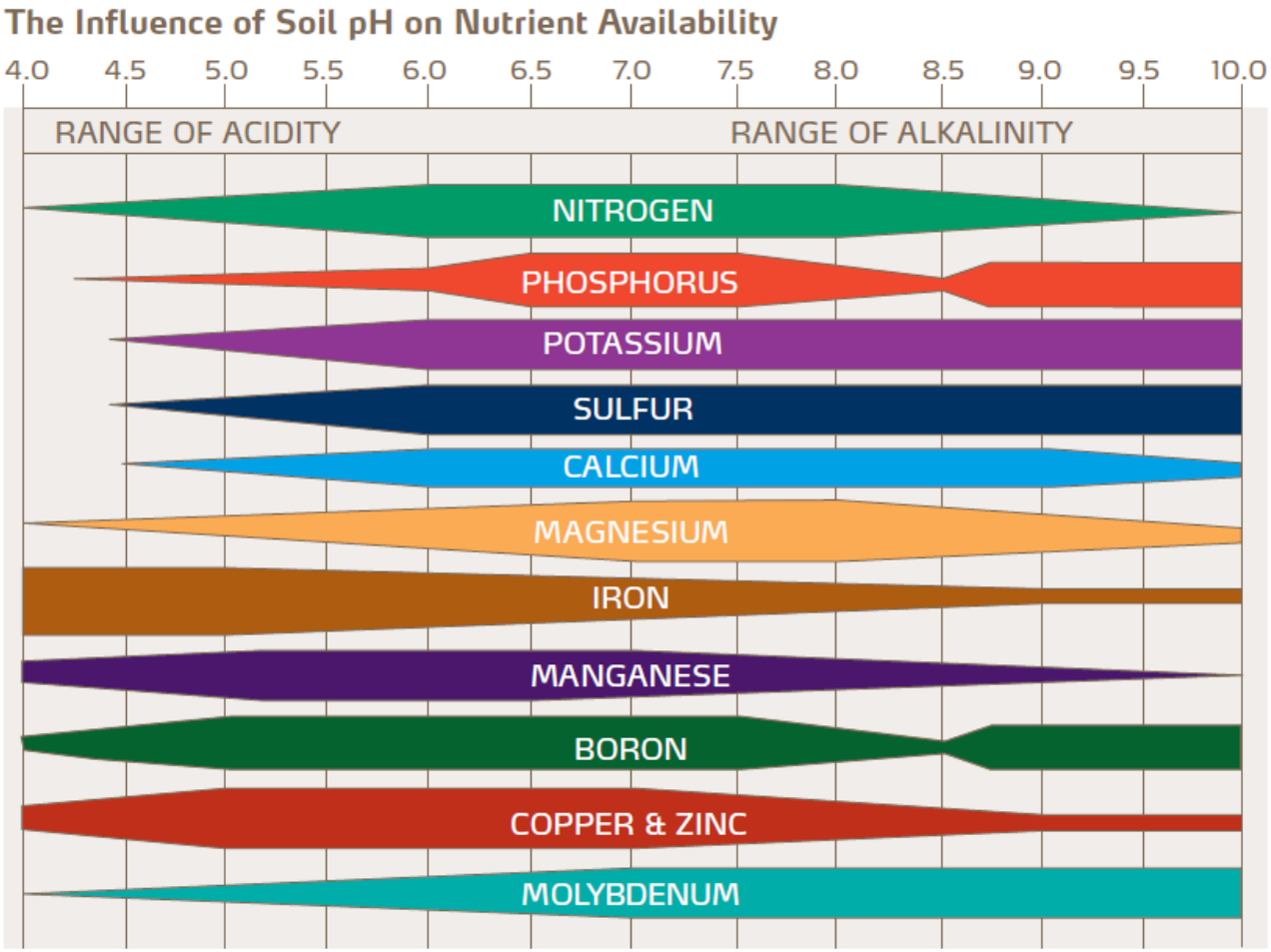

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pH Toxic elements

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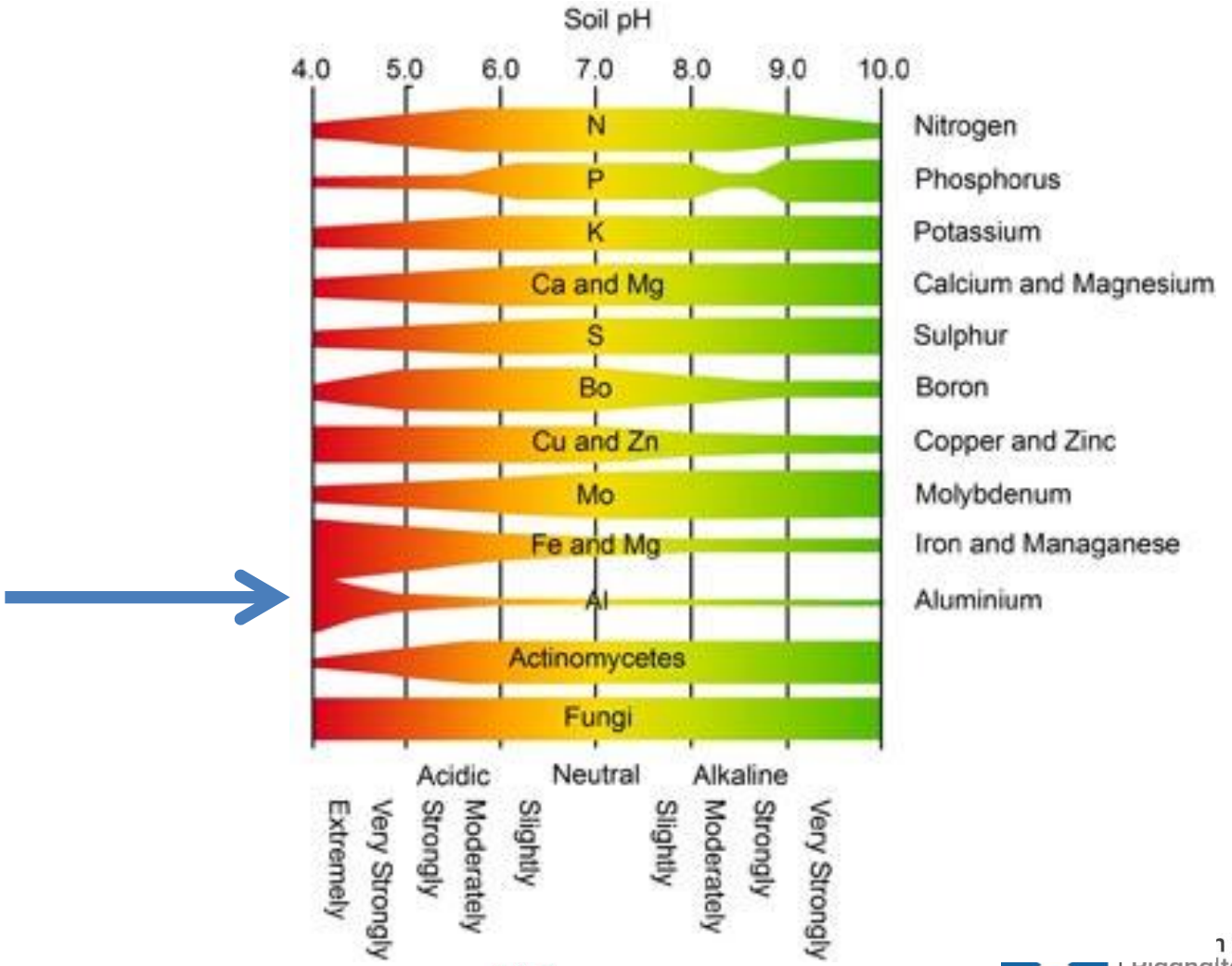

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Soil Testing

- Availability of nutrients is affected by the pH of the soil.

Low pH

- Phosphorus (poorer availability below 6)
- Calcium (poorer availability below 6)
- Sulphur (poorer availability below 5.5)
- Potassium (poorer availability below 5.5)

Crops differ in their sensitivity to soil acidity

increasing

sensitivity to

soil acidity

Potatoes, ryegrass

Oats, wheat, oilseed rape, clover

Barley, beans, peas, sugar beet

Hay (t/ha @ 85% DM)

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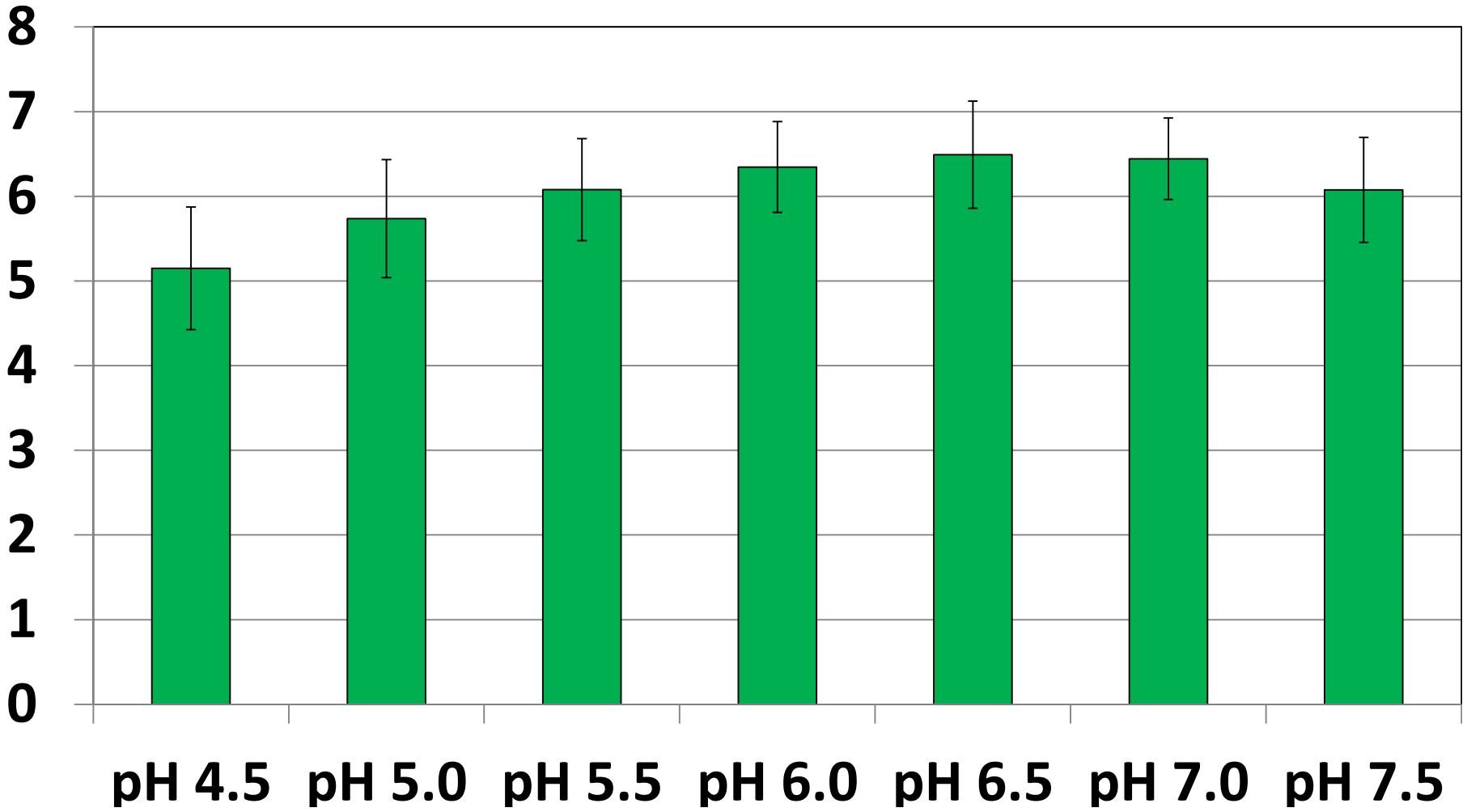

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Oats (t/ha @ 85% DM)

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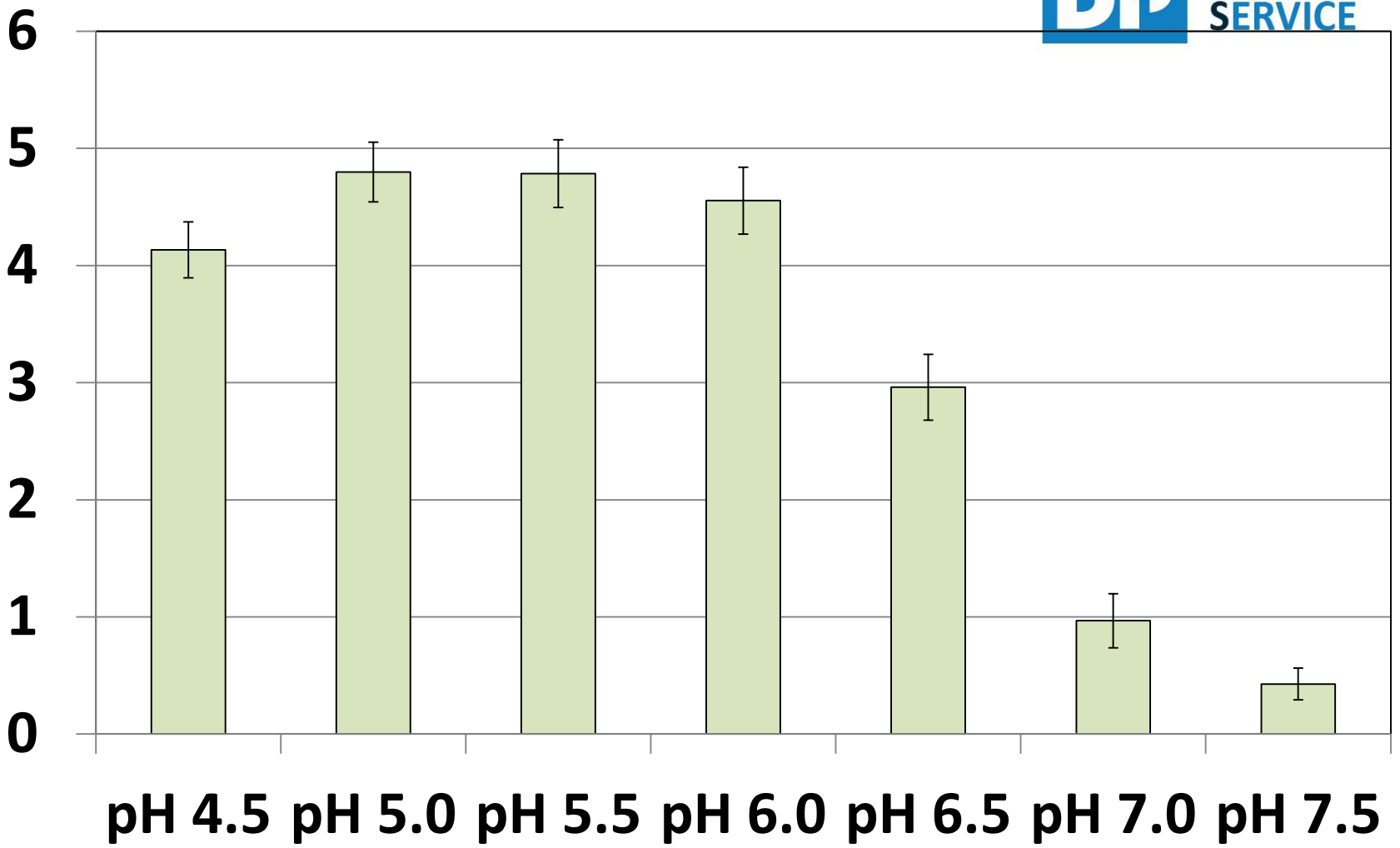

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Winter Wheat (t/ha @ 85% DM)

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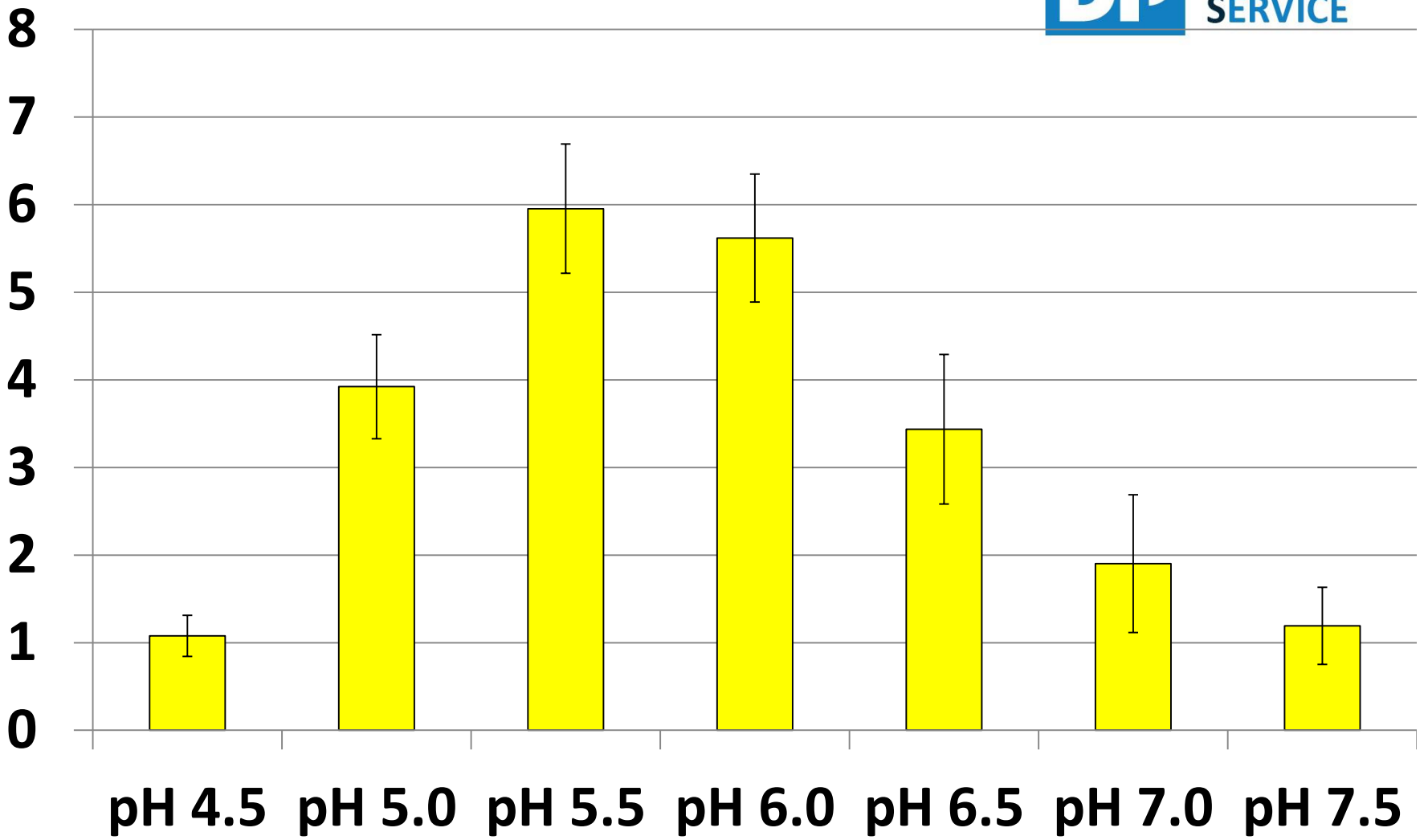

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Spring Barley (t/ha @ 85% DM)

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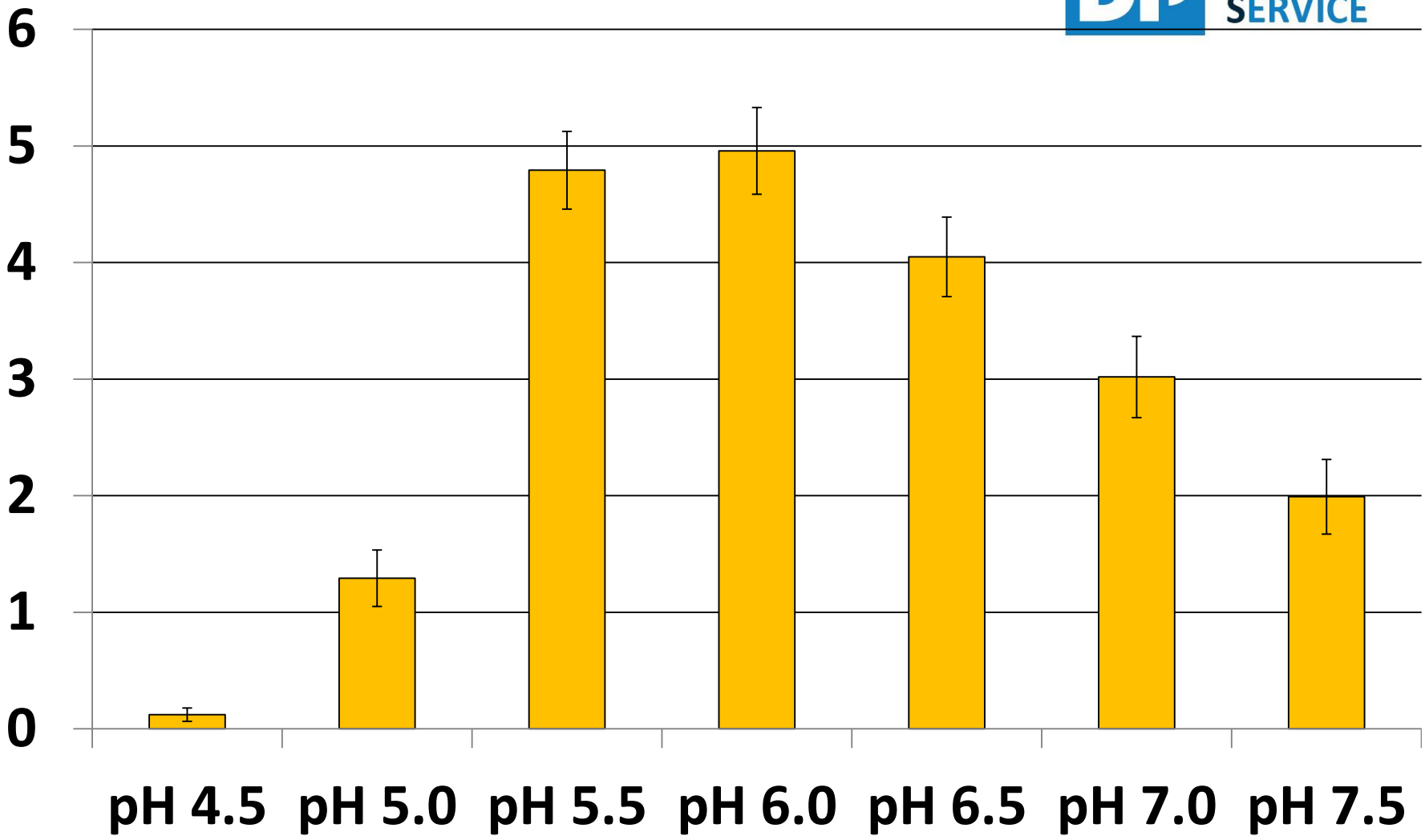

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Soil Testing

- Understanding your soil test: Plant available P and K
  - *Plant available* means the amount of P and K in your soil at the time of testing that is in a form that plants can **directly** access
- Use the results
- Test when Appropriate

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Soil Testing

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- Basic information on the condition of your soil
- Each field needs to be done every 4 to 5 years
- Important part of making sure we are taking climate change and environmental protection seriously
- Demonstrate that you are farming well

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Soil Testing

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- Timing
  - The processes of testing your soils assumes that no bagged fertiliser, manure or slurry has been applied in the past 12 weeks for P, and K.
  - For pH no lime should have been applied in at least the past 6 months
  - Sample your soils in the winter !

Midgarth Soil Results
(Sampled in June)

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Field Name	pH	P status	K status
Waterside	7.4	Very high	Very high
Greeni spot	5.7	Low	Low
Stursy Brothers	5.7	Low	Low
Rosebank	5.7	Moderate	Moderate
Millfield silage	6.3	Moderate	Moderate
Cott	5.9	High	High
Quoy	5.7	High	High
Millfield lay	5.4	High	Moderate
Hillihoose	5.6	Low	Moderate

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P status Midgarth

- 6 out of 15 are above target
- 4 are on target (moderate)
- 5 are low

- Differing requirements across the farm!

Phosphate

- **Grass** – Essential for energy transfer within the plant, therefore direct effect on yield and quality.

Made worse by

- Acidic or very alkaline soils,
- low organic matter,
- cold or wet conditions,
- crops with a poorly developed root system,
- soils with low P reserves,
- Soils with a high phosphate capacity, iron rich soils.

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Phosphate

- You are always fertilising next years crop (replacing)

- Being on target for Available P (Moderate Status) is the only proven method for ensuring adequate P will be available to support your crop
  - Currently accepted by regulators as an indicator of efficient management

- Once on target you must restrict additional P application to match annual crop offtake.

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Midgarth K status (Potash)

- 4 of 15 are above target
- 9 are on target
- 2 are low

- Maintaining good status is the priority

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Potash

- **Grass** – Internal water regulation, vigorous growth and healthy foliage, required in large amounts.

Made worse by

- Acidic soils (low pH),
- sandy or light soils (leaching),
- drought conditions,
- high rainfall (leaching),
- heavy clay soils, soils with low K reserves,
- magnesium rich soils.

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Midgarth pH status

- 3 or 15 are low (<5.7)
- 6 are close to target (5.7)
- 6 are at or above target (5.8 or higher)

- Making sure the source of lime is cost effective

Nitrogen

- **Grass** – Better synthesis of amino acids, improved formulation of co-enzymes and nucleic acids, increased synthesis of chlorophyll and ATP, improved crop vigour and development.

Made worse by

- Low or high pH soils, sandy or light soils (leaching.)
- low organic matter. drought conditions,
- high rainfall (leaching),
- addition or high levels of non-decomposed organic matter/manure (e.g. straw)

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Sulphur

- **Grass** - Component of enzymes and other proteins, necessary for chlorophyll formation and efficient N-utilization.

Made worse by

- Acidic and Sandy soils, light,
- low organic matter,
- poorly aerated soils (waterlogged soils.),
- Areas with low industrial emissions.

Make Sure a Source of Sulphur is being applied

- Manure and slurry or bagged fertiliser

P & K Removal Rates

FARM ADVISORY SERVICE

	Nutrients Removed	
Crop	P Removal (kg/t)	K Removal (kg/t)
Silage	1.7	6
Hay	5.9	18
Grazing	1.4	1.8

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Using P and K Soil test results

FARM ADVISORY SERVICE

Fertiliser requirements one cut silage (standard yields)

Soil Results	P_2O_5 (kg/ha)	k_2O (kg/ha)
On Target (M) Replace	39	139
Low (L) Build up	79	159
High (H) Draw down	30	70

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P & K requirements – Grass

FARM ADVISORY SERVICE

Soil Status	Crop	Yield - t/ha (bales per acre)	P requirement (kg/ha)	K requirement (kg/ha)
Moderate	1 cut silage	17.5 (14)	30	105
Low	1 cut silage	17.5 (14)	70	125
Very Low	1 cut silage	17.5 (14)	110	165
Moderate	2 cut silage	26 (21)	44	156
Low	2 cut silage	26 (21)	84	176
Very Low	2 cut silage	26 (21)	124	216
Moderate	Establishment		50	50
Low	Establishment		90	70
Very Low	Establishment		130	110

P & K requirements – Grass with High Clover

FARM ADVISORY SERVICE

Soil Status	Crop	Yield (t/ha)	P requirement (kg/ha)	K requirement (kg/ha)
Moderate	1 cut silage	17.5 (14)	30	105
Low	1 cut silage	17.5 (14)	70	125
Very Low	1 cut silage	17.5 (14)	110	165
Moderate	1 cut silage	26 (21)	44	156
Low	1 cut silage	26 (21)	84	176
Very Low	1 cut silage	26 (21)	124	216
Moderate	Establishment		70	70
Low	Establishment		110	90
Very Low	Establishment		150	130

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Midgarth fertiliser plan

- 26:10:0 used across the system
- 27:5:5 used after grazing and first cut
  - Based on soil tests it is working well
  - Need to ensure manure and slurry is spread across the farm (potash)
  - Consider straights to bring some fields up
  - Check that sulphur is coming in

Products Available

FARM ADVISORY SERVICE

Make sure you consider all options

- 25.5.5
- 23.4.13 + (7 SO_3)
- 20.9.9 +(7.5 SO_3)
- 20.10.10
- 16.16.16 + (7.5 SO_3)
- 12.22.22 + (7 SO_3)
- 0.46.0
- 0.0.60

Any Questions?

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