NORTHERN AGRICULTURAL DISTRICTS

DEMONSTRATION SOILS

For the
Hart Field Site Group
and
Soil Science Australia (SA Branch)

Produced by James Hall B .Ag. Sc., Director, Juliet Creek Consulting, Sept 2014

HART
SA's premier cropping field site

SOIL SCIENCE AUSTRALIA

Overview

In collaboration with the Hart Field Site Group (HFSG), the SA Branch of Soil Science Australia was successful in winning a Northern & Yorke Natural Resources Management Board project bid, which has lead to the production of this report. The HFSG are a farming systems group based in the Mid-North of South Australia who are providers of independent agricultural research and extension.

The aim of the project is the build the capacity of growers in the Mid-North by developing a series of local soil classification examples. Eight sites for this knowledge transfer activity have been selected from Mid-North region. The demonstration soils feature different soil types and rainfall areas, and are used by HFSG to run Yield Prophet® (a model to predict grain yield).

As part of the collaboration James Hall (contact: julietcreek@gmail.com), a soil consultant and Soil Science Australia (SA Branch) committee member, has characterised the demonstration soils and interpreted the results, the outcome of which is provided in this report. Related soil information from 'ApSoil' is also presented (see < www.apsim.info/Products/APSoil.aspx>).

The demonstration soils will be preserved and kept as permanent records, to be used by the HFSG at their annual field day in September 2014 and beyond. This will be an opportunity for growers to better understand the soil types on their properties and districts, and can assist with decisions on farm (such as stubble management or application of soil amendments).

By having the soil cores available on a permanent basis, HFSG staff will be at the ready and well-prepared to demonstrate the different soil types and their implications for farm management when engaging with farmers.

Dr Sarah Noack (Research & Extension Manager, Hart Field Site Group) is thanked for her efforts in leading this project and securing funding, as well as for her landscape descriptions and photographs. In addition, the Northern & Yorke Natural Resources Management Board are acknowledged for their generous support.

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Government of South Australia
Northern and Yorke Natural Resources Management Board

Contact

www.hartfieldsite.org.au

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Demonstration Soils

The eight demonstration cores come from sites at:

Tarlee (TAR)
Condowie (CON)
Kybunga (KYB)
Pinery (PIN)
Hart: upper slope (HUS)
Hart: lower slope (HLS)
Eudunda (EUD)
Farrell Flat (FF).

Soil profiles have been described with reference to the *Australian Soil & Land Survey – Field Handbook* (NCST 2000). Soil colour terminology derives from Munsell Color (1988).

Note that there are limitations to soil description when soil cores are utilised, in particular, it is difficult to assess soil structure. More information can be determined using an open pit face. Soil pits also allow the capture of soil profile images.

Moreover, there are have been no laboratory chemical analyses of soil horizon samples, which also limits interpretive capacity. However, field pH has been measured to the nearest 0.5 of a unit using a field-kit based on the specifications determined by Raupack & Tucker (1959) (nonetheless, laboratory tests should be conducted to confirm results), soil dispersion has been assessed using a quick dispersion test based on the test developed by Emerson (1967) (where slightly dispersive soil equates approximately to a exchangeable sodium percentage (ESP) of 6 or slightly greater), while surface soil water repellence has been assessed using the method developed by King (1981).

Tarlee Soil (TAR) [soil M4]

The Tarlee demonstration soil is represented by No. 279 in 'ApSoil' (see <www.apsim.info/Products/APSoil.asp>).

Landscape and Land Use

Landscape: valley
Slope: 10%
Surface: no surface stone
Land use (2014): wheat crop (crop with pasture rotation).

Soil Profile Description

Uniform clay with dark-coloured and calcareous subsoil

Hard acidic clay, grading to alkaline/calcareous dark-coloured clayey subsoil, with a sodic/dispersive clay lower subsoil and siltstone at depth.

Soil Name	Horizon	Depth (cm)	Description
TAR	Ap	0–5	Hard, acidic, dark reddish brown, light medium clay with moderate structure
	B21	5–14	Acidic, dark brown and dark reddish brown, medium heavy clay with moderate structure
	B22	14–37	Acidic, dark brown and reddish brown, medium heavy clay
	B23	37–64	Slightly calcareous, very dark brown, medium heavy clay
	B24k	64–80	Moderately calcareous, dark brown, medium heavy clay, with 2–10% fine carbonate segregations
	B3k	80–99	Moderately calcareous, slightly dispersive, dark yellowish brown and dark reddish brown, medium clay, with >50% fine carbonate segregations and 10–20% siltstone fragments

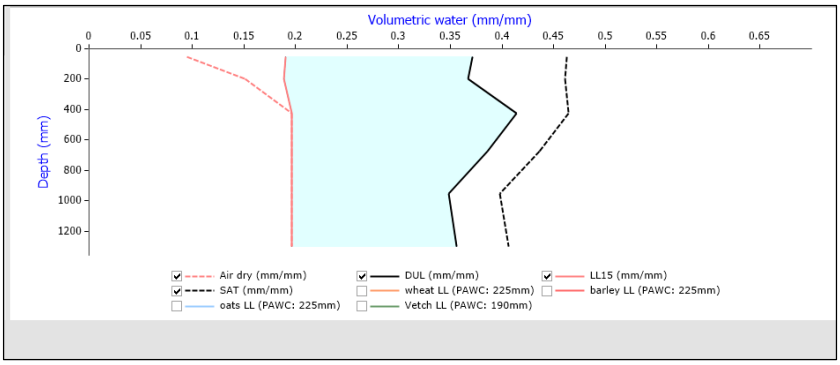
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *deep hard gradational soil* [**soil M4**].

The Australian Soil Classification (Isbell 2002): Sodic, Calcic, **Black Dermosol**; thin, non-gravelly, clayey / clayey, moderate.

Great Soil Group (see Stace et al. 1968): no suitable classification.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. The thin and clayey topsoil makes surface management difficult. Strong subsoil and dispersive lower subsoil restrict drainage and root growth. Surface soil pH should be monitored through laboratory testing, with lime applied if and where necessary. Maintenance of surface cover is also important to minimise water erosion.

ApSoil analysis data from nearby indicate that boron and exchangeable sodium percentage (ESP) reach moderately high levels in terms of plant toxicity below 80 cm. Few wheat roots are likely to grow beyond this depth. (No wheat roots were observed in the soil core below 40 cm.)

Condowie Soil (CON) [soil A6]

The Condowie demonstration soil is represented by No. 609 in 'ApSoil' (see <www.apsim.info/Products/APSoil.aspx>).

Landscape and Land Use

Landscape: plain
Slope: level
Surface: some surface hard carbonate (1–5 cm diameter)
Land use (2014): chickpea crop (continuous cropping).

Soil Profile Description

Calcareous clay loamy soil

Calcareous clay loam, grading to brown highly calcareous and dispersive clay loamy to light clayey subsoil with abundant fine carbonate.

Soil Name	Horizon	Depth (cm)	Description
CON	Ap	0–11	Moderately calcareous, dark brown, clay loam with moderate structure
	A3	11–29	Highly calcareous, dark brown, clay loam with massive structure and 2–10% hard carbonate nodules

	B1k	29–61	Highly calcareous, slightly dispersive, strong brown, heavy clay loam with massive structure, >50% fine carbonate segregations and 2–10% hard carbonate fragments
	B2	61–98	Highly calcareous, slightly dispersive, yellowish red, light clay with moderate structure

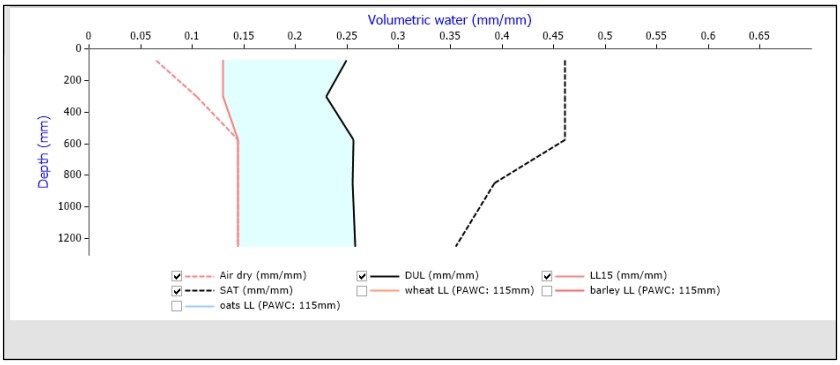
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *calcareous gradational clay loam* [**soil A6**].

The Australian Soil Classification (Isbell 2002): Ceteric, Pedal, **Hypercalcic Calcarosol**; medium, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): solonised brown soil or loamy mallee soil.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Trace element levels (especially zinc, iron and manganese) need to be carefully monitored owing to their limited availability in calcareous soil. Strong and dispersive subsoil restricts drainage and root growth. It is also likely that boron toxicity is an issue in this soil.

ApSoil analysis data from nearby indicate high levels of boron and exchangeable sodium percentage (ESP) in terms of plant toxicity below 70 cm. Few wheat roots are likely to grow beyond this depth. (No chickpea roots were observed in the soil core below 60 cm.)

Kybunga Soil (KYB) [soil C4]

The Kybunga demonstration soil is represented by No. 290 in 'ApSoil' (see <www.apsim.info/Products/APSoil.aspx>).

Landscape and Land Use

Landscape: plain

Slope: level

Surface: none present

Land use (2014): wheat crop (continuous cropping).

Soil Profile Description

Uniform clay loam to light clay with calcareous subsoil

Acidic clay loam, grading to highly calcareous silty clay loam, which grades to siltstone at depth.

Soil Name	Horizon	Depth (cm)	Description
KYB	Ap	0–6	Hard, acidic, dark reddish brown, clay loam with moderate structure
	A3	6–38	Dark reddish brown, silty light clay with weak to massive structure
	B1	38–60	Highly calcareous, dark reddish brown, silty light clay with moderate structure and 10–20% fine carbonate segregations
	B2k	60–96	Highly calcareous, yellowish red, silty light clay with moderate structure and 20–50% fine carbonate segregations

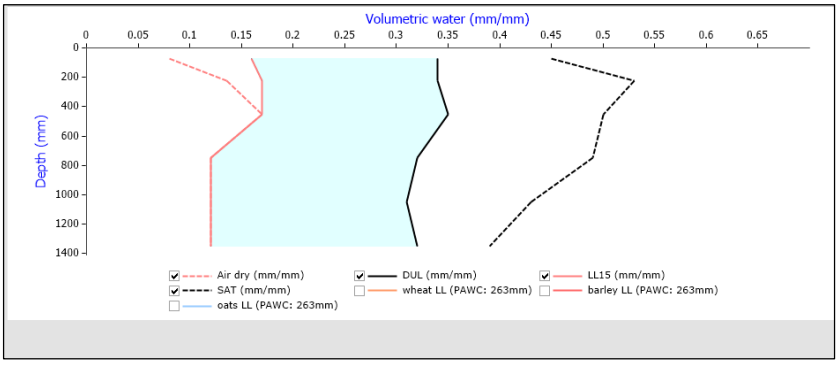
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *hard gradational clay loam* [**soil C4**].

The Australian Soil Classification (Isbell 2002): Haplic, Calcic, **Red Dermosol**; thin, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): no suitable classification.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate

fertility levels. Strong subsoil would limit drainage and root growth. Surface soil pH should be monitored through laboratory testing and lime applied if and where necessary.

ApSoil analysis data from nearby indicate no chemical barrier to plant root growth in the top 100cm. (Nonetheless, no wheat roots were observed in the soil core below 60 cm.)

Pinery Soil (PIN) [soil A6]

The Pinery demonstration soil is represented by No. 273 in 'ApSoil' (see <www.apsim.info/Products/APSoil.aspx>).

Landscape and Land Use

Landscape: plain
Slope: level
Surface: some surface hard carbonate (1–3 cm diameter)
Land use (2014): lentil crop (continuous cropping).


Soil Profile Description

Calcareous clay loam grading to clay

Calcareous clay loam, grading to highly calcareous and dispersive red clay.

Soil Name	Horizon	Depth (cm)	Description
PIN	Ap	0–11	Moderately calcareous, dark reddish brown, clay loam with moderate structure
	A3	11–22	Highly calcareous, reddish brown, clay loam with moderate structure
	B2	22–34	Highly calcareous, yellowish red, light clay with moderate structure and 10–20% fine carbonate segregations
	B2k	34–51	Highly calcareous, slightly dispersive, yellowish red, light medium clay with moderate structure and 20–50% fine carbonate segregations
	B3	51–91	Highly calcareous, yellowish red, medium heavy clay with 2–10% fine carbonate segregations

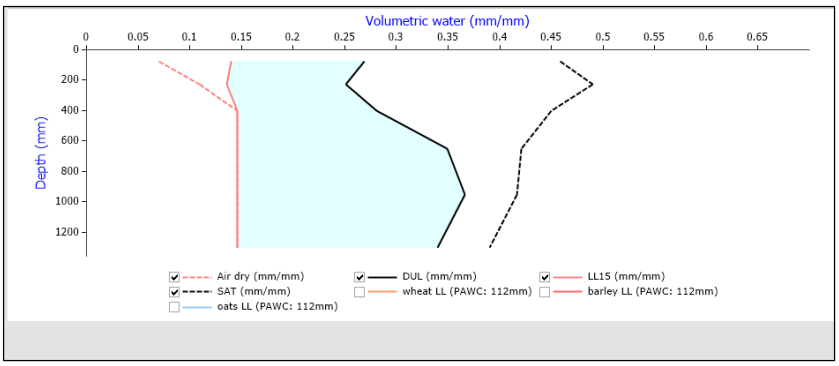
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *calcareous gradational clay loam* [**soil A6**].

The Australian Soil Classification (Isbell 2002): Ceteric, Pedal, **Calcic Calcarosol**; medium, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): solonised brown soil or loamy mallee soil.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Trace element levels (especially zinc, iron and manganese) need to be carefully monitored owing to their limited availability in calcareous soil. Dispersive subsoil restricts drainage and root growth. It is also possible that boron toxicity is an issue in this soil.

ApSoil analysis data from nearby indicate very high levels of boron and exchangeable sodium percentage (ESP) in terms of plant toxicity below 50 cm. Few wheat roots are likely to grow beyond this depth. (No lentil roots were observed in the soil core below 50 cm.)

Eudunda Soil (EUD) [soil K1]

The Eudunda demonstration soil is represented by the 'Point Pass' soil (No. 251) in 'ApSoil' (see <www.apsim.info/Products/APSoil.asp>).

Landscape and Land Use

Landscape: upper slope
Slope: 5–10%
Surface: no surface stone
Land use (2014): wheat crop (continuous cropping).

Soil Profile Description

Uniform clay loam on rock

Acidic silty clay loam, grading to red-brown silty clay loam with siltstone fragments which is dispersive in its lower part, overlying dispersive and highly weathered siltstone.

Soil Name	Horizon	Depth (cm)	Description
EUD	Ap	0–8	Acidic, dark reddish brown, silty clay loam with moderate structure
	B2	8–22	Acidic, dark reddish brown, silty light clay with moderate structure
	B3	22–40	Dark reddish brown and yellowish brown, silty clay loam with 10–20% siltstone fragments
	C1	40–55	Slightly dispersive, yellowish red and strong brown, light silty clay loam with 20–50% siltstone fragments
	C2	55–92	Slightly dispersive, olive-colour, highly weathered siltstone with a texture of silty clay loam and inclusions of dark reddish brown soil

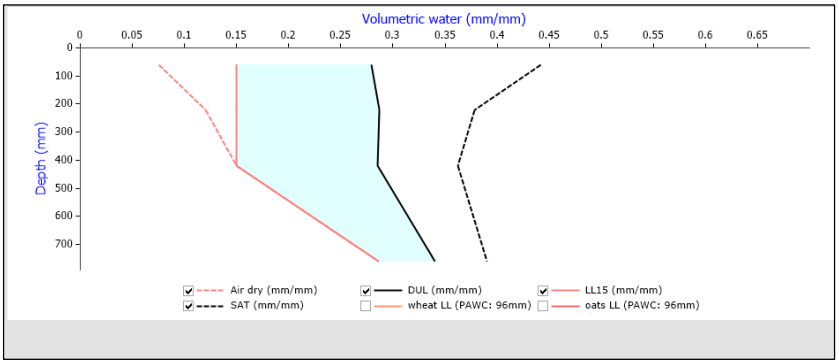
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *acidic gradational loam on rock* [**soil K1**].

The Australian Soil Classification (Isbell 2002): Sodic, Eutrophic, **Red Dermosol**; thin, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): Red Podsolic.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Strong subsoil and dispersive lower subsoil restrict drainage and root growth, as does weathered rock at 55 cm. Surface soil pH should be monitored through laboratory testing to determine if and where lime should be applied. Maintenance of surface cover is also important to minimise water erosion.

ApSoil analysis data from nearby indicate no chemical barrier to plant root growth in the top 100cm. However, the major barrier to roots is the presence of weathered rock substrate at 55 cm (no wheat roots were observed in the soil core below this depth).

Farrell Flat Soil (FF) [soil D3]

The Farrell Flat demonstration soil is represented by No. 283 in 'ApSoil' (see <www.apsim.info/Products/APSoil.asp>).

Landscape and Land Use

Landscape: mid-slope
Slope: 10–15%
Surface: some surface stone
Land use (2014): wheat crop (crop with pasture rotation).

Soil Profile Description

Hard clay loam over poorly structured clay

Hard fine sandy clay loam, overlying dispersive and red clayey subsoil, with a calcareous lower subsoil and siltstone at depth.

Soil Name	Horizon	Depth (cm)	Description
FF	Ap	0–11	Dark reddish brown, fine sandy clay loam with moderate structure
	B21t	11–23	Slightly dispersive, dark red, medium heavy clay with moderate structure
	B22t	23–50	Dark red, medium clay

	B3k	50–70	Moderately calcareous, red and reddish brown, light medium clay with 2–10% siltstone fragments and 2–10% fine carbonate segregations
	C1k	70–92	Moderately calcareous, red and light reddish brown, silty medium clay with moderate structure, 20–50% siltstone fragments and 20–50% fine carbonate segregations

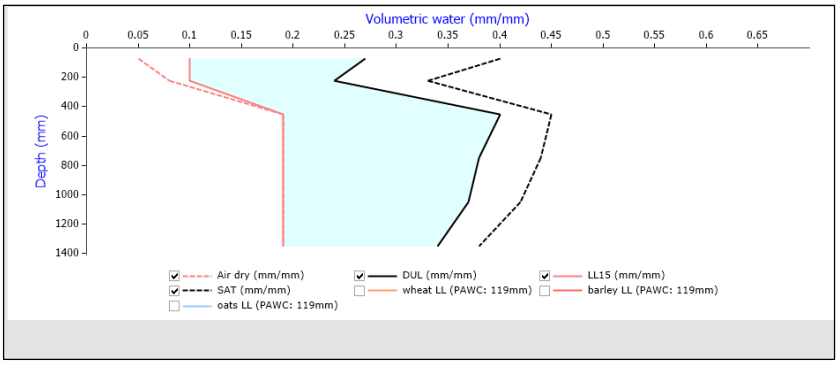
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *loam over poorly structured red clay* [**soil D3**].

The Australian Soil Classification (Isbell 2002): Calcic, Subnatric, **Red Sodosol**; medium, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): Red-Brown Earth.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Strong subsoil and dispersive upper subsoil restrict drainage and root growth. The shallowness of the clayey subsoil increases the difficulty of soil management and heightens erosion risk. Maintenance of surface cover is important to minimise water erosion.

ApSoil analysis data from nearby indicate that exchangeable sodium percentage (ESP) reaches moderately high levels in terms of plant toxicity below 60 cm. Few wheat roots are likely to grow beyond this depth. (No wheat roots were observed in the soil core below 70 cm.)

Hart Soil: upper slope (HUS) [soil C4]

The Hart upper slope demonstration soil is represented by No. 284 in 'ApSoil' (see <www.apsim.info/Products/APSoil.aspx>).

Landscape and Land Use

Landscape: rise

Slope: gentle slope

Surface: none present

Land use (2014): barley crop (continuous cropping).

Soil Profile Description

Clay loam grading to dispersive and calcareous clay

Acidic clay loam, grading to dispersive and then highly calcareous red-brown clay subsoil.

Soil Name	Horizon	Depth (cm)	Description
HUS	Ap	0–5	Acidic, dark reddish brown, clay loam with moderate structure
	A3	5–14	Dark reddish brown, light clay with moderate structure
	B2	14–35	Slightly dispersive, dark reddish brown medium clay with moderate structure
	B2k	35–60	Highly calcareous, slightly dispersive, yellowish red, light medium clay with 20–50% fine carbonate segregations
	B3	60–98	Highly calcareous, slightly dispersive, yellowish red, light medium clay

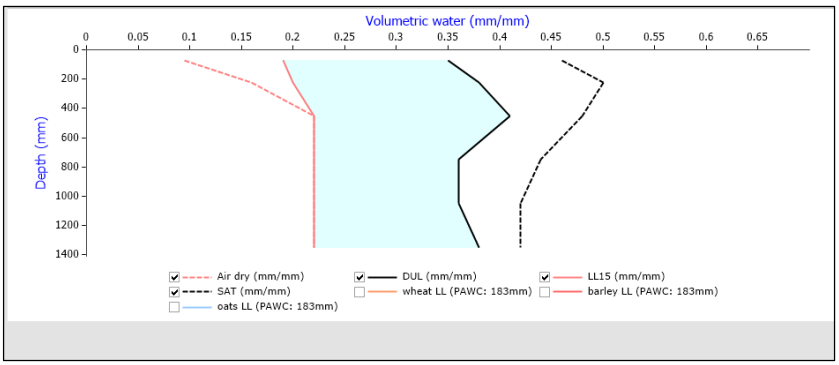
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *hard gradational clay loam* [**soil C4**].

The Australian Soil Classification (Isbell 2002): Sodic, Calcic, **Red Dermosol**; thin, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): no suitable classification.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Strong and slightly dispersive subsoil limits drainage and root growth. Surface soil pH should be monitored, with lime if and where necessary. Adequate vegetative cover should be maintained to minimise erosion.

ApSoil analysis data from nearby indicate high levels of boron in terms of plant toxicity below 30 cm, and very high levels below 60 cm, with high levels of exchangeable sodium percentage (ESP) also below this depth. Few wheat roots are likely to grow beyond 30 to 60 cm. (No barley roots were observed in the soil core below 60 cm.)

Hart Soil: lower slope (HLS) [soil C4]

The Hart lower slope demonstration soil is represented by No. 285 in 'ApSoil' (see <www.apsim.info/Products/APSoil.aspx>).

Landscape and Land Use

Landscape: rise
Slope: gentle slope
Surface: none present
Land use (2014): barley crop (continuous cropping).

Soil Profile Description

Clay loam grading to calcareous and dispersive clay

Clay loam grading to highly calcareous and dispersive red-brown clay subsoil.

Soil Name	Horizon	Depth (cm)	Description
HLS	A11p	0–8	Dark reddish brown, heavy clay loam with moderate structure
	A12	8–22	Moderately calcareous, dark reddish brown and yellowish red, light clay with weak structure
	B1	22–36	Highly calcareous, reddish brown, medium clay with moderate structure and 10–20% fine carbonate segregations

	B2k	36–65	Highly calcareous, slightly dispersive, reddish brown, medium clay with 20–50% fine carbonate segregations
	B3	65–96	Highly calcareous, slightly dispersive, reddish brown, medium clay

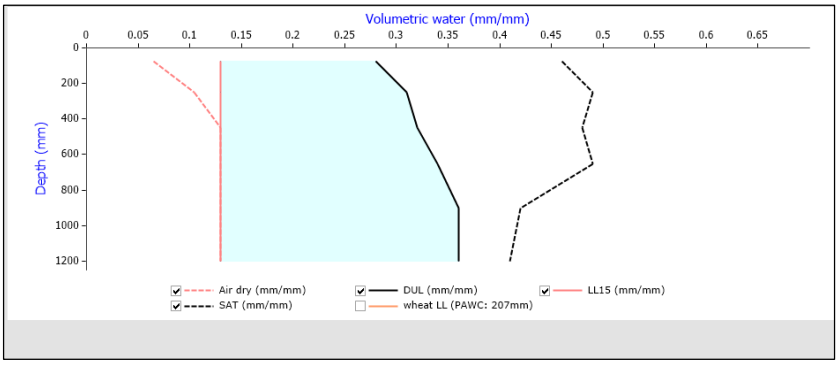
Soil Classification

The Soils of Southern SA (Hall et al. 2009): *hard gradational clay loam* [**soil C4**].

The Australian Soil Classification (Isbell 2002): Sodic, Calcic, **Red Dermosol**; thin, non-gravelly, clay loamy / clayey, moderate.

Great Soil Group (see Stace et al. 1968): no suitable classification.

ApSoil Soil Water Data from nearby



Land Management Comments

The main management concerns are to maintain and improve surface physical condition by minimising cultivation and maximising organic matter retention, whilst maintaining adequate fertility levels. Strong and slightly dispersive subsoil limits drainage and root growth. Adequate vegetation cover should be maintained to minimise erosion.

ApSoil analysis data from nearby indicate high levels of boron and exchangeable sodium percentage (ESP) in terms of plant toxicity below 55 cm, and very high levels below 75 cm. Few wheat roots are likely to grow beyond 55 cm. (However, a few barley roots were observed to the base of the soil core.)

Bibliography

Burk, L, Dalgliesh, N (2008). Estimating Plant Available Water Capacity – a Methodology. 40 pp. Canberra: CSIRO Sustainable Ecosystems.

Emerson, WW (1967). A Classification of Soil Aggregates based on their Coherence in Water. *Aust J Soil Research* **5**: 47–57.

French, RJ, Schultz, JE (1984). Water Use Efficiency of Wheat in a Mediterranean Environment. I. The Relation between Yield, Water Use & Climate. II. Some Limitations to Efficiency. *Aust J Ag Research* 35: 734–775.

Hall, JAS, Maschmedt, DJ, Billing, NB (2009). *The Soils of Southern South Australia*. The South Australian Land & Soil Book Series, Vol 1; Geological Survey of South Australia, Bull 56, Vol 1. Government of South Australia.

Isbell (2002). *The Australian Soil Classification – Revised Edition*. Australian Soil & Land Survey Handbook Series, Vol 4, CSIRO Publishing, Collingwood, Victoria.

King, PM (1981). Comparison of Methods for Measuring Severity of Water Repellence in Sandy Soils and Assessment of some Factors that Affect its Measurement. *Aust J of Soil Research* **19**: 275–285.

Munsell Color (1988). Munsell Soil Color Charts. MacBeth Division of Kollmorgen Instruments Corporation, Baltimore, Maryland.

NCST (2009). *Australian Soil & Land Survey Field Handbook*, 3rd edition. Australian Soil & Land Survey Handbook Series, Vol 1. The National Committee on Soil & Terrain (NCST), CSIRO Publishing, Collingwood, Victoria.

Northcote, KH (1979). *A Factual Key for the Recognition of Australian Soils*, 4th edition. CSIRO; Rellim Tech. Pubs, Glenside, Adelaide.

Raupach, M, Tucker, BM (1959). The Field Determination of Soil Reaction. *J Aust Institute of Ag Sc* **25**: 129–133.

Stace, HCT, Hubble, GD, Brewer, R, Northcote, KH, Sleeman, JR, Mulcahy, MJ, Hallsworth, EG (1968). *A Handbook of Australian Soils*. Rellim Tech Pubs, Glenside, South Australia.

Soil & Land Program (2007). Land & Soil Spatial Data for Southern South Australia – GIS Format. Soil & Land Program. Government of South Australia. [CD ROM]

Soil & Land Program (2007). Regional Land Resource information for Sothern South Australia. Soil & Land Program. Government of South Australia. [DVD ROM]