Case Study:
Soil Water Express Modelling

Introduction

In 2015, the Coomandook Agricultural Bureau (the Bureau) successfully obtained a grant from South Australian Murray-Darling Basin Natural Resources Management (SAMDB NRM) Board.

The grant enabled the group to better understand four of the Coomandook districts predominant soil types by investing in research and development on local soils. Soil Water Express (SWE) modelling was identified as a tool to do this. The model took into account the selected soils texture class and chemical attributes. From this data, it simulated the unconstrained and constrained plant available water capacity (PAWC) for each soil type. This case study outlines the processes the Bureau took to have confidence in the simulations being accurate, using existing results they obtained.

Background

South Australian Murray-Darling Basin Natural Resources Management Board granted money to the Bureau to build knowledge and capacity around the regions soils. The Bureau felt their soils were unique to the region and production capability was being limited through constraints, with successful production increases seen by growers in other regions from current and innovative techniques, not being achieved locally.

The Bureau and Natural Resources SAMDB Sustainable Farming team worked together on targeted projects to increase the knowledge around four predominant soil types;

- brown loam over calcrete rubble
- sandy loam over deep sand with some calcareous sandy clay and rubble below 40 centimetres
- deep grey loam over calcrete rubble
- deep sand.

A consultant was engaged to carry out; soil testing, excavate four soil pits and characterise the soil type and report against the challenges and barriers to production.

Natural Resources SAMDB increased its weather station and soil moisture monitoring network. A weather station was established at Sherlock, and four soil moisture probes installed on the targeted soils at Moorlands and Coomandook. The Coorong Tatiara Local Action Planning committee produced the Coomandook Compendium on the regions past and present agricultural studies, trials and research.

The Coomandook Agricultural Bureau elected to use SWE with funds provided by the SAMDB NRM Board grant. Previous soil testing had provided the Bureau soil testing results which was believed could be used with the SWE simulator.

Links to the weather station and soil moisture monitoring networks, and Coomandook compendium can be found in 'Links'.

Method

Soil Water Express required the physical and chemical parameters of the soil to be entered, to run the simulations. Simulations give insight to soil water availability throughout the root zone. Soil testing was conducted to a depth of 90 cm and split between 7 depth zones (0-10cm, 10-20cm, 20-30cm, 30-40cm, 40-50cm, 50-70cm and 70-90cm).

Physical soil parameters required;

- soil texture class and the makeup of sand, silt and clay percentage
- estimated rock percentage
- bulk density. (Can increase the accuracy of the simulation however due to difficulty of measuring bulk density in the field, the model automatically adjusts for this based on the identified texture class).

Chemical soil parameters required;

- estimated sodium percentage (ESP)
- electrical conductivity (EC)
- chloride content (Cl)
- boron content (B).

The physical and chemical parameters were entered into the model to obtain a simulation of constrained and unconstrained plant available water (PAW). Unconstrained PAW allows plant access to 100% of the PAW in the soil whereas constrained PAW shows limited PAW due to chemical and/or physical barriers. Constraining barriers could be high salt or boron levels or large percentages of rock within the soil. Click the link to view Soil Water Express.

Discussion

In March 2015, soil testing was conducted and samples bulked and sent for hand texturing to determine soil texture class and chemical analysis, occurring as part of the soil moisture probe installations. This initial data was used to populate the model. Hand texturing was completed and the identified texture class compared to a soils texture triangle (figure 1). It was thought that this would guide the amount of sand, silt and clay percentages of the soil. Rock percentage was estimated during the hand texturing process.

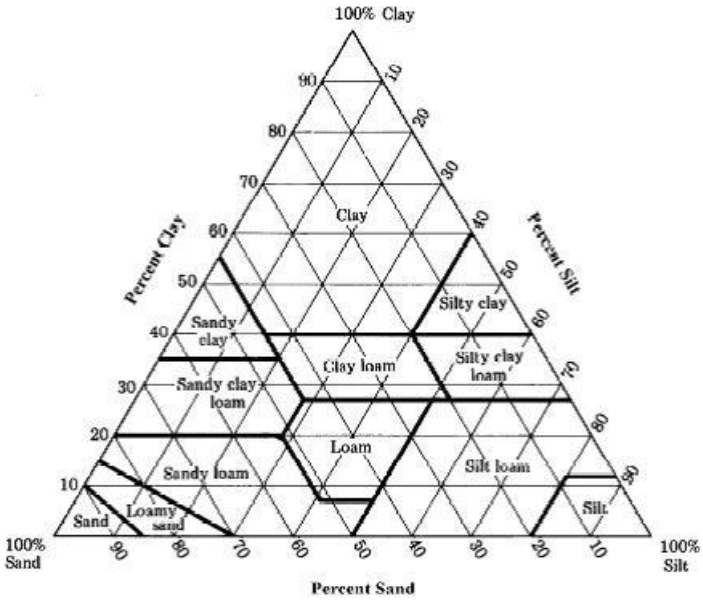


Figure 1 – Australian texture triangle

Chemical analysis results were populated into the chemical fields section of the simulator. Fields required were exchangeable sodium percentage (ESP), electrical conductivity (EC), Chloride (Cl) and Boron (B). Chemical data fields were available for six of the seven zones between 10-90cm, however the analysis did not provide ESP, Cl or B for the 0-10cm zone. The missing data values were derived from the 10-20cm zone to complete the 0-10cm chemical data fields. EC was available for all seven zones.

Coomandook Ag Bureau members attending the soil pit day held April 2015

Figure 2 shows the first simulation produced with the results previously obtained by the Bureau. It was quickly recognised that the simulated texture classes specified by SWE (figure 3) did not match hand texturing results as a different texture classing system had been used. Whilst simulated texture classes were similar, more investigation went into how to better match hand texturing results and the model texture classes leading to an increase in accurate results. Soil Water Express designers were contacted to define soil particle size composition percentages set for each texture class. The belief was a better understanding of texture class boundaries in SWE would allow more accurate matching of hand texturing results compared to simulated texture classes.

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	40	25	Silty Loam	6.25	165	12.5	3.55
2	10	20		0	35	35	Silty Clay Loam	6.25	133	12.5	3.55
3	20	30		20	35	35	Silty Clay Loam	16.19	224	12	5.29
4	30	40		60	40	25	Silty Loam	23.43	300	15.9	6.68
5	40	50		60	35	35	Silty Clay Loam	28.94	500	18.6	9.38
6	50	70		70	35	35	Silty Clay Loam	34.1	550	23.5	13.5
7	70	90		70	35	40	Silty Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

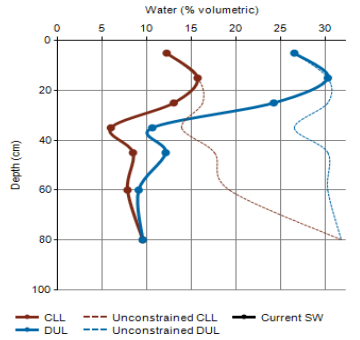
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.55	12	27	14	12	27	14
2	15	10	1.51	16	30	15	16	30	15
3	25	10	1.51	16	30	14	13	24	11
4	35	10	1.55	14	27	13	6	11	5
5	45	10	1.51	18	30	13	8	12	4
6	60	20	1.51	19	30	22	8	9	2
7	80	20	1.48	32	32	0	10	10	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	12.2	26.6					
2	15	10	15.7	30.3					
3	25	10	13.0	24.2					
4	35	10	6.0	10.6					
5	45	10	8.5	12.1					
6	60	20	7.8	9.1					
7	80	20	9.5	9.5					

Soil Profile Summary

Silty Loam over Silty Clay Loam



Plant Available Water Capacity (PAWC)	51mm
Profile Depth	90cm
Average Water Availability per cm	0.6mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	90mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Figure 2 – Coomandook Flat Initial Soil Water Express simulation Version 1

Key points seen in the first simulation (figure 2);

- Plant available water capacity (PAWC) of 51mm approximately 56% of the unconstrained PAWC of 90mm.
- Trend lines of constrained and unconstrained crop lower limits (CLL) or crop wilting point and Drained Upper Limits (DUL) or field capacity are shown in the graph.
- PAWC, otherwise known as the bucket, is the area between the CLL and DUL. Constrained PAWC (solid line) soil profile summary shows a higher PAWC in the top 0-30cm of the profile, reducing as you move deeper in the profile. This is reflected in a narrowing of the CLL and DUL between 35-80cm. Higher rock percentage content of the soil is mainly responsible for this narrowing.

Depth Zone	Hand Texture Class
0-10cm	Loam
10-20cm	Clay Loam
20-30cm	Clay Loam
30-40cm	Loam
40-50cm	Clay Loam
50-70cm	Clay Loam
70-90cm	Clay Loam

Figure 3 – Coomandook Flat Hand Texture

- Unconstrained PAWC (dashed line) mirrors the constrained PAWC in the top 0-30cm of soil profile due to the limited constraints. 30-90cm unconstrained PAWC deviates greatly from constrained PAWC. Mostly, PAWC is constrained at depth and if constraints could be reduced, this would increase the plants ability to access water.
- Average water available per cm of soil is 0.6mm/cm for this simulation.

Gaining access to SWE texture boundaries file showed a possible 5152 options of sand, silt and clay combinations. The 13 model texture classes were formed from these combinations. Texture classes were sorted (in excel) based on sand and clay percentage. Each texture class' midpoint (figure 4) was selected and the corresponding sand, silt and clay percentage, used for a second simulation. The second simulation (figure 5) had modelled soil texture classes now matching hand soil texturing results (figure 3).

Key points from the second SWE simulation (figure 5);

- Little difference seen between the average water availability per cm of soil for the first two simulations with both results at 0.6mm/cm.
- PAWC and unconstrained PAWC had reduced. PAWC reduced from 51mm to 46mm and unconstrained PAWC reduced from 90mm to 82mm.
- All data values used in the first and second simulation were the same except the sand and clay percentages. Differences seen between figure 2 and figure 5 come from the modification of texture class to better represent hand texturing results.

Texture Class	Sand %	Clay %	Silt %
Sand	93	4	3
Loamy Sand	79	5	16
Sandy Loam	79	15	6
Loam	63	19	18
Silty Loam	31	14	55
Sandy Clay Loam	72	24	4
Clay Loam	48	33	19
Silty Clay Loam	20	34	46
Sandy Clay	63	34	3
Light Clay	49	38	13
Silty Clay	8	58	34
Medium Clay	38	50	12
Heavy Clay	9	83	8

Figure 4 – SWE Texture classes and selected midpoint for sand, silt and clay

- Soil profile summaries from both simulations look similar when comparing CLL, DUL and bucket sizes.

However the second simulations (figure 5) overall bucket is replicated on a lower water (% volumetric) value then the first simulation (Figure 2) giving the lower PAWC values.

SoilWater express

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Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	63	19	Loam	6.25	166	12.5	3.55
2	10	20		0	48	33	Clay Loam	6.25	133	12.5	3.55
3	20	30		20	48	33	Clay Loam	16.19	224	12	5.29
4	30	40		60	63	19	Loam	23.43	300	15.9	6.68
5	40	50		60	48	33	Clay Loam	28.94	500	18.6	9.38
6	50	70		70	48	33	Clay Loam	34.1	550	23.5	13.5
7	70	90		70	48	33	Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

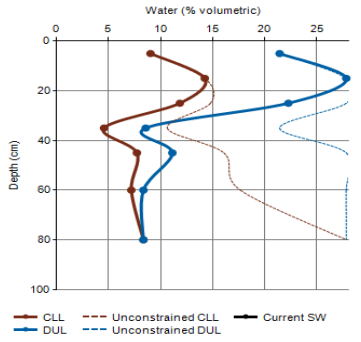
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.58	9	21	12	9	21	12
2	15	10	1.52	14	28	14	14	28	14
3	25	10	1.52	15	28	13	12	22	10
4	35	10	1.58	11	21	11	5	9	4
5	45	10	1.52	16	28	12	8	11	3
6	60	20	1.52	18	28	20	7	8	2
7	80	20	1.52	28	28	0	8	8	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	9.0	21.4					
2	15	10	14.2	27.8					
3	25	10	11.8	22.3					
4	35	10	4.6	8.6					
5	45	10	7.7	11.1					
6	60	20	7.2	8.3					
7	80	20	8.3	8.3					

Soil Profile Summary

Loam over Clay Loam



Plant Available Water Capacity (PAWC)	46mm
Profile Depth	90cm
Average Water Availability per cm	0.6mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	82mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Figure 5 – Coomandook Flat updated Soil Water Express simulation Version 2

Similarities were seen in the first two results, however there was enough difference to doubt which simulation was the most accurate. The Bureau began to understand sand and clay percentages were two very important drivers of SWE. To date investigation has been based on retro fitting existing results to a model which required precise information. Results were reviewed to establish the accuracy of the data parameters used and a plan to re-test the inaccurate components.

The review showed the physical soil components were based around estimations and open to human error. To increase accuracy, additional soil samples were taken from all sites, at each of the seven depth zones. Samples were sent for particle size analysis (PSA). This process sieves the soil into sand, silt and clay particles and measures their percentages based on the overall sample weight. Chemical analysis and PSA was tested on the 0 – 10cm zone as these were not previously available for this depth zone. The two sets of soil tests were merged to populate the model and to run a third simulation using the PSA as the basis for soil texture determination.

SoilWater express

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Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	55	19	Silty Loam	6.93	230	48	3.05
2	10	20		0	39	27	Silty Loam	6.25	133	12.5	3.55
3	20	30		0	31	40	Silty Clay Loam	16.19	224	12	5.29
4	30	40		15	31	46	Medium Clay	23.43	300	15.9	6.68
5	40	50		60	39	43	Light Clay	28.94	500	18.6	9.38
6	50	70		60	50	35	Light Clay	34.1	550	23.5	13.5
7	70	90		50	52	32	Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

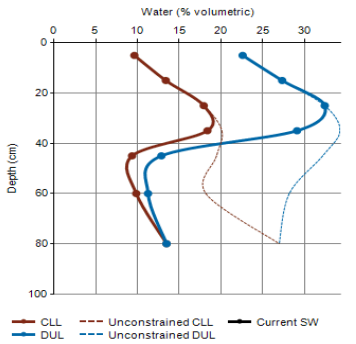
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.58	10	23	13	10	23	13
2	15	10	1.54	13	27	14	13	27	14
3	25	10	1.48	18	32	14	18	32	14
4	35	10	1.45	20	34	14	18	29	11
5	45	10	1.47	19	32	13	9	13	4
6	60	20	1.51	18	28	20	10	11	3
7	80	20	1.52	27	27	0	13	13	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	9.6	22.6					
2	15	10	13.4	27.3					
3	25	10	17.9	32.4					
4	35	10	18.4	29.1					
5	45	10	9.4	12.9					
6	60	20	9.8	11.3					
7	80	20	13.5	13.5					

Soil Profile Summary

Silty Loam over Silty Clay Loam



Plant Available Water Capacity (PAWC)	58mm
Profile Depth	90cm
Average Water Availability per cm	0.7mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	88mm

Plant Available Water (PAW)	0mm
% of PAWC	0%

Figure 6 – Coomandook Flat Soil Water Express simulation Version 3

Key points seen in the third SWE simulation (figure 6);

- Increase in both PAWC to 58mm and average water availability per cm of soil to 0.7mm/cm.
- PAWC in the third simulation was 13 – 26% greater than the first and second simulation. This is considered a large difference in a non-irrigated farming system.
- Unconstrained PAWC was at 88mm, a similar value to the first (figure 2 – 90mm) and second (figure 5 – 82mm) simulation.
- Unconstrained PAWC was 34% larger than constrained PAWC and reflected in the soil profile summary graph.

The model's chemical thresholds had ESP values greater than 15%, considered a constraint. As such, ESP levels at 20-30cm could start to limit crop production, becoming constrained at depths of 30cm and below. This in conjunction with an increase in rock percentage is responsible for narrowing PAWC.

To build accuracy and confidence into the models simulated results, the Bureau had created 3 different simulations. Each simulation used more accurate data to produce results. By building confidence in the model through more detailed and accurate testing, costs linked to extra soil testing resulted in increased expenses.

Results

Soil Water Express simulations were run for each of the four predominant soil types and in each case, the final simulation which incorporated PSA into the results gave vastly different PAWC compared to the first two. On the higher clay content (flats) soil types, variations could be seen between PAWC, unconstrained PAWC and average water availability per cm of soil for the third SWE simulation including PSA (attachment 4 & 10).

The sandier soil type profile summary graphs displaying PAWC also varied in the third simulation compared to the first and second, however this was not as larger change as seen in the higher clay content (flats) soils. Values of PAWC, unconstrained PAWC and average water availability per cm did not vary as greatly also for the sandier soil types as had been the case for the flats (attachment 7 & 13).

Each site was tested to 90cm deep and seven zones segregated from this depth. At the time of sampling, soil testing cost the Bureau $410 per site. The Bureau used some soil test results obtained earlier in the year, reducing the overall cost. If previous soil tests were unavailable, each site would cost approximately $750 for soil analysis. Contractor fees and soil sampling trailer costs could increase testing of each site. Overall cost per site could be lowered if the amount of soil depth zones were reduced. Four to five zones could offer similar results and be more cost effective. An opportunity exists for testing the parameters in addition to soil testing activities performed on farm throughout the year as a cost saving measure.

The use of SWE increased the knowledge base of the Bureau's growers by giving a better understanding of the investigated soils total water holding capacities, and constraints on plant available water moving deeper through the profile. Confidence was increased in making seasonal decisions on post nitrogen fertiliser application rates, heavily dependent on soil moisture and potential yield benefit. The simulations highlighted where the crops roots will be concentrated throughout the season and potential effects of wet or dry springs.

Conclusion

Soil Water Express was suggested to the Coomandook Ag Bureau as a tool in which to better understand a soils water holding capacity and limitations. The Bureau felt its use could add value to the investigation of four of the regions soil types undertaken in 2015. The initial soil testing parameters the Bureau obtained did not meet the SWE requirements and testing parameters to ensure accurate and reliable results gained.

Particularly in this scenario but with other opportunities to better understand the effects chemical and physical barriers have on production, it is important to have a clear understanding of;

- what you wish to test for or discover prior to undertaking the testing
- which model, simulator or tool will enable you to do this
- the benefits this tool will bring as well as time spent understanding the limitations or challenges
- what specific testing parameters are needed by the tool to obtain accurate and reliable results.

Producers or groups using soil testing to guide decisions throughout the crop growing season should consider using SWE as a tool to understand a particular soils potential water holding capacity as influenced by chemical and physical constraints. It should be used in conjunction with other available simulators. Soil testing is an expense to producers and can be costly to undertake. A farmer can add value to soil tests by using one set of data to populate multiple reliable simulators. Often these simulators are at low or minimal cost to the producer. It is important to identify early each tool to ensure one set of soil tests can be used for multiple models. This ensures testing will capture all data required so that one round of soil test results can be used in multiple models. Time must be spent to accurately understand parameters required before undertaking testing. This provides opportunity to specify extra testing measurements that might be required from the laboratory to meet the needs of the simulator. Using several tools to aid in decisions will increase the ability of the producer to learn more about production challenges and influences, helping them plan for and reduce risk.

After investigating how to build accuracy in the results obtained by SWE, the Coomandook Ag Bureau benefited from the simulations. Soil Water Express highlighted to the group some limitations in the soils which cannot be changed easily, and demonstrated how a producing crop would interact with this soil type. Producers can use this knowledge to make beneficial management decisions aiding in crop establishment and crop production.

Links & Abbreviations

Natural Resources SAMDB soil moisture network – http://aqualab-data.dyndns.info/secure/livedata/list.jsf?template=trend

Natural Resources SAMDB weather station network – http://aws.naturalresources.sa.gov.au/samurraydarlingbasin/

Coomandook Compendium – https://www.coorong.sa.gov.au/coomandook

Soil Water Express – www.apsim.info/swe/Default.aspx

PAW – Plant Available Water

ESP – Estimated Sodium Percentage

EC – Electrical Conductivity

Cl - Chloride
B - Boron

NR SAMDB – Natural Resources South Australian Murray-Darling Basin

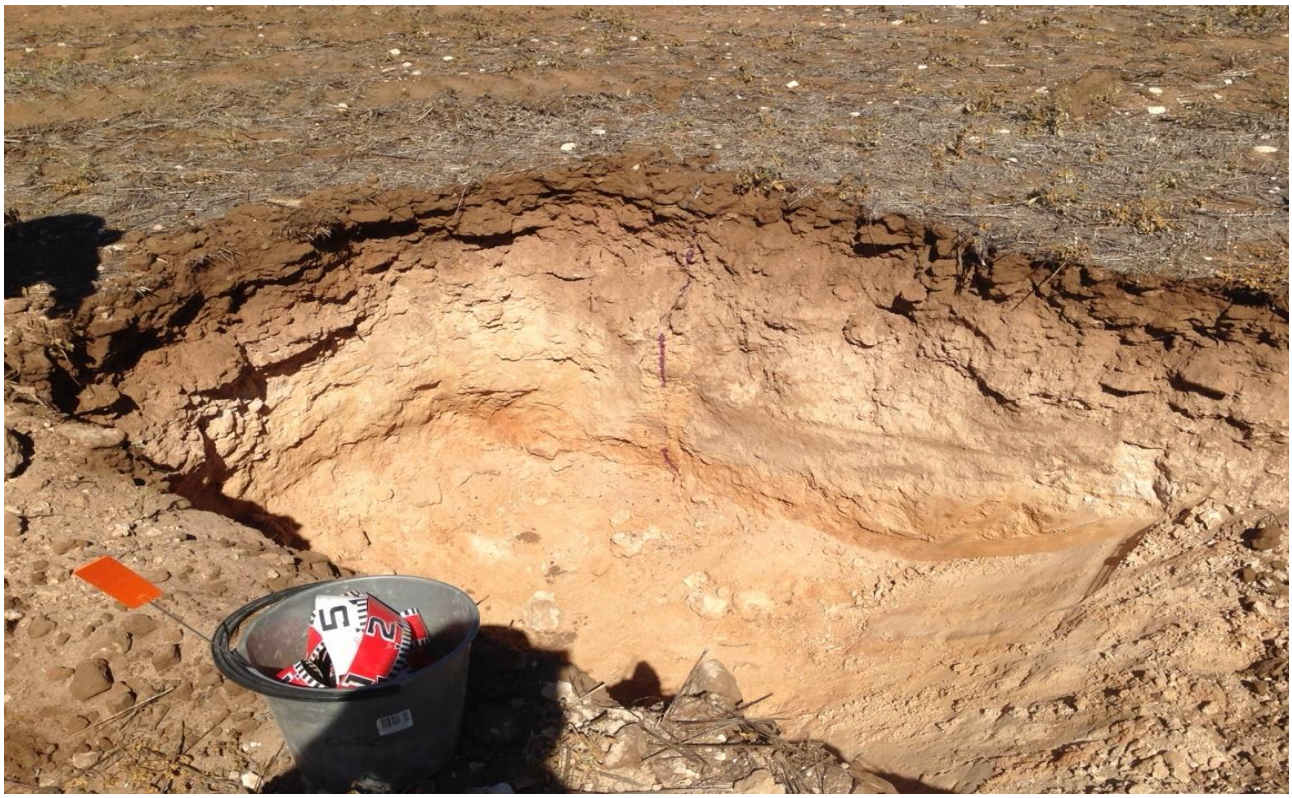
PAWC – Plant Available Water Capacity

The Bureau – Coomandook Agricultural Bureau

PSA – Particle Size Analysis

SWE – Soil Water Express

Coomandook agricultural members discussing the sandy soil profile at Coomandook



Brown loam over calcrete rubble soil pit at Moorlands

Acknowledgments

This project is supported by the Coomandook Agricultural Bureau and the South Australian Murray-Darling Basin Natural Resources Management Board through funding from the Australian Government's National Landcare Program.

Attachments

Attachment 1 – Cookes Plain Soil Testing Results

Attachment 2 – Cookes Plain SWE simulation final

Attachment 3 – Coomandook Flat Soil Testing Results

Attachment 4 – Coomandook Flat SWE simulation Version 1

Attachment 5 – Coomandook Flat SWE simulation Version 2

Attachment 6 – Coomandook Flat SWE simulation Version 3

Attachment 7 – Coomandook Sand Soil Testing Results

Attachment 8 – Coomandook Sand SWE simulation Version 1

Attachment 9 – Coomandook Sand SWE simulation Version 2

Attachment 10 – Coomandook Sand SWE simulation Version 3

Attachment 10 – Coomandook Sand SWE simulation Version 3

Attachment 11 – Moorlands Flat Soil Testing Results

Attachment 12 – Moorlands Flat SWE simulation Version 1

Attachment 13 – Moorlands Flat SWE simulation Version 2

Attachment 14 – Moorlands Flat SWE simulation Version 3

Attachment 15 – Moorlands Sand SWE Soil Testing Results

Attachment 16 – Moorlands Sand SWE simulation Version 1

Attachment 17 – Moorlands Sand SWE simulation Version 2

Attachment 18 – Moorlands Sand SWE simulation Version 3

For more information

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Parameters	UNIT	COOKES PLAINS WHEAT 0-10	COOKES PLAINS WHEAT 10-20	COOKES PLAINS WHEAT 20-30	COOKES PLAINS WHEAT 30-40	COOKES PLAINS WHEAT 40-50	COOKES PLAINS WHEAT 50-70	COOKES PLAINS WHEAT 70-90
pH Water		7.53	7.79	8.35	8.46	8.55	8.55	8.85
pH CaCl		6.97	7.20	7.68	7.75	7.97	7.92	8.04
EC 1:5	uS/cm	0.07	0.05	0.06	0.06	0.08	0.13	0.14
Exchangable Ca	c.mol/kg	4.30	2.67	2.27	2.86	6.03	23.26	24.62
Exchangable Mg	c.mol/kg	0.70	0.49	0.47	0.55	1.19	4.01	3.83
Exchangable K	c.mol/kg	0.18	0.21	0.22	0.18	0.28	1.06	0.53
Exchangable Na	c.mol/kg	0.08	0.06	0.05	0.06	0.12	0.43	0.48
Exchangable Na (ESP)	%	1.46	1.65	1.70	1.70	1.58	1.49	1.63
eCEC	c.mol/kg	5.26	3.43	3.01	3.66	7.61	28.76	29.47
B	mg/kg	0.32	0.17	0.15	0.19	0.35	1.32	1.69
Cl	mg/kg	14.00	14.00	16.00	15.00	11.00	14.00	19.00
Gravel %	%	<1	<1	<1	<1	<1	<1	30.00
Sand % (>0.63um)	%	94.00	93.00	94.00	92.00	78.00	63.00	69.00
Silt %	%	5.00	4.00	4.00	5.00	4.00	5.00	13.00
Clay %	%	<3	3.00	<3	<3	18.00	32.00	18.00

Attachment 1 – Cookes Plain Soil Testing Results

SoilWater express

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Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm^3)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	94	1	Sand	1.46	68	14	0.32
2	10	20		0	93	3	Sand	1.65	51	14	0.17
3	20	30		0	94	2	Sand	1.70	56	16	0.15
4	30	40		0	92	3	Sand	1.70	60	15	0.19
5	40	50		0	78	18	Sandy Loam	1.58	81	11	0.35
6	50	70		0	63	32	Sandy Clay	1.49	130	14	1.32
7	70	90		30	69	18	Loam	1.63	140	19	1.69

Add New Row

Estimated Soil Water Profile

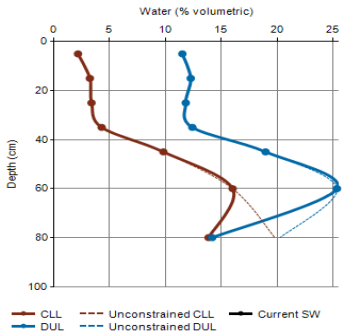
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm^3)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.67	2	12	9	2	12	9
2	15	10	1.66	3	12	9	3	12	9
3	25	10	1.66	3	12	8	3	12	8
4	35	10	1.66	4	12	8	4	12	8
5	45	10	1.59	10	19	9	10	19	9
6	60	20	1.52	16	25	19	16	25	19
7	80	20	1.59	20	20	1	14	14	1

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	2.2	11.5					
2	15	10	3.2	12.3					
3	25	10	3.4	11.8					
4	35	10	4.3	12.4					
5	45	10	9.8	19.0					
6	60	20	16.0	25.4					
7	80	20	13.9	14.2					

Soil Profile Summary

Sand



Plant Available Water Capacity (PAWC)	63mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	64mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 2 – Cookes Plain Soil Water Express simulation final

Parameters	UNIT	COOMANDOOK FLAT BARLEY 0-10	COOMANDOOK FLAT BARLEY 10-20	COOMANDOOK FLAT BARLEY 20-30	COOMANDOOK FLAT BARLEY 30-40	COOMANDOOK FLAT BARLEY 40-50	COOMANDOOK FLAT BARLEY 50-70	COOMANDOOK FLAT BARLEY 70-90
pH Water		8.60	9.20	9.60	9.80	10.00	10.20	10.10
pH CaCl		7.90	8.30	8.50	8.60	8.70	8.70	8.90
EC 1:5	uS/cm	165.00	133.00	224.00	300.00	500.00	550.00	400.00
Exchangable Ca	c.mol/kg	29.31	18.76	12.51	7.68	6.86	5.10	4.51
Exchangable Mg	c.mol/kg	8.18	9.55	11.83	8.95	10.06	8.78	5.79
Exchangable K	c.mol/kg	1.04	0.63	0.87	0.89	1.05	1.27	1.35
Exchangable Na	c.mol/kg	2.87	1.93	4.87	5.36	7.32	7.84	6.24
Exchangable Na (ESP)	%	6.93	6.25	16.19	23.43	28.94	34.10	34.88
eCEC	c.mol/kg	41.40	30.87	30.08	22.88	25.29	22.99	17.89
B	mg/kg	3.05	3.55	5.29	6.68	9.37	13.50	10.06
Cl	mg/kg	48.00	12.50	12.00	15.90	18.60	23.50	45.40
Gravel	%	<1	<1	<1	15.00	60.00	60.00	50.00
Sand (>0.63um)	%	55.00	39.00	31.00	31.00	39.00	50.00	52.00
Silt	%	26.00	34.00	29.00	23.00	18.00	15.00	16.00
Clay	%	19.00	27.00	40.00	46.00	43.00	35.00	32.00

Attachment 3 – Coomandook flat soil testing results

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	40	25	Silty Loam	6.25	165	12.5	3.55
2	10	20		0	35	35	Silty Clay Loam	6.25	133	12.5	3.55
3	20	30		20	35	35	Silty Clay Loam	16.19	224	12	5.29
4	30	40		60	40	25	Silty Loam	23.43	300	15.9	6.68
5	40	50		60	35	35	Silty Clay Loam	28.94	500	18.6	9.38
6	50	70		70	35	35	Silty Clay Loam	34.1	550	23.5	13.5
7	70	90		70	35	40	Silty Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

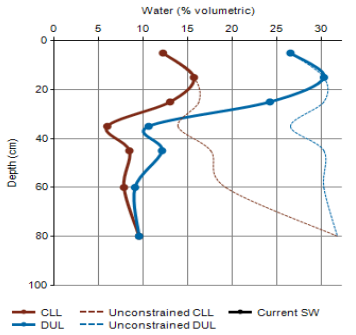
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.55	12	27	14	12	27	14
2	15	10	1.51	16	30	15	16	30	15
3	25	10	1.51	16	30	14	13	24	11
4	35	10	1.55	14	27	13	6	11	5
5	45	10	1.51	18	30	13	8	12	4
6	60	20	1.51	19	30	22	8	9	2
7	80	20	1.48	32	32	0	10	10	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	12.2	26.6					
2	15	10	15.7	30.3					
3	25	10	13.0	24.2					
4	35	10	6.0	10.6					
5	45	10	8.5	12.1					
6	60	20	7.8	9.1					
7	80	20	9.5	9.5					

Soil Profile Summary

Silty Loam over Silty Clay Loam



Plant Available Water Capacity (PAWC)	51mm
Profile Depth	90cm
Average Water Availability per cm	0.6mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	90mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 4 – Coomandook flat Soil Water Express simulation version 1

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	63	19	Loam	6.25	166	12.5	3.55
2	10	20		0	48	33	Clay Loam	6.25	133	12.5	3.55
3	20	30		20	48	33	Clay Loam	16.19	224	12	5.29
4	30	40		60	63	19	Loam	23.43	300	15.9	6.68
5	40	50		60	48	33	Clay Loam	28.94	500	18.6	9.38
6	50	70		70	48	33	Clay Loam	34.1	550	23.5	13.5
7	70	90		70	48	33	Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

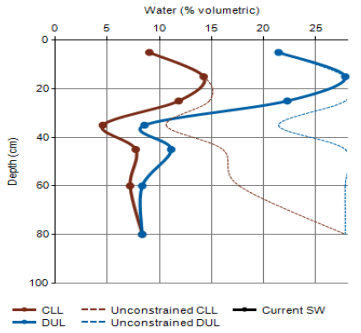
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.58	9	21	12	9	21	12
2	15	10	1.52	14	28	14	14	28	14
3	25	10	1.52	15	28	13	12	22	10
4	35	10	1.58	11	21	11	5	9	4
5	45	10	1.52	16	28	12	8	11	3
6	60	20	1.52	18	28	20	7	8	2
7	80	20	1.52	28	28	0	8	8	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	9.0	21.4					
2	15	10	14.2	27.8					
3	25	10	11.8	22.3					
4	35	10	4.6	8.6					
5	45	10	7.7	11.1					
6	60	20	7.2	8.3					
7	80	20	8.3	8.3					

Soil Profile Summary

Loam over Clay Loam



Plant Available Water Capacity (PAWC)	46mm
Profile Depth	90cm
Average Water Availability per cm	0.6mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	82mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 5 – Coomandook flat Soil Water Express simulation version 2

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	55	19	Silty Loam	6.93	230	48	3.05
2	10	20		0	39	27	Silty Loam	6.25	133	12.5	3.55
3	20	30		0	31	40	Silty Clay Loam	16.19	224	12	5.29
4	30	40		15	31	46	Medium Clay	23.43	300	15.9	6.68
5	40	50		60	39	43	Light Clay	28.94	500	18.6	9.38
6	50	70		60	50	35	Light Clay	34.1	550	23.5	13.5
7	70	90		50	52	32	Clay Loam	34.88	400	45.4	10.06

Add New Row

Estimated Soil Water Profile

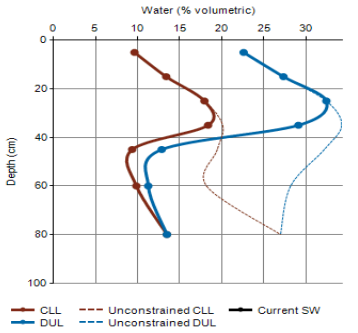
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.58	10	23	13	10	23	13
2	15	10	1.54	13	27	14	13	27	14
3	25	10	1.48	18	32	14	18	32	14
4	35	10	1.45	20	34	14	18	29	11
5	45	10	1.47	19	32	13	9	13	4
6	60	20	1.51	18	28	20	10	11	3
7	80	20	1.52	27	27	0	13	13	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	9.6	22.6					
2	15	10	13.4	27.3					
3	25	10	17.9	32.4					
4	35	10	18.4	29.1					
5	45	10	9.4	12.9					
6	60	20	9.8	11.3					
7	80	20	13.5	13.5					

Soil Profile Summary

Silty Loam over Silty Clay Loam



Plant Available Water Capacity (PAWC)	58mm
Profile Depth	90cm
Average Water Availability per cm	0.7mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	88mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 6 – Coomandook flat Soil Water Express simulation version 3 (final)

Parameters	UNIT	COOMANDOOK SAND BARLEY 0-10	COOMANDOOK SAND BARLEY 10-20	COOMANDOOK SAND BARLEY 20-30	COOMANDOOK SAND BARLEY 30-40	COOMANDOOK SAND BARLEY 40-50	COOMANDOOK SAND BARLEY 50-70	COOMANDOOK SAND BARLEY 70-90
pH Water		7.88	7.00	7.20	7.60	7.90	8.10	8.90
pH CaCl		7.23	6.40	6.50	6.90	7.20	7.40	8.20
EC 1:5	uS/cm	43.00	25.00	27.00	25.00	32.00	52.00	71.00
Exchangable Ca	c.mol/kg	2.35	1.41	1.05	1.00	2.59	5.84	6.27
Exchangable Mg	c.mol/kg	0.68	0.40	0.31	0.33	0.90	2.39	2.03
Exchangable K	c.mol/kg	0.09	0.08	0.09	0.10	0.19	0.51	0.38
Exchangable Na	c.mol/kg	0.06	0.04	0.02	0.03	0.07	0.13	0.08
Exchangable Na (ESP)	%	1.75	2.07	1.36	2.05	1.87	1.47	0.91
eCEC	c.mol/kg	3.18	1.93	1.47	1.46	3.75	8.87	8.76
B	mg/kg	0.22	0.24	0.23	0.19	0.28	0.58	0.66
Cl	mg/kg	12.00	7.10	2.20	1.30	3.40	3.20	1.10
Gravel	%	<1	<1	<1	<1	<1	<1	<1
Sand (>0.63um)	%	96.00	96.00	95.00	83.00	78.00	81.00	84.00
Silt	%	<3	<3	<3	<3	5.00	<3	4.00
Clay	%	<3	3.00	3.00	15.00	17.00	19.00	12.00

Attachment 7 – Coomandook sand soil testing results

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

	Layer		Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	85	5	Loamy Sand	2.07	43	7.1	.24
2	10	20		0	85	5	Loamy Sand	2.07	25	7.1	.24
3	20	30		0	85	5	Loamy Sand	1.36	27	2.2	.23
4	30	40		0	85	5	Loamy Sand	2.05	25	1.3	.19
5	40	50		0	85	5	Loamy Sand	1.87	32	3.4	.28
6	50	70		0	70	15	Loam	1.47	52	3.2	.58
7	70	90		0	70	15	Loam	0.91	71	1.1	.66

Add New Row

Estimated Soil Water Profile

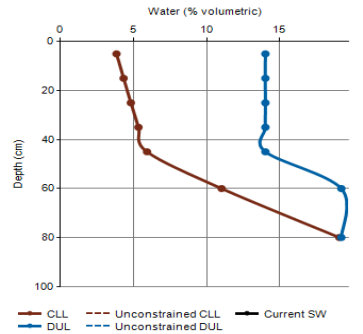
	Layer		Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.65	4	14	10	4	14	10
2	15	10	1.65	4	14	10	4	14	10
3	25	10	1.65	5	14	9	5	14	9
4	35	10	1.65	5	14	9	5	14	9
5	45	10	1.65	6	14	8	6	14	8
6	60	20	1.60	11	19	16	11	19	16
7	80	20	1.60	19	19	0	19	19	0

Monitoring Device Soil Water Profile

	Layer		Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	3.8	14.0					
2	15	10	4.3	14.0					
3	25	10	4.8	14.0					
4	35	10	5.3	14.0					
5	45	10	5.9	14.0					
6	60	20	11.0	19.2					
7	80	20	19.1	19.2					

Soil Profile Summary

Loamy Sand



Plant Available Water Capacity (PAWC)	62mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	62mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 8 – Coomandook sand Soil Water Express simulation version 1

SoilWater express

Help Print

Soil Water Express | Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	79	5	Loamy Sand	2.07	43	7.1	0.24
2	10	20		0	79	5	Loamy Sand	2.07	25	7.1	0.24
3	20	30		0	79	5	Loamy Sand	1.36	27	2.2	0.23
4	30	40		0	79	5	Loamy Sand	2.05	25	1.3	0.19
5	40	50		0	79	5	Loamy Sand	1.87	32	3.4	0.28
6	50	70		0	79	15	Sandy Loam	1.47	52	3.2	0.58
7	70	90		0	79	15	Sandy Loam	0.91	71	1.1	0.66

Add New Row

Estimated Soil Water Profile

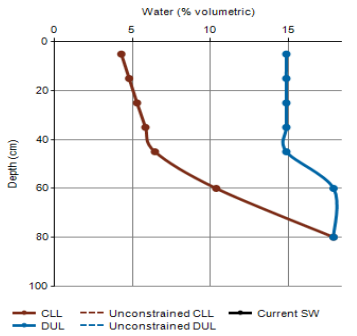
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.65	4	15	11	4	15	11
2	15	10	1.65	5	15	10	5	15	10
3	25	10	1.65	5	15	10	5	15	10
4	35	10	1.65	6	15	9	6	15	9
5	45	10	1.65	6	15	8	6	15	8
6	60	20	1.60	10	18	15	10	18	15
7	80	20	1.60	18	18	0	18	18	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	4.3	14.9					
2	15	10	4.8	14.9					
3	25	10	5.3	14.9					
4	35	10	5.8	14.9					
5	45	10	6.4	14.9					
6	60	20	10.4	17.9					
7	80	20	17.9	17.9					

Soil Profile Summary

Loamy Sand



Plant Available Water Capacity (PAWC)	63mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	63mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 9 – Coomandook sand Soil Water Express simulation version 2

SoilWater express

Help Print

Soil Water Express | Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	96	2	Sand	1.75	56	12	0.22
2	10	20		0	96	3	Sand	2.07	25	7.1	0.24
3	20	30		0	95	3	Sand	1.36	27	2.2	0.23
4	30	40		0	83	15	Sandy Loam	2.05	25	1.3	0.19
5	40	50		0	78	17	Sandy Loam	1.87	32	3.4	0.28
6	50	70		0	81	19	Sandy Clay Loam	1.47	52	3.2	0.58
7	70	90		0	84	12	Sandy Loam	0.91	71	1.1	0.66

Add New Row

Estimated Soil Water Profile

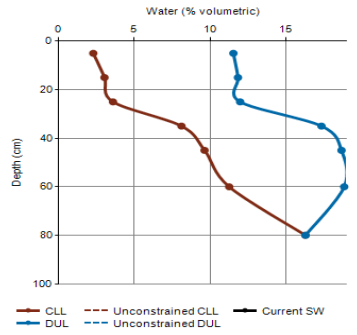
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.66	2	12	9	2	12	9
2	15	10	1.66	3	12	9	3	12	9
3	25	10	1.66	4	12	8	4	12	8
4	35	10	1.60	8	17	9	8	17	9
5	45	10	1.59	10	19	9	10	19	9
6	60	20	1.58	11	19	15	11	19	15
7	80	20	1.61	16	16	0	16	16	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	2.3	11.5					
2	15	10	3.0	11.8					
3	25	10	3.6	12.0					
4	35	10	8.1	17.3					
5	45	10	9.6	18.7					
6	60	20	11.3	18.8					
7	80	20	16.3	16.3					

Soil Profile Summary

Sand



Plant Available Water Capacity (PAWC)	60mm
Profile Depth	90cm
Average Water Availability per cm	0.7mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	60mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 10 – Coomandook sand Soil Water Express simulation version 3 (final)

Parameters	UNIT	MOORLANDS FLAT CANOLA 0-10	MOORLANDS FLAT CANOLA 10-20	MOORLANDS FLAT CANOLA 20-30	MOORLANDS FLAT CANOLA 30-40	MOORLANDS FLAT CANOLA 40-50	MOORLANDS FLAT CANOLA 50-70	MOORLANDS FLAT CANOLA 70-90
pH Water		8.36	8.90	9.20	9.30	9.70	9.80	9.90
pH CaCl		7.78	7.90	8.20	8.20	8.50	8.50	8.50
EC 1:5	uS/cm	176.00	149.00	205.00	285.00	293.00	361.00	451.00
Exchangable Ca	c.mol/kg	14.61	14.12	12.02	10.52	8.25	7.15	5.89
Exchangable Mg	c.mol/kg	2.03	1.82	3.27	4.15	4.90	4.88	4.39
Exchangable K	c.mol/kg	1.05	0.58	0.40	0.32	0.36	0.43	0.49
Exchangable Na	c.mol/kg	0.22	0.98	1.58	2.12	2.82	3.64	4.05
Exchangable Na (ESP)	%	1.22	5.60	9.15	12.39	17.27	22.61	27.33
eCEC	c.mol/kg	17.90	17.50	17.27	17.11	16.33	16.10	14.82
B	mg/kg	0.80	2.19	3.02	3.91	6.15	7.63	8.29
Cl	mg/kg	8.00	31.00	247.90	290.50	284.40	432.00	428.20
Gravel	%	1.00	<1	<1	40.00	10.00	<1	10.00
Sand (>0.63um)	%	80.00	79.00	76.00	72.00	69.00	70.00	73.00
Silt	%	10.00	12.00	11.00	16.00	17.00	18.00	16.00
Clay	%	10.00	9.00	13.00	12.00	14.00	12.00	11.00

Attachment 11 – Moorlands flat soil testing results

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

	Layer			Physical		Texture		Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	40	25	Silty Loam	5.6	176	31.	2.19
2	10	20		5	35	35	Silty Clay Loam	5.6	149	31.	2.19
3	20	30		40	70	15	Loam	9.15	205	247.9	3.02
4	30	40		25	60	30	Clay Loam	12.39	285	290.5	3.91
5	40	50		60	60	30	Clay Loam	17.27	293	284.4	6.15
6	50	70		20	35	35	Silty Clay Loam	22.61	361	432.0	7.63
7	70	90		10	40	25	Silty Loam	27.33	451	428.2	8.29

Add New Row

Estimated Soil Water Profile

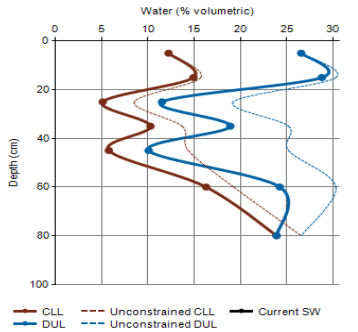
	Layer		Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.55	12	27	14	12	27	14
2	15	10	1.51	16	30	15	15	29	14
3	25	10	1.60	9	19	11	5	12	6
4	35	10	1.53	14	25	11	10	19	9
5	45	10	1.53	14	25	11	6	10	4
6	60	20	1.51	19	30	22	16	24	16
7	80	20	1.55	27	27	0	24	24	0

Monitoring Device Soil Water Profile

	Layer		Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	12.2	26.6					
2	15	10	14.9	28.8					
3	25	10	5.1	11.5					
4	35	10	10.3	18.9					
5	45	10	5.8	10.1					
6	60	20	16.3	24.2					
7	80	20	23.9	23.9					

Soil Profile Summary

Silty Loam over Silty Clay Loam over Loam



Plant Available Water Capacity (PAWC)	63mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	84mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 12 – Moorlands flat Soil Water Express simulation version 1

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	63	19	Loam	5.6	176	31	2.19
2	10	20		5	48	33	Clay Loam	5.6	149	31	2.19
3	20	30		40	79	15	Sandy Loam	9.15	205	247.9	3.02
4	30	40		25	72	24	Sandy Clay Loam	12.39	285	290.5	3.91
5	40	50		60	72	24	Sandy Clay Loam	17.27	293	284.4	6.15
6	50	70		20	48	33	Clay Loam	22.61	361	432	7.63
7	70	90		10	63	19	Loam	27.33	451	428.2	8.29

Add New Row

Estimated Soil Water Profile

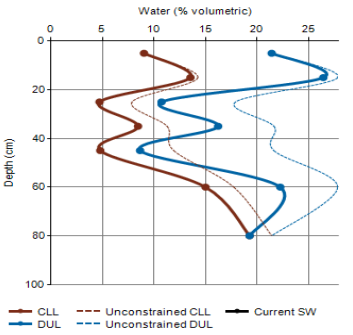
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.58	9	21	12	9	21	12
2	15	10	1.52	14	28	14	14	26	13
3	25	10	1.60	8	18	10	5	11	6
4	35	10	1.56	11	22	10	8	16	8
5	45	10	1.56	12	22	10	5	9	4
6	60	20	1.52	18	28	20	15	22	15
7	80	20	1.58	21	21	0	19	19	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	9.0	21.4					
2	15	10	13.5	26.4					
3	25	10	4.7	10.7					
4	35	10	8.5	16.2					
5	45	10	4.8	8.7					
6	60	20	15.0	22.3					
7	80	20	19.3	19.3					

Soil Profile Summary

Loam over Clay Loam over Sandy Loam



Plant Available Water Capacity (PAWC)	57mm
Profile Depth	90cm
Average Water Availability per cm	0.7mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	76mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 13 – Moorlands flat Soil Water Express simulation version 2

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		1	80	10	Sandy Loam	1.22	140	8	0.8
2	10	20		0	79	9	Loamy Sand	5.6	149	31	2.19
3	20	30		0	76	13	Sandy Loam	9.15	205	247.9	3.02
4	30	40		40	72	12	Loam	12.39	285	290.5	3.91
5	40	50		10	69	14	Loam	17.27	293	284.4	6.15
6	50	70		0	70	12	Loam	22.61	361	432	7.63
7	70	90		10	73	11	Loamy Sand	27.33	451	428.2	8.29

Add New Row

Estimated Soil Water Profile

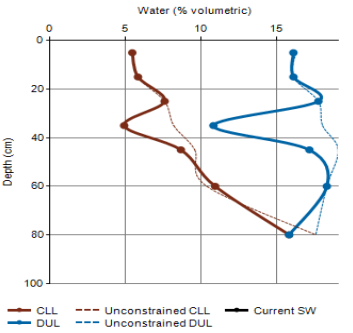
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.62	6	16	11	5	16	11
2	15	10	1.63	6	16	10	6	16	10
3	25	10	1.61	8	18	10	8	18	10
4	35	10	1.61	8	18	10	5	11	6
5	45	10	1.61	10	19	9	9	17	8
6	60	20	1.61	10	18	16	11	18	15
7	80	20	1.62	18	18	0	16	16	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	5.4	16.1					
2	15	10	5.8	16.1					
3	25	10	7.6	17.7					
4	35	10	4.9	10.8					
5	45	10	8.7	17.1					
6	60	20	10.9	18.3					
7	80	20	15.8	15.8					

Soil Profile Summary

Sandy Loam over Loamy Sand over Sandy Loam



Plant Available Water Capacity (PAWC)	60mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	66mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 14 – Moorlands flat Soil Water Express simulation version 3 (final)

Parameters	UNIT	MOORLANDS SAND LUPINS 0-10	MOORLANDS SAND LUPINS 10-20	MOORLANDS SAND LUPINS 20-30	MOORLANDS SAND LUPINS 30-40	MOORLANDS SAND LUPINS 40-50	MOORLANDS SAND LUPINS 50-70	MOORLANDS SAND LUPINS 70-90
pH Water		8.02	8.90	9.00	9.10	9.10	9.20	9.50
pH CaCl		7.44	8.20	8.20	8.20	8.20	8.30	8.40
EC 1:5	uS/cm	103.00	83.00	104.00	113.00	110.00	105.00	114.00
Exchangable Ca	c.mol/kg	5.31	6.89	10.09	8.71	9.95	8.21	6.83
Exchangable Mg	c.mol/kg	1.26	1.64	2.17	2.37	3.69	4.81	5.38
Exchangable K	c.mol/kg	0.44	0.58	0.64	0.52	0.59	0.55	0.58
Exchangable Na	c.mol/kg	0.05	0.07	0.09	0.10	0.14	0.19	0.32
Exchangable Na (ESP)	%	0.78	0.76	0.69	0.85	0.97	1.38	2.44
eCEC	c.mol/kg	7.07	9.18	12.99	11.70	14.37	13.76	13.11
B	mg/kg	0.39	0.89	1.53	1.57	2.37	2.74	3.67
Cl	mg/kg	14.00	4.00	5.60	7.30	11.30	6.50	11.20
Gravel	%	<1	<1	<1	<1	<1	<1	<1
Sand (>0.63um)	%	92.00	84.00	77.00	75.00	81.00	78.00	74.00
Silt	%	<3	<3	10.00	18.00	11.00	14.00	15.00
Clay	%	6.00	16.00	13.00	7.00	8.00	8.00	11.00

Attachment 15 – Moorlands sand soil testing results

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm^3)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	70	15	Loam	0.76	103	4.	0.89
2	10	20		5	70	15	Loam	0.76	83	4.	0.89
3	20	30		20	70	15	Loam	0.69	104	5.6	1.53
4	30	40		5	70	15	Loam	0.85	113	7.3	1.57
5	40	50		10	60	30	Clay Loam	0.97	110	11.3	2.37
6	50	70		10	40	25	Silty Loam	1.38	105	6.5	2.74
7	70	90		10	35	35	Silty Clay Loam	2.44	114	11.2	3.67

Add New Row

Estimated Soil Water Profile

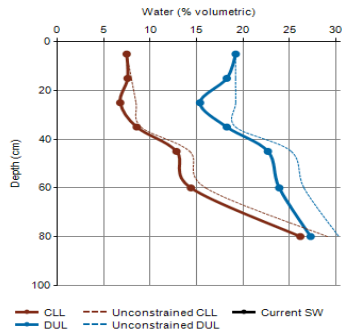
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm^3)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.60	7	19	12	7	19	12
2	15	10	1.60	8	19	11	8	18	11
3	25	10	1.60	8	19	11	7	15	9
4	35	10	1.60	9	19	10	9	18	10
5	45	10	1.53	14	25	11	13	23	10
6	60	20	1.55	16	27	21	14	24	19
7	80	20	1.51	29	30	2	26	27	2

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	7.5	19.2					
2	15	10	7.6	18.2					
3	25	10	6.8	15.4					
4	35	10	8.6	18.2					
5	45	10	12.8	22.7					
6	60	20	14.4	23.9					
7	80	20	26.2	27.3					

Soil Profile Summary

Loam



Plant Available Water Capacity (PAWC)	72mm
Profile Depth	90cm
Average Water Availability per cm	0.9mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	78mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 16 – Moorlands sand Soil Water Express simulation version 1

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	79	15	Sandy Loam	0.76	103	4	0.89
2	10	20		5	79	15	Sandy Loam	0.76	83	4	0.89
3	20	30		20	79	15	Sandy Loam	0.69	104	5.6	1.53
4	30	40		5	79	15	Sandy Loam	0.85	113	7.3	1.57
5	40	50		10	72	24	Sandy Clay Loam	0.97	110	11.3	2.37
6	50	70		10	63	19	Loam	1.38	105	6.5	2.74
7	70	90		10	48	33	Clay Loam	2.44	114	11.2	3.67

Add New Row

Estimated Soil Water Profile

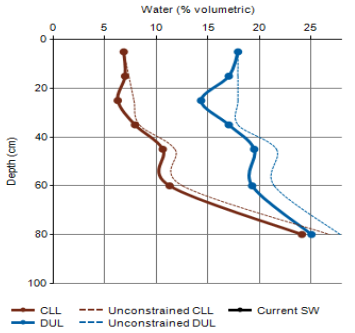
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.60	7	18	11	7	18	11
2	15	10	1.60	7	18	11	7	17	10
3	25	10	1.60	8	18	10	6	14	8
4	35	10	1.60	8	18	10	8	17	9
5	45	10	1.56	12	22	10	11	19	9
6	60	20	1.58	13	21	18	11	19	16
7	80	20	1.52	27	28	2	24	25	2

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	6.8	17.9					
2	15	10	6.9	17.0					
3	25	10	6.2	14.3					
4	35	10	7.9	17.0					
5	45	10	10.6	19.5					
6	60	20	11.3	19.3					
7	80	20	24.1	25.0					

Soil Profile Summary

Sandy Loam



Plant Available Water Capacity (PAWC)	65mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	71mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 17 – Moorlands sand Soil Water Express simulation version 2

SoilWater express

Help Print

Soil Water Express Notes

Soil Water Profiler

Modify Calculation Settings

Soil Characteristics

Layer			Physical		Texture			Chemistry			
No.	Top (cm)	Bottom (cm)	BD (g/cm³)	Rock (Vol %)	Sand (%)	Clay (%)	Texture	ESP (%)	EC (µS/cm)	Cl (mg/kg)	B (mg/kg)
1	0	10		0	92	6	Sand	0.78	94	14	0.39
2	10	20		0	84	16	Sandy Loam	0.76	83	4	0.89
3	20	30		0	77	13	Sandy Loam	0.69	104	5.6	1.53
4	30	40		0	75	7	Loamy Sand	0.85	113	7.3	1.57
5	40	50		0	81	8	Loamy Sand	0.97	110	11.3	2.37
6	50	70		0	78	8	Loamy Sand	1.38	105	6.5	2.74
7	70	90		0	74	11	Sandy Loam	2.44	114	11.2	3.67

Add New Row

Estimated Soil Water Profile

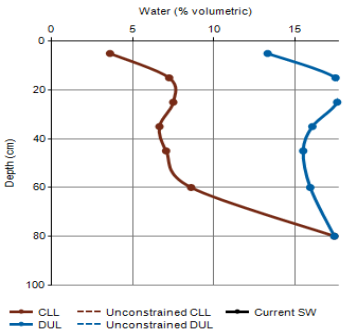
Layer			Physical	Unconstrained Soil Water			Plant Available Water Capacity		
No.	Depth (cm)	Thickness (cm)	BD (g/cm³)	CLL (Vol %)	DUL (Vol %)	SW (mm)	CLL (Vol %)	DUL (Vol %)	SW (mm)
1	5	10	1.64	4	13	10	4	13	10
2	15	10	1.60	7	17	10	7	17	10
3	25	10	1.61	8	18	10	8	18	10
4	35	10	1.64	7	16	9	7	16	9
5	45	10	1.63	7	16	8	7	16	8
6	60	20	1.63	9	16	15	9	16	15
7	80	20	1.62	17	17	0	17	17	0

Monitoring Device Soil Water Profile

Layer			Profile Estimates		Calibration Readings		Plant Available Water		
No.	Depth (cm)	Thickness (cm)	CLL (Vol %)	DUL (Vol %)	CLL Raw Reading	DUL Raw Reading	CURRENT Raw Reading	SW (Vol %)	SW (mm)
1	5	10	3.6	13.3					
2	15	10	7.2	17.5					
3	25	10	7.5	17.6					
4	35	10	6.7	16.1					
5	45	10	7.1	15.5					
6	60	20	8.6	15.9					
7	80	20	17.4	17.4					

Soil Profile Summary

Sand over Sandy Loam



Plant Available Water Capacity (PAWC)	63mm
Profile Depth	90cm
Average Water Availability per cm	0.8mm/cm
Depth to Solid Rock	N/A
Unconstrained PAWC	63mm
Plant Available Water (PAW)	0mm
% of PAWC	0%

Attachment 18 – Moorlands sand Soil Water Express simulation version 3 (final)