ARABLE

Arable Water
Activation Guide

Hardware Components

- Arable Mark 2 or Mark 3
- Gems Pressure Switch (optional)
- Sentek Soil Probe (optional)

Activation Instructions:

Step 1: Hardware Deployment

Deploy your Mark 2 or Mark 3
See Sentek Soil Moisture Probe Installation on Support Page
See Gems Pressure Switch Installation on Support Page

Step 2: Site Configuration

Ensure that you have created a site for your deployment. You can add one or multiple Marks to each site and data will be aggregated accordingly in the Arable Apps. Please refer to the Sites Onboarding Guide for any additional support in configuring your sites
*Before trying to access the Water platform ensure that you are on our latest software release by logging out and logging back in.

Step 3: Season Configuration in Web app

After setting up your Site you will need to associate a Season with it to track the growth stages of your crop. This is necessary for data to populate in the Arable Water. ***Note: the replacement ETc will default to 0 if you do not associate any growth stages with your site. Once you configure a growth stage, the default replacement ETc will be 100 until you change it.***

Step 4: Configure Site-Wide Application Flow Rate (if applicable)

If you have deployed a Gems pressure switch, you must configure your **site-wide application flow rate** in order for data to populate in the app. This should be done immediately after deployment as irrigation events will not be displayed in the Arable apps until this is done. Review the [Gems Installation Guide](#) and navigate to the connected sensors icon in the Web app in order to configure this value. Configurations of site-wide application flow rates are not possible from within the Mobile Application.

Step 5: Configure Soil Moisture (if applicable)

If you have installed a Soil Moisture probe with a Mark that is associated with your Site, you may configure its **soil texture properties, refill threshold, and selected depths** on the Water Tab of your site.
Once you define these values in the visual, values associated with soil moisture will populate throughout the app. Review the info modal in the title of the visual "Soil Moisture"

Step 6: Permissions and Views

In order to manipulate values for Sites, Seasons, and configurations on the Water pages, you must have Org Admin or Team admin permissions. If you are a team member you will be able to view the data but not configure settings.

The Water pages are available on web:
1. The Site details tab -> Water (Single Site View
2. The Left Side Bar - Analytics -> Water (Multi-site view)
They are also available via the Arable Mobile app

Arable Water Info Modals & Definitions

Web - Single Site View

Water Summary (header)

Water Balance Change
A calculation of the precipitation plus irrigation minus crop evapotranspiration over the duration selected.

Irrigation to Replace ETc
The irrigation system runtime needed to meet the user-defined Replacement ETc. The Replacement ET % is set in the Arable Web Water page, Water Balance visual. It will default to 100% if a Growth Stage is defined for the measurement period and otherwise it will be 0%. This value will only populate if a flow rate for a Gems Pressure Switch has been configured.

Soil Moisture
The proximity to the refill point set in the soil moisture graph. This equals the mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold. This will appear blank if no soil probe is attached or if the soil moisture measurement has not been configured in the soil moisture graph below.

Total Heat Stress Hours
The total number of daylight hours during which the canopy temperature is above the GDD max temperature threshold for the crop at the site since the start of the current season. If the GDD max temperature threshold is not defined for the crop in the system, then a default of 96°F is used.

Growth Stages
Growth Stages mark physiological development throughout a plant's life, primarily driven by heat, light, or the combination of heat and light, and occur at progressive Growing Degree Days. They are unique to a crop or even varietal, and matter for a range of timed applications and events, including irrigation, inputs, pests/disease risk, frost risk, deficit irrigation strategies, and insurance policies. We offer default Growth Stages for some Varietals. You can also edit these or enter your own Growth Stages if you know them.

Water Details
A breakdown of the measurements contributing to water insights for the site and season, as defined below. The default summary shows at-a-glance water, soil, and heat measurements; clicking on the drop-down menu will show more detailed water balance, soil, and heat stress measurements.
The first row in the chart shows a 7-day forecast including today; the next row shows measurements from earlier today and the past 6 days; subsequent rows show prior weeks chronologically.

Summary

Water Balance Change
The change from previous to current value of water balance for the measurement period.

Soil Moisture
The average soil moisture across all depths and Mark deployments associated with the site for the measurement period, presented as a percentage of available water content (field capacity - permanent wilting point). It is required to set the field capacity and the permanent wilting point in order for the soil moisture graph to be initialized and as such display soil moisture readings.

Total Heat Stress Hours
Total heat stress hours up to and including the end of the measurement period.

Water Balance

Water Balance Change
The change from initial to last value of water balance for the measurement period.

Replacement ETc
The amount of water needed to apply to meet the user defined Replacement ETc. This value can be set in the Arable Web Water page, Water Balance visual. It will default to 100% if a Growth Stage is defined for the measurement period and otherwise it will be 0%.

Precipitation
The amount of rainfall on the site for the measurement period. If multiple Mark deployments were associated with the site for the same period, the rainfall measurements are averaged.

Irrigation
The irrigation application depth for the measurement period, calculated as the pressure switch flow rate times the irrigation runtime divided by the site area. If multiple pressure switches are associated with a site, the amount is a sum total.

Heat Stress

Heat Stress Hours
Number of daylight hours that have experienced heat stress at the site during the measurement period.

Total Heat Stress Hours
The total number of daylight hours during which the canopy temperature is above the GDD max temperature threshold for the crop at the site during the period selected. If the GDD max temperature threshold is not defined for the crop in the system, then a default of 96°F is used.

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Soil Moisture

Soil Moisture Change
The mean soil moisture in the measurement period minus the mean soil moisture in the previous period.

Proximity to Refill Threshold
The mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold.

Water Balance

Scale
The y-axis is showing the water balance in inches or mm based on your Account Settings. The x-axis defaults to the weekly changes for each measurement. This can be changed to daily, monthly, or growth stage intervals on the Water Details table.

Precipitation
The amount of rainfall at the site for the x-axis measurement period. If multiple Mark locations were associated with the site for the same period, then the rainfall measurements are averaged.

Irrigation
The irrigation application depth at the site for the x-axis measurement period. It is calculated as the pressure switch flow rate times the irrigation runtime divided by the site area. If multiple pressure switches are associated with a site, then their contributions are summed. This graph will also include values that are input manually by clicking on the three dots in the right corner of the visual.

ETc
The Arable Canopy Evapotranspiration at the site for the x-axis measurement period. If multiple Marks are associated with the site, then their individual ETc values are averaged.

Replacement ETc
The percentage of ETc that you would like to irrigate. It can be configured by clicking on the three dots on the right hand side of this modal. For instance, in order to irrigate to replace 80% of your observed ETc you may set the value for your current growth stage at 80. Values between 0-200 are accepted.

Soil Moisture

Soil Moisture
The soil probes attached use default Sentek coefficients of sandy loam soil texture.

For the Graph to display data, first set your site's field capacity and wilting point based on your soil's textural properties. You may also set a Refill Threshold to use as a safe threshold to irrigate above. You must enter these to define the water holding capacity from which the percentage scale is derived. Secondly, configure your depths of interest. Depending on the length of your probe, you may enter values from 10-120 cm. The selected depths will create an average which will display on the graph. Note that the depths you select will impact your field capacity, and wilting points as a given soil will have different water holding capacities at different depths. If you select multiple or all depths, you will see an average of the selected depths.

The graph will then display the average soil moisture (in % AWC - Available Water Content) across all depths of interest and Marks associated with the site for the measurement period using default crop coefficients of sandy loam soil texture in this release. It is possible to edit the depths of interest and the Field Capacity (FC), Permanent Wilting Point (PWP), and Refill Threshold (RT) at any time, and the change will apply to the complete time series for the site and season.

Below are steps for determining each value:

Field Capacity
The Field Capacity is the amount of water remaining in the soil a few days after having been wetted and after free drainage has ceased. It may take two weeks after deployment for your soil probe to establish full contact with the soil around it unless you have saturated the area around the probe. This can be expedited by performing a Bucket Saturation Test (see Arable Support page).

A first value can be entered based on the general guidelines that the volumetric soil moisture content remains at Field Capacity for a given soil texture. Below is a table for values for Field Capacity at different soil textures. You will need to iterate over time to find the right settings based on monitoring the soil moisture graph during rain events or wetting events. Upon being configured, Field Capacity will denote 100% on the y-axis, and the associated Volumetric Water Content expressed in millimeters or inches will be found on the right side of the graph. The value you ultimately set for the field capacity should reflect the reading of the soil probe when your field is at 100% storage capacity for the given depths you selected.

Soil Type Field Capacity
Sand 200 mm/m (2.4 in/ft)
Loam 400 mm/m (4.8 in/ft)
CLAY 500 mm/m (6.0 in/ft)

Permanent Wilting Point

The Permanent Wilting Point is the water content of a soil when most plants (corn, wheat, sunflowers) growing in that soil wilt and fail to recover their turgor upon rewetting. The crop will experience severe, possibly unrecoverable, stress.

The Permanent Wilting Point can be set by multiplying the Field Capacity (as identified through the Bucket Saturation Test) with the percentage value from the below table for the identified soil texture.

Soil Type
Permanent Wilting Point (% of Field Capacity)
sand
67
sandy loam
33
loam
30
silt loam
33
clay loam
41
clay
57

Source - University of Minnesota

Alternatively, a first value for Permanent Wilting Point can be entered based on the general guidelines that the volumetric soil moisture content remaining at Permanent Wilting Point is about 75 mm/m (0.9 in/ft) for sandy soils, 125 mm/m (1.5 in/ft) for loam soils, and 250 mm/m (3.0 in/ft) for clay soils and then iterate over time to find the right settings based on monitoring the soil moisture graph during rain events. The Permanent Wilting Point will then denote 0% on the y-axis and the associated Volumetric Water Content will be found on the right side.

Refill Threshold

Enter the Refill Threshold associated to the crop-varietal if a Soil Moisture Probe is connected. The Refill Threshold is your definition of a point you don't want to go below and as such is used to indicate the need of an irrigation event and, in the future, will trigger an Arable alert. The Refill Threshold usually has an ample buffer above the Wilting Point to avoid crop stress. It is set as a percentage of the Available Water Content (Field Capacity minus Permanent Wilting Point) and has a default value of 70%.

Upon configuration, this value will be associated with the Proximity to Refill Point found elsewhere throughout the Arable Web and Mobile apps.

Arable Water Info Modals

Web - Multi-Site View

Left hand Table

Irrigation to Replace ETc
The irrigation hours needed to meet the defined Replacement ETc. The Replacement ET % is set in the Arable Web Water page, Water Balance visual. It will default to 100% if a Growth Stage is defined for the measurement period and otherwise it will be 0%. This value will only populate if a flow rate for a Gems Pressure Switch has been configured for your site.

Last Irrigation Runtime
The date and amount when an irrigation event was last observed using data from the pressure switch or from data which was manually entered on the Water tab for that site.

Proximity to Refill Threshold
The distance to the soil moisture refill point for a site expressed as a percentage. This equals the mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold. This will appear blank if no soil probe is attached or if the soil moisture measurement has not been configured in the soil moisture graph below. This value is configured in the Water tab for each site with a soil moisture probe.

Heat Stress Hours
The accumulated number of daylight hours during which the air temperature is above the GDD max temperature threshold for the crop at the site for the period selected. If the GDD max temperature threshold is not defined for the crop in the system, then a default of 96°F is used.

Status Bars

Irrigation to Replace ETc
Sites that require more than 8 hours of irrigation to replace ETc are colored red. If they require between 2 to 8 hours they will be colored yellow and if they require less than 2 they are colored green. Sites that do not have pressure switches will not be included in the status bar. Manual entered irrigation events will not display here, on the map, or in the benchmark graph.

Irrigation Runtime Hours
For the last 7 days: If sites have received over 21 hours of irrigation they are colored dark blue. If they have received between 5 and 20 hours they are colored blue, and if they have received 4 or less hours they will be colored light blue. Sites that do not have pressure switches will not be included in the status bar.

Proximity to Refill Threshold
If sites are at or below the refill point they will be colored red. If they are within 10% above the refill point they will be colored yellow and if they are above 10% they will be colored green. Sites that do not have soil probes will not be included in the status bar.

Heat Stress Hours:
Sites that have received over 15 hours of heat stress will be colored red. Sites with between 5 and 15 hours of heat stress will be colored yellow and sites with less than 5 hours will be colored green

Benchmark Graphs

Water Balance Tab
Irrigation to Replace ETc
The irrigation hours needed to meet the defined Replacement ETc. The Replacement ET % is set in the Arable Web Water page, Water Balance visual. It will default to 100% if a Growth Stage is defined for the measurement period and otherwise it will be 0%. This value will only populate if a flow rate for a Gems Pressure Switch has been configured for your site.

Irrigation Tab
Irrigation Hours: The total number of hours that each site has been irrigated over the previous 7 days.

Soil Moisture Tab
Proximity to Refill
The proximity to the refill point set in the soil moisture graph. This equals the mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold. This will appear blank if no soil probe is attached or if the soil moisture measurement has not been configured in the soil moisture graph below.

Heat Stress Tab
Heat Stress Hours
The accumulated number of daylight hours during which the air temperature is above the GDD max temperature threshold for the crop at the site for the period selected. If the GDD max temperature threshold is not defined for the crop in the system, then a default of 96°F is used.

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Arable Water Info Modals

Mobile- Single Site View

Irrigation Hours
(i)This value must be configured in the Arable Web App and will appear blank if no pressure switch is present or if no manual entry of irrigation events have been recorded in the Water tab for a given site.

The total number of hours that each site has been irrigated over the period selected. This is based on data collected from the pressure switch or from data which was manually entered on the Water tab for that site.

Proximity to Refill Threshold
(i)This value must be configured in the Arable Web App and will appear blank if no soil probe is associated with a given site. It can be configured in the Water tab for a given site.

The proximity to the refill point set in the soil moisture graph. This equals the mean soil moisture for the measurement period (as a percentage of field capacity) minus the refill threshold.

Replacement ETc
(i) The amount of water needed to apply to meet the replacement ET amount. It can be configured in the Water tab of a given site in the Arable Web App.

The amount of water needed to apply to meet the defined Replacement ETc. This value can be set in the Arable Web Water page, Water Balance visual. It will default to 100% if a Growth Stage is defined for the measurement period and otherwise it will be 0%.