Water volumes to be treated for soilless cultures

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The previous article in this series was about the quality of source water. This article deals with quantities of water in soil-less cultures. For the short-term, the volumes of nutrient solution and run-off on a daily basis determine the required capacity of water treatment systems and short-term water holding tanks. On the long term, the variation in water demand and water availability over a year determines the seasonal storage capacity required to ensure water availability in summer. A graphic is presented to illustrate the various components of a watering and drain system, including water treatments.

Lay-out of water supply
A complete water and nutrient system for a soil-less culture can consist of many components. A possible lay-out is shown in the schematic drawing. It starts with the source water. Many growers use bore water, that may or may not need treatment to overcome quality problems (e.g. iron, see previous article). This can be the first water treatment on the property (treatment number 1). The main water supply on many properties would be rainwater collected from the greenhouse roof and surrounding buildings and/or water from a stream. This source water is often stored in an open pond or dam. In some regions the dams appear to contain pathogens. If these are potential plant diseases that can affect your crop it is advisable to treat this water before usage. This is then water treatment number 2 in the scheme. Thereafter the water goes into a mixing tank to make up the nutrient solution. There can be a range of mixing tanks supplying different nutrient solutions to different crops. Water treatment 2 can be handled in two ways: either on demand (in-line), or by using a tank that holds the treated water for a day or two. For in-line water treatment, system 2 must be large enough to deal with the maximum water consumption on a hot day (see below). By buffering the clean water in a holding tank, the water treatment can be spread over 24 hours per day, and the water treatment system 2 can be of a smaller capacity.

Lay-out of run-off system
The drain water (run-off) coming from the plants is collected in one or more drain pits, and is either kept in these drain pits or stored in a 'dirty water tank' or processed immediately (in-line). Other options are of course dumping or temporarily storing and dumping later. If the run-off is to be re-used, it is wise to properly sterilise it. This is then water treatment 3. This system does not necessarily use the same technique as the other water treatment systems on the property. Also here are two options: in-line processing or processing over 24 hours combined with short-term storage. Again for in-line water processing the water treatment system must have enough capacity to deal with peak amounts.

Re-used water
The treated water can be collected in a holding tank, or can flow directly into the mixing tank. In the mixing tanks the stock solutions are added and the pH is adjusted. In the mixing tank there is a fair risk that some elements build up and others deplete (see previous article). The conductivity factor can look good, but the actual composition of the nutrient solution could become unbalanced. The mixing tank gets a large amount of fresh water added to the recycled water, to replace the water that is taken up. The top-up with fresh water ensure that the plants get good water. However, it depends mainly on the quality of the source water (e.g. sodium content), how slow or fast the build-up of sodium is. Frequent monitoring of the composition of the nutrient solution will help to avoid nutritional problems.

Volumes of water supply and run-off

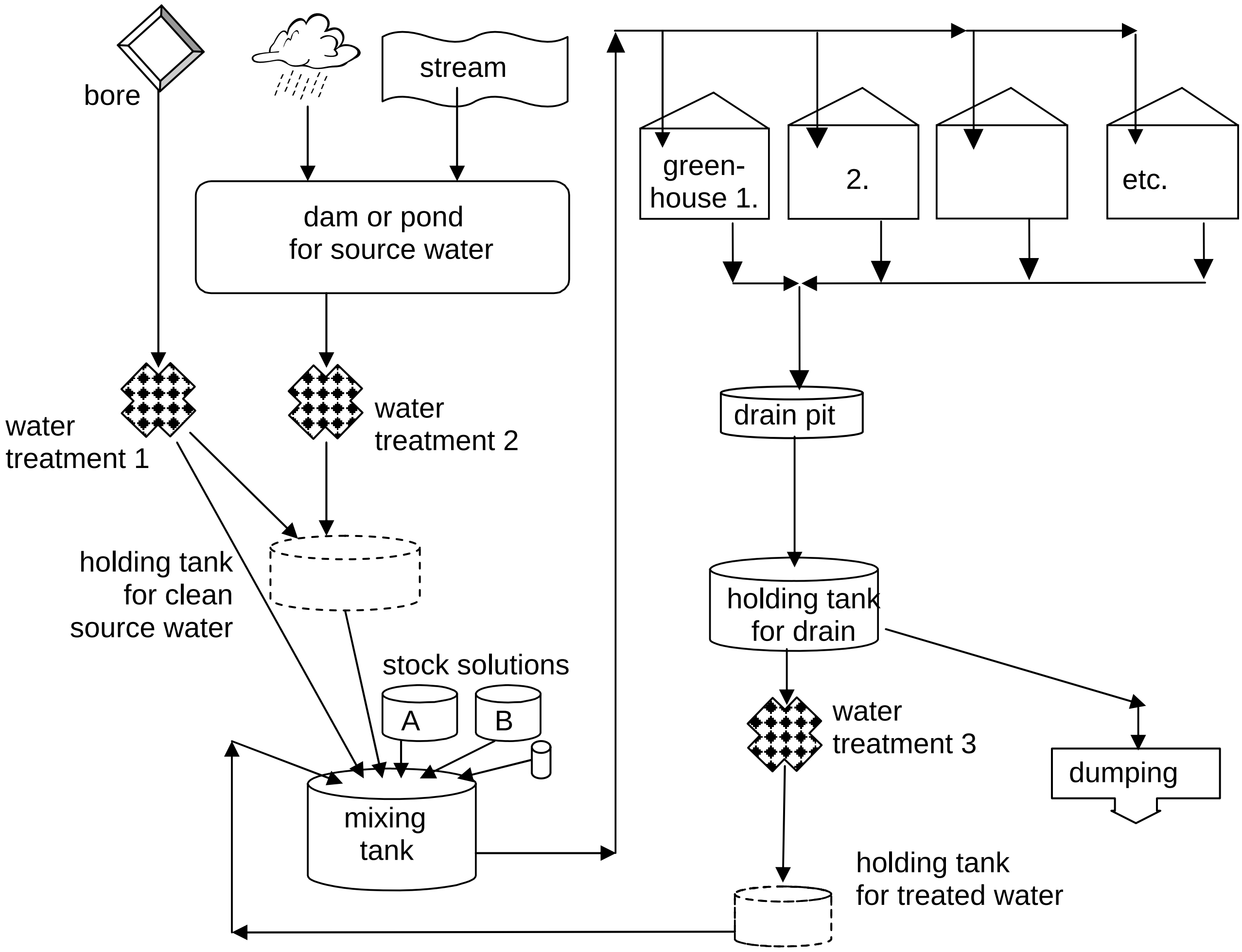
The water consumption in a greenhouse varies a lot, depending especially on the radiation, the leaf area, the type of crop and other factors. We are interested in the maximum quantities of nutrition solution and run-off on a day, because these determine the capacity required of the water treatment and holding tanks. It is known from measurements that the maximum uptake on a sunny day of most greenhouse crops when full-grown is in the order of 7 litre per m^2 per day, or 7 m^3 per 1000 m^2 per day. It will be mostly less than this and only by exception a bit more. The water supply must be markedly higher than the water uptake, to allow for uneven water distribution and uneven transpiration. This excess water will drain out of the system. The aim would be to give 20-30% in excess. With that included, the maximum water supply is around 8-9 litre per m^2 per day, or 8-9 m^3 per 1000 m^2 per day. For an easy approximation we round this figure to 10 m^3 per 1000 m^2 per day, as being the maximum water consumption of a greenhouse crop.
The amount of run-off or drain coming from the bags or tubes in a soil-less culture is the 20-30% that is supplied on top of the water uptake. That is 20-30% of 7 litre, which is 1.4-2.1 litre. However, there can be much more drain on a dark day when the uptake is not very high and if the supply is not adjusted to the conditions. If there is no proper watering control, one must calculate with potentially bigger volumes of run-off, e.g. 3 to 5 m^3 run-off per 1000 m^2 per day. The 10 m^3 and 3-5 m^3 per 1000 m^2 per day are the two figures to work with for calculating water treatment and storage capacities, unless more particular data are available.

Rain fall

Naturally the rainfall varies considerably throughout New Zealand, and also between seasons and between years. As an example, the average rainfall in the South Auckland region is in the order of 1200 mm per year, which equals 1200 litre per m^2 per year. When harvesting the rain water from the greenhouse roof and storing it in a dam, each 1000 m^2 of greenhouse area would yield 1000 x 1200 litre = 1.2 million litre or 1200 m^3 water per year. A small part of this will evaporate from the dam, which can be calculated.
The rain fall on the greenhouse roof is generally less than the water consumption in that greenhouse. This holds especially for the summer period, and thus rainwater has to be collected and stored for a couple of months. However, also on an annual basis the rain water generally falls short for most greenhouse crops. This can only be overcome by collecting rainwater from a larger catchment area than just the greenhouse roof, or by using other sources of water in addition.

Calculations

It would go too much in detail to work out any calculations here. The fact of the matter is that for any given situation, one can calculate the required catchment area, seasonal storage capacity, water treatment capacities and short-term holding tanks based on crop information and average meteorological data (rainfall and radiation). With the unpredictable changes in weather that we have seen in the last couple of years it is probably wise to opt for a larger catchment area and larger storage pond than minimally needed, or to ensure that alternative water sources of sufficient quality are available.



Possible lay-out of fertigation system for soilless cultures, including water supply, treatment & storage, as well as run-off collection and re-use. Second holding tank (dotted) is optional.