Open Hydroponics : Risks and Opportunities

Stage 1

Water Supply Impact Assessment Report

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LWA DAN 22

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(Land & Water Australia, National Program for Sustainable Irrigation funded Project DAN 22)
Water Supply Impact Assessment Report

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Overview

Aim of the assessment

The aim of this assessment was to examine the irrigation supply related issues that relate to existing and more importantly potential enterprises undertaking Open Hydroponic (OH) irrigation within the major irrigation districts of Victoria and New South Wales. While this assessment looked at the irrigation of Citrus in particular, it did not exclude the use of OH on other crops and sought to address the supply issues for all potential crops.

The assessment specifically aimed to address the following points:-

- Assessment of the ability of irrigation water suppliers to meet the irrigation supply requirements of OH users.
- Assessment of the requirement for on-farm buffer storages.
- Assessment of the ability to supply subject to seasonal water requirements.

How the assessment was undertaken

A water flow requirement was determined prior to discussing the irrigation supply issues with irrigation supply providers. This was provided to the company representatives prior to the interview in the form of a briefing sheet (shown in *italics* below). Questions asked at interview that reflected the assessment aims are located at the end of the briefing sheet.

Interviews were conducted in October 2004 with representatives of Lower Murray Urban and Rural Water Authority (Interviews were conducted at the former Sunraysia Rural Water Authority, Irymple, Victoria); Western Murray Irrigation Limited, Dareton, New South Wales; Goulburn-Murray Water, Tatura, Victoria and Murrumbidgee Irrigation, Leeton, New South Wales. These areas represent a large cross section of the potential locations for OH systems and the existence of most of the crops that are either grown or believed possible to be grown with OH.

Briefing sheet for water service providers for stage 1 of the NPSI funded Open Hydroponic project.

Brief Open Hydroponic background

Open Hydroponics in citrus replenishes moisture daily along with continuous applications of nutrients. It is the aim to keep soil moisture levels above 10% of the readily available water (RAW) level for each soil type. This is the ideal soil moisture condition for optimal plant growth and maximising nutrient utilisation.

Water supply requirements for Open Hydroponic Systems

The following figures are based on existing systems in the Mildura area.

Based on the Eto requirement for drip irrigated Citrus water use at Mildura, the peak summer water use is 6.5 mm/day with an average summer usage of 5.0 mm/day.

This water is applied for approximately 13 hours during the day, for example from 7am til 8pm – mimicking actual citrus daily plant water use. The application rate is estimated to be a minimum of 0.005 Ml/Ha/hr in a single shift up to 0.007 Ml/Ha/hr (resulting in a lower application time) with the absolute maximum undetermined at this stage.

Hence the total amount required each day would be in the area of 0.065 Ml/Ha/day at the plant.

For every 10 Ha of orchard this would be 0.65 Ml per day.

Question for water service providers:

1. *What is your ability to apply this flow requirement ?*
2. *How does this vary across your distribution system ?*
3. *What are the impediments that you can identify and what solutions can you offer ?*
4. *Will this situation change in the future and how ?*
5. *How do your winter supplies vary ?*

Interview Outcomes

Level of risk

When the first three questions of
"*What is your ability to apply this flow requirement ?,*
How does this vary across your distribution system ?
and What are the impediments that you can identify ?"
were asked in interview, there was some commonality in the answers provided.

One of the most common re-occurring themes that came from the interviews was that the risk of supply variations was not the responsibility of the water authority, but a risk that has to be managed by the grower. It is essential therefore that the requirement for irrigators to assess their own level of risk with regard to ensuring continuity and reliability of supply. While there were minor differences between the various water service providers, essentially the theme remained constant. Irrigators are responsible for the management of their own supply risk.

OH require water for up to 13 hours a day during the warmer parts of the season. The need to have a reliable irrigation water supply is a priority. Crops grown with OH have a reduced active root-zone. The crops rely on the constant daily moisture replenishment to offset the lack of buffering ability provided by the reduce root-zone volume. If the daily application is delayed for any reason, significant reduced fruit quality and yield loss could occur.

There must be a reliable and constant irrigation supply available at all times to crops being grown with OH.

This need is dependant on the ability of the water service provider and their delivery system to have a reliable and constant supply available, and where this is not possible then other methods such as on-farm water storage will be required.

The water providers will treat all customers equally regardless of the irrigation system/s used within their enterprise. In some cases the existing supply infrastructure will favour one irrigation type over another, but the level of service to the customer and the access to supply for customers is based on equality. The option of providing a different level of service based on a user pays system was discussed, however this was dismissed by the water service providers because it opposed the "equality for all customers" principle (see Premium Access Right section) and contravened State legislative requirements.

Access to supply cannot be guaranteed all of the time, even though every attempt is made to do so. This applies to all systems, not just to OH. Some examples of supply inadequacies can be due to breakdowns, supply over extraction, upstream flow fluctuations and seasonal supply requirement peaks.

The providers claimed that water is available to their customers for use between 75 and 99% of the time depending on the location and the method of supply. There are various methods of supply – direct pumping from a river, pumping or gravity supply from an open gravity fed scheme channel or a piped pressurised on-demand supply to the farm gate. Water service providers were unable to give a guaranteed supply estimate, as no system has a guaranteed supply. The estimate provided above is a variable range, because the reliability of each of the supply methods mentioned varies due to specific characteristics of each method. A more intensive study would be required to establish a more accurate estimate.

Direct river / major canal pumping

Direct pumping from rivers or main irrigation canals tends to be the most reliable and flexible method of supply due to the large volumes of water that are accessible and the near constant available flow with minimal depth variation. Irrigators in this situation should have reasonable confidence that their access to water will be reliable. However, with an increasing demand on water and a tighter water delivery requirement, rostering although rare, has started to occur in some sections of the Murray in particular during times of peak demand.

Open scheme channels

The most significant variation in supply availability occurs when supplies are drawn from open scheme channels. In most cases these channel supply systems are quite old, prone to leaks and were designed to supply water to surface irrigated crops under a gravity flow. Leakage in channels has a multiplier effect in that losses can cumulate over long sections of channels. This factor can contribute to the unreliability of supply at the end sections of supply channels.

Competition for access to water on most channels (and smaller laterals) is high . Quite often the supply of irrigation water is rostered between the users on a particular channel. The demands of differing irrigation systems place further pressure on the scheduling of deliveries as the different systems effect the rostering supply flows through varied flow requirements. Drip and micro irrigation systems do not cope well with rostered supplies at peak water use. Changes in irrigation practices have seen the introduction of drip and micro irrigation to horticultural crops. It is the difference in the timing of irrigation applications and the corresponding flow requirement that causes problems when these differing irrigation systems are supplied from the one channel. A flood irrigated crop will require a large volume of water less often than a drip/micro crop that requires small volumes of water often, daily or in the case of OH constant supply during hours of daylight. This variance in supply requirement should not be a problem where there is a majority of one system over another on a particular channel. The supply conflicts are more evident where the ratio between systems changes or where they are in similar proportions.

These problems differ from channel to channel and from lateral to lateral. While there is some commonality, these problems tend to be unique in their composition for each specific channel or lateral and are closely related to the channels capacity, length, number of customers, mix of irrigation system type and the variation in crops grown.

This is an important and significant point and needs to be fully addressed when assessing supply risk. A large supply channel that is not far from the river will have fewer problems than a small lateral at the end of the scheme.

Piped pressurised on-demand

Recently in horticultural districts, there has been a move to replace open scheme channels replaced by piped pressurised on-demand supply systems. A supply pressurised at the source is delivered in a closed system to the farm gate at a minimum supply pressure. These systems tend to have the least variation in supply availability where they have been designed to be used with micro sprinkler and drip irrigation. Some problems may exists where flood is used because flow rates may need to be increased pushing the delivery system out of balance. A system designed for a mixture of flood and pressurised irrigation (sprinkler and drip) are costly and not often constructed.

Changes in flow requirement delivered by the systems are controlled at the point of extraction by multiple pumping units. These multiple pumps automatically alternate between on and off line to match the demand for water at the farm gate. Rostering of supply access does occur but as the systems are usually quite new, their design capacities have been developed to suit the requirements of a combination of irrigation systems.

It appears that the requirement for OH to utilise water diurnally is readily offset by the tendency of traditional drip and micro systems to be operated nocturnally. This point is equally as valid on gravity fed open channel supplies where there is a good mix of traditional drip/micro and OH irrigation methods. OH require a supply flow rate of about 1.5L/sec/ha during peak demands conditions (6.5mm/day, 0.5mm/hr application rate, 12 hour daily irrigation). Some recently built pressurised pipe delivery systems supply up to 1.4L/sec/ha at the farm gate for all customers. It is feasible that these systems would be able to supply water if 93% of the district was irrigated to OH requirements during daylight, leaving 7% of capacity for irrigation of non OH crops at night.

Minimising risk associated with property location and water source for OH irrigation

Following the discussions with the water service providers about Irrigators managing their supply risk, the following points raised in answer to the question "*What solutions can you offer ?"*

- The highest interest is in the farms with access to reliable volumes and availability of scheme water. This point was common to all areas and confirms the importance of the reliability and consistency of supply. However, the location of a property on a pressurised piped supply is not as important as it is on a gravity fed open channel supply if the pressurised piped supply system has been designed well. Good design ensures that all properties have equal access to the supply.

- Supply channel buffering in addition to sourcing water from a river or main irrigation canal quite often negates the need for on-farm storage. Conversely, a farm at the end of a scheme channel or system would be more likely to require

some form of supply buffering. If an OH venture was started from the point of property purchase, then it would be highly likely that a site would be chosen in order to minimise the supply access risk. A poorly chosen site would be unlikely. Where a farm is converted from an existing irrigation practice to OH, then the same circumstance would exist if a thorough risk assessment were to be undertaken, that is, if there was a question about the security and reliability of supply then either on-farm buffering would be introduced or a decision not to utilise OH would be made.

- Many supply areas within a scheme will have conflicting issues with the demand for water resulting from differing crops and systems requiring access at the same time. This is normal on smaller supply channels and laterals with the conventional irrigation system mixes and crop variety. Conflicts arise when an enterprise changes its supply requirement due to a change in crop or more significantly a change in irrigation system, most prominently a conversion from surface irrigation to drip/micro. The main issue tends to be in finding a readjustment to suit the change to the status quo that does not impact significantly on the parties that have not changed while ensuring that the requirements of the proponent of the change are met. Currently the problems are solved by schedules, rosters or on-farm irrigation storages. In some cases the supply demands issues are solved by informal localised "self rostering".

- In order to ensure that customers with pressurised systems are content with their open channel supply, it quite often means that the channel operators are pushed with the task of fine tuning the channels more often and even out of hours. In most cases it is difficult to get the mix right because of fixed working hours and the drive to achieve efficiencies in delivery practices. A total channel control system might assist to alleviate this problem by adjusting the channel flows consistently to suit requirements, rather than 2-3 times per day by channel attendants.

- An increase in the parts of schemes or whole schemes that are set up for constant supply and have more potential to suit OH supply requirements is apparent in recent years. Two cases that are identified in this study are the Goulburn Murray Water new automated channel scheme and Western Murray pressurised piped supplies. In addition, there is a significant area of the Murrumbidgee Irrigation scheme area that is planned to be converted from open channel to pressurised piped supply.

- The water service providers were united in saying that OH could be sited in most locations within a scheme, subject to supply risk analysis and implementation of pre-emptive solutions where required.

- If the uptake of OH and other similar drip irrigation management programs continues to increase an opportunity exists for water supplier to provide a specialised supply service (premium access right). However this would require water suppliers to change in the policy of "equality of supply to all customers" and meet relevant legislation. This is further discussed in the "Premium Access Right" section.

Seasonal Access

- There are minimal problems with overall access from a seasonal point of view in the period from August to May. This is due to the main irrigation season going from August to May in most areas.

- There is variable access (varying between limited access to no access) in the off season from May through til August on open channel schemes due to the requirement for these systems to be drained for maintenance and the upgrade and repair of structures. Independency of supply at this time is essential if OH are in place and will to continue to operate successfully. Winter shut down may not pose a major threat for deciduous perennials (i.e. stone fruit, vines etc) but will pose some problems for evergreen perennials (i.e. citrus, avocados etc). This risk is highly variable depending upon the regularity of winter rainfall and on agronomic crop needs.

- The areas with piped pressurised schemes have good access nearly all year round, subject to their supply source being sound. Some of the newer piped supplies within the larger irrigation schemes would most likely experience the off season shutdown in the same way the open channels do.

Supply Risk Management on-farm

On-farm storage

A significant means of alleviating the supply source variation and risk associated with OH on open channel supplies is the on-farm Storage. The benefits provided by these storages are numerous; however the potential for them to become a major source of water loss through evaporation and seepage should not to be ignored. Seepage from on-farm storages has been identified as a common source of localised salinity and high water tables. For on-farm storages to be effective they not only have to be designed and sited correctly, but constructed to a standard guaranteed to ensure their integrity.

Why install an on-farm storage ?

In the case of OH, the main reason for having an on-farm storage is to avoid the variation in supply that occurs upstream of the meter. By storing an amount of water on farm, an irrigation event can commence when required and not be reliant on the availability of off-farm supply. An on-farm supply becomes more useful when a supply system is pushed to its limits in times of high peak season demand and when scheme breakdowns occur. At a local level, channel attendants have been known to dispose of excess flows into on-farm storages rather than dispose of them out of the channel system though escapes. This water is often off cycle to the irrigator with the storage, thus providing an unexpected advantage. In some cases the flow into on-farm storages is not restricted for the majority of the season, except in times of shortage.

Most of the water service providers support the installation of on-farm storages to assist with the buffering of supply variation, but none of them insist that an irrigator do so. In fact, none of the water service providers have a compulsory standard in place for the construction of on-farm storages, which given their potential for seepage due to poor siting or construction is somewhat surprising.

Siting and construction of on-farm storages

The correct siting of all on-farm storages has been shown in the cotton and rice industries to be an important factor in minimising water losses through seepage. Soil Surveying techniques such as test boring, backhoe/excavator pits or electromagnetic surveying are all methods employed to aid in the detection of suitable clay based soils of minimal leakage. The subsequent storage construction phase requires that suitable clay soils are compacted in such a way as to create a base and walls that prevent seepage.

Storage related problems

The water in an on-farm storage has passed through the farm water meter, so any losses from seepage and evaporation are worn by the farm. For this reason alone, serious thought must be given to the need for on-farm storages and they should only be installed once all other options have been exhausted.

Storages on small farms have a tendency to leak through a combination of poor site selection and poor construction practices. Not only is the loss of water an issue, but the potential for localised water logging, shallow water tables and soil salinity issues are high. In addition, when a new storage is constructed it provides a new source of water loss through evaporation. This occurs at a time when best practice promotes the installation of loss minimising “closed” irrigation and supply systems.

Apart from the tendency of poorly sited and constructed soils to leak, there is one more downside. An on-farm storage built on an existing horticultural farm often has a large footprint covering a significant amount of productive land. The crop in this footprint has to be removed in order to provide the area required for the on-farm storage.

Small storages have the additional disadvantage of costing more per Ml to construct.

Further information on the design, siting, construction and operation of on-farm storages can be found in the following publications:

- NSW Agriculture, 1999, “On-farm Water Storages – Guidelines for siting, design, construction and management.” NSW Agriculture.

- Irrigation Association of Australia, 1998, "Guidelines for ring tank storages" – currently being revised.

- Dugdale, H., et. al., 2004, "WATERpak – a guide for the irrigation management of cotton". Cotton Research and Development Corporation. In particular Chapter 2.5 "Developing a surface irrigation system", Chapter 2.6 "Assessing the efficiency of storages, channels and reticulation systems" and Chapter 2.7 "Managing evaporation and seepage in storages and channels".

Additional on-farm contingencies

The previous section has dealt with the issue of securing water volumes to maintain delivery to the suit the demands of an OH. However, the security of the on-farm delivery component also needs to be looked at.

Essentially, this is the pumping section of the on-farm system. There are several important components, but the pump is the crucial one. If a pump was to fail through breakdown or failure of power supply, then the potential for the interruption to irrigations is significant and the associated potential for crop yield and quality decline is equally significant.

The solution to this problem is to consider having:-

- backup pumps and motors on hand
- designing new systems with multiple pumps in parallel (so a disabled pump can be isolated while the system operates at a reduced capacity)
- on site power generators for use during power outages.

Filter systems tend to consist of multiple components and are more suited to situations where one component is taken off line for repairs or maintenance. As such, these multiple filter systems have an inherent backup system due to the way in which individual filters are isolated during the back flush process. There is no need to have complete back up systems for filters.

Premium Access Right

Water Supply Authorities were asked about the possibility of irrigators being able to "pay" for preferential access to irrigation water. It was proposed that irrigator could offset their risk by paying for a guaranteed supply during peak times. This is somewhat similar to situations where high security water is on available alongside general security. In Victoria, this type of premium access is restricted by legislation and any preferred access would come at the expense of those without it. The current edict is equality for all customers.

It is known that there are ongoing debates that high security allocations should be abolished requiring irrigators to manage their own risk with water markets. This provides a situation that is contrary to the proposed idea of guaranteed or premium access. Opportunity may exist for water service providers to develop methods to

better meet customers variable supply requirements, however as discussed earlier, a well sited OH enterprise would have little need for preferential access.

Future issues

When looking ahead to try and ascertain potential issues or problems associated with an increase of OH installations, there appears to be little to stand in the way of expansion.

The supply of irrigation water can only improve when the following factors are considered:-

- There will be an increasing number of open channel schemes converted to pressurised piped supplies in coming years.
- There is an increasing acceptance of pressurised irrigation systems on farms and this will results in an improved water supply service on the open channel schemes.
- Open channel schemes are being automated at increasing rates, allowing the finer tuning of delivery through constant adjustment, to better suit customer requirements

The accelerated expansion of citrus based OH may be low in some of the areas studied i.e. Sunraysia Rural Water Authority and Goulburn Murray Water, due to the small acreages of citrus currently in their areas.

Goulburn Murray Water is currently undertaking a study on supply difficulties which should assist in improved awareness of supply issues and also assist with changes to future delivery mechanisms.

Summary

In summary, the majority of horticultural and broad area properties could be supplied with water at the volume and flow rate required to operate an OH enterprise**.** The ability to supply water is dependant on the localised delivery system conditions, surrounding crop types and irrigation systems, on-farm water storage and the extent of water delivery conflicts within a district.

In planning the development of an OH enterprise, a supply risk assessment needs to occur. The supply risk assessment needs to look at the reliability of supply and identify the means to manage the associated risk. Preceding the supply risk assessment, an evaluation of a site's suitability for favourable crop growth. This would include the traditional soil suitability assessment (soil pits) to ensure that the soil characteristics (eg. Depth, pH, salinity, drainage) are suitable for crop growth. It is recognised that OH is quite suitable for sandy soils, however its effect on heavier soils is not known. These assessments will be mostly site specific and their content will differ for each individual farm location. In essence, each location needs to be assessed on a case by case basis. The ideal site will have both beneficial soils and a constant and reliable water supply.

There are no restrictions with siting OH within irrigation schemes, but some sites are obviously better suited than others. Private diverters have the most reliable supply closely followed by pressurised piped water delivery systems. Channel delivery systems are variable in their ability to provide reliable supply. It is highly likely that an OH enterprise located on a channel system not close to the main canal would not have a reliable supply and require on-farm storage. The need for on-farm storage on other water delivery systems is highly variable and site specific.

The supply risk assessment will identify that some sites will require on-farm buffer storages. These storages need to be designed and constructed in order to minimize evaporative and seepage losses.

All OH should consider supply system backups for pumps and power ensuring continuity of on-farm delivery.

Irrigation supply providers are keen to meet the supply requirements of all customers including any OH customers. All customers are treated the same with regard to water supply access.

District Supply Estimate

Crops grown with the OH method are able to be potentially grown in the majority of irrigation scheme areas, however some locations are obviously better suited then others.

The percentage of areas where the irrigation supply is suitable for OH within an irrigation scheme can be quite high up to 100 %, but suitable supply risk counter-

measures would need to be in place (i.e. on-farm water storage). The actual figure will be less than this ideal figure once reliable irrigation supply sources, localised competition for water, soil types, salinity risk and watertable levels are all taken into account in localised areas. As said earlier, this would have to be evaluated on a case by case basis as blanket percentage figures could be misleading without further localised investigation.

Recommendations

1. Potential OH irrigators need to be introduced to the process of planning, assessing and addressing supply flow rates and accessibility through a supply risk assessment. This needs to occur during the planning phase of an OH venture and would benefit from input from the water service provider. The factors that help minimise the supply risk need to be promoted. Water service providers should be aware that supply risk assessments are required during planning and be able to assist the process.

2. A water supply risk assessment to be conducted in conjunction with the traditional soil crop suitability assessment (soil pits). The ideal site will have an acceptable soil and a constant and reliable water supply.

3. If on-farm storages are required, then comprehensive information and advice is required on site selection, construction and management in order to minimise seepage losses to groundwater and evaporation losses to the atmosphere. Where possible on farm irrigation supply systems should be "closed" systems to prevent any water loss as per best practice.

4. Opportunity may exist for water service providers to develop services to meet variable supply needs.