Rainwater Recovery Systems for Commercial Irrigation: Do's and Don'ts

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Introduction

For many years the majority of commercial irrigation systems have relied on potable water supplies as their source of water. The advantages to potable supplies are many and include: "unlimited" use, pressurized delivery, superb water quality and reliability. However, as water resources have become more critical and competition has increased for its use, using potable water as an irrigation source has come under more and more scrutiny. This has resulted in water withdrawal permits, water restrictions and all-out bans. As "green" and "sustainability" have become the buzz words of the decade, alternative water sources for irrigation systems have become necessary and in some cases rewarded. There are a number of different alternative sources that can be considered for an irrigation system and include: gray water, reuse, water, effluent water, and rainwater. This paper will concentrate on one of these sources, rainwater and considerations that should be undertaken when using it with commercial irrigation systems.

Planning, Codes and Laws

First, codes and laws need to be investigated. In some states most notably, Colorado and Utah, rainwater cannot be collected, stored and used for irrigation by law. Due to water law (prior appropriations) and downstream user rights, the water cannot be collected. In Utah the law is not as restrictive as in Colorado so there may be instances where rainwater can be used. Plumbing and health codes also may need to be considered. Some health codes, especially local ones, do not allow non-potable water to be piped through a building. Others may not allow irrigation of interior plantings with non potable water. Lastly, code may effect how and where the water can be stored, for example it may not be allowed to be stored inside a building, only outside.

Second, it is important that the irrigation designer be involved from the inception of the building planning and design, including the site work. Tank sizes and location, wire and conduit routing, and rainwater collection routes cannot be add-ons to an already designed building—it will be too late. In rainwater systems the water balance inputs and outputs need to be determined very early in the process, long before the irrigation system is designed. Inputs consist of roof area, rainfall data and collection efficiencies. Outputs consist of ET data, evaporation data and irrigation efficiencies. Once this balance is undertaken, the storage tank can be sized and located.

Storage
There are a number of different storage scenarios that can be undertaken and will be based on location, how much storage is needed and the cost of the storage. Storage can be above ground, below ground, in a building or as a water feature. Materials can be concrete, fiberglass, certain types of plastic or specialty materials made just for storage of rain or stormwater. In its simplest form storage is just 55 gallon rain barrels, but they are a bit small for commercial systems. It is important to remember that not 100% of the storage is usable, i.e. you can never get all of the water out. So for example, if you require 20,000 gallons of usable storage the tank more realistically will need to be 25,000 gallons. The amount of unusable storage will be determined by the shape of the tank, the size of the tank and what type pumping system is installed. You also want to leave some buffer in the bottom in case you get some settling of containments. Concrete tanks are easily obtainable from pre-cast companies. Ganged together septic tanks work well and the cost is low. Fiberglass tanks are also available, but are not always cost-effective. Plus with fiberglass, you need to worry about buoyancy, which is usually not a problem with concrete. There is prefabricated storage also made of plastic such as the Trident system. Above ground tanks can be of all shapes, sizes and materials. The trick is to make them aesthetically pleasing to the eye and to blend into the building and landscape. Storage costs range from $1.00 to $2.00 per gallon (for material costs), with the price getting lower with size.

On some sites multiple tanking may be required to maximize the collection of the rain water by gravity. In these cases several smaller tanks may transfer water into one larger tank to pump into the irrigation system. An economic analysis needs to be performed to determine if it is better to pump from one tank or several tanks into the irrigation system. Although transfer pumps are required in the other tanks, the cost of controls and the more sophisticated pumping system for irrigation is usually more economical than pumping from multiple locations directly into the irrigation system.

The tank will need an overflow pipe in case it gets too full. The configuration of the overflow system will depend on the inputs and where the overflow water will be going. Usually just a properly sized pipe towards the top of the tank will suffice as an overflow. If the controls are properly set up and working, then the overflow pipe is essentially just a safety measure.

Pumping
The type of pump associated with the system to pump out of the tank can be accomplished in many different ways, from the cheap to the expensive. The pump can be in the tank or out of the tank. The pump system can be submersible, flooded suction or suction lift. Keep in mind the serviceability of the pump system and the controls required. You also want to maximize the available storage. Submersible pumps lain horizontally (never vertically without a deep sump if you want any usable storage) in the bottom of the tank will work. You need to make sure from the pump manufacturer that the bearings on the pump are rated for horizontal installation. The submersible pump is

probably the simplest way to pump out of the tank, but if something goes wrong, someone is going into a dark, wet tank. A centrifugal pump can be installed on top of the tank and a suction line installed down into the tank. This will be better for maintenance as the pump is out of the tank but will minimize useable storage as their will be a minimum submergence level over the foot valve and the foot valve will have to be installed some distance off the bottom to prevent contamination. This type system also will have the inherent problems of any suction lift application. It's always preferable to avoid suction issues when possible. A flooded suction type pump system works best from our experience. The pump is installed in a manhole beside the tank and a suction pipe of the proper size cored through the wall into the tank. The only part of the pumping system in the tank then is the intake screen. The manhole allows for easy access to the pump and all its controls. The chamber is dry but you may want a sump pump in the bottom as a safety in case it starts to take in water for some reason. Since it is a dry well, all of the electricity can be installed in close proximity to the pump. As with any irrigation pumping system on a diversified landscape the pump system will work best if it includes a VFD drive. Otherwise the pump system should have standard equipment: isolation valve, check valve and maybe a filter depending on the water quality although it is preferable to filter the water going into the tank not out.

If transfer pumps are required, a simple submersible or trash/sump pump can be used as long as there is not a high head required and piped directly to the main irrigation storage tank.

Controls

The brain of any rainwater recovery system is the controls. There needs to be logic with these systems which inherently raises the cost. Without logic in the system it can be a disaster as it is very important to be able to control levels, inputs and outputs. As a result of the required logic, either some mechanical logic (float or pressure switch) and/or some sort of programmable logic controller (PLC) will be used. The simple part of the controls turns the pump on and off – on a very large system there could be multiple pumps – in conventional ways. Either buy a flow switch, pressure switch or pump start relay from the irrigation controller. The pumps will the stop on a similar signal. The VFD depending on its sophistication and the logic controller in combination with it may require a flow and pressure signal. In these cases a flow meter and pressure transducer will be needed. Keeping track of the water pumped is always a good idea any way. Water level sensors for the tank will be required to make sure it does not get too empty or too full. They will also protect the pump and signal make up water or other transfer pumps to add water to the tank. Because the level controls have different tasks at different heights in the tank, i.e. water in at one level, pump off at another, and one pressure sensing level indicator usually is better than multiple probes. The sensor then, in combination wit the logic, can be used to perform its various functions. This makes for a neat control package at an economical cost with reduced maintenance. If there is a sump pump, it will just start and stop with a float switch.

Make Up Water

Unfortunately, when irrigation water is needed the most, it is when it has not rained for awhile. Rarely can a system balance between ET requirements and rainfall received over the whole year, unless there is very sizable storage and that gets expensive quickly. Calculations can indicate the percentage of time the system could be out of water based on historical weather data and a climate analysis. However, most clients do not want a dry landscape so make up water is required. There are systems that rely 100% on rain water either because another source of water is not available or local restrictions do not allow for make up water. Make up water can be a groundwater source, a potable source or from other storage if water is available. The make up water into the tank needs to be sized and controlled. If it is a pumped source, transfer or groundwater, a signal is sent to the pump starter when the tank reaches a certain level. If it is a potable source a properly sized electric solenoid valve can be installed and signaled to come on. Make sure proper backflow prevention is employed which in a tanking case may be an air gap. In some systems there may be two or three make up sources and that logic needs to be programmed through the senses. For example, the tank level drops to a certain point and the transfer pump or pumps turn on, the tank level continues to drop and the well turns on, but the tank continues to drop so then the potable supply turns on. To reduce the dependence of make up water, an efficient irrigation system with weather-based controls works best—if economically feasible.

Coordination

Rainwater recovery systems require a great deal of coordination with other disciplines. As mentioned previously, this needs to be done early in the process, not late. The roof leaders and drainage need to be run to the tank or tanks, tanks need to be sized and located, power needs to be run to pumps and controls and monitoring coordinated. This will require coordination engineers, building and landscape architects. A level of design detail, that you are not use to may also be required. Because of the timeline, sophistication and coordination required on these systems they do not lend themselves to design-build scenarios and need to be engineered.

Conclusion

Rainwater recovery systems are becoming more popular and in some cases mandated by authorities. Coordination and engineering of these systems early in the process is imperative to have them operate correctly. Tanking, pumping and controls need to be customized for each system and a water and climate analysis performed. As potable and groundwater sources come under increased scrutiny rain water systems will be common place and an understanding of there requirements is a must.