GCUOF Sustainable Irrigation System

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Abstract. A design is presented to provide water for irrigation purposes to a farm developed by the Guelph Centre for Urban Organic Farming (GCUOF). The system collects rainwater from four roofs at the nearby townhouses of East Residence to a pond, from which the irrigation system fed by solar pumps draws water. This system will allow the GCUOF to remain off grid and supplies water to the crops even during drought. The projected cost of this design is approximately $135,000.

Key words: Rainwater Harvesting, Solar Pumps, Irrigation, Urban Organic Farming.

1 Introduction

The Guelph Centre for Urban Organic Farming (GCUOF) is an initiative by the University of Guelph which has been designed to grow organic crops on campus in a sustainable manner. The site is currently unserviced and a water supply for irrigation is needed. Tapping into the municipal grid or digging a well to irrigate the site was discouraged by the GCUOF. As such, a sustainable and environmentally friendly solution with low recurring cost was preferred. The farm is located on a 1 hectare plot at the north-west corner of the University of Guelph Arboretum. The centre will initially include a farming area and a greenhouse. As the centre grows it may include a visitors’ centre and a learning commons including a small lecture hall and pilot scale factory operations. The irrigation system should be able to support the greenhouse and specialty crops year round as well as sustain all the crops in times of drought. The design utilizes the precipitation run-off from the nearby rooftops of the East residence buildings at the University of Guelph for water collection. This water would then be piped via an underground piping system that follows the natural grading of the land, to a storage pond on the GCUOF site. The storage pond is large enough to supply water to the field for a drought lasting twenty-eight (28) days.

2 Conceptual Design

2.1 Rainwater Harvesting

Rainwater is to be collected from a large portion, approximately 2400 m², of rooftop area on the eastern sloping roofs of the eastmost buildings, shown in Figure 1. The water will flow into the buildings’ eavestroughs, which will then lead into a 375mm diameter pipe that runs from the east residence collection area to a pond located on the south side of the farm. The pipe is designed to handle 50 year storm flows to both harness events when most of the water supply will be captured, as well as prevent the pipe from backing up and overflowing the eavestrough during high-intensity storms.

Fig. 1. Rooftop Collection Area

2.2 Storage and Delivery

The rainwater supplied by the townhouses will be collected in a 750 m³ pond, (shown in Figure 2) sized to provide enough water to adequately supply the farm during the summer growing season of 50 year low rainfall, as well as sustain crop development during a 50 year (28 day) drought.

A (6m x 1m) ditch stemming from the eastern end of the pond, passing through the middle of the farm and
emptying into the existing ditch that runs alongside College Avenue has been designed to handle any pond overflow during high flows. It is believed that the overflow ditch will not negatively impact the existing ditch because the existing ditch currently handles all of the runoff from the East townhouses.

To prepare the water for distribution, it will be pumped using solar power through a rapid sand filter (to remove any bugs or sediment) to a 22.5 m$^3$ concrete storage tank located near the greenhouse, 1.5 m underground. The tank was sized to hold enough water to adequately supply the greenhouse during the months of November to March when the pond is likely to be frozen. This is also the reason for the underground location of the tank, as it must be under the frost line for the water not to freeze.

From the storage tank, the water is pumped, using a second solar pump, to the field to be used in drip irrigation; or is pumped by hand into a watering can to water the greenhouse.

3 Discussion

The final design meets the constraints proposed by the GCUOF and attempts to optimize the criteria set forth. The design is environmentally friendly, resource efficient and sustainable since it utilizes low impact and renewable solar energy to power the pumping system. The system has a low maintenance cost and as such is economical in the long term. Since the water does not require heavy treatment, the rapid sand filter requires no added chemicals and can simply be cleaned by backflow washing. The design is aesthetically pleasing as it involves no bulky above ground tanks or piping and the pond storage system minimizes the use of permanent concrete foundations that may be used on large storage tanks. However, this design has proven to have a large initial cost of approximately $134,000. Many iterations and optimizations have been attempted in order to minimize cost, however, it was found that the required pipe diameter and water demand kept the cost rather stable. The design, although having a relatively high capital cost, is an ideal choice for a long term project. The low operation and maintenance cost of the system allows for many years of service with minimal additional resources. The system allows for flexibility in crop rotation, being able to support high water demand crops, such as tomatoes, in large quantities. In the event of an expansion of the farm, the pond could be enlarged to accommodate an increased need for storage, which would provide for more fields without near as large a capital cost. Overall, the design is a highly sustainable one, while remaining easy to operate and easy to expand.

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