UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An investigation into South Campus Storm water Catchment and Filtration Technologies

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University of British Columbia

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ABSTRACT

In this report, research concerning the possibility of capturing rainwater for use at the UBC Farm during the dry months of the year was conducted. Currently, the UBC Farm relies on the City of Vancouver for most of its water needs, and the prices during the peak season (summer) can get very expensive. However, since water usage during said season is also at its peak, the total cost is very high. Therefore, a solution to tackle the problem of reliance on city water is needed.

The current infrastructure at the UBC Farm allows for many solutions to be implemented for solving this issue. The constraints that had to be taken into account had to do with how easy is it to maintain a certain solution, and how expensive is it to implement. As for assumptions, it was assumed that there is enough space to build, for example, a cistern, or a wet pond. These assumptions were verified by visiting the Farm and asking employees for information about available space, as well as infrastructure. To come up with adequate solutions, many studies done by several universities were consulted, as well as systems that were proven to work on the field that were built by users across the globe. Many manufacturers' websites were also used for research, but this was limited to filters that can be used in conjunction with other solutions. The main three studies that were taken into account, and that were discussed in this report, include an underground detention system for rainwater that was collected from parking lots, a system that used rooftops as a mean of catching rainwater then passed it through a chain of filters all the way into a detention tank or cistern. Then a wet pond solution for catching any rainwater that is flowing on the ground which also incorporates natural filtering of the water. It was found that all three solutions can introduce considerable savings in water usage during the peak season, however, the most cost effective and easy to implement solution is the wet pond. This solution will work quite well since the UBC Farm already has space in which a wet pond can be built, and the ground is sloped towards it which also minimizes any landscape changes.

More research was done to validate whether the wet pond is the ideal solution, and it was found that the latter can save the UBC Farm a total $12,000 for the entire lifetime of the wet pond which is about 25 years. Thus it is recommended that the wet pond solution be implemented because it meets all the constraints, and it will also help the UBC Farm save a considerable amount of money, while also decreasing its reliance on water from the City of Vancouver.

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GLOSSARY

Detainment	The act of holding water for a set period of time which is usually short.
Catchment	Collecting and containing water for further use.
Filtration	Removing pollutants and/or particles from water or any other substance.
Storm Water	An abnormal amount of surface water often due to heavy rain or a snowstorm.
Grey water	Wastewater generated from domestic activities such as laundry, dishwashing, and bathing, which can be recycled on-site for uses such as landscape irrigation and constructed wetlands.

LIST OF ABBREVIATIONS

UBC	The University of British Columbia
GVRD	Greater Vancouver Region District

1.0 INTRODUCTION

The University of British Columbia is known as a living lab. This makes the entire campus a space for experimenting with sustainable projects. If the experiment succeeds and provides an efficient and sustainable approach to collect, filter and reuse water, the university will become a leading example for a larger audience even outside the campus walls.

Currently the university storm water management system has four catchment areas on campus. These are targeted locations where rain water flows from a higher to lower elevation and the collected water ends up at the city of Vancouver's water filtration system. By making use of a water catchment and filtration system to reuse rainwater in watering plants, the university can reduce chances of flood since the cisterns can also be used as a detention tank. Moreover, the soil erosion on campus can be reduced and the overall sustainable image of UBC will be lifted.

UBC is not part of the city of Vancouver which means the city laws do not necessarily apply on campus. This allows the university to freely experiment with new technologies in order to promote sustainability. The stakeholders for this project include the students, faculty and staff members of UBC, the residents, the UBC Farm and UBC Utilities.

Currently the UBC farm gets water from the city of Vancouver. However, the farm would like to investigate the possibility of making use of a storm water catchment and filtration system. This is partially due to the fact that even though it rains a lot in Vancouver, the farm is still dry for three months during the summer. This is due to water shortage from the city water supply.

After speaking in person with some of the UBC Farm staff, it seems that the farm needs a simple to install and use, easy to maintain and a cost effective solution. This report will discuss three different case studies on various technologies used to collect and use storm water. This report will discuss the social, economic and environmental impacts of each individual technology. A recommended solution for the UBC Farm is also enclosed in this report, along with specific reasons as to why the chosen solution is most feasible compared to the other methods presented.

2.0 CURRENT STATE OF UBC FARM

2.1 Overview of the UBC Farm's Water Supply

UBC Farm is looking to update where it attains its water for agriculture. Currently UBC Farm is acquiring its water from the Greater Vancouver Region District's (GVRD) main water supply. So far this has worked fine but UBC Farm would like to assess the possibility of using storm water runoff for irrigation. This has multiple benefits: potentially, it can benefit the farm economically; the farm can save money on water both during the peak season and also off season. Using storm water runoff is environmentally friendly. Storm water is generally considered waste water and runs into storm drains which run off into Vancouver's water filtration system. If the runoff was instead used to water plants, this would be less wasteful and also lower the load on Vancouver's water filtration system. Finally, implementing storm water filtration and catchment fits in with UBC Farm's philosophy of self-sustainability; they would be self-reliant and that would benefit the community's self-image.

2.2 UBC Farm's Water Usage and Expenditures

Currently, UBC Farm is buying 22800 m^3 of water a year from the GVRD regional water supply, and most of it is used for irrigation. The breakdown of UBC Farm's seasonal water consumption is included in figure 2.1

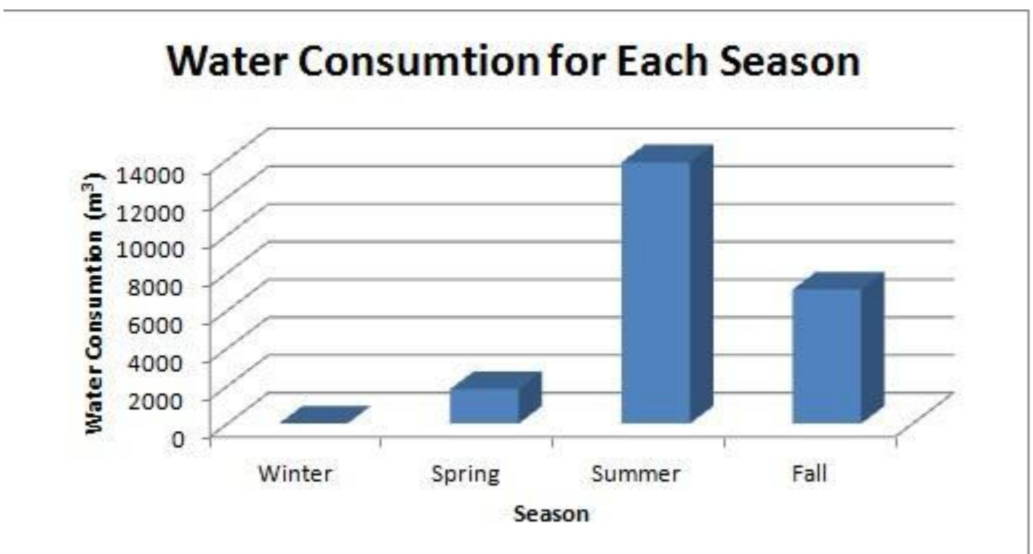

Figure 2.1: Seasonal Water Consumption for UBC Farm.
Adapted from UBC Farm water meter data

UBC Farm is paying \$0.66 per m^3 in the off peak seasons (spring and fall) and pays \$0.88 per m^3 during peak season. Figure 2.2 (included below) demonstrates the water expenditure per season.

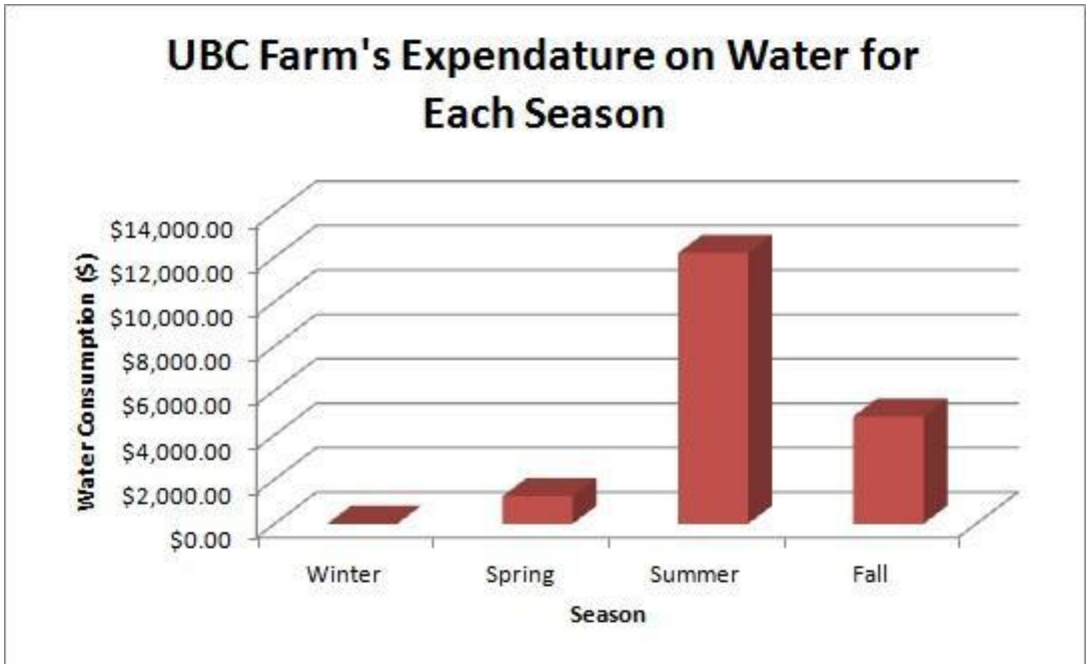

Figure 2.2: Seasonal Water Expenditures for UBC Farm.
Adapted from UBC Farm water meter data

2.3 Current Infrastructure

There is already some infrastructure in or near UBC Farm that can be repurposed for storm water catchment and filtration. There is a large detention cistern near Nobel Park. The cistern is currently not being used but it was originally intended to be used to store up to 1.2 years of storm water overflow. Plant Ops has discontinued using it, but they are potentially allowing it to be used for storm water detainment. Some surveying of the land has already been completed and it has been determined that there is already a semi-wetland in place [CS-2], shown in figure 2.3. This could potentially be expanded into a full retention pool, wetland, or wet pond.

Figure 2.3: Topographical map of UBC Farm including wetland areas
Retrieved from "Farm Drainage Map" by Thurber

3.0 CASE STUDY OF AN UNDERGROUND DETAINMENT AND FILTRATION SYSTEM

One option for storing rainwater is to use underground storage tanks. Recognizing that open air systems are not always feasible because of a lack of available land, researchers at the University of Edinburgh built an underground storm water detention system and assessed its performance (Scholtz & Yazdi, 2009). An example of an underground storage tank is shown in figure 3.1. In order to assess this type of system for use with the UBC Farm this section will firstly give a description of this system and results obtained by the study and then analyze this system in terms of its environmental, societal, and economic impacts.

Figure 3.1 Example of an underground storage tank

Polywest(2013). Underground Tank Image. Retrieved from http://www.polywest.ca/zcl-storm water-retention-tanks/

3.1 Methodology and Results

In the study, Treatment of Road Runoff by a Combined Storm Water Treatment, Detention and Infiltration System, authors Scholtz and Yazdi collected and treated water from a 640 m^2 area consisting of a parking lot and part of a roundabout, where the entire area is covered with asphalt (2009, p.56). Water collected in this area then passed through a filter. The filter is of a three layer design and where the top layer is a coarse gravel, the middle layer is finer gravel, and the bottom layer is a mixture of sand, EcoSoil© and woodchips (Scholtz & Yazdi, 2009, p.57). Once the water has passed through the filter it enters the underground detention tank. The tank used is produced by Alderburgh Limited and has a total volume of 14.94 m^3 (Scholtz & Yazdi, 2009, p. 57).

The study assessed many factors such as flow rates and precipitation data, however these data do not apply directly to how this system would be applied for the UBC Farm. What the study did discuss what the ability of this system to filter out pollutants. The study found promising “pollutant removal efficiencies for biological oxygen demand (77%), suspended solids (83%), nitrogen-nitrogen (32%) and ortho-phosphate-phosphorus (47%)” (Scholtz & Yazdi, 2009, P.55). Another interesting result of the study was that “50% of the rainfall volume escaped the system as evaporation” (Scholtz & Yazdi, 2009, P.55).

3.2 Environmental Assessment

An underground system like the one described by the above study would have very little negative impact on the environment. Because it is underground this system can make use of land which is already being used for other purposes. Large areas for water collection also exist in the form of parking lots and roadways. There is also the possibility of being able to repurpose existing infrastructure, eliminating the need to manufacture new tanks.

What this system is missing is the ability to add much value to the immediate environment. While plants can be incorporated into the filter structure (Scholtz & Yazdi, 2009, p.57) this system lack some of the other tangential benefits of open air detention systems. Because this system is underground it cannot provide any habitat for plants or wildlife.

3.3 Societal Assessment

A system such as this would require the consent of the community members living in the Westbrook Village area. While a system such as this has the ability to reuse some existing infrastructure, it would require a fair amount of roadwork to install the filters and upgrade any existing storm water tanks or even install new tanks if needed. This would be a temporary inconvenience, however during this time it may be a determent to the quality of life for those living near any such works.

Another aspect to be considered for the surrounding community would be possible restrictions on what types of fertilizers and pesticides they are using on their lawns. The filters for the underground system may not be able to handle large amounts of contaminants. The community may see this as an unreasonable restriction if they value their own lawns and gardens over the wants of the UBC Farm. The underground system is, for the most part, not visible. Where a filter pond could become an attraction and add to the local scenery, in turn providing a nice place for the community to visit and relax, the underground system would become another part of the regular infrastructure which, unless it is not working, the public has almost no interaction.

3.4 Economic Assessment

Any proposed system is going to cost money to install and maintain. This system has the advantage of being able to possibly utilize existing infrastructure. However, there are no existing agreements with the UBC municipality to allow the use of any existing cisterns or tanks. Even with such an agreement there will be costs associated with building filter mechanisms, redirecting the current flow of storm water, and maintaining the tanks. A worst case scenario would mean that UBC Farm would have to install new detainment tanks as well as build the filters.

These costs have to be weighed against the cost of using city water. If there is a cost savings per liter of water collected versus buying water from the city of Vancouver, then it needs to be determined how long it would take to realize those savings versus the costs of building this system.

There may be tangential economic benefits for the UBC Farm in terms of publicity and furthering research. There may be some economic benefits in providing a proof of concept for areas where land resources are limited, such as in cities. The underground system may, however, be at a disadvantage to above ground wet pond systems. The underground system is not nearly as visible and lacks the natural beauty of the wet pond systems. While the underground system is functional, it is out of sight and out of mind.

3.5 Summary

An underground system has the potential to be a useable system for the UBC Farm if the farm is able to secure access to existing infrastructure. An underground system would be a functional and utilitarian solution for the collection of storm water.

4.0 POTENTIAL WETLANDS FOR UBC FARM

4.1 Overview and Principles of Operation

Wet ponds are a way to implement waste water filtration. They have a large pool which can be filled with storm water. There are three main types: detention pond, which is regularly dry, and fills only when there is a storm; a wet pond, which has water in it all the time and finally a wet land, which is a wet pond with plant life encouraged to grow in it. They detain storm water runoff in the pond, works as both catchment and filtration. They primarily remove contaminants from storm water by allowing any sediment to settle to the bottom of the pond, but they also have algae which can help remove some bacteria. If plant life is included in the wet pond it can also help with filtering the runoff. Containment can be simply having the storm water in the pond, or the pond runoff can be moved into a cistern.

Wet ponds are also effective at reducing peak storm water runoff. This is because wet ponds have a large amount of extra storage, so any extra rainfall just fills the pond up higher. Reducing peak flow is important because too much flow at one time can cause flooding, which can potentially damage the crops and infrastructure at the UBC Farm.

4.2 Design Requirements

Wet ponds require a significant amount of clear land. As they act as a pooling area for rainwater, they also need to be on a low area, where rain water would collect. They need to have a slope which is about 15 percent. They don't need to have a steep slope, but they do need significant elevation difference between the top and bottom of the pool. Improperly designed wet ponds can also become infested with mosquitoes, so this must be taken into account when designing the wet pond. For a pond which is 2000 m^3 the pond must be about 18 m in radius for a depth of 2 m. This seemed to be the best size for a potential wet pond because it is a fair balance between depth and surface area.

4.3 Effectiveness of Wet Ponds as a Filtration and Catchment Technique

Wet Ponds are effective for both storm water catchment and filtration. Wet ponds are effective at controlling the volume and velocity of the run off. They control the velocity of the run off by detaining the water in the holding pools. This leads to reducing the erosion in local creek beds and streams. They also regulate the volumetric flow rate to the storm water which helps reduce local flooding.

Wet ponds are also effective at removing pollutants from storm water runoff. A study by Saunders (1997) claims they are good at removing suspended solids, phosphorus and bacteria (see figure 4.1). The suspended solids will settle to the bottom of the pond and algae in the pools will destroy most bacteria. Unfortunately, wet ponds lack in removing nitrogen and nitrates.

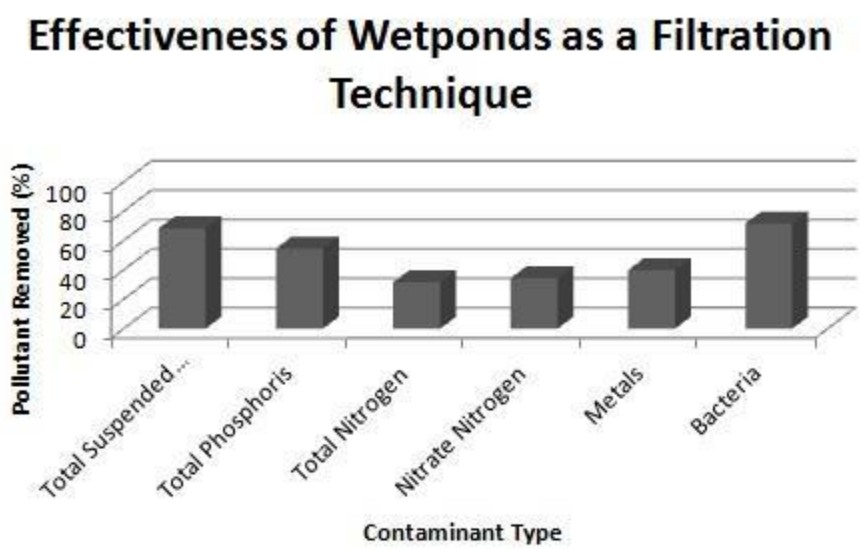

Figure 4.1: Effectiveness of wet ponds as a filtration technique

4.4 Societal, Environmental, and Economic Analysis

The use of wet ponds as a storm water catchment and filtration technique will mostly have a positive effect on the local community and UBC Farm's culture. Wet ponds are visually appealing if properly maintained which means that the local community will probably allow it to be constructed. It also will be a spot that people would want to see, which would attract people to the farm .It also fits into UBC Farm's goal of becoming less reliant on the GVRD's water supply. A potential downside of having a wet pond as a catchment and filtration technique is that they attract mosquitoes. This can easily be prevented during construction by ensuring that the water doesn't stagnate in the pond and that it's constantly moving.

Wet ponds will also mostly benefit the environment near UBC Farm. They don't use any chemicals during filtration, in fact they remove chemicals from the runoff before the water re-enters the water cycle. They also time average the volumetric flow of the storm runoff, which helps reduce flooding and erosion. They also act as a habitat for local wildlife. The environmental costs of wet ponds are that they require a lot of land, which would displace local foliage.

Wet ponds can also have economic benefits. UBC Farm spends approximately \$18000 per year purchasing water from the GVRD. A study by Brown claims a 2000 m^3 pond would cost approximately \$20000 to construct (including piping and electric pumps to pump into the detention cistern located at Nobel Park) and about 3-5% (approximately \$500) of the initial cost in maintenance; this is compared to the \$1800 UBC Farm currently pays for 2000 m^3. The payback period of the wet pond is approximately 15 years, but the lifespan of wet ponds are very long, typically greater than 25 years, so UBC Farm will be saving approximately \$12,000 over the life of the wet pond, demonstrated in figure 4.2.

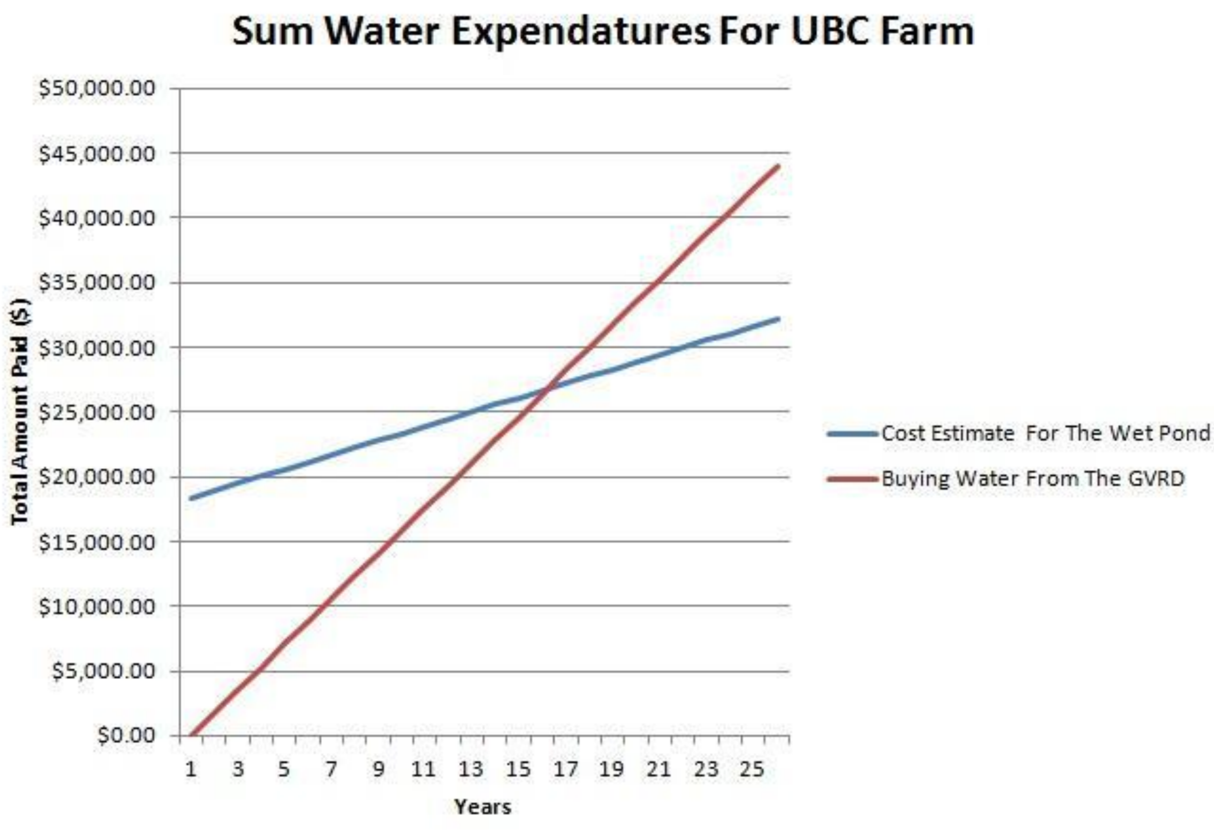

Figure 4.2: Water expenditure projections for UBC Farm

4.5 Summary

Wet ponds are one of the recommended best management practices for storm water catchment and filtration. They are environmentally friendly, and have societal benefits. They capture and detain storm water in a pond, and then remove most sediment, phosphorus and bacteria. A filtration technique that helps remove nitrates could be added before or after the wet pond. Economically, wet ponds could potentially save the farm $12,000 over the lifespan of the farm.

5.0 CASE STUDY: METHOD FOR WATER CATCHMENT USING ROOF AREA

In this case study, we present an option that the UBC Farm could implement with readily available materials in order to catch and store rainwater for use during the dry months of summer. This system assumes that there is enough roof area to implement the system. A study by the University of Arizona shows how one can harvest rainwater using this system (University of Arizona, 1998).

5.1 Methodology and Results

The water catchment system has three components: the source of water, the consumer, and the component that moves the water to the consumer (University of Arizona, 1998).
In our case, the source is rainwater. Depending on the area in which we are capturing rainwater, we can either immediately capture the latter if the surface is impermeable. However, if the surface is permeable, then we will have to wait for it to saturate with water, then after that, we will start getting runoff water (University of Arizona, 1998). In the case of the UBC farm (and the study), we are using roof area which has a surface that is impermeable to water thus allowing immediate catchment. Figure 5.3 shows a roof area at the UBC Farm that can be used for implementing the system.

There are quite a number of catchment systems that can be implemented, and they range from simple designs to very complex ones. A simple design can be something that simply redirects the water from the runoff water of the roof directly to the plants. Figure 5.1 illustrates such a system.

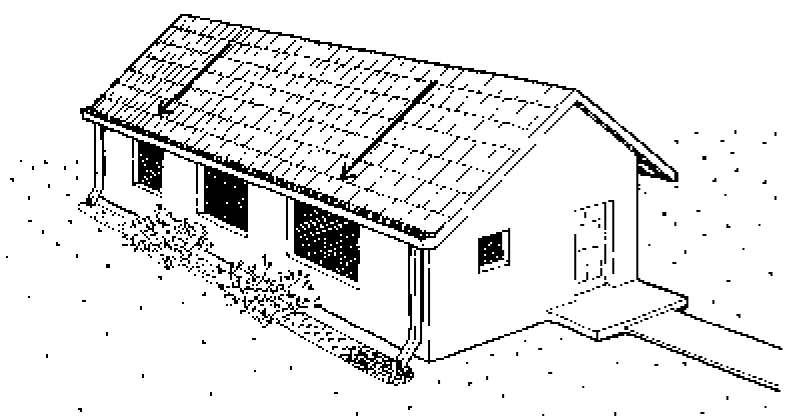

Figure 5.1 – A simple system to redirect runoff water to plants.
University of Arizona (1998). Harvesting Rainwater for Landscape Use. [online] Retrieved from: http://ag.arizona.edu/pubs/water/az1052/harvest.html [Accessed: 4 Apr 2013].

A more complex system would use the same technique discussed above, however, instead of simply redirecting water straight to the plants, it uses a system to catch the water, filter it from any pollutants and particles, move it to a storage tank or cistern, then when needed, transport it to the plants for watering using any technique necessary. The study assumed a drip irrigation distribution system. Figure 5.2 shows how such a method can be implemented. Figures 5.3, 5.4, and 5.5 show the buildings at the UBC Farm that can be used for implementing the system.

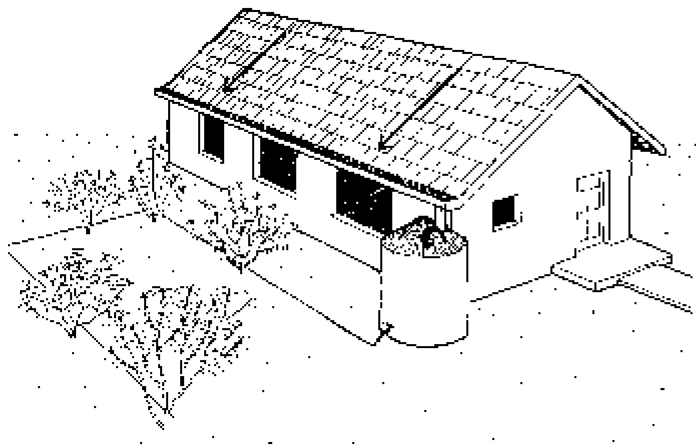

Figure 5.2 – A complex system to catch, treat, store, and distribute rainwater.
University of Arizona (1998). Harvesting Rainwater for Landscape Use. [online] Retrieved from: http://ag.arizona.edu/pubs/water/az1052/harvest.html [Accessed: 4 Apr 2013].

Figure 5.3 – Harvest Hut at the UBC Farm. Approximate roof area is 100m^2

Figure 5.4 – Farm Center at the UBC Farm. Approximate roof area is 216m^2

Components of complex systems that utilize storage include catchment areas, usually a roof, conveyance systems, storage, and distribution systems, to control where the water goes. The amount of water or "yield" that the catchment area will provide depends on the size of the catchment area and its surface texture. Concrete, asphalt, or brick paving and smooth-surfaced roofing materials provide high yields (University of Arizona, 1998). Bare soil surfaces provide harvests of medium yield, with compacted clayey soils yielding the most (University of Arizona, 1998).

A system to move the water from the roof to the next stage would depend mainly on gutters and drainpipes. For a high capacity, the latter must be sized appropriately. The Farm Center building at the UBC Farm already has a gutter and drainpipe system in place as can be seen in figure 5.5.

Figure 5.5 – Farm Center at the UBC Farm. A view of the gutters and drainpipes

After being collected from the roofs, the water has to be filtered from debris and any particles that could clog the system in the long run. The first stage of filtration would have to get rid of any leaves and debris that reside on the roofs using gutter guards. After that, we can choose a number of different filters depending on how fine of filtration we would like. Since this system is aimed towards drip irrigation, a relatively fine filter is required. Since the study did not discuss any filtration systems, we suggest using drip irrigation filters by Flotender. These filters are optimized for drip irrigation, and also come with pressurizing pumps for moving water. Figure 5.6 shows one of the filters offered by Flotender™.

Figure 5.6 – A Flotender™ Grey Water Machine

The final stage is to store the water in an appropriately sized cistern or tank. There are many ways we could go about implementing a cistern, and the available options would be to have an underground system, or one above the ground. Another thing we must consider is that the tank or cistern must be very well sealed so as to prevent mosquitos and algae growth. Figure 5.7 shows a few commercial cisterns that can be purchased.

Figure 5.7 – A sample of cistern manufactured by Barr™ Plastics

Instead of purchasing the cistern, we can also build our own in-house provided we get the right materials. Figure 5.8 shows such a cistern.

Figure 5.8 – A cistern that can be built in-house. Courtesy of The Gulf Islands Rainwater Connection Ltd

For the study conducted by the University of Arizona, their results were pretty promising. It was found that for a total roof area of 1000 square feet (Approximately 92m^2), they were able to harvest a total of 6057 gallons which translates to approximately 25m^3 (University of Arizona, 1998). The average rainfall for the year in which the study was conducted was 27 centimeters.

5.2 Environmental Assessment

The system described in this section uses almost all available infrastructures for implementation. This means that the environmental impact is miniscule. The only area of concern for the UBC Farm would be the cisterns itself. Since the latter can cover quite a bit of area, one can argue that it is holding space that can otherwise be used to grow plants thus having a bit of a negative impact on the environment.

5.3 Societal Assessment

Implementing this system is a very small scale project because all the construction work that has to be done will be confined and limited to the grounds of the UBC Farm alone. The only impact such construction can have is a slight inconvenience for UBC Farm employees since the project will involve a slight number of modification to the buildings ,which is necessary, especially the main building at the farm which hosts the main offices for the employees. Another inconvenience will arise when in the stage of installing the piping for the system and connecting it to the main drip irrigation system at the UBC Farm. This will require a temporary shutdown of the irrigation system in order to install the full system.

5.4 Economic Assessment

A system like the one proposed in this section has the potential to save the UBC Farm some money during the dry months of the year.

Following is a calculation to estimate how much water can be caught using the roofs at the farm:

Vancouver has an average annual precipitation of 1588mm. We have a total roof area of 360m^2. So the total water saved per year would be:

Total Water = 1588 mm x 360m^2 = 571680 litres/year.

So as can be seen from the above calculation the total water saving per year that can be achieved is about 571000 litres, which is equivalent to 571m^3.

Other factors we must include are the cost of the system and how much savings will it accumulate over time. Since the system will require a bit of maintenance work, especially when the filters wear out, this also has to be factored in the return on investment. However, because of the low maintenance nature of this system, one would expect that it will save the farm more over time.

5.5 Summary

We presented in this section a complete system for capturing rainwater using available roof area at the UBC Farm. This method will allow us to save on average $571m^3$ of water annually. This system has a good feature which is its low maintenance which translates into good savings in water cost over time. This system also relies on existing infrastructure at the UBC Farm which cuts down the costs of development quite considerably.

6.0 CONCLUSION AND RECOMMENDATION

There is a large detention cistern near Noble Park which could be used to store water in order to increase water storage capacity. There is a semi-wet land which already exists at the UBC Farm at location “Site B” shown in section two of the report which can be expanded and made into a full retention pond.

The first case study at the University of Edinburgh made use of a parking lot which was asphalt surface and sloped it such that all the water is directed towards the cistern underground. This method made use of a three stage filter and was able to filter out pollutants very well. Since this system is underground it is not able to provide a habitat for plants or wildlife. A system such as this one requires a large amount of asphalt to collect water on a large scale which is not available at the UBC Farm since most of the farm has unpaved roads or parking lots.

The underground system is mostly not visible and the public has almost no interaction with it. However, a wet pond could become an attraction and add to the local scenery. A wet land works as both catchment and filtration naturally. It lets any sediments settle to the bottom of the pond and to increase storage capacity the water can be moved into a cistern. This method has a lower maintenance cost when compared to other case studies and

The last case study analyzed made use of the roof to catch water. This system is a relatively easy to install since the parts are readily available. Making use of the two large roofs on the farm, the harvest hut and the farm center buildings this system can produce 571680 liters per year of water. This system is difficult to scale up at the farm since there is no one single large roof area and the buildings are spread apart. Moreover, this system uses a filtration system and it will require more maintenance when compared to the wet pond system. Also, with any catchment and filtration system, a pump will be required to move water to desired locations after it is captured.

Therefore, the wet pond system is the recommended solution for the UBC Farm. Not only will this storm water catchment filtration system make use of rain water, it will also prevent soil erosion and decrease the load on city of Vancouver’s filtration system. In addition, it will add natural beauty at the farm if designed correctly.

If a wet pond of 2000 m^3 capacity is made, it will require nearly \$20,000 as an upfront investment for materials such as piping and pumps, etc. Then the maintenance cost of this system would be approximately \$500 per year. UBC currently spends about \$1,800 for 2000 m^3 capacity of water. Also, wet ponds are long lived, so based on a 25 years lifetime the UBC Farm saves nearly \$12,000 over the lifetime of this system. In order to have a backup storage system, the detention cistern at Noble park can also be used which is 1650 m^3 to make this system more reliable. Therefore, we recommend the wet pond option since it is the most feasible based on the calculations and triple bottom line analysis performed.

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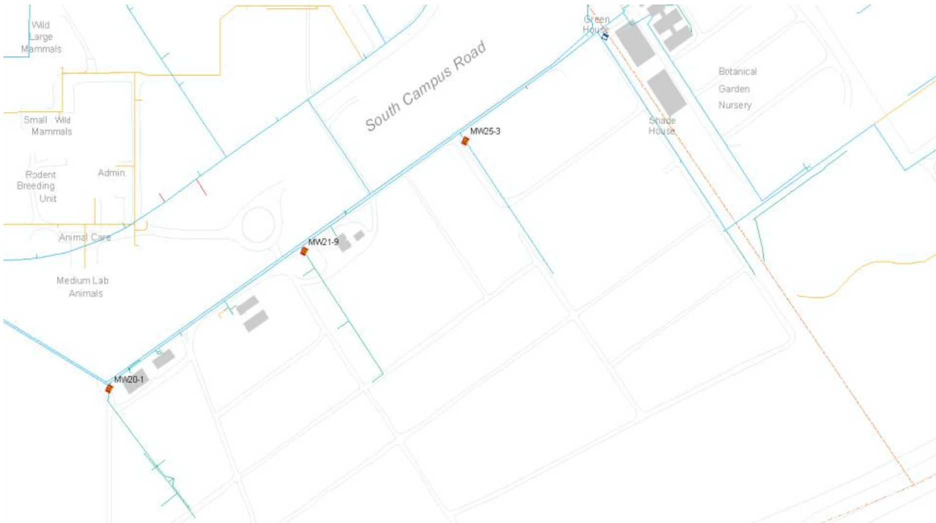
APPENDIX A

UBC Farm Irrigation Water Meter Reads and Consumption (m3)

Facility	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	TOTAL
UBC Farm - Irrigation West	500	500	500	505	685	no read	1145	1785	2135	no read	2320	2320	
MW21-21		0	0	5	180	#VALUE!	460	640	350	#VALUE!	185	0	1820
UBC Farm #3	5350	5350	5350	5390	6675	no read	13075	17110	19700	no read	21775	21775	
MW20-07		0	0	40	1285	#VALUE!	6400	4035	2590	#VALUE!	2075	0	16425
UBC Farm Irrigation East	3863	3863	3863	3870	4184	no read	5254	6500	7930	no read	8412	8412	
MW25-14		0	0	7	314	#VALUE!	1070	1246	1430	#VALUE!	482	0	4549

UBC Farm Irrigation Meter Statistics



UBC Farm Water Meter Locations