Water Conservation and Irrigation in Vancouver Parks

Insights into Turf and Horticulture Irrigation

EXECUTIVE SUMMARY

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Introduction

As part of the City of Vancouver's Greenest City Action Plan (GCAP), a goal that has recently become of increasing importance is Water Conservation (COV 2015). The Clean Water CGAP target includes the reducing of potable water use by 30% from 2006 levels (COV 2015). At the Park Board, water conservation has also become a priority. Though the Park Board uses only approximately 3% of the total water in Vancouver, it may have a larger impact during the summer months (Kelgren et al. 2000; COV 2017). Furthermore, the Park Board has a variety of water complex end uses, so there is far to go in terms of understanding water use at many levels. An emerging priority has been to review water use by irrigation (COV 2017). This project follows suit, by analyzing water use through irrigation on sports fields and in gardens. Throughout the project, we analyzed water use to identify key drivers of water use, compare methods of watering and find areas of improvement. We also developed a benchmark for sports fields to identify high water users and provide information to better assess the total water usage by Vancouver Parks.

Project Goals:

1. **Benchmark water use for irrigation of sports fields and identify drivers of consumption**
2. **Identify and compare irrigation methods in gardens**

Background

Irrigation in municipalities can take many forms. For this research, we focused on two main types of irrigation: Manual and Automatic. Manual irrigation we define as irrigation that must be set up each use and connected to a water source (such as a quick coupler), while automated irrigation is installed permanently, and runs on an automated program. Unfortunately, there is no clear picture of which type of irrigation is more efficient (Evett et al. 2006; Kvalbein and Aamlid 2014; EPA 2014; Home Water Works 2018), though the BC Government estimates that both systems typically operate at approximately 70% efficiency (BC 2005). There are three main ways water is lost: leaks/faulty equipment, evaporation, inefficient programming - both automated and manual irrigation can share these issues (Connellan 2002; Koehler et al. 2004; BC 2005; CoV 2018). In general, manual irrigation typically loses water to evaporation as it is often done during the day, but it is less likely to cause overwatering as gardeners will typically only water when plants need it most (not after rainfall, for example) (COV 2018). Automated irrigation, on the other hand, can be applied at night minimizing evaporation, but is much more likely to overwater or have longer-lasting leaks as they aren't monitored as often (USEPA 2017;

Home Water Works 2018). The EPA estimates that poor management of automated sprinklers can reduce water use efficiency to 50% (USEPA 2013).

There are several ways to improve irrigation efficiency for both manual and automated irrigation. For example, using sprinkler types that minimize spray, such as soaker hoses (also called microirrigation), or non-rotating sprinklers, can reduce water use (USEPA 2018). Mostly, it is recommended to tailor the watering schedule (or program for automated sprinklers) to needs of the specific area, or zone (Puhalla et al. 2010; COV 2018). This can include watering heavily in one zone that gets more sun, and less in another, or using a smaller sprinkler on a bed close to a pathway to minimize water flowing away. Schedules should also be flexible based on the weather, and able to reduce watering when the weather is cooler, or after a rainstorm (Home Water Works 2018; EPA 2018). While this is typically done by the operator with manual watering, automated irrigation systems can have sensors installed to ensure watering changes with the weather, such as soil moisture probes, which are estimated to improve water use efficiency by up to 92% (Mayer et al. 2015).

There also exist several other non-system methods to improve irrigation efficiency. This includes establishing a plant root depth, a technique where plants are given less water early in the year to cause them stress, which they respond to by growing roots deeper into the soil (COV 2018). This allows them to collect water from a larger area and makes them more resistant to droughts or periods without water (COV 2018). Interval watering is another common technique, which requires small but frequent watering to maximize water absorption by soil and plants, requiring overall less water (Aronson et al. 1987; Qian and Fry 1996; Connellan 2002; Puhalla et al. 2010). Other methods include fertilizing or mulching, which increase the organic content of the soil, and its water holding capacity, reducing how much it should be irrigated to keep moist (COV 2018). Finally, landscaping can be also be effective for maximizing water use efficiency, putting plants with similar water needs together, or using plants with lower water needs (Mayer et al. 2015).

In Vancouver, irrigation is complex. Typically, the city has automated irrigation in a few select parks: sports fields, destination parks (parks that are groomed for special occasions or tourists), and a few select others. Automated irrigation is managed mostly by the irrigation department, who monitor the sprinklers, fix broken heads and will change watering schedules at the request of park managers. At many garden areas around Vancouver, however, irrigation is still done by hand by gardeners, sometimes on top of areas with automated irrigation. However, the amount of water used by these practices is not known, nor is which irrigation methods are preferable. This study will, however, fill these data gaps.

Goal 1: Irrigation on Sports Fields

The first part of the project was to review water use on sports fields by irrigation. To do this, we analyzed parks with Grade A Turf, which are parks that have grass maintained for continuous recreation. Of these parks, we identified those with water meters that are devoted to the turf only, and those that have meters with other irrigation. We then standardized by the irrigated area to determine average water consumption for the Winter Season (Dec to Feb.) and the Irrigation Season (March to Nov). A benchmark was then developed of average consumption by sports fields, which will be used to estimate water use at non-metered sports fields. Irrigation season water consumption by sports fields can be found in Figure 1.

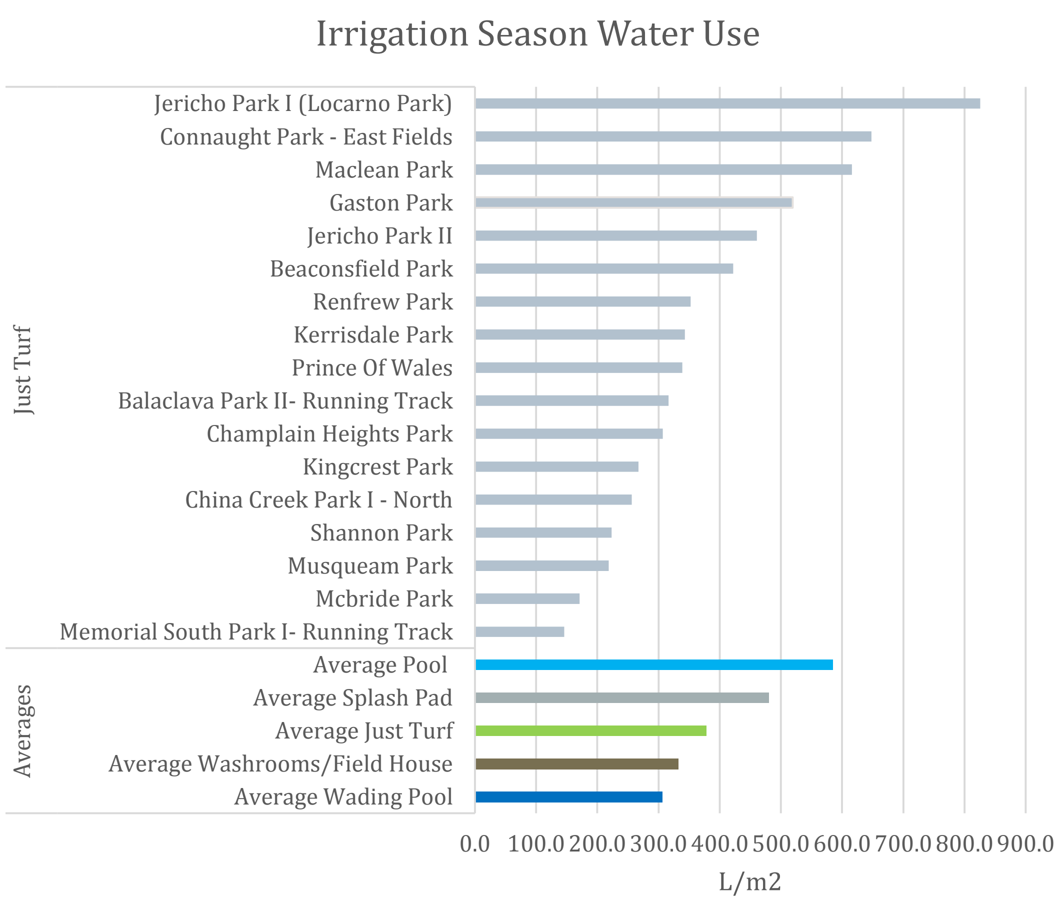

Figure 1: Average (2012-2017) annual irrigation season (March to November) water consumption, normalized by irrigation area for Vancouver Park Board sports fields.

We were also able to identify several drivers of high water use in sports fields: weather, soil type, field use, and irrigation management. The first was weather, where hotter and drier conditions will reduce natural soil moisture, and grasses will require more water. Another critical driver is soil type, where Grade A Turf are split into sand and soil fields. Sand fields have a much higher percentage of sand, and so have more space between the soil particles, allowing water to percolate past the roots much faster than in fields with lower sand. As such, sand fields require much more water to keep the same amount of grass healthy, which is evident from our data (see Figure 2). Third is what the field is used for. Some fields might be in busy areas, and so experience a lot of foot traffic, wearing down grasses, or some fields may be used for sports finals, and so may be kept in better condition. Both will require an increase in the amount of water needed. Finally, management is also a large contributor to water use. Management encompasses many things, including how the irrigation is maintained, how quickly leaks are fixed, how much water is applied, and what other methods are used to keep grass healthy. Overall, the irrigation department in Vancouver is quite small, so non-emergency leaks can be a challenge to fix, resulting in overuse. Additionally, different managers will have different philosophies about how to optimize watering time on fields, or how to treat fields before watering to encourage growth. All of which will have differing consequences in terms of water use.

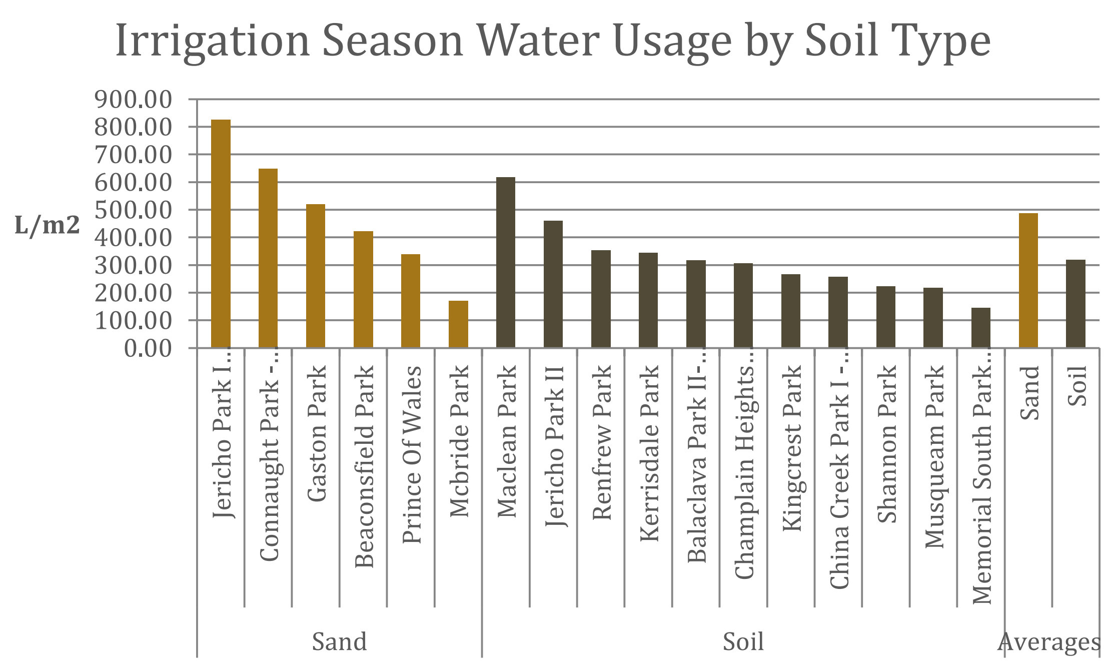

Figure 2: Average (2012-2017) annual irrigation season (March to November) water consumption, normalized by irrigation area shown by soil type, where sand fields appear to have much higher water use than soil fields.

To improve water conservation on sports fields we developed several recommendations. The first of these was to specifically target the high water users and potential leaks we identified in this project. Reduction in these areas could mean reducing watering to just the recreational area, reviewing the amount of water needed to keep grass healthy, adding fertilizer to increase soil water holding capacity, or improving irrigation systems to include soil moisture probes. It could also include updating the irrigation in these areas, to simply newer models, adding soil moisture sensors, or changing to passive-subsurface irrigation methods (similar to a soaker hose) (Sydney Water 2011; IWT 2017). Additionally, the irrigation department currently appears understaffed in terms of the number of leaks that need fixing, and the number of parks to be managed. Increased staff could improve this situation. Finally, the Park Board should develop a consistent strategy of how to conserve water in irrigation, including methods to improve grass condition before and during watering, irrigation system updates and reviewing the best watering intervals. This should include communication methods with the Irrigation team to determine the best ways to develop and manage flexible irrigation schedules to keep up with weather changes. The protocol should also include an irrigation audit program, to determine the water use and efficiency weaknesses in each park.

Goal 2: Irrigation in Horticulture Areas

The second part of the project was to review water usage by a variety of irrigation methods in horticulture areas. To do this, we performed a series of interviews with park staff to understand watering tools and habits. We then collected water use data of a variety of watering methods at Stanley and Queen Elizabeth Parks. We could then estimate overall water use for manual watering in these areas, shown in Figure 3, which could be used in further understanding the total water used by Vancouver Parks. We also could compare between irrigation methods, in terms of water efficiency and time spent by staff, shown in Figures 4 and 5. Overall, Stanley Park uses much more water than Queen Elizabeth Park, but they are a much larger park by area and number of gardens. For sprinkler efficiencies, it appeared that soaker hoses were the most efficient, as were hoses/water wands, which had low overall use per area despite high hourly rates. We did see a range in oscillator water use, however, pointing to a large source of error in this data, which is the large water pressure difference between Queen Elizabeth Park and Stanley Park, which may also contribute to the differences in water use between them. Finally, there was a substantial amount of staff time attributed to manual watering in each of these parks.

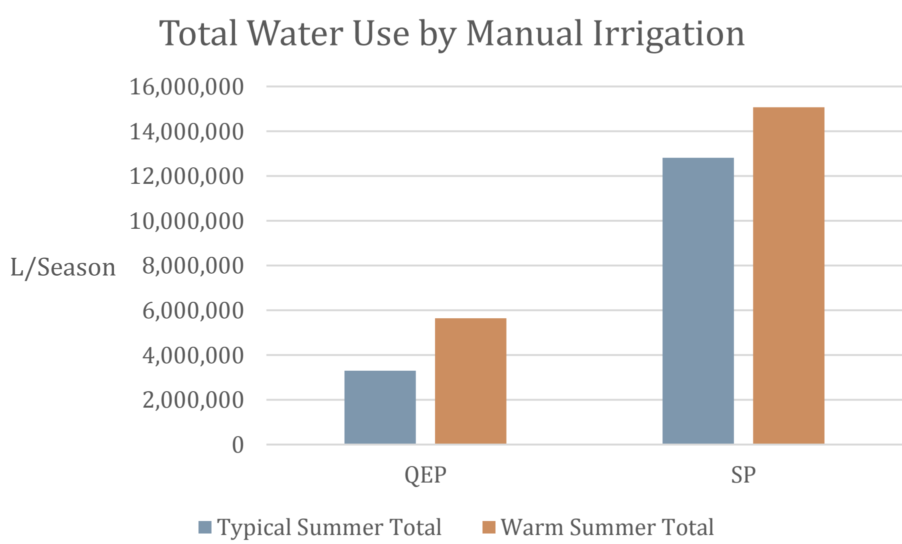

Figure 3: Water use by the different sprinkler types used in QEP and SP, broken down by hourly rate, and the amount of time they are usually used per area.

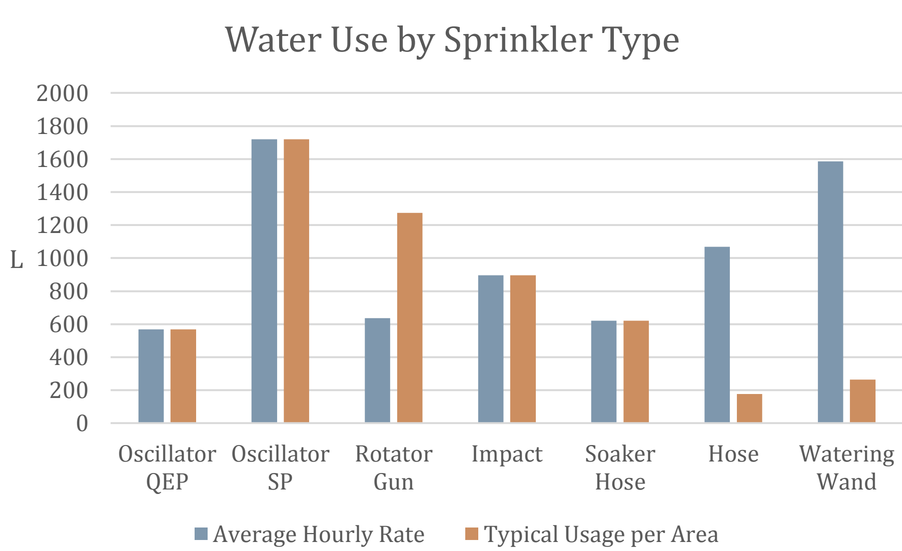

Figure 4: Water use by the different sprinkler types used in QEP and SP, broken down by hourly rate, and the amount of time they are usually used per area.

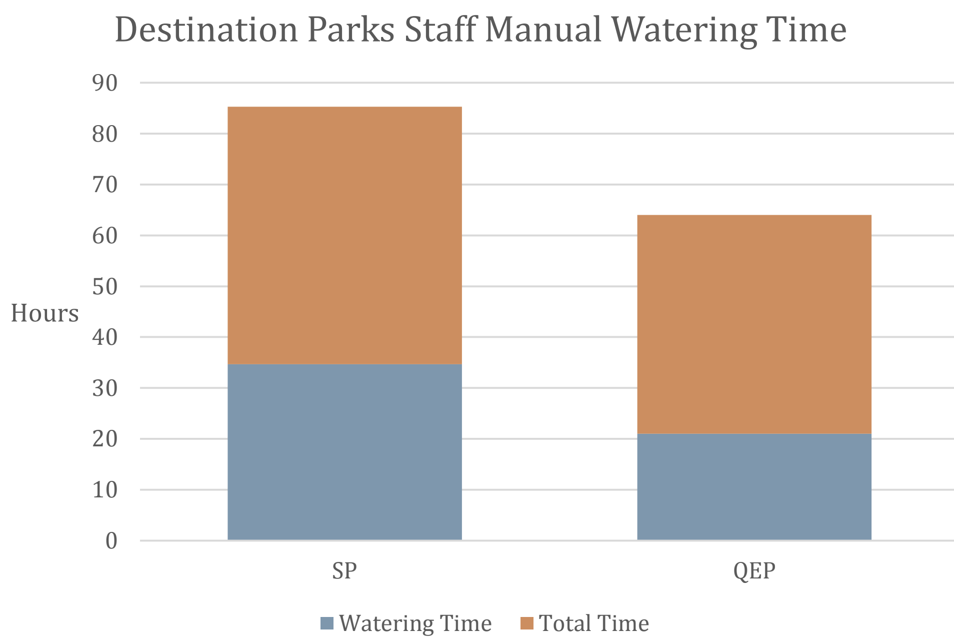

Figure 5: A comparison of staff time at Stanley Park and Queen Elizabeth Parks on overall gardening (total time), and time spent on water.

There were a variety of observations that came up during this study around the issue of water use efficiency. The first was that neither manual nor automated irrigation in the current systems appeared to be extremely efficient. Manual irrigation was done during the day, often with sprinklers that had poor coverage, were often slightly damaged and couldn't properly spray the beds. On the other hand, automated irrigation often had poor coverage, or broken heads and malfunctions, and so manual irrigation occurred on top to fill in the gaps. That said, it did appear that automated systems could improve if installed correctly and be well-maintained. In terms of time, manual irrigation did appear to take up a significant amount of staff time. This was to the point where staff were having trouble completing other tasks and getting everything watered, especially under the new watering restrictions. This was extremely apparent in Queen Elizabeth Park, where we found that the pressure was significantly less than Stanley Park, and it was much warmer due to less tree coverage, meaning the amount of watering time needed would be significantly higher.

Also interesting, however, was that there were mixed reviews in the optimal type of watering methods, and how much water various plants needed. Staff appeared to use mostly oscillators, though some preferred watering wands for select areas. Soaker hoses were used in certain locations, though they were generally thought to interfere with planting or not deliver enough water. Generally, however, it appeared staff did not have a lot of sprinkler options to chose from.

Several staff suggested that some plants be allowed to establish more roots, and watered less often, while other staff suggested that consistent watering to keep the soil damp was ideal. Another idea was an increase in mulch or fertilizer methods be applied in various beds to improve soil moisture capacity. However, there was no consensus.

Our recommendations for this part of the project were similar to those of our first goal. We recommended that the irrigation department be increased as well, to deal with the number of broken sprinklers, particularly if any new sprinkler systems are to be installed. We also recommended that the Park Board develop a consistent scheme for watering for maximum conservation, by outlining areas where root depths should be developed, areas where watering may be able to decrease in frequency, and optimal methods for soil/landscape treatment (such as increased mulching). Optimal methods may require extra staff in these areas as well. Specific to this part, however, we found that watering wands and soaker hoses were the most efficient watering methods, and should be used whenever possible, while rotator guns are less efficient and should be phased out. In addition, we also recommended that due to asset death, low pressure, and heat intensity at Queen Elizabeth Park, an automated irrigation system would be optimal for select areas if installed properly and with the necessary personnel to maintain it. Ideally, this would involve a combination of sprinkler types, including soaker hoses for smaller flower beds, as well as a combination of irrigation department control and local control, to allow to maximum watering flexibility to account for weather changes. We also recommend that turf grass watering should be phased out in this park, except in a few priority areas which can be serviced by automated sprinklers.

Overall Insights

When discussing water conservation techniques and irrigation for both aspects of this project, it became clear that a number of issues were common across the park board, and not limited to the individual sectors. This includes the size of the irrigation department, which was discussed. Similarly, several staff echoed the statement that they would utilize other methods (such as more fertilizer or sprinkler upgrades) if the budget were present. However, water is currently the cheapest resource to parks, as they don't receive a bill, so financially it makes sense to utilize this resource as much as possible in lieu of other things. Furthermore, even if these methods were to be used, it may take much more funding and personnel to keep systems running at an optimal level of efficiency. Simply put by a Supervisor "saving water costs money." As such, as the Park Board increasingly prioritizes water conservation, it will have to be willing to back this up with an increased budget.

Finally, the Park Board, the City of Vancouver, and the public may need to consider what their priorities are for parks in the city. Currently, it appears that value is placed on keeping sprawling lawns, green playing fields, and decadent flowers. This style of park is not ideal for water conservation, which would favour more of the native forests we have, or simply allowing the native grass to go dormant and yellow. Therefore, a large part of water conservation is simply changing the expectations of how a park or sports field should look, which is already happening. For example, City Hall is now opting for “Golden Lawns” over green lawns, due to the amount of water it would save. To really go towards water conservation, Vancouver will ultimately have to decide where the traditional irrigation-reliant parks are necessary, and where expectations can be changed. This could be, for example, expecting sports fields to have live grass, but not bright green, or expecting to find drought-tolerant species in horticulture areas.

Key Lessons

Lesson #1: Irrigated Turf Water Use Benchmarking

Lesson

- Sports fields show high variation in water use, wiht the highest users using as much as a pool
- Water use driven by soil type, weather, use and field management

Recommendations

- Reduce water use in highest water users
- Standardize water irrigation management protocols

Lesson #2: Irrigation of Horticultural Areas Method Comparison

Lesson

- Large variety of sprinkler types and watering methods
- Both watering types require staff time and have inefficiencies

Recommendations

- Install automated irrigation in QEP with improved efficiency techniques
- Standardize water conservation protocols

Lesson #3: Overall Irrigation and Water Conservation in Parks

Lesson

- Competing priorities for maintenance of parks means many water conservation techniques are underused
- Irrigation department is unable to keep up with the growing number of parks

Recommendations

- If water conservation is a priority, allocate more funding towards water saving techniques
- Increase irrigation personnel, improve communication between irrigation and park managers

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