WATER CONSERVATION AT VANCOUVER INTERNATIONAL AIRPORT

STRATEGIES FOR WATER CONSERVATION AND EFFICIENCY

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EXECUTIVE SUMMARY

Water is essential to Vancouver International Airport (YVR), the main air transit hub for British Columbia. It is used heavily in both aircraft operations and providing services to the 19 million passengers that pass through YVR's gates each year. As water resources in southwestern British Columbia are predicted to become more stressed in years to come as a result of growing population and climate change, there is an impetus for the Vancouver Airport Authority to introduce water conservation programs. The research presented in this report examines various academic, government, and case study literature as well as interviews with Airport Authority employees to summarize the current state of water conservation initiatives at airports worldwide and provide preliminary recommendations to the Airport Authority on context-appropriate programs for YVR and its tenants. Adoption of these programs would provide benefits to the financial, environmental, and social sustainability of YVR as well as the many tenants who lease facilities from the Airport Authority. The recommendations found from the research are summarized below:

- Creation and implementation of programs to **encourage water conservation among the airports tenants**, including green leases mandating retrofits and consumption reductions, incentive programs, sustainability rating systems, and educational seminars.
- **Installation of water monitors** throughout airport and undertaking of a water audit to fully understand water use at YVR and create targets for future.
- **Consistent monitoring** of the water distribution network so that leaks and other inefficiencies can be quickly solved to prevent waste.
- **Installation of high-efficiency water fixtures and appliances** in bathrooms and kitchens throughout the airport and tenant facilities.
- Construction of systems to **capture alternative sources of water** such as rainwater for use in airport operations where water does not have to be potable.

INTRODUCTION

Long-term water shortage has never been much of a concern for Vancouver, a city that is renowned for rainy days and long, wet winters. However, the notion of nearly unlimited local water is being challenged by researchers who note that Vancouver faces a trifecta of challenges in the face of changing climate, aging infrastructure, and a growing population (Walker & Sydneysmith, 2008). In light of likely decreased supply and increased demand, water prices are expected to rise over the next few years, prompting local institutions to seek out strategies for reducing their water usage, therefore saving money and reducing their impact on the local environment. With these future challenges in mind, this report explores institutional water conservation strategies for possible implementation at Vancouver International Airport (YVR).

Large airports like YVR tend to be significant water consumers in "water cooling systems, fire control, cleaning and washing of vehicles, runways and aircrafts" (Carvalho, 2013, p. 23) and in providing services to passengers such as bathrooms and restaurants (Smith, 2013, p. 1). Given this great consumption, airports present significant water conservation opportunities in uses where water does not have to be potable such as vehicle washing, irrigation, and toilet flushing (Neto, 2012, p. 36; do Cuoto, 2013a, p. 44). In addition, airports can encourage water conservation amongst their tenants to reduce potable water usage overall (Smith, 2013, p. 15). The challenges to implementing these measures include identifying which programs, installations and retrofits are appropriate in a particular airport's context and determining long-term cost effectiveness as well as drawbacks to the airport and its tenants.

In this report, various water conservation and efficiency measures in place at airports around the globe will be assessed for their applicability to YVR and the Vancouver Airport Authority, the community-based, non-profit organization that manages the airport. After a discussion of water

resources in Metro Vancouver, various water conservation improvements including monitoring systems, high-efficiency appliances, and alternative water sourcing will be discussed. Following that, the report will focus on various strategies used by other airports and similar businesses for encouraging tenants to adopt retrofits and water conservation programs. Based on this research, a number of recommendations will be provided to YVR on how to best conserve and make use of water in the future.

WATER IN METRO VANCOUVER

Vancouver is perceived to have abundant water resources and generally this perception is founded in reality. Metro Vancouver, the regional political body for the greater Vancouver area, states that the current capacity of fresh water infrastructure should be sufficient "to meet the region's needs until at least mid-century" (Metro Vancouver, 2011, p. 4) . Nonetheless, climate change, a growing population, and aging infrastructure all increase the risks to Metro Vancouver's water supply (Walker & Sydneysmith, 2008, p. 371).

Several studies have shown that winters on the southern coast of BC are predicted to become shorter, wetter, and warmer while summers will likely become longer and drier (Walker & Sydneysmith, 2008, p. 343), leading to increased water scarcity as summer reserves decrease (Harford, et al., 2008, p. 7). Further, climatic changes will be met by increased demand as the region continues to grow. In Metro Vancouver's *Drinking Water Management Plan*, it is estimated that the greater Vancouver region will add an additional 35,000 people annually for the next few decades, which will "place demands not only on water supply, but also on water infrastructure if not carefully planned" (Metro Vancouver, 2011, p. 4). It is clear then that water policy is becoming a more important issue in British Columbia, with governments at the local and provincial levels planning for increasing water scarcity in British Columbia. In 2014, the provincial government has updated the *Water Act* with the *Water Sustainability Act,* which will be phased in over the next few years and allows for increased water fees and integrated water

management (Water Sustainability Act 2014, 2014). These fee increases, as well as concern about the impact of water usage on long term environmental sustainability, have prompted local institutions like YVR to begin to formulate their own water conservation policies and strategies.

WATER AT YVR

Like other airports around the world, YVR uses large quantities of water in its daily operations. The airport draws water from the City of Richmond, which in turn buys its water wholesale from the Greater Vancouver Water District, the regional body responsible for managing Metro Vancouver's water resources (Metro Vancouver, 2011). Under the City of Richmond's Bylaw, the airport is charged $1.0717 per cubic meter of water consumed, with YVR also being responsible for maintaining infrastructure within airport grounds (City of Richmond, 2014). The airport then charges its tenants per unit of water monthly, as well as mandating annual inspections for leaks (Anonymous, 2015).

The Airport Authority is seeking to reduce water consumption in three areas: in airport operations, with building-lease tenants, and with land-lease tenants. Airport operations include uses like vehicle and aircraft washing, washroom amenities, and landscape irrigation. Building lease tenants operate out of buildings owned by the Airport Authority and include food and beverage tenants, aviation service providers, and car rental companies. Land lease tenants have long term leases for the land from Airport Authority, but generally own the buildings they operate and include businesses like hotels and restaurants. All of these areas present opportunities for water conservation, which will be explored in the subsequent sections.

METHODS

Research was conducted through primary research and a literature review drawing from academic and governmental sources. The primary research consisted of an interview with a staff member with good knowledge of YVR's tenants and their operation who wishes to remain anonymous. Academic literature from a wide array of disciplines was used to inform discussions around technological retrofits and green leases. Finally, case studies from airport authorities, governmental bodies, and non-profit organizations were invaluable in providing working examples of various retrofits and tenant programs.

WATER CONSERVATION TECHNOLOGIES AND PROGRAMS

Retrofit programs can greatly improve water efficiency at airports. Basic measures, such as water monitoring and water efficient amenities, are generally applicable to all airports while more complex and capital-intensive measures such as rainwater reuse and greywater recycling should be considered with detailed cost-benefit analysis in the context of the individual airport. This section reviews various technologies and their use at various airports around the world but does not discuss strategies for their implementation among tenants which are discussed in the next section.

WATER MONITORING

Monitoring systems are an essential step to reduce water consumption as they allow for measurement of baselines and the effectiveness of programs and retrofits over time. Numerous studies advocate installing monitors and conducting a water consumption audit as a mandatory step before installing any retrofit technologies (Carvalho, 2013, p. 5; Smith, 2013, p. 9). Monitoring systems

provide the most useful information when submeters are installed at the level of individual tenants and operational uses. Many systems available today allow for real-time digital metering of water supply, allowing staff to track which tenants and uses are consuming the most water at certain times (Smith, 2013, p. 9). Conducting an audit of water use provides data that can then be used to justify and measure the benefits accrued from certain retrofits.

Monitoring systems provide an additional benefit of allowing the detection of leaks. Leaks are a major problem in commercial buildings that can account for up to 30% of water use (Smith, 2013, p. 11), and Sydney Water has documented commercial buildings with leaks consuming up to 80% of their water consumption (Sydney Water , 2007, p. 58). Fixing leaks and continuously monitoring water distribution systems is the cheapest and often easiest way to reduce water consumption by significant amounts. For instance, Sydney International Airport installed a water monitoring system and found that the system had paid for itself within one year (Smith, 2013, p. 11). For these reasons, water monitoring systems and leak detection programs are the most prevalent water conservation measure undertaken at airports around the world, including London, Toronto, Manchester, and more (Carvalho, 2013, p. 32).

HIGH-EFFICIENY AMENITIES

High-efficiency toilets, faucets and appliances are a key area where water efficiency can be cheaply pursued in water conservation strategies (Gauley, 2008, p. 32). As bathroom fixtures are the main source of water use by passengers at airports, accounting for up to 56% of all water usage, improving their efficiency is a cost-effective method of significantly reducing water consumption (Smith, 2013, p. 12). Kitchen appliances in restaurants, such as dishwashers, steamers, and faucets can also be retrofitted for additional water savings.

Dozens of airports have retrofitted their bathroom facilities with water efficient fixtures, including Atlanta, Frankfurt, San Francisco, and London-Heathrow. At Fort Lauderdale Airport, an airport with a comparable passenger load to YVR at 21 million, installation of efficient bathroom fixtures saved 163,000 cubic meters of water and resulted in financial savings of $281,000 with a payback on initial investment after only 10 months (Carvalho, 2013, p. 32). Commercial kitchens contain dishwashers, faucets, icemakers, steamers, and other appliances that are significant consumers of water and are therefore additional targets for retrofits (Sydney Water , 2007, p. 84), though there are few published case reports on the exact amount of savings accrued by doing so.

The installation of high-efficiency amenities is certainly one of the lowest-hanging fruit when pursing water conservation and efficiency, as validated by the numerous airports that have applied it. Though, as noted by the Port of Seattle, high-efficiency amenities can also increase the concentration of waste in water being sent to treatment plants, resulting in higher treatment fees (Port of Seattle, 2009, p. 36). This issue points to a need to establish a balance between water efficiency and the economic impacts that result.

WATER REUSE

Airports often possess significant water resources within their own grounds that they can reuse to reduce their reliance on local water sources. These water resources and their systems of capture generally fall into two categories: water reuse and water recycling. Both types of systems are present in major airports around the world and their benefits have been extensively researched and reported on. However, given the high upfront capital costs of these systems and their limitations, it is important to carefully consider the contexts for which have been designed.

Water reuse systems take advantage of water resources present on airport grounds that have not been previously used, such as rainwater, groundwater, and seawater. Of these three, rainwater is by far the most widely harvested and reused, and rainwater capture systems are present at Frankfurt, Paris, Atlanta, London, Zurich and Tokyo airports (Carvalho, 2013, p. 33). In most cases, this water is applied to non-potable uses at airports such as toilet flushing, landscape irrigation, air conditioning, and vehicle washing so as to save energy that would be expended treating it for human consumption. Despite their benefits, there are financial and safety concerns with these harvesting and reuse systems that must be considered. As noted by Neto (2012), the capital costs of the physical components of harvesting systems as well as their maintenance can be more expensive than relying on the municipal grid, depending on the context. Furthermore, safety concerns in using untreated water that may have come into contact with contaminants like bird feces for applications such as toilet flushing and car washing must be considered, especially given the vulnerability of air travel to spreading infectious diseases (Carvalho, 2013, p. 33).

Water recycling systems utilize water that has been previously used at the airport and would normally be sent to waste, like greywater and sewage effluent. Greywater, defined as “untreated wastewater that has not come into contact with sewage” (Allen, et al., 2010, p. 7), has demonstrated the most feasibility for reuse, with greywater systems in place at Hong Kong and Tokyo airports (Carvalho, 2013, p. 33). Further, reusing water resources present in airport sewage, after significant treatment, for irrigation purposes has been shown to be possible and advantageous (do Cuoto, 2013b). While airports demonstrate great possibility for water recycling (do Cuoto, 2013a), the upfront capital costs, safety concerns, regulatory roadblocks, and religious objections make greywater recycling at many airports difficult to implement (Allen, et al., 2010, p. 24). Overall, these systems can create significant water savings for airports, but must be cautiously implemented due to their high capital costs.

STRATEGIES FOR IMPLEMENTATION AMONG TENANTS

As tenants can account for a large portion of water consumption in airports, encouraging water conserving practices as well as water efficient retrofits among tenants is a key strategy airports should implement to increase water conservation. While the technologies listed in the previous section should all be considered for implementation in facilities owned by the Airport Authority, encouraging tenants to install scale-appropriate retrofits and adopt sustainable water use practices is more complex as the Airport Authority has limited control over its tenants, especially with land-lease tenants. The focus of this section is to summarize strategies other airports and commercial building owners have used to encourage sustainable water practices and retrofits among tenants, including green leases, sustainability ratings, green leases, and rebate programs, and education.

GREEN LEASES

A lease that "seeks to remove disincentives in a commercial lease to reduce energy, water, and raw material consumption; [...] and encourage sustainable practices by both the landlord and the tenant" can be a powerful tool for commercial landlords seeking to implement sustainable practices and technologies among tenants (Brooks, 2008, p. 25). Leases with these goals are known as green leases and include targets for consumption reduction, retrofit mandates, and resolution mechanisms for use in the case that consumption goals are not met.

Green leases have had demonstrated success in reducing tenant's water consumption in airport settings. Portland International Airport (PDX) mandated retrofits and increased maintenance when it renewed its lease with a consortium of car rental companies on its Quick Turnaround washing facility, and justified those upgrades by providing a timetable of estimated savings to tenants (Airport Cooperative Research Program, 2013, p. A14). San Francisco International Airport (SFO) requires that

Food and Beverage tenants install kitchen appliances that use 20% less water than standard fixtures (Airport Cooperative Research Program, 2013, p. A14). Similarly, Atlanta airport reduced its water consumption per passenger by half over four years through specifying high-efficiency amenities in tenant leases (Airport Cooperative Research Program, 2013, p. A7).

Green leases are the most direct means of modifying tenant behavior, but they must be beneficial to both tenant and landlord to be effective. This can be achieved by clearly explicating financial benefits of installing retrofits and assuring tenants that installing retrofits will take place in a way that will not interfere with business (Miller & Buys, 2008, p. 554). There are many innovative clauses for environmental concerns being developed in various commercial real estate contexts, and green leases will continue to gain popularity as environmental issues come to the fore (Pivo, 2010).

INCENTIVE PROGRAMS

As leases can be set in terms lasting up to ten years, more immediate measures than reworking leases may be necessary. Offering incentives such as rebates to tenants for installing water efficient appliances is one viable means of reducing consumption between lease terms. This strategy is popular with American airports, which typically employ their regional water utility's programs to offer rebates on water efficient fixtures to their tenants. For instance, Seattle used its regional water utility's rebate program to retrofit all its toilets in 2003 (Saving Water Partnership, 2003, p. 26). These programs are further aided by the nationwide WaterSense program run by the Environmental Protection Agency, which designates water efficient standards for appliances and bathroom fixtures (Freeman Associates, 2010, p. 14).

As incentive programs such as rebates and vouchers have been identified as one of the most effective ways of encouraging water conservation (Freeman Associates, 2010, p. 22), they have great

potential as agents of change. However, as there is currently no rebate program for water efficient appliances and fixtures for businesses or institutions in the Vancouver area, nor any nationwide program that identifies water efficient appliances in Canada, the responsibility of developing the program would rest on the airport authority. As far as available literature suggests, there are no case studies or examples of airport authorities enacting their own rebate programs independent of their regional water authorities. This presents an interesting avenue of progress for YVR that should be researched further.

TENANT SUSTAINABILITY RATING

Rating tenants on their sustainability practices is an incentive-based alternative to mandating changes through leases. Rating programs typically incorporate many sustainability factors, including water conservation, and reward tenants for meeting consumption goals and installing technological retrofits. Tenants can then use these ratings to market themselves to customers as sustainable companies.

The pioneering and most prominent rating program is the Chicago Department of Aviation's Green Airplane system, in which tenants are awarded points for improving their sustainability measures which then accrue into rankings (Chicago Department of Aviation, 2012, pp. CT-10). The CDA's *Sustainable Airport Manual* provides the structure of the rating program and detailed requirements for points and rankings in a variety of sustainability sectors. For water efficiency in particular, the manual focuses mainly on installing high-efficiency appliances and provides prerequisites for entering the program as well as further steps tenants can take to earn points, such as developing a water management plan (Chicago Department of Aviation, 2012, pp. CT-164). The CDA has found that this ranking system "has had a transformative effect on the local contracting and vendor community, without enforcing action through contract mandates" (Airport Cooperative Research Program, 2013, p. 23). Given that many of the tenants at the Vancouver airport are already interested in sustainability and

that resources for designing such programs are widely available, rating systems are a viable means for encouraging tenant involvement in sustainability (Anonymous, 2015).

TENANT EDUCATION

As tenants are usually in favor of increasing their sustainability but are not always clear on the best means of doing so (Smith 2013, 15), educating tenants on the financial and environmental benefits of water conservation can significantly ease introducing the previously discussed tenant-focused retrofits and programs. As financial concerns are often the primary deterrent to installing retrofits (Anonymous, 2015), meeting one-on-one with tenants and laying out the financial long and short term benefits of improving their water efficiency tenants can ease acceptance of green leases and incentives.

In addition, educating tenants on best practices to conserve water when doing routine tasks like cleaning can be beneficial, as the efficacy of retrofitting is limited if water is being wasted. Information about general strategies, such as how to report leaks and use high-efficiency appliances, can be delivered in general informational seminars. Information targeted to address certain high consumption tenants, such as educating car rental facilities on how to conduct water efficient car washing, can be delivered by tailored water saving guides and meetings (Smith, 2013, p. 16). However, the usefulness of educational efforts is limited by the size of tenants' employee population, as it is very difficult to ensure that all non-Airport Authority employees attend events like seminars (Anonymous, 2015). Therefore distributing information via posters, emails, and stickers would be more effective than educational seminars; something the airport authority already does in limited amounts (Anonymous, 2015).

RECOMMENDATIONS

Based on the research discussed above, the following recommendations for the Vancouver Airport Authority have been formulated. Though the recommendations appear here in numerical order, each recommendation builds on and is dependent on the one before it.

1. TENANT INITIATIVES

Since tenants have demonstrated an interest in sustainability (Anonymous, 2015), the Airport Authority should begin consulting with tenants and educating them on the risks to regional water resources and the financial and environmental benefits of conservation. Following this, the authority should implement strategies to get tenants to conserve water, either through mandatory retrofits included in leases or incentives such as ratings and rebates for retrofits.

2. WATER AUDIT

The airport authority should upgrade and expand its current water monitoring system to more fully understand its current water consumption. Though building-lease tenants have their water consumption metered on a monthly basis (Anonymous, 2015), monitoring should be expanded to include airport operations as well. In addition, water should be measured on a more frequent basis or ideally be in real-time. Results from this water audit can be used to set consumption goals and benchmarks for the leases and incentives mentioned previously.

3. LEAK DETECTION AND REPAIR

Once the monitoring system has been installed, it should be used to detect and repair leaks, which can lead to water and financial waste. High consuming land-lease tenants should be encouraged to perform more frequent maintenance on their plumbing or install their own leak detection systems via lease clauses or incentives from the airport authority.

4. HIGH-EFFICIENCY AMENITIES

As inefficient amenities have been identified as one of the largest consumers of water at airports (Smith, 2013, p. 12), the airport should endeavor to install high efficiency bathroom fixtures and kitchen appliances throughout its properties. Where it does not have direct control over facilities as with land-lease tenants, the airport authority should consult with its tenants and use the previously outlined mechanisms including green leases and incentives to encourage building-lease tenants to retrofit their bathrooms and kitchens.

5. WATER REUSE

The previous steps would greatly increase water efficiency at YVR and improve the long-term sustainability of the airport. However, should the airport want to continue to pursue water conservation efforts, water reuse systems could potentially be constructed. In the context of YVR where precipitation is plentiful most of the year, it would be logical to take advantage of these resources rather than recycling wastewater. Therefore, rainwater capture systems would probably be the most appropriate and cost-effective means of reducing reliance on the municipal water grid. Water from rainfall could be collected from rooftops during the wet winter months, held in storage tanks, and then used during summer for irrigation and other non-potable uses such as toilet flushing and vehicle washing.

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