UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Installing Waterless Urinals at Koerner's Pub

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EXECUTIVE SUMMARY

In alignment with UBC's Sustainability goals, Koerner's Pub is determined to lower its water consumption through practices, policies, or implementation of technology. Restrooms account for a significant portion of a restaurant's total water consumption, mainly due to the vast amount of water flushed in the urinals. This report investigates into the possibility of installing waterless urinals at the Pub in order to eliminate water usage due to flushing. Using the Triple Bottom Line assessment, three different options are considered: keeping the existing urinals, installing new waterless urinals and retro-fitting the existing urinals into waterless urinals.

The investigation focuses on solutions that do not necessitate a large capital investment. After evaluating each of the three urinal options based on the triple bottom line indicators, it is found that keeping the existing flush urinals is the most economically feasible option due to high costs attached to the waterless urinals. Waterless urinals project a positive impact on the environment and are socially acceptable in places that do not have high user loads, such as Koerner's Pub. Despite the mammoth potential water savings of approximately 47,000 liters per year, merits of waterless urinals are negated by the strong economic pushback. Since it would be impossible for the stakeholder to recover the costs for installation and maintenance of waterless urinals, it is recommended that the Pub management should just continue to use and maintain the existing flush urinals.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

GLOSSARY

Bactericide	A substance that kills bacteria.
Carcinogen	An agent, a substance or a radiation, that can cause cancer.
Cartridge	A plastic insert that is placed in the housing at the bottom was a waterless urinal. It acts as a channel for urine to flow into the sewer while trapping the odor.
Microbe	A micro-organism, specifically a bacterium that causes disease
Retro-fitting	The practice of converting an existing structure for the purpose of improvement (e.g. retro-fitting older buildings to be earthquake-resistant) or to yield new functionality (e.g. converting water-based urinals into water-less urinals).
Specific Density	Ratio of density of a substance to the density of water. If a substance has a higher specific density than 1, it will float on water and vice-versa.

LIST OF ABBREVIATIONS

AERL .... Aquatic Ecosystems Research Laboratory
EOLM .... End-of-life management
MSDS .... Materials Safety Data Sheet
TBL .... Triple Bottom Line

1 INTRODUCTION

Koerner's Pub, operated by HK Commerce, is a casual dining restaurant located in The University of British Columbia campus (McDonald, 2013). After undertaking several sustainable initiatives in the food sector and the waste management sector, the Pub is now looking to become more sustainable in the area of water usage. Restaurants and bars use plenty of water for their operation, and hence create an opportunity for water conservation. The stakeholder, Tim Yu, principal of Koerner's Pub, encouraged us to focus on a small section of the Pub rather than trying to propose solutions for the entire Pub. This would allow the proposed solution to be more cost-effective and easier to implement. The area that we chose to focus on was the restroom. As Figure 1 suggests, restrooms account for close to one-third of the total water used in a typical restaurant. To cut down water usage in the patron restroom, we investigated into the option of replacing the existing flush urinals with waterless urinals.

The goal was not just to propose solutions that would save more water, but also to propose solutions that would be financially viable and socially acceptable. Therefore, we carried out a Triple Bottom Line assessment to determine whether the waterless urinals would outweigh the existing flush urinals.

This report compares three options: keeping the existing flush urinals, installing new waterless urinals and converting existing urinals into waterless urinals. The economic, environmental and social implications of each option are identified. Based on the indicators used to assess the options in each of the areas, we determined whether it would be more sustainable to switch to waterless urinals or to carry on with the existing urinals.

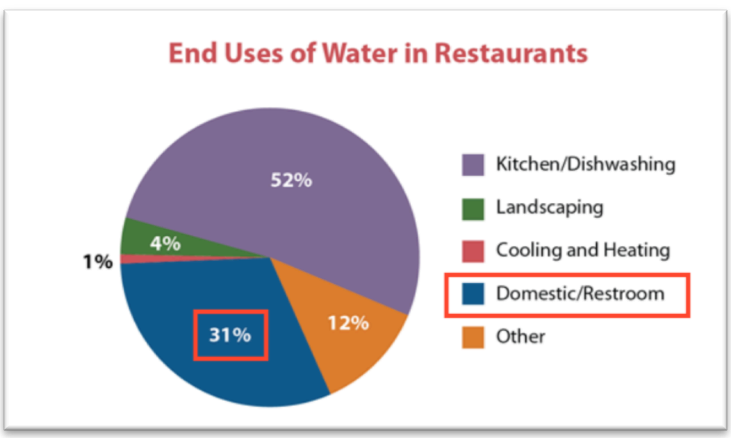

Figure 1: End Uses of Water in Restaurants (United States Environmental Protection Agency, 2012)

2 BACKGROUND INFORMATION

This section briefly explains the functionality of waterless urinals and the various installation options we consider in this report.

2.1 EXISTING FLUSH URINALS

There are four urinals currently installed in place at Koerner's Pub. These urinals are of the low-flush type, which operates at flow rates as low as 1.9 Liters per flush (The University of British Columbia, 2013). Each urinal has a flush valve mechanism in place, which only allows the flow of water when the user is finished. This prevents any unnecessary flow of water. Unless there are leaks observed in the pipes or the flush valves break down, maintaining the existing urinals is simple. Standard cleaning solutions are used to clean the urinal bowls.

2.2 WATERLESS URINALS: NEW INSTALLATIONS

Waterless urinals eliminate the need for water in flushing urine. Figure 2 shows the urine flow in a waterless urinal.

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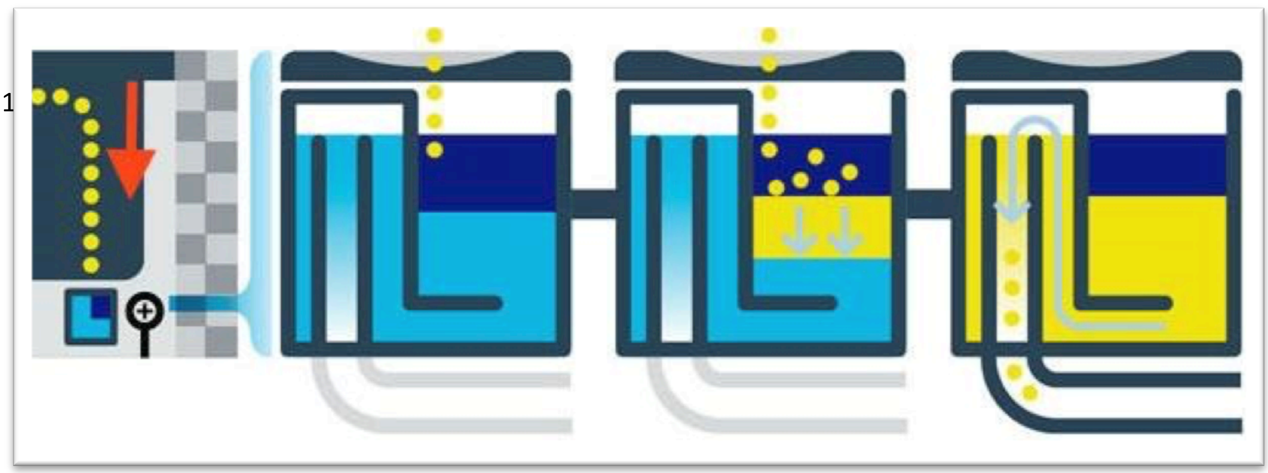

Figure 2: Urine Flow in a Waterless Urinal (Davis , 2010)

1. The urine (yellow) flows into the cartridge through the cartridge openings

2. The urine passes through a layer of liquid sealant (dark blue), is a chemical with a lower specific density than that of water and urine.

3. The urine passes is trapped under the sealant layer. This prevents odor and sewer gases to escape into the restroom.

4. As the urine is displaced by more urine, it eventually overflows into the drain line.

Cleaning procedure for the waterless urinals is similar to that for the existing flush urinals. Some waterless urinal manufacturers may require different cleaning products for the bowl.

Maintenance of waterless urinals is largely predicated on proper replacement of the cartridge. The replacement procedure is briefly explained as follows (Sloan Valve Company, 2014):

1. Pull out the old cartridge from the urinal using the key provided. Place the cartridge in a sealed bag for disposal

2. Scrub the cartridge housing and flush it down with 20 liters of hot soapy water

3. Place the new cartridge in the housing and fill it with 1 liter of clean water

4. Add the sealant to the cartridge. Wipe any excess sealant clean.

The two different brands of waterless urinals that we came across at the UBC campus were Sierra™ (See Figure 3) and Sloan™ (See Figure 4). Both the models work on the same principle described above. They fit on to the standard drain line. The Sloan™ urinals are installed in the Aquatic Ecosystem Research Laboratory (AERL) and the Sierra™ urinals are installed in the Fred Kaiser building. In general, the Fred Kaiser building has more urinals users than the AERL due to a much higher traffic.

Figure 4: Sierra™ Waterless Model #2102 (Photograph by Jason Too)

Figure 3: Sloan™ WES-2000 (Photograph by Jason Too)

2.3 WATERLESS URINALS: RETROFIT SYSTEMS

Retro-fitting implies converting the existing urinals into waterless urinals with the use of retro-fit kits which can be purchased from various manufacturers. Retro-fit waterless urinal systems have been available for the past 10 years and can be fitted on most standard urinals (Gentworks, 2014). The retro-fitting process would involve capping the water supply from the current pub urinals, then installing the retro-fit kit provided by the manufacturer.

Figure 5 shows a schematic of the retro-fit option we chose, which is manufactured by Gentworks. The replaceable cartridge (dark green) dispenses harmless microbial spores on contact with urine (yellow liquid). The micro-organisms break down the urine content and multiply, further accelerating the urine consumption (Gentworks, 2014). Note that this process is not specific to just the retro-fit systems and is also used in purpose-built urinals.

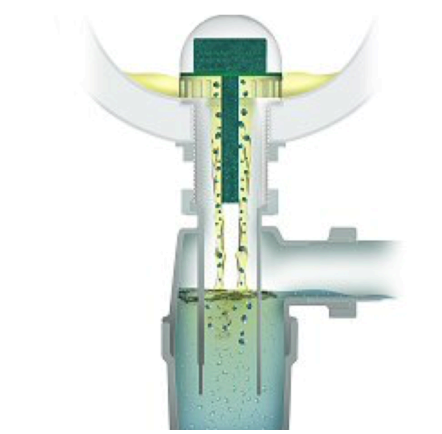

Figure 5: Aquafree Schematic Flow (Gentworks)

3 TRIPLE BOTTOM LINE INDICATORS

The Triple Bottom Line (TBL), a concept developed by John Elkington, is a tool put to use by businesses, nonprofits and governments to gauge sustainability. The three dimensions to the TBL assessment are people, planet and profit as it measures how an undertaking impacts the society, the environment and the economy (Slaper & Hall, 2011). TBL allows for a comprehensive analysis of each element affecting sustainability. We can measure the economic impact based on monetary profits and losses. To measure the social impact, we gauge how the technology affects the people who interact with it. The environmental impact can be measured by how the technology affects quality and quantity of natural resources. Following are the indicators used to gauge the impact of each urinal option on the environment, the economy, and the society.

3.1 ENVIRONMENTAL IMPACT INDICATORS

To streamline our environmental impact analysis, we introduce 3 primary indicators namely: Water Savings, Cleaning By-products, and End-of-life management. We analyze each product's performance based on these indicators as described below.

Water Savings

This indicator refers to the amount of water saved (in liters) as a result of implementing each of the options.

Cleaning By-products

This indicator refers to any byproducts resulting from the use of and cleaning of the product. Focus is devoted to any side effects, which may result from the use of required cleaning products as specified by the manufacturers. It is important to note that manufacturers often require a specific cleaner due to compatibility requirements with specific technologies that each urinal uses. We examine the environmental impact of these cleaners.

End-of-life Management

End-of-life management (EOLM) refers to the management of each product post-use. This indicator can be separated into short-term and long-term EOLM. For short-term considerations, we focus on the fact that waterless urinals use cartridges that require replacement. We examine how each urinal cartridge fits within a sustainable waste-management strategy such as recycling, reusing, or composting. Long-term, all the urinals discussed in this report are made of non-recyclable porcelain and therefore have similar waste components that end up in the landfill.

3.2 ECONOMIC IMPACT INDICATORS

To streamline our economic impact analysis, we introduce 3 primary indicators namely: Upfront cost, Maintenance cost, and Payback period. We analyze each product's performance based on these indicators as described below.

Upfront Costs

These are the costs at the onset of the implementation of each of the three urinal options. These include the cost of the installation and the cost of modifying the existing infrastructure prior to installation, if applicable.

Maintenance Costs

These are the annual costs needed to maintain each of the urinals. The maintenance costs would depend on the frequency of material usage and component replacement. It also includes the cost of calling out a plumber or another skilled worker, if applicable.

Payback period

We make use of net annual savings/losses to determine the time (in years) that it would take to recover the upfront cost in case of each urinal option. We also acknowledge if the payback period is not applicable or is impossible to determine.

3.3 SOCIAL IMPACT INDICATORS

To streamline our social analysis, we introduce 3 primary indicators namely: Public acceptance, Custodial Acceptance, Health and Hygiene. We analyze each product's performance based on these indicators as described below.

Public Acceptance

To determine the user acceptance of any possible implementations of waterless urinals, we first find how users feel about existing and waterless urinals. We investigate the number of people using the washroom daily and their washroom experiences. This includes odor control as it plays a significant role in public acceptance.

Custodial Acceptance

In alignment with public acceptance, any implementations of new urinals will greatly affect personnel in charge of maintaining the washrooms. To determine custodial approval, we look at overall custodial staff opinions and experiences on maintaining the urinals.

Health and Hygiene

Diseases and viruses has long been a significant medical issue in human society. These diseases are carried in the form of bacteria and germs. Most importantly, these diseases have the ability to spread through physical contact. One of the major forms of physical contact lies in the washroom setting. In conjunction with the use of urinals, we focus on the exposure of microbes in the washroom setting.

4 INVESTIGATION

This section investigates the options for implementing water-less urinal systems. We first examine the existing water-based urinal installation in Section 4.1, then compare its performance in comparison to a new installation in Section 4.2 and a retro-fit installation in Section 4.3. Section 4.4 concludes with a summary of our findings.

4.1 OPTION 1: EXISTING URINALS

We investigate the existing water-based urinals in order to gauge the performance in comparison to the waterless urinal options. The next section provides some background about the current installations. The following sections examine the environmental, economic, and social impacts of the current urinals.

4.1.1 Environmental Impact

We discuss the environmental impacts of the existing urinals based on the indicators described in Section 3.1.

Water savings

The four urinals at Koerner's Pub use approximately 47,424 Liters annually (See Appendix A). This amount of water could potentially be saved if the existing urinals are replaced with waterless systems.

Cleaning by-products

The existing urinals flush urine using water and do not require any special chemicals to operate. The urinals require cleaning, however, no specific products are required; natural cleaning products are available in the market. We make the assumption that sustainable cleaning products are used as per UBC's sustainability policy (The University of British Columbia, n.d.). Therefore, the existing urinals do not produce any harmful by-products.

End-of-life management

The existing urinals do not require cartridges and produce no short-term waste. Long-term, the porcelain material would end up in the landfill.

4.1.2 Economic Impact

We discuss the economic impacts of the existing urinals based on the indicators described in Section 3.2.

Upfront Costs

The existing urinals in the patron washroom will require no upfront investment as it pertains to upgrades in fixtures.

Maintenance Costs

Although there are no upfront costs associated with the existing flush urinals, there are costs attached to the maintenance of these urinals. The stakeholder indicated that plumbers were called twice in the last one year. Since we do not have the information on what the plumbers were specifically called for, we assume that they were in service for two hours per visit. The minimum wage rate for plumbers in British Columbia in $29.30 (Government of Canada, 2013). Therefore, we estimate the annual maintenance cost of the existing urinals as $117.20.

Payback period

With the existing flush urinals, the total cost of water annually is $29.64 (See Appendix A). Adding this to the maintenance costs makes the total expenditure to be $146.84 per year. Since the upfront cost was $0, having a payback period is not applicable in this case.

4.1.3 Social Impact

We discuss the social impacts of the existing urinals based on the indicators described in Section 3.3.

Public Acceptance

Flush urinals have become the standard toilet fixtures for urination for many years. Unless there is a lack of maintenance or a breakdown in the plumbing system, which may cause problems with odor control, these fixtures have become widely accepted among the general public. This translates to the general public acceptance of the existing urinals at Koerner's Pub. Furthermore, from personal experience being at Koerner's Pub, the urinals have been regularly maintained with no issues in regards to odor.

Custodial Acceptance

In order to maintain these urinals, the custodial staff may be required to use the appropriate cleaning solutions. This presents the issue of staff having to deal with heavy odors especially in the cases of urine buildup directly beneath the urinal. As the existing urinals use a flushing system to carry urine into the wastewater systems, they are susceptible to clogging. (Bristow et al., 2006). However, most custodians do not have the proper tools and training to repair the plumbing fixtures.

Health and Hygiene

According to a national hand washing survey by Bradley Corp., a leading industry manufacturer of commercial plumbing fixtures and washroom accessories, 70% of public washroom users admit to just rinsing their hands instead of thoroughly washing with soap and water. Furthermore, only 60% of males say they always wash their hands prior to leaving the restroom (Safety Matter, 2006). Also, due to the flushing action and damp fixture surfaces in flush urinals, bacteria is more prone to going airborne. This raises a major issue with the spread and exposure of disease-causing bacteria when users operate the manual flush fixtures currently in place.

4.2 OPTION 2: NEW INSTALLATION OF WATERLESS URINALS

We investigate the prospect of replacing the existing water-based urinals with waterless urinals. The next section provides some background about new installations. The following sections examine the environmental, economic, and social impacts of this option.

4.2.1 Environmental Impact

We discuss the environmental impacts of new installations based on the indicators described in Section 3.1.

Water savings

The use of waterless urinals would effectively eliminate the use of water for flushing urine; this would amount to saving approximately 47,424 Liters (L) per year (See Appendix A).

Cleaning by-products.

The manufacturer does not require as specific cleaner to maintain the waterless urinals (Sloan Valve Company, 2009). Among these recommendations are environmentally friendly cleaners such as the "Rochester Midland Corp/Enviro Care" cleaner which is Green Seal[1] certified. As such, this option results in no harmful cleaning by-products.

End-of-life management.

With some calculation, we determined that each cartridge would last approximately a year given the pub's current usage (See Appendix A for calculations). The cartridges are non-

[1] Green Seal is a non-profit organization that certifies products based on environmental requirements.

biodegradable but can be recycled to reduce harmful environmental effects (Sloan Valve Company, 2014).

4.2.2 Economic Impact

We discuss the economic impacts of new installations based on the indicators described in Section 3.2.

Upfront Costs

We examine two models of waterless urinals. The Sloan™ WES-2000 Waterfree Urinal costs $456.20 (Sloan Valve Company, 2009). The Sierra™ Waterless Model #2102 Waterless Urinal costs $350.00 (WaterlessExperts.com, n.d.).

Assuming it takes about 30 minutes to replace the existing flush urinal with the waterless urinal, the installation cost for four waterless urinals comes out to be $58.60.

Therefore, the cost of installing 4 Sloan™ urinals would total $1883.80, while installing 4 Sierra™ urinals would cost $1458.60.

Maintenance Costs

Typically, a urinal cartridge has to be replaced every 7000 flushes (Bristow, McClure, & Fisher, 2006). The estimated number of flushes per urinal per year = 6240 (See Appendix A). Therefore, the cartridge for each urinal at Koerner's Pub can be replaced once a year. The Sloan™ Universal Waterfree Urinal Cartridge costs $61.90 (Sloan Valve Company, 2009). The Waterless Co. Eco-Trap® No-Flush™ Urinal Cartridge costs $7.75 (WaterlessExperts.com, n.d.).

Payback period

We calculated the cost of water saved annually to be $29.64 (See Appendix A). Give the data from Appendix A, we can derive the following costs:

The cost of 4 Sierra™ cartridges ($7.75 × 4) = $31.00

Net annual savings/loss = -$1.36

Cost of 4 Sloan™ cartridges = $61.90 × 4 = $247.60

Net annual savings/loss = -$217.96

Therefore, with the Sierra™ cartridge, the water cost savings almost offset the cartridge costs. Whereas, with the Sloan™ cartridge, there will be a perpetual monetary loss.

Regardless, with the current water rates and maintenance costs, the payback period cannot be determined for either of the two waterless urinals that cost $1883.80 and $1458.60 respectively.

4.2.3 Social Impact

We discuss the social impacts of new installations based on the indicators described in Section 3.3.

Public Acceptance

Relative to the possible public acceptance in Koerner's Pub, a survey was conducted by the Seattle Public Utilities Department in 2003. Respondents from 22 facilities were asked to rate their washroom experience with no-flush urinals implementations on a scale from 1 (unacceptable) to 5 (excellent) (Bristow, McClure, & Fisher, 2006).

Area	Mean
Overall experience	3.5
Plumbing maintenance (vs. flush-type)	3.5
Custodial care requirements (vs. flush type)	3.1
User acceptance	4.2

Table 1: Survey Results by Seattle Public Utilities Department (Bristow, McClure, & Fisher, 2006).

In accordance with the results of the survey, it was found that respondents rated the overall experience an average of 3.5 and the user acceptance an average of 4.2.

With regards to odor control, the sealant liquid acts as a trap, which prevents most of the odor from climbing upward and entering the washroom space.

Custodial Acceptance

To obtain further knowledge on the satisfaction and acceptance of waterless urinals, we interviewed UBC utilities staff, Sukhwinder Sekhon and Inderpal Toor, with first-hand experience in maintaining the Sierra™ waterless urinals placed in Fred Kaiser Building and in Sloan™ waterless urinals placed in AERL. Prior to interviewing them we composed a few questions listed below:

Interview Questions

1. Describe your overall experience with maintaining the waterless urinals.
2. Are there any changes in the maintenance process?
3. What is the frequency of repairing the waterless urinal and changing the cartridge?
4. Would you recommend waterless urinals being implemented in other facilities?

We found that maintenance processes are kept relatively the same when transitioning from conventional to waterless urinals with the exception of cartridge replacement. However, when maintaining the waterless urinal in the Fred Kaiser Building, which contains a cheaper urinal, it often experienced urine buildup in the piping just beneath the cartridge. This resulted in heavy odor while replacement. Plumbers often called in to repair the drain pipes and other fixtures. Furthermore, as there is only one urinal installed on each floor, many users have been upset and dissatisfied when they would find that the urinal is out of order. On the other hand, in low user settings such as AERL, the need for repairs and cartridge replacement is much less frequent. Sukhwinder noted that the last time he changed the cartridge on the fourth floor men's restroom was about 8 to 9 months ago (Sekhon & Toor, 2014). To conclude, custodial staff recommended the installation of waterless urinals only in areas with a low user loads.

Health and Hygiene

Bacteria and viruses depend on the presence of a moist environment in order to flourish. In conventional flush urinals, water is the standard method of flushing urine. This frequent source of water flow thus provides bacteria with the environment it needs to grow. In waterless urinals, however, due to the absence of constantly wet surfaces flushing mechanism, the occurrences of microbes growing and going airborne are reduced. Also, these urinals are touch-free, significantly reduces the spread of communicable diseases. (Bristow et al., 2006)

4.3 OPTION 3: RETRO-FITTING EXISTING TO WATERLESS URINALS

We investigate the prospect of retro-fitting the existing water-based urinals into waterless urinals. The following sections examine the environmental, the economic, and the social impacts of this option.

4.3.1 Environmental Impact

We discuss the environmental impacts of retro-fit systems based on the indicators described in Section 3.1.

Water savings

A retro-fitted urinal would effectively eliminate the use of water for flushing urine; this would amount to saving approximately 47,424 Liters of water annually (See Appendix A).

Cleaning by-products

The manufacturer recommends weekly cleaning with a bactericidal cleaner (Gentworks, 2014). The required bactericidal cleaner contains Tri-sodium nitrolotriactate and other hazardous ingredients (Gentworks, 2012). Tri-sodium nitrilotriacetate is a corrosive substance that can cause skin burns and is a possible carcinogen (Brown, 2014). The Materials Safety Data Sheet (MSDS) specifies that the cleaner should not be discharged to drains or rivers, as the product is toxic to aquatic organisms (Gentworks, 2012).

End-of-life management

The manufacturer recommends cartridge replacement every 3 months. Fully biodegradable cartridges are available for this technology. Therefore, any harmful short-term impact on the environment resulting from cartridge disposal minimizes (Gentworks, n.d.). In long term, the retrofitted urinals would produce landfill waste as they are made of non-recyclable porcelain.

4.3.2 Economic Impact

We discuss the economic impacts of retro-fit systems based on the indicators described in Section 3.2.

Upfront Costs

Cost of Gentworks Aquafree Installation Pack = 22GBP = $39.02 (Gentworks, n.d.). Assuming it takes about 30 minutes to retrofit the existing flush urinal and turn it into a waterless urinal, the installation cost for four retro-fits comes out to be $58.60. Therefore, the cost for installing four Gentworks retro-fit systems would be $214.68.

Maintenance Costs

Cost of Gentworks Aquafree Replacement Cartridge = 20GBP = $35.47 (Gentworks, n.d.). Since the cartridge is required to be replaced every 3 months, the annual cost of cartridge replacement would be $141.88 ($35.47 × 4). Cost of Gentworks Bactericidal cleaner (5L container) = 20GBP = $35.47 (Gentworks, n.d.). Since the cartridge has to be cleaned with 100 mL of Bactericidal cleaner once every week, 4 of such containers will last for roughly one year. The annual cost of Bactericidal cleaner would equal $141.88 ($35.47 × 4). Therefore, the total cost of maintenance of the retrofitted waterless urinals sums to $283.76.

Payback period

We calculated the cost of water saved annually to be approximately $29.64 (See Appendix A). As previously discussed, the cost of maintenance of retrofitted waterless urinals = $283.76 with a net annual savings/loss of -$254.12. Just like in the case of new waterless urinals, there will be a perpetual monetary loss on an annual basis in case of retrofitted waterless urinals. Although the upfront cost for this option is only $214.68, the maintenance costs make the payback period impossible to determine.

4.3.3 Social Impact

The social impact of this option is similar to the social impact of new waterless urinal installations (Refer to Section 4.2.3).

4.4 INVESTIGATION SUMMARY

This section summarizes our findings. Section 4.4.1 summarizes the Environmental Impacts. Section 4.4.2 summarizes the Economic Impacts. Finally, Social Impacts are addressed in Section 4.4.3.

4.4.1 Environmental Impact Summary

We summarize our findings regarding the environmental impact of each option. We consider the water savings, cleaning by-products, short-term End-of-life Management (EOLM), and long-term EOLM as described in Section 3.1. Table 2 summarizes our results for each option.

Product	Water savings	Cleaning by-products	Short-term EOLM	Long-term EOLM
Existing urinals	None	None	None	Land-fill
New installations	47,424 L/year	None	Recyclable	Land-fill
Retro-fit installations	47,424 L/year	Hazardous chemicals	Biodegradable	Land-fill

Table 2: Environmental Impacts Summary

With the existing urinals as the baseline, we found that the environmental impact for new installations and retro-fits are very similar. However, new installations trump retro-fit installations when it comes to cleaning by-products. The cleaning products required by the retro-fit manufacturer contain toxic chemicals that bear questionable effects on the environment. As such, new installations perform best in this category.

4.4.2 Economic Impact Summary

We summarize our findings for the economic impact of each option. We consider the upfront cost, maintenance cost, and payback period as described in Section 3.2. Table 3 summarizes our results for each option.

Note: We used the costs for the Sierra™ waterless urinal for new installation option as it is the less expensive one of the two brands stated. Even though the custodial staff had an unpleasant experience with the Sierra™ urinal, we anticipate that it would not be the case at Koerner's Pub restroom due to much less user traffic compared to Fred Kaiser building.

Product	Upfront cost	Maintenance cost	Payback period
Existing urinals	$0	$117.20/year	Not Applicable
New installations	$1458.60	$7.75/year	Cannot be determined
Retro-fit installations	$214.68	$283.76/year	Cannot be determined

Table 3: Economic Impact Summary

For both the waterless urinal options, it turns out the payback period cannot be determined because the maintenance costs are much higher than the annual savings. Even though the existing urinals have maintenance costs associated with them, the stakeholder would not have to worry about recovering any initial investment. Therefore, keeping the existing flush urinals is the best option economically.

4.4.3 Social Impact Summary

We summarize our findings regarding the social impact of each urinal option. We consider public acceptance, custodial acceptance, and health and hygiene associated with each option.

The existing urinals have become widely accepted by the public and the custodians. Depending on the maintenance and cleaning schedules, the abundance of germs and other microbes in the restrooms can vary.

For new and retro-fit waterless installations, it was found that in areas of high traffic, public and custodial acceptance were greatly compromised. However, in areas of low traffic, such as Koerner's Pub, waterless urinals can be more hygienic and more acceptable by the custodial staff.

5 CONCLUSION AND RECOMMENDATIONS

The positive environmental impact of installing waterless urinals is tremendous, but the negative economic and social impacts provide substantial resistance against the implementation of this initiative. Even though the potential water savings of approximately 47,000 Liters per year is significant, this only amounts to about $30 worth of water utility savings. Our calculations show that the cost of implementing this initiative will only increase long-term due to regular cartridge replacement costs and no return on the upfront installation investment. Furthermore, custodians that we interviewed expressed strong reluctance towards dealing with waterless urinals due to odor issues and constant drain blockage. Therefore, we recommend continuing the use of the existing flush urinals and up keeping them with proper cleaning and maintenance.

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APPENDICES

Appendix A: Water Consumption and Cost Savings Calculations

According to UBC Water Conservation, the approximate amount of water in Liters (L) consumed at UBC per year equals 4 billion liters, while the total water cost per year equals $2.5 million (The University of British Columbia, n.d.). Therefore, the crude estimation for water cost per liter is as follow.

$$\frac{\$2.5 \times 10^6}{4 \times 10^9 \text{ L}} = \mathbf{\$0.000625/L}$$

The following estimates were provided to us by the stakeholder:

- Average number of costumers visiting the Pub per day (Monday to Friday) ≈ 300
- Percentage of costumers using the restroom ≈ 67%
- Number of people using the restroom ≈ 200
- Percentage of male costumers using the restroom ≈ 60%
- Number of male costumers using the restroom ≈ 120
- Number of urinal users/day = Number of flushes per day ≈ 96
- Number of days Koerner's Pub is open in a year = 260

For the purpose of our calculations, we assumed that approximately 80% of male costumers to use the urinals. Since there are 4 urinals in the Pub's men's restroom, the estimated number of flushes per urinal per day is 24. The minimum amount of water dispensed for each flush = 1.9 L (The University of British Columbia, 2013).

The following calculations were made using the above data.

$$\text{Number of times a urinal is used per year} = \frac{260\ days}{1\ year} \times \frac{24\ flushes}{1\ day} = \text{6240 flushes/year}$$

$$\text{Amount of water used by each urinal per year} = \frac{24\ flushes}{1\ year} \times \frac{1.9\ L}{1\ flush} \approx \mathbf{11856\ Liters/year}$$

$$\text{Amount of water used by all 4 urinals per year} \approx \mathbf{47424\ Liters/year}$$

$$\text{Cost of water used for flushing per year} = \frac{\$0.000625}{1\ L} \times \frac{47424\ L}{1\ year} \approx \mathbf{\$29.64}$$