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Changing Tides at Dalhousie University

ENVS 3502 Final Report

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Abstract

As a leading Canadian university in research and educational experience, the *Greening the Campus Movement* presents Dalhousie University with the opportunity to make new name for itself. Dalhousie has embarked on some initiatives including a campus sustainability office, low flow toilet technology and is home to a dedicated campus greening society, SustainDal. The *Changing Tides at Dalhousie University* research project was carried out in order to determine if it would be socially and economically acceptable to put dual-flush toilets in a new residence at Dalhousie University. The objective of this research is to compare the water consumption and costs of Dalhousie's Flushometer to that of alternative dual-flush toilets. Simultaneously, research regarding the social acceptance and knowledge of dual-flush toilets was carried out. Information was collected about student's toilet practice and their perception of water-use in both conventional and dual-flush toilets. This data was gathered through surveys, and taken from the student population in Risley Hall residence during peak times of the day. This information was then used to asses the level of education that students in residence have about dual-flush toilet technology. The results strongly recommended that Dalhousie University install dual-flush toilets in future residences. If the project's recommendation does follow through and Dalhousie implements dual-flush toilets in a new residence, this will save money, lessen environmental degradation and have a very reasonable payback period. Through the use of dual-flush toilets, Dalhousie University has the potential to be one of the model university's in North America for water conservation.

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Project Definition

As Dalhousie's most recently built residence and home for many undergraduate students, Risley Hall reflects the current failures and successes of sustainable water use in universities (see Appendix D). While Risley Hall is a prime example of sustainable strategies at Dalhousie University, its current 'low-flow' toilet technology leaves plenty of room for improvement. Moreover, students living in Dalhousie residences continue to abuse the water system, causing serious environmental degradation. It is imperative that universities move away from such traditional practices that act in direct repudiation to the *Tallories Declaration*, signed by Dalhousie in 1999.

Changing Tides at Dalhousie University provides insight into the economic and operational feasibility of implementing dual-flush toilets in future Dalhousie residences. Since it is the most recently built residence, Risley Hall is used as a platform to demonstrate the ability for educational institutions around Canada to revert to dual-flush toilet systems. Even more sustainable than the existing low-flow (six liter) Flushometer toilets at Risley Hall, installing dual-flush toilets (three and six liter) will reduce the amount of stress placed on the local water systems and tables (see *Appendix* A and B). By addressing the issue of water waste at Dalhousie residences through both qualitative and quantitative research, this project provides an alternative to current toilet practices.

The upgrade to more sustainable technologies demonstrates that a student trends exists at Dalhousie University to reduce the amount of water wasted through improper water management. Currently at Dalhousie, there is no policy that monitors the amount of water being used in washrooms, nor is there any plan to implement such policy. Therefore, in addition to gathering data on current water-use practices from Risley Hall

students, students were inquired on whether they would be opposed to reverting from the six liter Flashometer toilet system to an alternative high efficiency dual-flush system. Besides the fact that dual-flush toilets are upscale in terms of water conservation, another important quality is that it adds the element of human interaction during its operation. Since the user has the option of either a low (3 liter) or high (6 liter) flush, the dual-flush system promotes individual consideration during each use (see *Appendix* C).

The overall goal is to establish an efficient water policy at Risley Hall that will be taken as a model for the rest of Dalhousie University. It is important to note the effort being put forward, specifically in the placement of the dual-flush toilet proposal targeting to new building of Dalhousie University. Through promoting sustainable water use, Dalhousie University could become a leader in the Greening the Campus Movement. At the same time, the plan calls for feasible, long-term sustainable water use that would be part of the mechanism to monitor and manage its impact in terms of financial savings to Dalhousie University. By implementing dual-flush toilets, Dalhousie would be promoting sustainability on campus. Making this link to the Greening the Campus Movement would give credibility to Dalhousie as a leader in water efficient practices. Furthermore, Dalhousie University's commitment to campus sustainability will be an additional alley for the promotion of environmental awareness regarding water conservation. With the creation of the *Environmental Goals and Sustainable Prosperity Act*, Nova Scotia has committed itself to become one of the most sustainable and environmental friendly economies in the world by 2020. Dalhousie University can help the Nova Scotia government achieve these goals through the implementation of alternative water management practices such as dual-flush toilets.

Objective

The objectives of this research will be explored by applying quantitative methods that examine the economic and operational feasibility of installing High efficiency dual-flush toilets. The high end dual-flush has a function of 3 and 6 liter usage. The Flushometer low-flow, six liter toilets will be compared with the more environmentally friendly dual-flush. By analyzing the two toilets, we will be able to understand the reality of installing such systems. In addition, the average lifespan of the two toilets will be compared to understand the maintenance required, and to judge whether it would be wise, economically, to continue with the existing Flushometer toilet system, or to replace them. In this regard, alternative flushing systems by design and efficiency of water use of dual-flush toilet system stand above any products in the world. Regarding to water usage at Risley Hall, the analysis will be performed during the traditional school timeframe: winter /fall semester. This will give an overall estimate to the amount of water used at the youngest residence, which would subsequently provide an idea of the amount of water wasted at other residences. By understanding the amount of water wasted during one semester, it will be possible to calculate the potential water savings that dual-flush toilets would have in the future. Because Risley is a co-ed residence, there is a large amount of toilets, and no urinals, which greatly increases the amount of water being wasted.

This project emphasizes an approach to working with a combination of qualitative and quantitative, to establish factual observation in the overall cost analysis. The Risley Hall Flushometer toilet system and the dual-flush system will be compared with a cost analysis comparison. The outcome of these findings will construct a pathway that will re-enforce the dual-flush toilet system model. This outlook reflects the researches secondary

objectives to satisfy Dalhousie University's sustainability movement. The research team looks forward to make compelling reasons and findings as to why Dalhousie University should choose the dual-flush system as a model for all its properties.

Apart from providing additional quantitative data, the qualitative approach will provide additional information on the proposed implementation of such toilets. It is the best-suited mechanism to explore the behavioral perception and pattern of toilet usage by all residents of Risley Hall. In addition, it will help to understand how students feel about the implementation of such a plan. By analyzing the social factors associated with such a project, we will get a general sense of the climate among undergraduate students to understand whether or not they would be opposed. As the Greening the Campus Movement continues to gain momentum throughout educational institutions across Canada, it is the belief of the researchers that the majority of undergraduate students residing in Risley Hall will not be opposed to the implementation of dual-flush toilets. It is very important to understand what the overall mood is, when considering changing an integral part of ones life. This research will analyze the behavioral perception of current water use in toilets and, through patron willingness, come to a consensus as to whether a great majority of the Risley population is opposed or willing to adapt to the change.

The Scope

The scope of this paper is to research the possible adoption of dual-flush toilets in Risley Hall. It is beyond the scope to perform a complete water audit of Risley Hall. In order to researching the potential water and cost savings of dual-flush system, the root cause of water waste must be recognized and analyzed. This includes analyzing the

Risley Hall student population that use the washrooms on a daily basis, and the maintenance staff, who clean the washrooms. The research team also looked into the return rate of dual-flush toilets and the amount of time it will take for the dual-flush toilets to generate savings. Interviews were performed with the Facilities Manager and the Utilities Supervisor of Risley Hall to understand what limitations there would be with the installation of these toilets. It is believed that with the implementation of this research proposal, the scope will encompass all of Dalhousie University, thereby facilitating the spread of sustainable water practices throughout the campus and Canada.

Methods

Research Design:

The methods of research were designed to address the main objectives of the study as stated previously. The quantitative research methods worked to gather information on the economic and operational feasibility of future installation of dual-flush toilets at Dalhousie residences. For qualitative research methods, the approach was directed towards gathering information regarding student and staff acceptance of the future implementation of dual-flush toilets at Dalhousie. Through the purposive sampling of the population at Risley Hall residence, we were able to obtain data relevant to student perception and water use as stated in the objectives. Specifically, information was collected by means of questionnaires that were later used to draw conclusions. In addition, measures such as interviews, document analysis and calculations were used add on to and triangulate the information collected from the Risley Hall population. The research team used statistical and inferential data analysis to summarize and make further

inferences about the research findings. Upon the completion of the data analysis, issues of reliability and validity in the methods of data collection and in the results became apparent. By relating these results to the main objectives of the project, discussion and conclusions were written for outside observation. To complete our research design, the research team made suggestions for further research so as to encourage the future implementation of dual-flush at universities across Canada.

Sample Population:

To gather information pertinent to the study, a non-probabilistic sampling procedure known as purposive sampling was the foundational technique used to gather information. Palys (2003) describes this sampling procedure as data which is gathered from either pre-determined or international people or locations. This method served to narrow the Dalhousie population down to a realistic target group to gather date to meet the desired interests and objective of the study. In the preliminary stages of the study, particular individuals within this group were strategically targeted to obtain inductive, explanatory information pertinent to the research. Mateo York, the facilities building manager for Risley Hall, Sherriff Hall, and Eliza Ritchie, was an individual contacted in the beginning stages of the study regarding information on the structural components such as the number and type of toilets currently in Risley Hall. As well, Darrell Boutlier, the manager of utilities for Dalhousie, was contacted in the early in the study as he was strategically important to meet the economic interests of the study. Furthermore, the students and staff of Risley Hall were intentionally sought to gather data regarding water use in the current Flushometre systems as well as perceptions and acceptance of future implementation of dual-flush toilets at Dalhousie.

Instrumentation and Justification:

The project used various interactive methods when gathering information from the students and representatives of Risley Hall and Dalhousie's Facilities Management. At Risley Hall, self-administered surveys were used to gather information from the student population. The survey consisted of nine different types of closed, or structured questions (Palys, 2003, p.175). Included in the survey were closed-ended questions of the categorical-reponse and rating-scale variety (Palys, 2003, p. 178-179). In the beginning of the survey, Risley Hall students responded to categorical-response items about daily flushing habits. They were also to rate their knowledge of environmental issues and water issues in relation to water consumption in toilets. As the survey proceeds, participants responded to questions about water consumption in Risley Hall toilets and dual-flush toilets (see *Appendix* E). The last item in the survey is a more general opinion-directed question about the future implementation of dual-flush toilets at Dalhousie. The survey was designed to gradually introduce the respondents into issues with water –use before delving into questions about dual-flush toilets. The hope was that by the time the respondent was at the end of the survey, they would be more decided about the future implementation of dual-flush toilets.

The research team was able to gather both quantitative and qualitative information from the surveys because of its structure and content. For example, there was data collected on the frequency of flushes as well as behavioral habits such as how many students flush before they use the toilet. In addition, using closed-ended questions focused and formatted the survey so that we were able to obtain specific information needed for our research. For example, questions with a categorical-response such as 'Yes,

No, Don't Know' provided a clear indication of student's knowledge of conventional and alternative toilets structures. Other responses were used as indicators for the calculation cost and water savings and student perception regarding the future installation of dual-flush toilets at Dalhousie. Finally, self-administered surveys promoted a high level of participation, which is important in minimizing volunteer bias and ensuring that the appropriate persons completed the survey (Palys, 2003, p.153).

Face-to-face semi-structured interviews, *telephone interviews* and electronic communication was used to gather both qualitative and quantitative information during the interviews with Dalhousie's Facilities Management. Additionally, representatives from Halifax Regional Water Authority were contacted via phone to obtain information about Halifax Municipality water rates. *Two Halifax-based companies also supplied us information on the costs of Caroma and American Standard dual-flush toilets.*

The interviews with Mateo Yorke were crucial in that he provided us with the necessary building information for Risley Hall as well as individuals to contact. Since Mr. Yorke was very interested in our project, his suggestions for research were plentiful with ideas. During the face-to-face interviews, he provided us with detailed information about the layout and number of Risley Hall toilets. He also provided general information about the reason for installing Flushometre toilets across Dalhousie. To collect more data on the costs and performance of Flushometre toilets, Mateo suggested that the research team contact Darrell Boutlier. While it was very difficult to meet Mr. Boutlier in-person, he sent the Risley Hall's 2007 water bills and maintenance costs by email. Although it was very difficult to obtain the water bills, the information was vital for the completion of the cost benefit analysis. Since the monthly maintenance costs were for Risley Hall as a

whole (not by utility), we were unable to use the data when calculating potential water and cost savings. In the end, this helped progress the research, as the team realized that because maintenance information was difficult to obtain, we needed to develop a different approach.

Document analyses provided the research team with the additional qualitative and quantitative data needed for conventional and dual-flush toilets. The Caroma website provided plenty of information pertaining to the variety of cost-savings that can achieved when switching from six-litre Flushometre toilets to dual-flush. On the website, a dual-flush toilet water savings calculator and worksheet is available for home-owners and businesses to determine the payback period of installing a Caroma high efficiency dual-flush toilet (see *Appendix* F for the worksheet which contains the calculations of the water and cost savings and *Appendix* G for the Coroma water savings calculator) (Caroma, 2008). In addition, Caroma also provides an extensive list of localities around the world that provide Caroma toilets to be purchased. From this, we were able to compile a list of businesses in Nova Scotia that carries Caroma dual-flush toilets. In the Halifax region, we contacted by phone *Eddy Group - Donnie Davis & Doug Murphy & Stephen Howland* in Bayers Lake Business Park, and *W. Bird and Companies (Plumbing and Heating Products)*. Lastly, the website was a source for Caroma dual-flush 'success' stories at university facilities across Canada.

Basically, the Caroma water savings calculator calculated the water and cost savings for Caroma dual-flush toilets, and the worksheet described how the calculations were realized. By using the worksheet as a guide, it became clear what data was required to complete the project. After finding all the necessary variables for the water use

calculations, a monthly and annual water-use reduction (m3) was found (Caroma, 2008). After inserting the water rate for Halifax Municipality, the Caroma calculator gave the monthly and annual water costs and savings (Caroma, 2008). Finally, the calculator verified the research team's predicted payback period of five years. Specifically, the Caroma calculator gave the payback period for both new installation projects and existing fixture refit projects. This is an added bonus for future research projects as they can compare such payback periods of Dalhousie's Flushometre's to Caroma's dual-flush. All of the preceding findings will be discussed in greater length in the discussion section. Finally, during the research process, a previous project for ENVS 3502 was analyzed and used as a guide during the study (*Reducing the Energy use in Dalhousie Residences through Infrastructural and Behavioral Changes*, 2007).

Reliability and Validity:

The reliability of the data collection is strong. There is confidence that the approach used toward collecting data, that being through a survey and interviews would be able to be reproduced independently. When conducting the interviews, there was no template created as to what each individual was to be asked; rather they was approach on a need-to-know basis. Each individual interviewed held different information, thus the questions could not be the same. The initial use of the survey was by each group member was a pilot test. This pilot test allowed for noticing any questions that needed to be adjusted, or variables that needed to be operationalized. There were few random errors which we incurred through the data collection phase using the survey. These random errors were mostly accounted for in the last question of the survey. Due to the fact that the methods used for collecting data were through survey and interviews, the same results

would be assumed to be able to be garnered. In particular reference to the surveys, the same type population would need to be used and the research would need to be carried out in the near future.

The validity of this data collection is mainly is weighted on the fact that they the survey and interviews would have be conducted in the near future. This is because technology and general views on environmental issues pertaining to everyday life are dramatically changing. Once it becomes the norm to have dual-flush toilets in every Canadian home and business, the questions on this survey will essentially be meaningless and lead to confusion for the respondents. The findings from the interviews would be able to be replicated; however, the questions would have to be asked without any change and, similarly to the survey, in the near future. There was no systematic error found during data collection period.

Procedure:

Before the data collection process, the research team collaborated and designed a research proposal. Pilot tests of instrumentation included in the proposal allowed the team to make any revisions before beginning any major data collection. In addition, an ethics form was completed and handed in to the appropriate individuals to ensure that the project's research methods were acceptable.

One hundred *self-administered surveys* were distributed to students in the Risley Hall foyer as a means to gather both qualitative and quantitative data for the study. The research team was present throughout the entire process to answer any inquires of questions that participants may have had regarding the survey. Respondents were assured complete anonymity and given information sheets for any further information.

In the beginning, general interview questions were brought to the meetings with Mateo Yorke and Darrell Boutleir. As the research team collected more data, information from Mr. Yorke and Mr. Boutlier was provided via telephone and email. Telephone interviews were frequently used when face-to-face contact was difficult questionnaires or impossible. Interviews were informal and used to obtain specific data; therefore, no formal interview questionnaires were completed. Finally, information regarding the Caroma toilet prices, installation and delivery costs for the Halifax region was given to us by J.W Bird and Companies over the phone.

Analysis:

The information gathered from the students at Risley Hall through surveying was organized according to responses given for each question. The information was entered into an Excel spreadsheet to provide easy access to the data. Analysis of the data was accomplished through descriptive statistics and inferential statistics. Descriptive statistics, such as frequency distributions and central tendency were used to summarize the data (Palys & Atchison, 2008). This included qualitative information such as the student's behavioral patterns in terms of toilet use, their perceptions of water-use in toilets with regards to the environment, their knowledge of dual-flush toilets, as well as, their reception of the three-litre and six-litre flush option. Other qualitative data that was analyzed through frequency distribution was the student's openness to the installation of dual-flush toilets in future Dalhousie buildings. This addressed a main objective of the study which was student's acceptance of the future implementation of Dual-flush toilets at Dalhousie. The quantitative data obtained from the surveys was also preliminarily analyzed through frequency distributions.

Inferential statistics was used to measure the association between two of the questions asked in the survey (Palys & Atchison, 2008). It was used to depict the relationship between two variables, one of which was the student's perception of environmental issues in relation to their perception of water-use in toilets, and the other was the student's knowledge of dual-flush toilets in relation to their reception to the three-litre and six-litre flush option.

Cost-Benefit Analysis:

A cost-benefit analysis was conducted to address the economic feasibility of implementing dual-flush toilets in future Dalhousie buildings which was one of the main objectives of the study. An Excel worksheet found on the Coroma USA website was used as the main analytical tool for the cost-benefit analysis. It was provided in a Canadian version which incorporated measurement used in Canada. Both qualitative and quantitative data was used in the calculations sheet. The qualitative data used in the calculations included the perceived use of the three-litre flush as opposed to the six-litre flush which was provided within the surveys. The quantitative data included flushes per day for each individual which was also provided in the surveys. In order to use this data in the calculation sheet, the researchers were required to find the mean flushes per day for each individual and extent this number to the population of Risley Hall which was 490 individuals. Furthermore, information regarding the number of toilets in Risley Hall, as well as, water costs per metres^3 were needed for the cost-benefit analysis which were respectively obtained through interviews with Mateo York and the Halifax Regional Municipality Water Utilities. Through the calculation's sheet, data regarding water

savings and thus, cost savings was obtained, as well as, the payback period for the installation of each dual-flush toilet.

Limitations:

Certain limiting factors affected the study. Although, we had not foreseen these limitations, throughout the course of the study we were able to overcome some of these factors. However, some limiting factors influenced the study's results and therefore, must be address.

During the final consultation with the facilities manager at Risley Hall, prior to the administration of the surveys, we realized that a communication error had occurred. This realization occurred after the design of the study had been agreed upon and the survey was drafted. The error in communication was problematic, as the original design of the study was to investigate the feasibility of retrofitting the current toilet systems at Risley Hall with low-flush toilets that used six-litre per flush. However, the miscommunication was that the current systems in Risley Hall, which used Flushometer toilets, were already six-litre per flush toilets. After further consultation with the facilities manager, he suggested shifting the focus of the study to the installation of a higher water conservation toilet system in future Dalhousie residences. Dalhousie was planning on building a residence similar to the size of Risley Hall within the next 5 years. Therefore, Risley Hall could provide baseline data of the water consumption of the current toilet systems compared to the water conservation that dual-flush toilets could achieve. This limitation was overcome through prompt changes in the design of the study and a redraft of the survey.

The actual administration of the survey, after the necessary changes were made seemed to be successful, however, upon analyzing the results, some discrepancies were noticed in the student's responses and the information required for the overall analysis. Specifically, the responses for flushes per day were given in categories, i.e. 3-4. Therefore, in order to use this data in the cost-benefit analysis, these categories had to be averaged producing one number for each of the categories. Then the average for flushes per day for each individual was calculated using the categorical averages. Also, student's commonly misinterpreted question number two on the survey. Subsequently, some responses had to be disqualified, therefore, affecting the accuracy. Furthermore, in regards to the administration of the survey, it is speculated that some student's targeted for the survey were not Risley Hall residents. This is a possible explanation for some students responding 'never' to flushes per day at Risley Hall. Therefore, this would affect the accuracy of flushes per day for each individual in Risley Hall.

In the early stages and within the discussion of the study, we began to notice the lack of literature available regarding the implementation of alternatives toilets, in particular dual-flush toilets in Canadian institutions. Although, we had found information that two Canadian universities had installed dual-flush toilets, little information supporting the processes involved in the shift to the higher water conservation toilets was found.

Lastly, the responses of the student's could have been influenced by their knowledge that the study was being conducted by an environmental studies class. Therefore, the accuracy of student responses could have been affected, yielding more

environmentally conscious or sustainable responses not necessarily reflective of actual behavior or knowledge.

Delimitations:

In the preliminary planning stages of this study, we recognized the importance of limiting the scope of study to realistically be conducted and completed within the given time period. The major restriction placed on the study, was to focus the research to one Dalhousie residence, Risley Hall. This enabled the research to be analyzed in the context of a set population, as well as, controlling the number of toilets in use which was necessary for the completion of the cost-benefit analysis. Also, we focused the study towards implementing dual-flush toilets in new Dalhousie buildings, instead of retrofitting existing Dalhousie buildings with the alternative toilet systems.

Results

First, the results from the survey will first be given according to order of the questions asked in the survey (See Appendix E for a copy of the survey). The data collected from the interviews will then be given.

Toilet Use in Risley Hall:

On average, student's flush the Risley Hall toilets between 3 and 4 time per day as depicted in **Figure 1**:

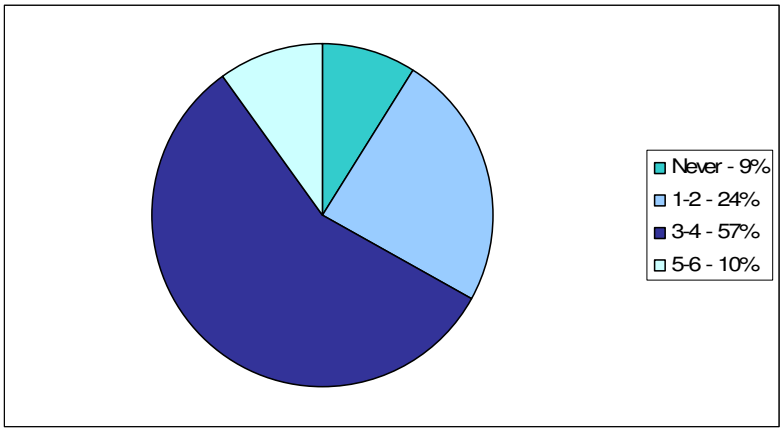


Figure 1. Average per day at Risley Hall

Results regarding flushing behavior of students at Risley Hall are depicted in **Figure 2**.

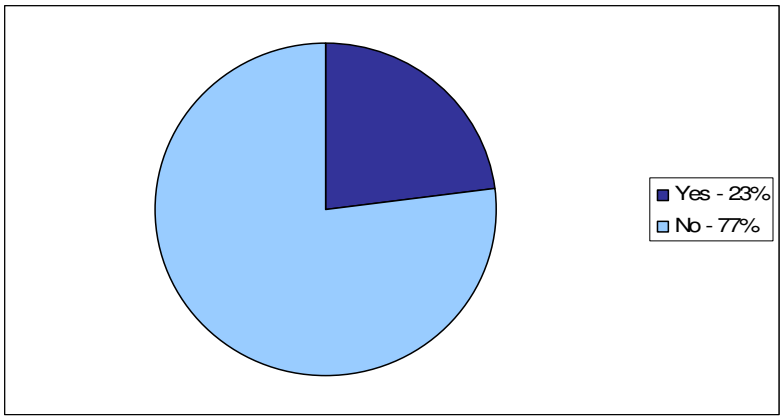


Figure 2. Percentage of students that flush more than once per use

Knowledge of Water-Use and Environmental Issues

Water-Use in Toilets:

When students were asked to rank their knowledge of water-use in toilets, the majority replied that they had little knowledge (1 on the scale). No student ranked themselves as very knowledgeable (5 on the scale). The frequencies of responses are listed in **Table 1**:

Table 1: Student's ranking of their knowledge of water use in toilets

Response	Frequency	Percentage
(Little Knowledge)		
1	41	41
2	31	31
3	21	21
4	7	7
5	0	0
(Very Knowledgeable)		
All Response	100	100

Environmental Issues:

When students were asked to rank their knowledge of environmental issues, the majority of student's ranked their knowledge as average (3 on the scale). The responses are listed in **Table 2**:

Table 2: Student's Ranking of their Knowledge of Environmental Issues

Response	**Frequency**	**Percentage**
(Little Knowledge)		
1	1	1
2	16	16
3	44	44
4	31	31
5	8	8
(Very Knowledgeable)		
All Response	100	100

Water-Use with Respect to Environmental Issues:

When students were asked to rank the importance of water-use as an environmental issue, the majority of students responded that "water-use is an extremely important environmental issue". The responses are listed in **Table 3:**

Table 3: Student's Perceptions of Water-Use as an Important Environmental Issue

Responses	Frequency	Percentage
I do not think it is important	0	0
Water-use is important, but not a major issue	9	9
Water-use is an extremely important environmental issue	83	83

Water is the most important environmental issue	7	7
Other	1	1
All Response	100	100

To further illustrate the relationship between student's perceptions of their knowledge of water-use in toilets to their knowledge of environmental issues, a bivariate graph of the two questions was constructed in **Figure 3**.

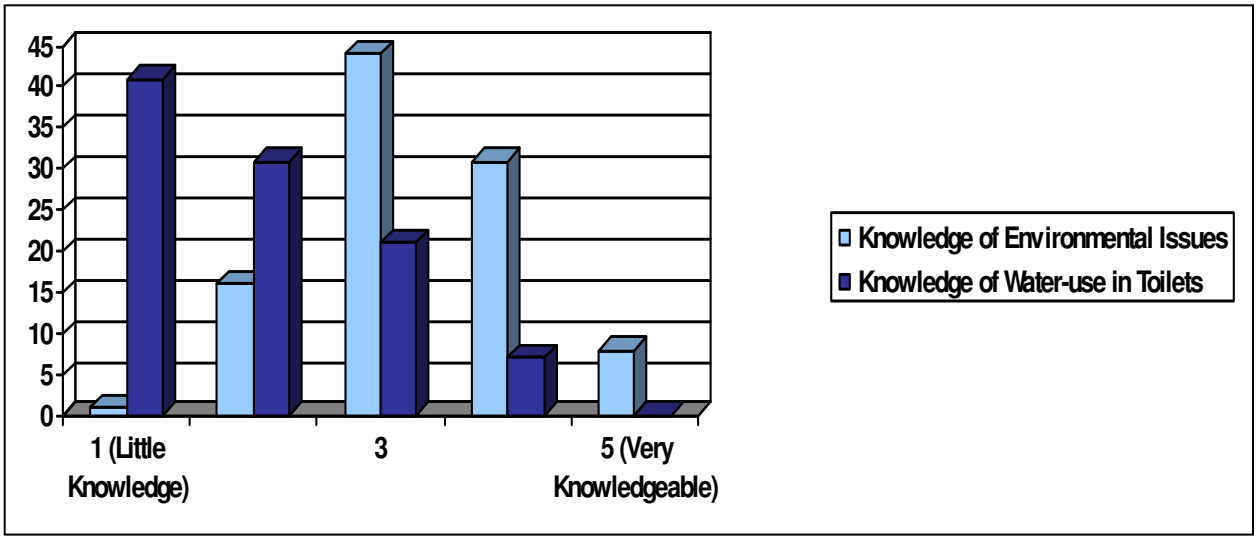
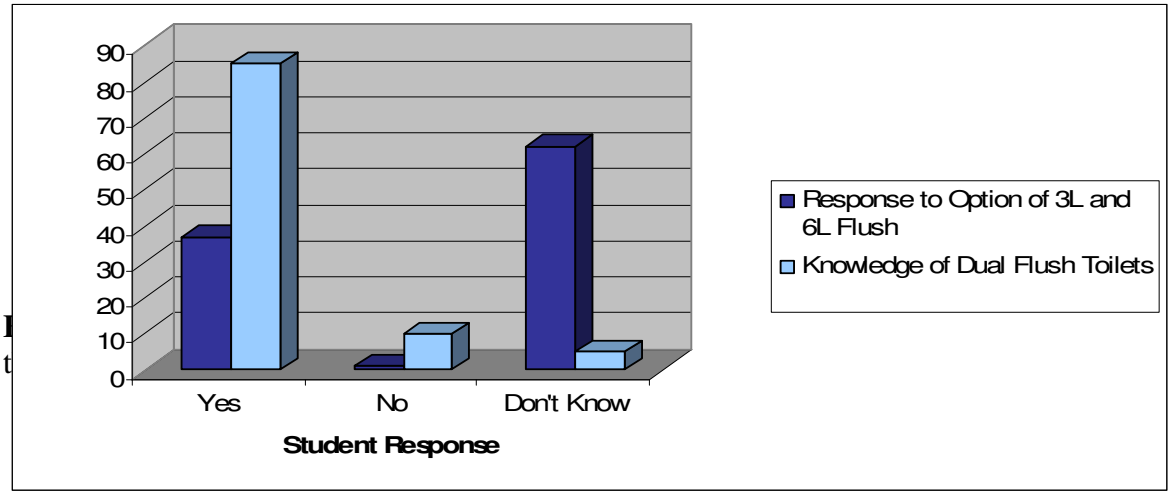


Figure 3. Knowledge ranking of environmental issues and water use in toilets

Knowledge of Dual-flush Toilets:

The question of student's awareness of dual-flush toilets was asked. Responses are shown in Figure 4. In addition, students were asked if they liked the option of a 3L flush and a 6L flush. The responses are also shown in **Figure 4.**



Future Installation of Dual-Toilets at Dalhousie

Student's opinion of the future installation of Dual-flush toilets at Dalhousie was asked. The responses were overwhelmingly positive. The responses are shown in **Figure 5.**

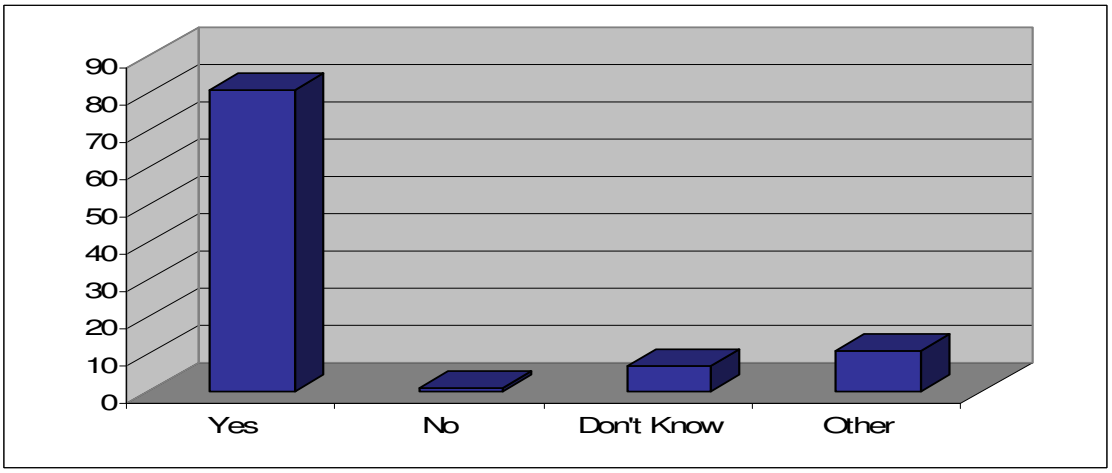


Figure 5. Student's responses regarding the future installation of Dual-flush toilets at Dalhousie

Cost-Benefit Analysis: See *Appendix* F.

Discussion

In performing this research it became quite clear to the researchers that the great majority of students would be in favour of implementing dual-flush toilets at Dalhousie. This held true to our original hypothesis, which argued that there would be an overwhelming acceptance to this change. The research was performed to understand and discover the economic and social feasibility of installing dual-flush technology within the Dalhousie community. Similarly, the environmental benefits attributed to this alternative technology were researched, so as to get an understanding, with regard to the positive impacts that dual-flush technology would have on local watersheds and ecosystems. It was the belief of the researchers that there would be a great positive difference within the environment, and that this difference would be felt throughout the Halifax community. As the research concluded, it became very apparent that the economic, social and environmental benefits of implementing dual-flush toilets within Dalhousie were overwhelming. This realization further helped to promote the benefits of the Greening the Campus Movement, and it is hoped that this report will add to Dalhousie University's ability to partake in this global movement.

An important part of our research was to discover the amount of flushes per day at Risley. This was achieved through questions on the survey, which asked the amount of times per day each person flushes the toilet. The results showed that the majority of students flush between three and four times per day, which means they consume, on average, between 18 and 24 liters of water per day, in flushes alone. While this number may not seem large, when considering that the residence houses four hundred and ninety students during peak semesters, the amount of water being consumed by 57 percent of the

students is between 5,027 and 6,696. This astounding figure represents the general problem that Dalhousie is facing. If 57 percent of the current population of Dalhousie University are flushing, on average three to four times per day, then the amount of water being haphazardly drained away is shocking. However, this number represents an area where great changes can be made, and where results will be noticed fast. In total, when analyzing all of the surveys, the average amount of water consumed in flushes alone at Risley Hall, during a 24 hour period, is 31,153 liters. This number, however, does not account for maintenance and other staff who use the washrooms, nor visitors and other students, therefore these estimates are modest, and it can be assumed that the daily flow of water through toiled usage would be much higher. Thus, this chart shows how greatly affected one residence within Dalhousie could be if dual-flush toilets were implemented.

A similar aspect of the survey was to analyze each student's perception to environmental issues. Because the environment is a very important topic, and has been in the news a great deal over the past years, a great majority of students (83%) recorded that they feel water use is an extremely import environmental issue – 7% believed it was the most important environmental issue we, as a society, are currently facing. This shows that this a general concern for our environment, and the water use practices that we employ in our daily lives. However, there is a margin for error when considering this number. It is believed by the researchers that there was a cognitive bias in the surveys, known as the *halo effect*, which refers to the influence we, as environmental science students, place on those being surveyed. In considering this effect, it must be assumed that there was a selection of students who merely answered in a certain way to please the researchers. So, caution was taken when we analyzed this, and other sections of the data.

Quite similar to the aforementioned figure, is the correlation between the knowledge of environmental issues and the knowledge of water use in toilets (Figure 3). An assumption was made, prior to delivering the survey's that a majority of students would not have a great familiarity, or understanding of water use in toilets. This could be for the reason that it is not a highly talked about problem, when one considers water consumption. It is hoped that with this report, and further analyses of water consumption in toilets, the number of those who are knowledgeable of water use in toilets will rise. As the figure shows, most students considered themselves knowledgeable of environmental issues, while their knowledge of water use in toilets was limited. Not surprisingly, those who knew and understood environmental issues were more likely to be familiar with water use in toilets – a reason for such a correlation would be that student who take the time to familiarize themselves with environmental issues are more likely to come across information relating to water use in toilets. With the assumption proven correct, one of the recommendations that arose from our research was that there is not enough discourse with regard to this issue, and that, in creating a "buzz," students and faculty alike would change their washroom tendencies.

Our hypothesis that the majority of students would not be opposed to the implementation of dual-flush toilets was further proven when we analyzed the student reception to such a proposal. Figure 4, which depicts the correlation between the knowledge or awareness of dual-flush toilets and the student reception to the three and six liter flush option, shows that 85 percent have a knowledge of dual-flush toilets. An interesting fact that arose from the data was that the majority of students poled (62%) did not know whether or not the option was a viable solution. This is a great example to show

that there is not enough understanding of alternative, green technologies in Canadian society. While much of the world has adopted more environmentally friendly technologies to lower their impact on surrounding environments, North Americans still choose to disregard such a choice. Also, the data showed that, while 85 percent had knowledge of dual-flush toilets, only 37 percent responded "yes" to the option. It is assumed that knowledge of these toilets would give enough reason to approve the option, yet it appears that there could have been some misconceptions from the students, or it could be a result of the *halo effect*. The one constant throughout the data is the lack of understanding with regard to environmentally friendly, alternative technologies. Assuming that the *halo effect* skew's some of the data, it is believed that the actual amount of students who have knowledge of environmental issues and water consumption is much smaller. However, while there may be less amount of knowledge, the great majority of students polled shared a desire to change their current practices, and adopt more environmentally friendly measures.

The acceptance of the possible future installation of dual-flush toilets was further emphasized when 81 percent of students responded "yes" to such an option (Figure 5). Once again, our hypothesis holds true, and shows that there is a general desire to change current practices. While only one person responded no to such a plan, seven students did not know whether or not it would be beneficial. Again, this shows that there is a lack of understanding with regard to alternative technologies. It is hoped that with the spreading of the Greening the Campus Movement, students will become more knowledgeable on environmental issues and will thus come to accept and understand the importance of implementing green technologies.

Very important with regard to the implementation of dual-flush toilets is the economic feasibility, which must be considered to demonstrate the savings. We considered the option to refit an existing area of Dalhousie (Risley Hall) and the option to install them in a new project, which Mateo Yorke insinuated in an interview would be happening in the near future. *Appendix* F shows the annual costs savings of installing 110 dual-flush toilets in Risley Hall would be $1,066. However, installing the toilets in an existing residence would yield a payback period of 29.9 years, while installing the toilets in a new project would be 5.2 years. Thus, while it would be better for the environment to install these toilets in all Dalhousie buildings, it would not be economically feasible. The easiest and fastest way to attain results would be to incorporate the toilets into a new project, at which a small fee of $50 would be added additionally to each respective toilet. After 5.2 years of use, the toilets would begin to generate savings, which could then be used to further implement such toilets across campus.

Currently there is not a lot research with regard to dual-flush toilets. The technology is still rather new in its global reception, and it is because of this infancy that there is only a small recognition of it in North America. There is also the widespread problem that water consumption is not as pressing an environmental issue in North America, which controls a vast amount of the world's water supply. However, there are certain institutions in Canada that have reverted, or are in the process of reverting, to dual-flush toilets. One such place is the University of British Colombia, which has begun implementing dual-flush toilets in its recent residential developments – a reason which helps to explain why it is the only university in Canada to receive *Green Campus Recognition* from the US based National Wildlife Federation (University of British

Columbia, 2005). UBC is also on track to meet their Kyoto Protocol Targets ahead of time. Similarly, UBC also has plans in the making to implement both dual and low flush technology in many more of their campus buildings. While UBC is many steps ahead of Dalhousie in becoming an environmentally friendly institution, there is no reason that Dalhousie cannot continue in this path, and learn ways in which to implement such changes.

A local East-Coast university, Mount Allison, has also adopted similar plans as UBC to leave less of an environmental footprint. It currently has a *Green Action Plan* that calls to reduce water consumption by 25 percent within the next ten years. One aspect of this plan is to continue the installation of dual-flush toilets – currently two areas of the institution have plans in affect. Mount Allison is also setting a baseline for water use within the grounds, which will greatly decrease the amount of wasted water (Mount Allison University, 2005). The Greening the Campus Movement has obviously had more impact at certain universities, but that does not mean that Dalhousie is not embracing it, rather that there is room for improvement.

While there is not a lot of existing research on water consumption in toilets, it is hoped that this report will spur interest in the issue, and will make people think twice about their traditional washroom policies. It is for the reason that there is not very much existing research that this project is so important: it will give much needed insight into the potential environmental and economic savings of alternative toilets. It is also hoped that this research will spawn other groups to look into water use practices, and will thus cause a change in attitude towards our very fragile ecosystems.

Conclusion

Upon completion of performing the surveys and analyzing the data, the conclusions reached are that the implementation of dual-flush toilets is greatly in the interests of, not only Dalhousie University, but the Halifax Regional Municipality and Nova Scotia. The acceptance of such toilets, which has proven our original hypothesis, shows that the vast majority of students believe the implementation to be based on ethical grounds. As Nova Scotia continues to strive for the *Environmental Goals and Sustainable Prosperity Act*, Dalhousie University can play its part in helping the coastal province achieve these reachable goals. Similarly, with the Greening the Campus Movement gaining momentum throughout North America, Dalhousie can act as a pioneer in the establishment of sustainable water practices.

The conclusions that have been drawn from the discussion are summarized below:

- There is a general desire among the student population of Risley to lessen their impact on the environment, and more importantly limit their consumption of water in the washroom.
- There is not enough discourse in society about alternative, green technologies.
- The majority of students, even if they were not sure about dual-flush technology, were in favour of implementing such a plan, so as to reduce water consumption.
- The implementation of dual-flush toilets is economically feasible, in the long and short term (re-fit or new project).
- There is a great potential for Dalhousie to reduce its water consumption, if this plan is implemented.

One of the goals of this project was to educate the students of Risley Hall on the benefits of sustainable water practices, and dual-flush toilets. Consisting mainly of first year students, it is hoped that we influenced enough of the students to seek change, and potentially, actively strive for this change to be achieved. As this research is the first of its kind at Dalhousie, it is a stepping-stone for more to be performed. It is the hope of the researchers that there will be further research performed which will provide extra insight on the implementation, and will show to the executives at Dalhousie that environmentally friendly practices can save money, and don't have to always be viewed as a risk. The recommendations for further research are:

- A full water waste audit be performed at Risley Hall to understand the exact amount of water being wasted on a daily basis.
- A large comparison of all dual-flush toilets on the market, which includes the lifespan of each toilet, the cost, the maintenance etc…
- Take a more neutral approach to the surveying of questionnaire; it is believed that the *halo effect* had a great influence on the data.

As this is the first step in toilet water reduction policies at Dalhousie, this research will act as baseline for further work. In an age where water is a precious commodity, it is up to educational institutions like Dalhousie University, to lead the way and implement sustainable, environmentally friendly practices.

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Appendix A: Risley Hall Flushometer Toilet

Appendix B: Caroma Dual-Flush Toilet

Appendix C: 3 and 6 Liter Option

Appendix D: Risley Hall Residence

Appendix E: Survey

Student Reception of Dual-Flow Toilet Project- 2008

Age: ____ Sex: F M Academic Year (first year etc.):____ Program or Faculty: _____

1. How many times per day do you use and flush Risley Hall toilets? (circle one) Never 1-2 3-4 5-6+

2. Do you flush the toilet before use? YES NO

3. On a scale from 1 to 5, how would you rate your knowledge of water-use in toilets? (circle a number)

(little knowledge) 1 2 3 4 5 (very knowledgeable)

4. On a scale from 1 to 5, how would you rate your knowledge of environmental issues? (circle a number)

(little knowledge) 1 2 3 4 5 (very knowledgeable)

5. How important do you consider water-use with respect to environmental issues? (please check all that apply)

( ) I do not think it is important
( ) Water use is important, but not a major issue
( ) Water use is an extremely important environmental issue
( ) Water is the most important environmental issue
( ) Other _____

6. a) Do you think Risley Hall toilets use too much water? (circle one)

YES NO Don't know

7. a) Have you ever heard of Dual-Flow toilets?

YES NO

b) Do you think that Dual-Flow toilets save a large amount of water?

YES NO Don't know

8. Do you like the option of selecting either "short" (3 litre) flush or "long flush" (6 litre)?

YES NO Don't know

9. Do you think that future installation of Dual-Flow toilets at Dalhousie residences is a good idea?

YES NO (please explain)

_____

Appendix F: Water and Cost Savings for Caroma Dual Flush Toilets - Canada

www.caromausa.com

Project information		Input values into yellow boxes		
Number of toilets	**110**			
Number of people	**490**			
Flushes/person/day	**2.91**	Use 5 for residential, 2 for office use		
Days used per week	**7**	7 for residential, 5 for office		
Water and sewer cost, per cubic metre	**$ 1.63**			
Existing or proposed single flush volume (L)	**6**	Generally 20, 13.5 or 6L		
Caroma 6/3L Dual Flush volume (average)	**4.25**	4 out of 5 flushes are 3L	3L	
(1US Gal = 3.78L)				
Water Consumption Calculations				
	Single Flush toilets		Caroma *Dual Flush* toilets	
Flush Volume	6		4.25	
Flushes per day	1026.55		1026.55	
Water use per toilet per day	0.055994	cu.m	0.039662	cu.m
Water use per day	6.1593	cu.m	4.362838	cu.m
Water use per year	2241.985	cu.m	1588.073	cu.m
Daily water use reduction with Caroma Dual Flush			**1.8**	**cu.m/day**
Annual Water use reduction with Caroma Dual Flush			**654**	**cu.m/yr**
Water/Sewer Costs and Savings				
Annual water cost per toilet	$ 33		$ 24	
Total annual water cost	$ 3,654		$ 2,589	
Annual Cost Savings with Caroma Dual Flush			**$ 1,066**	
New Installation Project				
Additional cost for Caroma toilets, each	$ 50			
Total additional project cost	**5500.0**			
Payback Period (years)	**5.2**			
Existing Fixture Refit Project				
Unit cost of Caroma toilets	$ 240			

Installation cost (per toilet)	$ 50
Total Refit Cost	**31900.0**
Payback Period (years)	**29.9**

User's Note: This water analysis is based upon certain assumptions about usage patterns and flush volumes. Usage patterns can and do change from domestic to commercial to public situations. There is real and anecdotal evidence that shows many low flush toilets flush at higher than their specified volume, which lead to greater savings than calculated here. Additionally, in refit situations, there is often substantial leakage associated with old toilets, which will create further water savings.

Appendix G: Caroma Water Savings Calculator

www.caromausa.com

27-Sep-02

Water and Cost Savings for Caroma *Dual Flush* Toilets - Canada

metric worksheet

Site Name _____

Location _____

Worksheet completed by; _____

Water Use Calculations				
Number of toilets			A	
Number of people			B	
Flushes/person/day			C	Use 5 for residential,
Flushes/day	BxC		D	2 for office use
Original toilet flush volume (L)		20	E	Generally 20, 13.5 or 6L
Original toilet water use (L/day)	DxE		F	
Caroma 6/3L Dual Flush volume (average)			G	4 out of 5 flushes are 3L
Dual flush daily toilet water use (L/day)	DxG		H	
Daily water use reduction (L)	F-H		I	
% Reduction	H/Fx100%		J	
Monthly water use reduction (cu.m)	30.5xl/1000		K	
Annual water use reduction (cu.m)	12xK		L	
Water/Sewer Costs and Savings				
Water and sewer rate ($/cu.m)		$	M	
Monthly $ saving	KxM	$	N	
Annual $ saving	12xN	$	O	
New Installation Project				
Additional cost for Caroma toilets, each		$	P	
Total additional project cost	PxA	$	Q	
Payback Period (years)	Q/N		R	
Existing Fixture Refit Project				
Unit cost of Caroma toilets		$	S	
Installation cost (per toilet)		$	T	
Total Refit Cost	Ax(S+T)	$	U	
Payback Period (years)	U/N		V	

User's Note: This water analysis is based upon certain assumptions about usage patterns and flush volumes. Usage patterns can and do change from domestic to commercial to public situations. There is real and anecdotal evidence that shows many low flush toilets flush at higher than their specified volume, which lead to greater savings than calculated here. Additionally, in refit situations, there is often substantial leakage associated with old toilets, which will create further water savings.

Notes