Entry to the Stockholm Junior Water Prize 2018

Disappearance ≠ Disintegration

The Environmental Impact of Pseudo Flushables

Holly Tetzlaff

East Northumberland Secondary School

Ontario, Canada

2. Preliminary Matters

2a. Abstract

This study involved testing the disintegration rates of current products on the market which manufacturers have labelled as flushable. The flushable industry is growing rapidly, while at the same time, global sewer blockages are increasing. This study is designed to see if there is a correlation between products introduced to consumer markets, which are sold with the intent to flush into wastewater systems, and the increase in costly sewer clogs. Sewer authorities remain steadfast that only toilet paper and human waste should be flushed down toilets; exactly what the sanitary system was designed for; however, manufacturers continue to claim product flushability. Using controlled trials, items labelled as flushable are tested for relative disintegration rates. Testing included: seven day exposure to water with agitation, three hour sewer simulation, toilet bowl flush tests – low flow and regular flow toilets, no agitation with water and exposure to heat with water. Conclusions found products labelled as flushable did not disintegrate like toilet paper. Findings showed that post-experiment residual masses, left from the non-toilet paper test samples, could become sources of sewer clogs and fatbergs.

2b. Table of Contents

2c. Key Words

· Flushable · Non-woven · Red Fish Route · Toilets · Fatbergs · Non-Flushables · Effluent ·Disintegration · Flushability · Environment · INDA · EDANA · Wastewater ·Sewer Authorities ·

2d. Abbreviations and Acronyms

CWSF – Canada Wide Science Fair, RFR – Red Fish Route, LTC – Lower Trent Conservation, FOG – Fats, oils and grease, MESUG – Municipal Enforcement Sewer Use Group, INDA – The International Nonwovens & Disposables Association, EDANA – European Disposables and Nonwovens Association, GD3 – Third Edition Guidance Document, IWSFG – The International Wastewater Services Flushability Group, CSA – The Canadian Standards Association, ISO – International Organization for Standardization, CWWA – Canadian Water and Wastewater Association.

2e. Acknowledgements

Barry Orr BA, Sewer Compliance Officer/Sewer Outreach and Control Inspector City of London, extended an invitation to me as Founder of Red Fish Route to display my educational campaign, in support of Canada's involvement with the International Standards Council on Flushables, at the "Toilets are Not Garbage Cans" International Conference, in London ON, May 5th 2015. Also, on World Environment Day, June 5th 2017, Mr. Orr invited me to be a guest presenter and panelist alongside The Water Brothers, at the public screening of "The Big Leak" in London, ON. Over the last five years, Mr. Orr and I have stayed in contact, corresponding via email to discuss current wastewater environmental issues and progress with the ISO standard for flushable products.

Jennifer Leno B.Sc., Environmental Officer, Risk Management Official and Inspector Environmental Services Town of Cobourg and MESUG Chairperson, for tour of Cobourg Water Pollution Control Department Treatment Plant #1 and job shadowing.

Corinne Harris, Lower Trent Conservation Environmental Education Technician, for use of The Lower Trent Conservation "Royal Flush" toilet bowl display equipment. In addition, for including RFR as a presenter, at the Tri-County Children's Water Festival, each May from, 2015 to 2018.

East Northumberland Secondary School Senior Science Department Teachers, for encouragement.

2f. Biography

My first 'Best in Grade' win at our regional science fair, came in grade 6, for my Banana Briquettes which replaced charcoal with dried mashed banana peels and saw dust. I cooked a hotdog to an internal temperature of 160 degrees, roasted marshmallows and won a trophy almost as tall as I was, I knew then that I was hooked on science. By grade 8, while searching online for a real-life problem to tackle as a topic, I came across a picture of a large mass pulled out of the City of London Ontario's sewer system. It caught my eye, sparked my interest and my scientific inquiry took off on this not-so-glamorous, but important topic of flushables. In 2014, my first project regional project on this topic titled *Wipes Vs. Pipes*, won gold at the Canada Wide Science Fair (CWSF) and upon returning from the fair, I was inspired by a quote by Dr. Marcus Eriksen, "Science without solutions is only doing half its job." So in 2015, armed with Nelson Mandela's idea that, "Education is the most powerful weapon which you can use to change the world," I founded Red Fish Route (RFR), an educational awareness campaign to promote change and as a solution to this local, national, and global problem faced by environmental wastewater systems. Since grade 9, I have presented to over 6800 students grades 1-6 on my PA days, exam breaks and at the local Tri-County Children's Water Festival for the last four years; as well as hundreds of adults. Using my "Toilet Paper Challenge" experiment, I continue to help establish good flushing habits for the next generation and teach them that 'toilets are not garbage cans.' Returning to the CWSF recently in Ottawa, winning a bronze medal with this new project, on this same topic of Flushables; has bookended my high school career, with another great opportunity to bring more awareness to this environmental water topic that I am very passionate about. I love public speaking and seize any opportunity to present my RFR at city council or board meetings or in schools; and I am motivated by young students who at the end of my presentation tell me things like, "I will never forget this for the rest of my life" and adults who tell me, "I will change my ways after 40 years." I welcome everyone to view my Toilet Paper Challenge on YouTube at 'Red Fish Route' and also, the CBC news article and video I am featured in at http://www.cbc.ca/news/canada/toronto/flushable-wipes-cause-waste-treatment-plant-backups-1.2772543.

As I am in my graduating year, I will be attending the University of New Brunswick in Fredericton, NB, in eastern Canada, this fall. I consider myself one of the youth Terry Fox spoke of when he said the youth must keep his dream alive. So I actively participate in the annual Terry Fox Run and fundraising. I also enjoy fencing, slacklining, running, origami and geocaching.

Remember to think twice before you flush.

3. Introduction

Figure 1 Barry Orr standing beside a fatberg found in London, ON - 2013 Image from Dave Chidley, Canadian Press.

For more than a century, toilet paper, produced with pulp, has been user-friendly and approved by international sanitation systems. Yet the 'flushable' market has expanded, and the flushable wipe (non-woven product) industry is forecasted "for sales to increase further to $2.7 billion by 2020" [8]. However, the criteria for the designation, "flushable", have not been determined by wastewater authorities and manufacturers. Furthermore, no regulation of logos for packaging of "flushable" products exists. The lack of regulation results in contradictory, fine print packaging disclaimers such as, "Not all systems can accept flushable wipes. Ignoring disposal instructions may lead to clogs, property damage or regulatory violations" [2]. The International Nonwovens & Disposables Association, (INDA) and European Disposables and Nonwovens Association, (EDANA) have published the Third Edition Guidance Document (GD3) in June 2013, outlining seven core tests which must be passed to support flushable claims. The GD3, however, is described as a "tool for manufacturers... [and] it provides framework... to help decide" if a product is flushable [6]. The International Wastewater Services Flushability Group (IWSFG) has the objective "to develop and maintain clear standards that define suitable criteria for products that can be flushed down toilets and drains, to protect water collection and transfer systems, treatment plants, their workers and the environment" [4]. The wastewater authorities and manufacturers have yet to agree unanimously on flushability or authenticate testing by any standards body, and therefore the flushable industry currently relies on manufacturers adhering to environmental sustainability. In 2013, 'fatberg' masses, consisting of congealed fats and hygiene products, were news headlines. CBS News reported, "Utility Company, Thames Water, removed what it's calling the biggest "fatberg" ever recorded in Britain — a 15-ton blob of congealed fat and baby wipes the size of a bus lodged in a sewer drain" [1]. This topic became the core of my earlier work done for the 2014 CWSF, *Environmental Impact of Shifting Consumer Hygiene Trends*, where three types of toilet paper were tested against five name-brand flushable wipes, baby wipes, facial tissues and paper towels. This study proved that nothing disintegrated like toilet paper. Tests included exposure to water, strength ability, and effect of agitation on the breakdown properties of the materials being studied. Disappointingly, by September, 2017, the 15-ton record setting fatberg had been surpassed, by "a fatberg weighing the same as 11 double-decker buses and stretching the length of two football pitches" [9]. Wastewater repairs and replacements due to non-flushable clogs cost Canadian Tax Payers $250 million yearly [5], literally flushing money down drains. Research can reveal that toilets are not garbage cans and the use of sanitary systems impacts our health, environment and economy; toilets should be used more wisely. The purpose of this study was to determine if current products, labelled "flushable", will disintegrate sufficiently and be as compatible with wastewater systems as toilet paper. A nonwoven wipe, labelled as not flushable was used as a negative control, to determine if disintegration rates of wipes labelled as flushable reacted differently. Dog feces bags, feminine hygiene products and toilet fresh brush refillables were also tested against the controls to determine if these items branded as flushable,

disintegrated. The study was designed to separate the test samples into two categories: those which disintegrate like toilet paper (flushable) and those which do not disintegrate like toilet paper (non-flushable). For this study, it was predicted that if disposable products labelled flushable were introduced into water and tested against long term exposure with agitation, sewer simulation, real toilet bowl flush, no agitation and exposure to heat, they will not break down like toilet paper, and are expected to react similarly to the negative control. The overall goal of this study is to test the breakdown of flushable products. Longer term goals would include changing public opinion and consumer behaviour about products labelled flushable and to influence the proper testing and labelling of these products.

4. Materials and Methods

4a. Long Term Exposure to Water with Agitation

Thirty jars contained 355 mL of water, eight samples and 1/8 teaspoon of sand and two corn kernels to simulate grit aspects of the sewer. Lids were secured and jars were swirled for 5 seconds, the average toilet flush. Jars remained sealed and out of direct sunlight for 7 days. Every 24 hours the 5 seconds swirl was repeated.

Purpose: To assess the effect of long term exposure to water with agitation, on disintegration rate.

Figure 2 Three trials of each sample were prepared and kept out of sunlight for seven days, agitating for five seconds every 24 hours.

4b. Sewer Simulation A large clear bowl was filled with 2050 mL of water. Tubing for an air pump was placed in the bowl and weighed down with washers. A jar was filled with 750 mL of water and one sample. The capped jar was shaken three times and then poured into the large bowl. Two more repeats of the same sample were added to the large bowl. This created a total volume of 4300 ml, which equals the average amount of water used to flush a toilet. A timer and an air pump were used to simulate sewer 'lazy river' flow, and observations were recorded every hour, for three hours. NOTE: Three hours was used to give maximum exposure for degradation because "the typical transit time for a flushable product to reach a pump station in a municipal sewer system is approximately 1-3 hours" [7].

Purpose: To assess transport effects of sewer systems on disintegration.

Figure 3 Three trials of toilet paper sample in sewer simulation test for three hours of 'lazy river' agitation.

4c. Low Flow and Regular Flow Flush

Low flow (6 L) and regular flow (13 L) toilets were used. One sample was placed in the centre of the bowl and flushed after three seconds, to saturate the sample in the bowl. Three trials per sample were completed per toilet. NOTE: Before each trial was initiated, toilet bowl refilling was complete.

Purpose: To assess disintegration rate after an actual toilet flush and compare the impact of water capacity of toilets on disintegration.

Figure 4 Three trials of each sample were flushed down the low flow toilet and same parameters were repeated for the regular flow toilet as well.

4d. No Agitation

Thirty jars with 355 mL of water contained each of the eight samples and were left for observation. Every hour, for three hours observations were recorded.

Purpose: To isolate the role of agitation in disintegration.

Figure 5 Three trials of each sample left for three hours of no agitation.

4e. Exposure to Heat

Thirty jars contained 355 mL of 41°C water, the average temperature of shower water which could be introduced to sewer lines. Samples were then placed in jars, for a total of 8 minutes, the average shower length. This was repeated for each sample type.

Purpose: To isolate the effect of heat on disintegration rate.

Figure 6 No disintegration seen in samples after exposure to increased temperatures.

5. Results

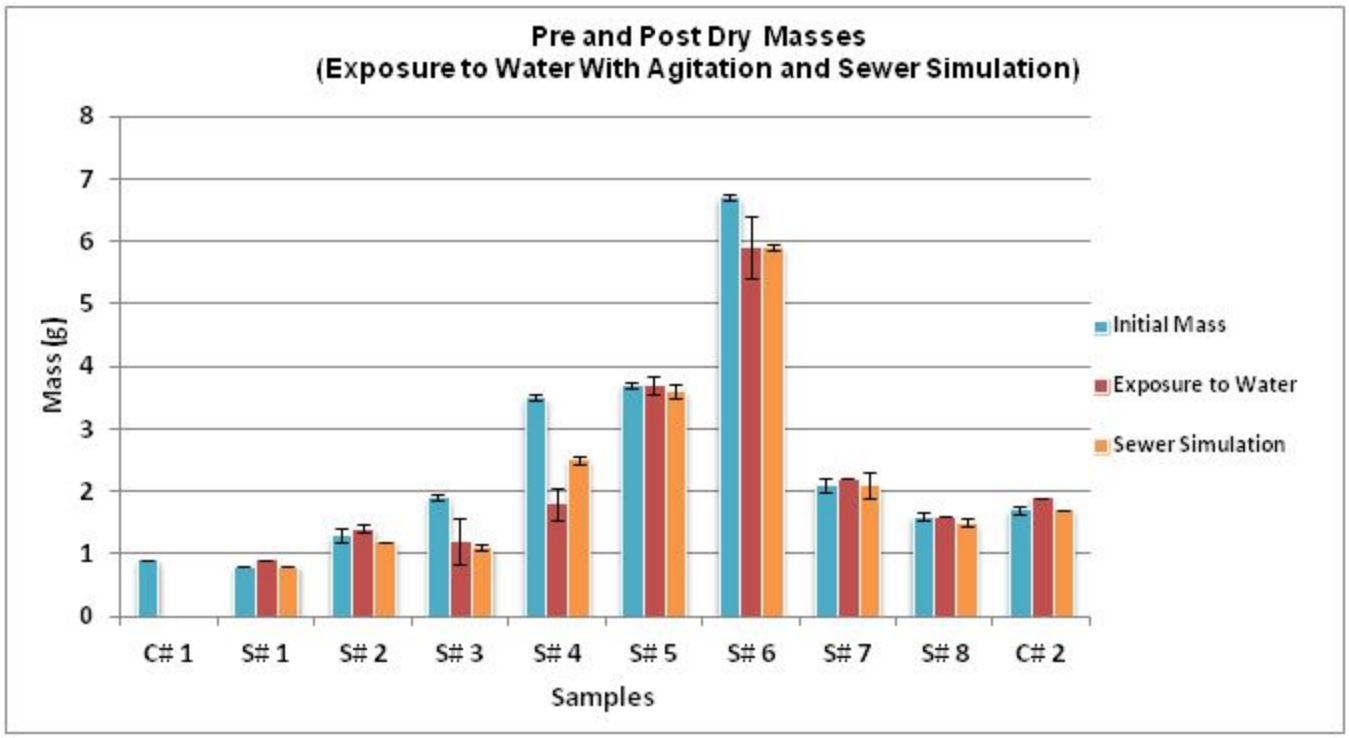

Figure 7 The arithmetic mean showing initial masses versus post experiment masses from exposure to water with agitation tests and sewer simulation tests. No significant disintegration shown; standard error bars indicate ± 0.1g.

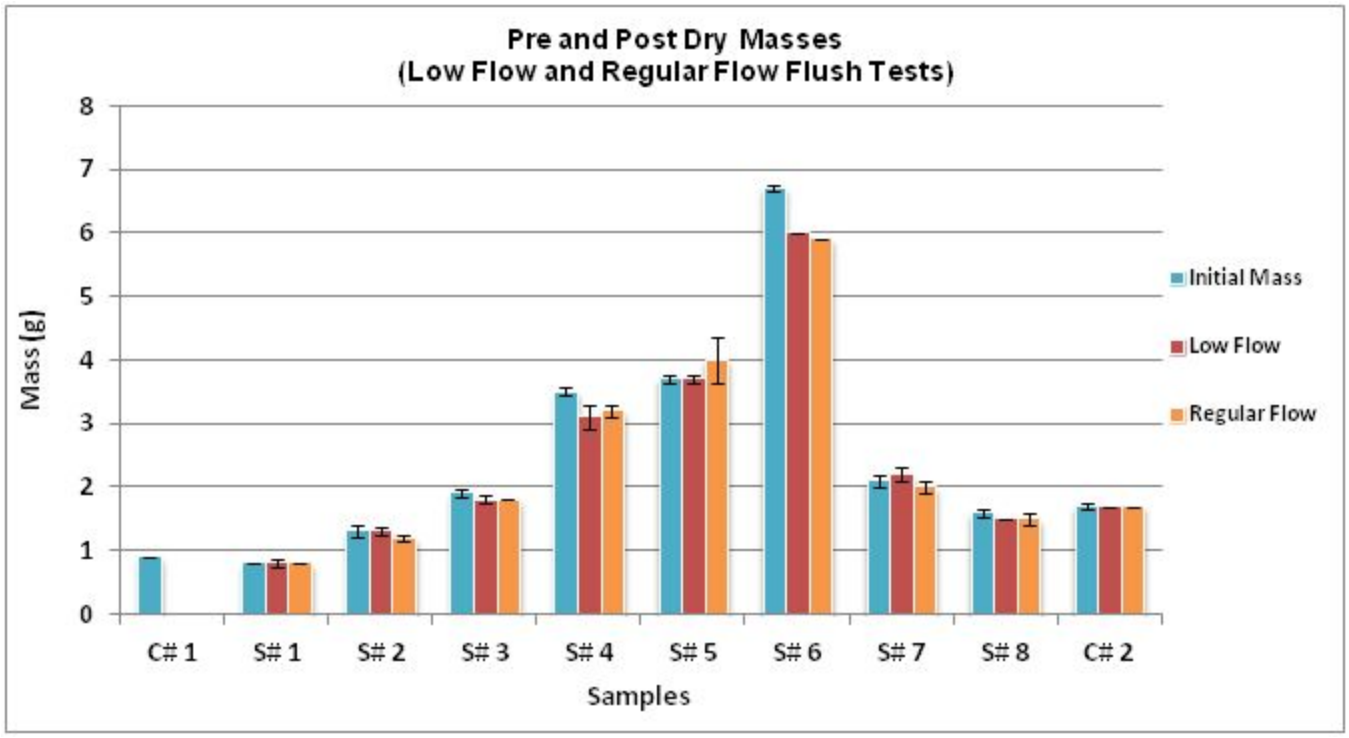

Figure 8 The arithmetic mean showing initial masses versus post experiment masses from low flow flush tests and regular flow flush tests. No significant disintegration shown; standard error bars indicate ± 0.1g.

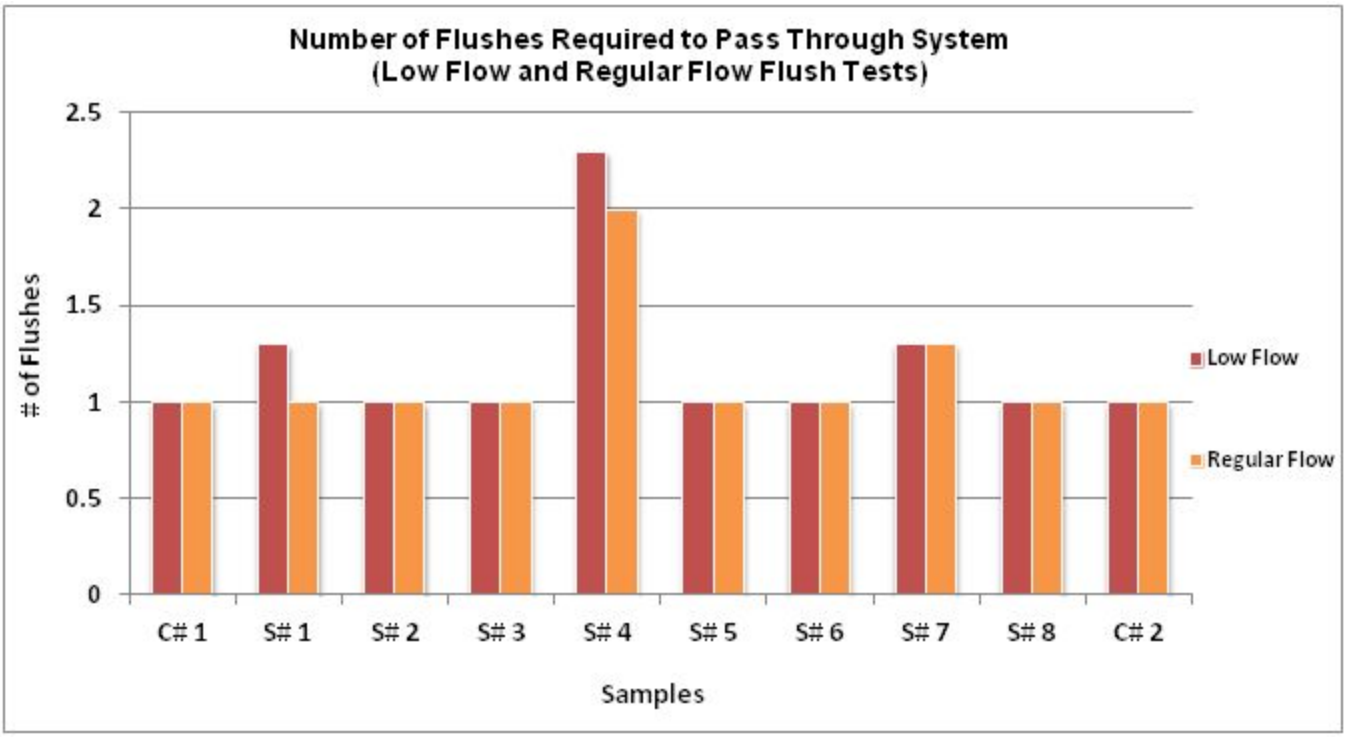

Figure 9 Many sample trials required more than one flush.

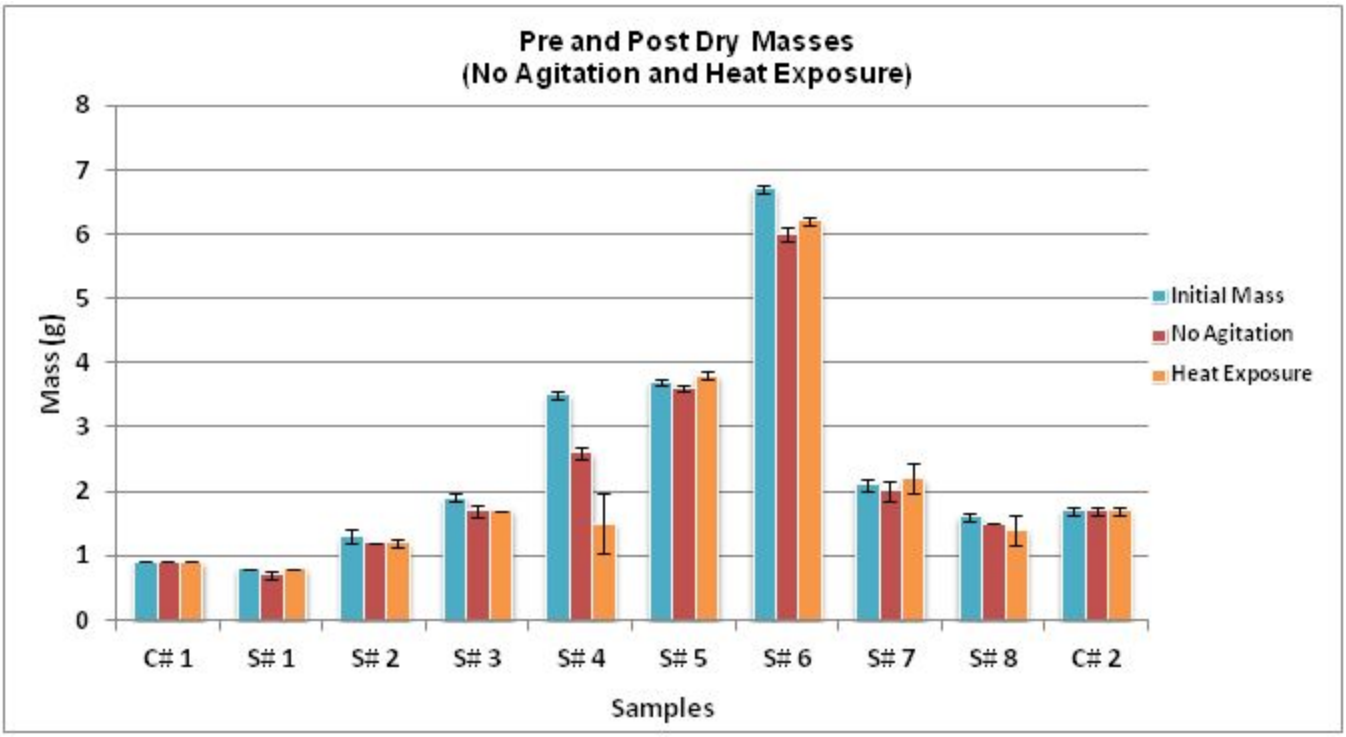

Figure 10 The arithmetic mean showing initial masses versus post experiment masses from no agitation tests and exposure to heat tests. No significant disintegration shown; standard error bars indicate ± 0.1g.

Pass – Fail of Samples' Mass Loss

Products	Exposure to Water with Agitation	Sewer Simulation	Low Flow Flush	Regular Flow Flush	No Agitation	Exposure to Heat
C#1 Toilet Paper	✔ 100	✔ 100	✔ 100	✔ 100	X 0	✔ 100
S# 1 Flushable Wipe	X Gain	X 0	X 0	X 0	X 0	X 0
S# 2 Flushable Wipe	X Gain	X 8	X 0	X 8	X 8	X 8
S# 3 Flushable Wipe	X 37	X 42	X 0	X 8	X 11	X 11
S# 4 Dog Feces Bag	X 51	X 29	X 11	X 9	X 26	X 57
S# 5 Feminine Hygiene Products	X 0	X 3	X 0	X Gain	X 3	X Gain
S# 6 Toilet Fresh Brush Refillables	X 12	X 12	X 10	X 12	X 10	X 7
S# 7 Flushable Wipe	X Gain	X 0	X Gain	X 5	X 5	X Gain
S# 8 Flushable Wipe	X 0	X 6	X 6	X 6	X 6	X 1
C# 2 Non-Flushable Wipe	X Gain	X 0	X 0	X 0	X 0	X 0

Figure 11 Numbers above indicate percentage of average mass lass. Requirements to Pass Acceptance Criteria: SAMPLE MUST HAVE ≥ 95% MASS LOSS; in accordance to the International Wastewater Services Flushability Group.

✔ - Pass, **X** - Fail

Notes: Items that were seen to gain mass, is due to drying process.

6. Discussion

The results showed significant differences in the disintegration rates of the samples, as compared to toilet paper, and similar disintegration rates, to the non-flushable wipe. EXPOSURE TO WATER WITH AGITATION: No flushable products disintegrated. The control had no measurable residue and the negative control did not disintegrate. SEWER SIMULATION: 8 out of 8 flushable products and the negative control withstood the sewer simulated agitation without breaking up, where toilet paper samples broke up easily. One flushable wipe showed some disintegration but even its greatest disintegration lost less than 50% of its initial mass. LOW FLOW AND REGULAR FLOW FLUSH: No flushable products disintegrated from the agitation of a low flow or regular flow toilets, while toilet paper disintegrated. The non-flushable wipe did not disintegrate. Results also indicated 8 out of 60 trials (13%) required more than one flush because the flushable product clogged the toilet; the low flow toilet accounted for 5 of 8 clogs. One trial of a dog feces bag was stopped due to unsuccessful flushing after three attempts. NO AGITATION: All flushable products, the control and negative control, showed no disintegration with just water exposure. Finally, EXPOSURE TO HEAT: Seven of 8 flushable products' disintegration were not affected by the rise in water temperature. It was observed and data supported that the dog feces bags did disintegrate at a greater rate with heat and the control and negative control were not affected by heat.

<u>Limitations:</u>

- Samples were left in the state they would be used by a consumer, so any chemicals or lotions were not removed by preconditioning prior to tests. INDA/EDANA GD3 testing, run samples through the Toilet and Drain-Line Test prior to the Slosh Box Test, to remove lotions and chemicals from the flushable product. This is a limitation because the pre-dried sample mass would have dried lotion included in that mass. The post-dried sample mass would have these lotions removed after exposure to water and their post-dried mass could be slightly less without the chemicals present. The No Agitation test indicates mass loss, which could be related to the lotions.
- The United Kingdom's testing allows 24 hours for a sample to disintegrate and if it does not clear a drain line test, the sample is considered a potential clog inducer. Duration of Exposure test was 7 days, extending the test period significantly. Although it had potential to allow more disintegration, due to the length of exposure, this did not happen, proving how non-flushable these products are. Manufactures in the USA, test over 24 hours with shaking agitation at the following minute intervals 60, 80, 100, 120 and the final 24 hour mark. The sewer system, which is described as an intermittent, gentle, gravity fed flow, has wastewater introduced from household toilets flushing, draining sinks, showers, baths or laundry; therefore, swirling every 24 hours may not have been enough agitation. Therefore the sewer simulation test was designed.
- Toilet flush tests, looked at the agitation received from the flush of a toilet only. Toilet contents dropped into a bucket directly below the toilet; contrastingly, manufacturers' Toilet and Drain-Line Tests, connect a toilet to 22 metres of drain-line. The positive control however, did not require further agitation from tumbling in the drain-line, since it disintegrated after only the flush. Tests were also completed in a storage warehouse, and the water used could not be regulated to room temperature, as in other tests – average toilet water temperature is 20^{o}C. After speaking with a member of MESUG, it

was noted, the average water temperature in the sewer is 15°C, which is closer to the water temperature used for this test.

My project focuses on raising awareness and creating change in the way people manage our wastewater. It is said, history repeats itself. Has too much time passed from the lessons learned in 1858, in London England, during the Great Stink; where waste and pollution in the Thames River made it contaminated, unhygienic and the source of waterborne illnesses? Recent news stories like London's growing fatbergs and the federal court fine, on April 12, 2018, under the Australian Competition & Consumer Commission to Pental Limited for misleading consumers about the flushability of their White King bathroom cleaning wipes; are proof that it is a very real problem.

My Solution: Red Fish Route, established 2015

Being part of a student generation who learned from elementary school programs like litter-less lunches and proper e-waste disposal; I recognized good, life-long habits could be formed from a young age, with the right encouragement. I believe this global problem can be avoided through education. Barry Orr states, [Water] "Pollution Prevention is the most cost effective sustainable method to protect our environment" (Orr, B). We need to protect our aging infrastructure and our water environments; as highlighted in The Water Brothers episode called "The Big Leak" available online.

Red Fish Route is an environmental, educational program, aimed at grades 1-6; to teach the connection between the drains in houses, schools and city buildings; through the wastewater treatment facility, to where the effluent is released into streams, rivers and bodies of water in the surrounding area. In short, it connects what we flush down our toilets and drains to our watershed.

I use a display board to map out this very path.

Using my love of science, I designed a hands-on experiment called "The Toilet Paper Challenge" to illustrate firsthand the comparison of disintegration rates of commonly flushed items against toilet paper, as well as, display static containers which show a visual of more non-flushable items in water; like make-up pads, ear swabs, unused medicines, and kitty litter.

In addition, I created a logo; a fish, shaped and coloured red like a stop sign, to remind people to stop and think twice before they flush. Using the logo, stickers were made for school bathroom stalls to be a visual reminder that human wastes, and toilet paper, are the only two sewer approved flushable items.

Lastly, I designed a doorknob hanger that students who participate in my program can take home and colour to personalize and hang on their bathroom door, to help spread the knowledge they have gained to their family and friends.

Next Step: Design a RFR website with links and materials which teachers can use to delve deeper into the topic of flushables and non-flushables.

Examples of local impact of RFR: My teacher, Ms. Betty Lynn Bird, expressed to me, that her children participated in my RFR at their school and she has seen firsthand how they are more conscientious with their water use and the creation of waste. Suzanne Cholasta, a principal in Stirling, ON, whose school participated in the RFR program, said it kicked off her grade 2-3 class challenge to save the earth and their hashtag #earthwillthankyou. Corinne Harris of the LTC, also stated, "The longevity has been proven with this [RFR] program as I am in the school community, and the students and the teachers still talk to me about the program. And when I am talking about other things with the kids they mention different aspects that Holly has impressed upon them."

The results of my project will be of interest to the following groups:

- As founder of **Red Fish Route**, presentation materials will need to expand and include new "non-flushables," to continue to teach lifelong, environmentally friendly flushing habits to the next generation.
- **MESUG**, as my findings are consistent with those of their own testing and with the messages of their sewer outreach.
- The Canadian Standards Association **(CSA)** & the International Organization for Standardization **(ISO)**, since Canada took the lead to develop ISO standard for flushable products in September 2014.
- Canadian Water and Wastewater Association **(CWWA)**, Rob Haller, Executive Director, wrote in a congratulatory letter to me "Wastewater is rarely seen as an interesting topic and certainly not an attractive topic, but it is a very important one! How we treat our waste is critical to the health and economy of any community and the viability of this environmental system is threatened by misuse."
- **Homeowners** who are also taxpayers and consumers of these flushable products – for their own plumbing and their safe usage of the public sewer system or their own private septic systems. Water and sewer bills have already seen an increase, and the addition of 'Wastewater Capital Charges' are appearing in some municipalities.
- Recent polls on the internet show that close to **60% of females flush feminine hygiene tampons** down the toilet, which are not sewer approved. Bringing awareness to this matter should be of interest to all tampon users and manufactures so they can properly label all packaging.
- **New home purchasers** in the future should be aware that individual household grinders are becoming more evident in new homes' plumbing. Usage of products that should not be flushed down the toilet could possibly be an expense coming from their own pocket, to fix a clog.
- **Manufacturers** of products that are used near toilets so they can ensure their products are properly labeled.
- Mayor of Brighton, His Worship Mark Walas has invited me to address the **Brighton City Council** on my findings and my RFR solution.
- Quinte West Mayor, His Worship Jim Harrison has also invited me to address the **Quinte West City Council** – June 18, 2018.

Figure 12 Image taken at Cobourg Water Pollution Control Department Treatment Plant #1, April 25, 2018: Monster™ Finescreen Separation System seen with large flushable wipes clogging the holes. In September 2017 Cobourg installed a $2 million set of new submersible pumps, to try and grind these larger items before they damage the screens.

Figure 13 Image taken at Cobourg Water Pollution Control Department Treatment Plant #1, April 25, 2018: Items seen clogging the shaft, after initial screening, to go to landfill.

Figure 14 Image taken at Cobourg Water Pollution Control Department Treatment Plant #1, April 25, 2018: Feminine Tampon applicators and candy sticks are seen in the chlorine contact basin, the final step before the water reaches the effluent and out water bodies.

Figure 15 Image taken at Duffin Creek Water Pollution Control Plant, September 18, 2014: Barry Orr and I standing beside the Monster™ Finescreen Separation System, examining non-flushables clogging the screens.

Figure 16 Image taken at Duffin Creek Water Pollution Control Plant, September 18, 2014: The initial step of the Monster™ Finescreen Separation System, bombarded with non-flushables.

Figure 17 Image taken at Duffin Creek Water Pollution Control Plant, September 18, 2014: Barry Orr extracting non-flushables, fully intact, from the Monster™ Finescreen Separation System.

Figure 18 Image taken at Duffin Creek Water Pollution Control Plant, September 18, 2014: Non-flushable items, removed from the wastewater system, heading to landfill. Duffin Creek Wastewater alone sends one of these bins full every day.

7. Conclusions

- Products marked as flushable **do not break down like toilet paper.**
- By comparing the results of the test samples to that of the control, it can be concluded that toilet paper should be the only item flushed in our sewer system. This concurs with the **wastewater authorities' sewer-approval** of toilet paper only.
- Toilet paper is quick to breakdown however **agitation plays a role** in the process of its disintegration.
- The **low flow toilet clogged** more frequently than the regular flow one, however, sample disintegration rates are similar, after flushing through both toilets; with the exception of the dog feces bag which did not flush in the low flow toilet.
- Flushable wipes **do not disintegrate consistently** across different brand names or under one brand name, through all tests.
- Only one of five flushable wipes showed any disintegration but even with its greatest disintegration in the sewer simulation test, it lost less than 50% of its initial mass.
- Flushable wipes have the potential to **cause clogs**, and **damage pumps, filters and grinders** in the sewer system, as they maintained their pre-test states after experimentation.
- The dog feces bags needed hot water to show any significant disintegration.

- The feminine hygiene product and toilet fresh brush refillables sink, and do not degrade; and if fats, oils and grease are poured in the system, could **bind together forming a fatberg**.
- The feminine hygiene strings tangled together and therefore are a potential for clogs in the sewer system.
- The negative control did not clearly distinguish itself from flushable wipes during the tests and therefore, does not explain why the two are labeled differently (flushable and non-flushable).

Until there is a firm industry definition of what is 'flushable' and mandatory standardized tests, accepted by both sewer authorities and the manufacturers are established; and **consistent logos** for 'flushable' and 'non-flushable' products are more clearly marked on the front of products, then **public education** and awareness of these results are **necessary.** The **public should not treat toilets like garbage cans** and should be more skeptical of product claims. Simply stated, by flushing only toilet paper we could redirect $250 million in Canada alone, towards other areas of need.

8. References

[1] CBS. *15-ton 'fatberg' blasted out of London sewer*. https://www.cbsnews.com (accessed Oct 2013).

[2] Equate. *Personal Wipes*. Manufacturer packaging. Accessed Apr 2018.

[3] IWSFG. IWSFG PAS 3: 2018 – Disintegration Test Methods – Slosh Box. Retrieved from https://www.iwsfg.org (accessed Apr 2018).

[4] IWSFG. *Memorandum of Understanding to establish the International Water Services Flushability Group: Background*. https://iwsfg.org (accessed Apr 2018).

[5] MESUG. *Flushables*. https://sites.google.com/site/mesug2011 (accessed Feb 2018).

[6] Ogle, S. *Executive Summary: Third Edition Guidance Document for Assessing the Flushability of Nonwoven Disposable Products*. https://www.inda.org (accessed Mar 2018).

[7] Ontario. *Preliminary Treatment and primary sedimentation*. https://www.ontario.ca (accessed Feb 2018).

[8] Smithers Group. *Key trends driving the Global Flushable Wipe Market*. https://www.smitherspira.com (accessed Feb 2018).

[9] Taylor, M. *'Total monster': fatberg blocks London sewage system*. https://www.theguardian.com (accessed Feb 2018).

9. Bibliography

Bitz-McIntyre, K. *Flushability: The Fight Continues.* https://www.nonwovens-industry.com (accessed Apr 2018).

Environmental Working Group. *Skin Deep Cosmetic Database - EWG Certified*. https://www.ewg.org (accessed Mar 2018).

Flush Puppies. *Are flush puppies safe for septic and sewer systems.* https://www.flushpuppies.com (accessed Feb 2018).

Goodman, L.A. *Growing array of 'flushable' products wreaking havoc on Canada's sewage system*. https://www.theglobeandmail.com (accessed Apr 2018).

Kimberly-Clark. *Kimberly-Clark Jar Test.* http://www.kimberly-clark.com (accessed Mar 2018).

Kirkpatrick, N. *Why you shouldn't flush flushable cat litter*. https://www.mnn.com (accessed Feb 2018).

Noyes, J. *False flush: Company behind White King 'flushable wipes' fined $700K*. https://www.smh.com.au (accessed Apr 2018).

Orr, B. (2014). If you do not think wipes are an issue, look closer! City of London, Municipal Enforcement Sewer Use Group. 48.

Shaver, K. *Fight over labeling of 'flushable' wipes headed to federal court.* https://www.washingtonpost.com (accessed Apr 2018).

The Weather Network. *Flushable Wipes aren't actually flushable.* https://www.theweathernetwork.com (accessed Apr 2018).

10. Annex 1

Red Fish is operated on a pay-it-forward basis, where schools voluntarily pay the cost-only of bathroom stickers and doorknob hangers, which allows for the program to continue.

Figure 19 Red Fish Route logo and bathroom stall sticker for schools.

Figure 20 Red Fish Route doorknob hangers, colourable for all students to personalize.

Figure 21 Red Fish Route visual display, illustrating the pathway between toilets in our households, schools and buildings, to wastewater treatment plants and finally to our watershed. Students see the connection between what we flush down our toilets and how it directly affects ours lakes, rivers, streams and oceans.