City of Guelph
Guelph Residential Greywater Field Test Draft Final Report

Appendix E

Municipal Management Framework – Risk Model/Process

Final Report

June 29, 2012

Municipal Management Framework – Risk Model/Process

Please refer to the included PDF file below (Grey Water Reuse Risk Framework.pdf).

Water

City of Guelph

Residential Greywater Reuse Field Test Management Framework Municipal Stakeholder Workshop

Prepared by:

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Project Number:

60241592

Date:

February 23, 2012

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March 6, 2012

Wayne Galliher
Water Conservation Project Manager
Water Services Division
Planning & Building, Engineering and Environment
City of Guelph

Dear Mr. Galliher:

Project No: **60241592**

Regarding: **Residential Greywater Reuse Field Test Management Framework Municipal Stakeholder Workshop**

AECOM is pleased to present one (1).pdf copy our **Final Workshop Report** associated with our consulting services for the Facilitation of the City of Guelph's Residential Greywater Reuse Workshop.

AECOM would like to acknowledge the efforts and contributions provided by the City of Guelph and thank you for this opportunity.

We trust that our report submission meets your requirements. Should you have any questions or require further information about our submission please contact the undersigned at 905.390.2004.

Sincerely,
AECOM Canada Ltd.

Geoff Linschoten. CET
Branch Manager, Hamilton Office

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1		February 23	Draft 1
2	GL	Feb 23, 2012	Incorporated comments and Added Section on Risk Changes due to expanded program
3	GL	March 5, 2012	Final Report

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References Used in Presentation

Reference A. Presentation: Residential Greywater Reuse Field Test Pilot Module 1 – Module 6
Reference B. Presentation: Introduction to Risk Management Framework

1. Project Background

In May of 2009 the City of Guelph Water Services Division initiated the Guelph Residential Greywater Reuse Field Test in alignment with recommendations of the City's 2009 Water Conservation and Efficiency Strategy. This field test aimed to evaluate the appropriateness of current home based greywater reuse technologies as a future demand side management and green building alternative through the installation of study of greywater technologies within 30 homes in the City of Guelph.

To asses the feasibility of greywater home-based residential systems, five (5) core areas of study were selected:

- System Operation and Performance
- Homeowner Satisfaction
- Household Water Use Monitoring
- Municipal Management Frameworks and Required Support Networks
- Premise Isolation Device Requirements

This project is now within its final steps with the study project team working towards preparation of a final report to the Federation of Canadian Municipalities for April 2012. In working to evaluate the appropriateness of these current technology alternatives a final deliverable under the project includes defining the management framework necessary for Canadian municipalities to employ home based greywater reuse technologies as a demand management/substitution approach (as appropriate).

As an initial step in defining this framework, a staff stakeholder workshop was held on February 8, 2012. The workshop served as an initial opportunity for the project team to share results of the field test with a wide range of internal City stakeholders and gain stakeholder insights/feedback with respect to key barriers and opportunities related to current technologies.

Stakeholder representation from various groups and divisions within the City were invited and requested to participate in this workshop. The following summarizes the individuals and groups that participated in the workshop:

Name	**Position / Program Area**
Bruce Banting	Associate Solicitor
Bruce Poole	Chief Building Official
Caroline Charbonneau	Water Conservation Program Assistant (Coop
David Auliffe	Plumbing Inspector III
Jennifer Gilks	Water Conservation Program Coordinator
Kiran Suresh	Manager of Capital Projects, Acting General Manager of Wastewater Services
Michelle Rickard	Communication Coordinator
Rob Blakeney	Program Manager, Community Energy
Rob Reynen	Manager, Inspection Services
Wayne Galliher	Project Manager, Water Conservation

Information attained as a result of this workshop will ultimately be utilized by the project team to inform the creation of potential management frameworks for Canadian Municipalities to consider when evaluating the application of such technologies in their respective jurisdictions.

AECOM (Geoff Linschoten and Erin Hobbs) was retained to assist with facilitation of the workshop, guide City staff and solicit feedback regarding the probability and consequence of potential known issues associated with residential

grey water reuse from their individual viewpoints, as well as document the workshop dialogue and produce this summary report.

2. Workshop Format

A full day workshop was conducted with City of Guelph Project Team, invited Stakeholder Representation.

The follow summarizes the workshop agenda:

1. Overview of Project Background and Workshop Objectives: Wayne Galliher
2. Overview of Workshop Agenda and Ground Rules: Geoff Linschoten
3. Round Table Introductions: All Attendees
4. Residential Greywater Reuse Field Test Pilot: Wayne Galliher
    a. Module 1: Introduction and Greywater Overview
    b. Module 2: State of home Grey Water Systems
    c. Module 3: Water and Energy Demands
    d. Module 4: Water Quality Monitoring
    e. Module 5: Social Acceptance
    f. Module 6: Life Cycle Analysis
5. Roundtable discussion about the Test Pilot and Questions
6. Introduction to Risk Management Framework
7. Greywater Reuse Risk Model Development

The morning portion of the workshop focused on providing City stakeholders with a background understanding of the pilot project as well as an overview of the grey water field test summary of results which was presented through six (6) summary modules listed above.

The afternoon portion of the workshop focused on providing City stakeholders an overview of risk, sample risk management frameworks, followed by facilitation of the development of a risk management framework as it pertained to the City of Guelph's Greywater Reuse Field Test.

Further Details are provided below.

2.1 Residential Greywater Reuse Field Test Pilot

Wayne Galliher presented an overview and results of the residential greywater reuse field test pilot through as series of modules. The following summarize key points discussed in each module.

Module 1: Introduction

- Guelph has specific water conservation program targets to reduce 2006 average day water production by 20% by 2025 and a goal to use less water and energy use per capita then any other Canadian City.
- Co-benefits include greenhouse gas (GHG) reduction and operational savings.
- Focus has been placed on multi-sector approach, with emphasis on public and youth education, harnessing internal efficiencies, and support for innovation and capacity building.
- Saturation of current water conservation program is expected in a 10 year period, so the City is now looking to new demand management programs – Greywater reuse systems showed a great amount of public support through public consultation as part of the City's Water Conservation Strategy.
- There are benefits for both water and wastewater. The Wastewater Treatment Master Plan recognized the benefits of the conservation strategies, for example the Master Plan counts on demand reduction to optimize

current infrastructure and proposes investigation of a communal effluent system for treated wastewater to substitute appropriate non-potable uses and reduce additional water/wastewater demands/infrastructure.

- Two greywater reuse systems were looked at: Centralized and Communal. Centralized systems offer low cost, not need to stage timing of other infrastructure removal, and the technology exists. The negative aspects include performance dependant homeowner maintenance, lack of controls for municipality, technology readiness and uptake, and social acceptance. Communal systems offer high level automation, controls for quality and quantity in place. The negatives include high capital investment, question as to whether or not the customer base exists, lack of standards, and feasibility (maintaining minimal stream flows).
- The communal systems currently installed in pilot homes utilize water from showers to flush toilets. There seems to be a comparable demand between shower water use and toilet flushing needs.
- The pilot project duration was established from May 2009 – April 2012. The goal was to install 30 greywater reuse systems in 30 new and existing homes (25 were installed in the end). The FCM Green Municipal Fund provided $72,524. Participant requirements included site access for water quality monitoring and providing feedback.
- Project partners included Fusion Homes, Reid's heritage homes, Evolve Builders Group, Veritec Consulting, University of Guelph School of Engineering, Federation of Canadian Municipalities, and a large internal team in the City.
- The field test program was established to assess the feasibility of large scale implementation of systems. Field studies included water quality monitoring (both microbiological and chemical), energy use, water demands, social feedback, and comparison of energy and water demand before and after installation.
- Some challenges included lack of third party performance testing standards (CSA B128.3). CSA B128.1/2 exist but are not enforceable standards via the Ontario Building Code. Pilot programs addressed the desire to test systems in real-world situations, public awareness of technologies, homeowner maintenance & operational sustainability, limited end use application (toilets, urinals, flow drain priming), and system costs.
- Grey water re-use offers many opportunities: substitution of demand, matching quality to task, community and political support and expertise, community conservation ethics, facilitating growth in a ground water based community, backflow prevention expertise, and building industry support.
- Applicable standards include: Ontario 2006 Building code, Standards - CSA B64.10, CSA B128.1/2 CSA B128.3, and Heath Canada Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing, Backflow Prevention – bylaw.
- 25 homes participated in study, 15 retrofit, and the remaining in new homes.
- $1,500 rebates were offered as well as five (5) years of backflow prevention device inspections by the City.
- The results indicated that water use decreased 10.2% in new homes, 26% in older homes.
- Water Quality testing parameters included turbidity, total and free chlorine, biochemical oxygen demand, chemical oxygen demand, E.coli, coliform.
- City of Guelph employee visits took place in each home to take water quality samples, with a subset of systems monitored on a heightened frequency by the University of Guelph, School of Engineering.
- Social feedback was achieved through four surveys to gain an understanding of homeowner satisfaction: knowledge of the system, satisfaction, personal care products used, system performance, bathing schedules/habits.
- Qualitative research was undertaken through ongoing homeowner surveys, focus groups, homeowner interviews, and web based surveys.

Module 2: State of Home Greywater Systems

- Some challenges include rainwater and grey water being lumped together as storm sewage through the OBE, outdoor uses are not permitted, permitted indoor uses are minimal, and a direct bypass to the system is not permitted by code should the system pump fail or there be a power failure at the home (and lack of power to system to operate the pump)..

- Retrofit systems require research, purchase of a system, modifications in basements, require a licensed plumber to install, access to plumbing and pipe labelling. Installation is much more feasibility if the home is already undergoing renovations.
- New systems require little effort on the part of the homeowner; however the homeowner is often not involved or unaware of the responsibility of the system. There can also be builder cost mark-ups on system installation due to supply chain costs in new construction which pose additional financial barriers to uptake.
- Greywater pilot system eligibility criteria included: system available in Canada with local tech support, must be generally cost effective, maintain chlorine residual, remove particulate matter, have a minimum of 150L of storage capacity, achievable maintenance program, and be installed in accordance with OBC.
- Maintenance requirements include knowledge of certain beauty products, monitor and awareness of tank level, cleaning/changing the filter once per week, and adding chlorine pucks once per month.
- Homeowner requirements and challenges include awareness of system's requirements, understanding the recycle system if going on vacation, accepting the responsibility of reading the system manual, and knowledge of mould.

Module 3: Water & Energy Demands

- Efficient showers and toilet heads were used in the pilot program. The average shower duration is 8.5 minutes, with an average of 0.75 showers per day per person.
- Average toilet flushing is five (5) flushes per person per day.
- Expected savings were estimated at 24 lcd.
- Savings were validated through two water meters fitted on systems with data loggers. Meter 1 recorded volume of potable water makeup supplied to system, Meter 2 the volume of greywater supplied for toilet flushing.
- The average savings achieved through the pilot was 22.6 lcd. In new homes the savings was 16.6 lcd due to new more efficient low volume fixtures.
- In some instances, it was observed that water use went up. It was suspected that potable water was being used to fill the greywater reservoir when the system was running on bypass for reasons such as insufficient maintenance.
- A energy kWh meter was also used to assess the energy requirements of the system pump. An average of 1.58kWh/m3 or $3 per household / year was observed.
- For the City of Guelph's entire Water and Wastewater Treatment System process, the cumulative energy intensity is 1.2kWh/m3.

Module 4: Water Quality Monitoring

- 20 homes were sampled by City, Five (5) by University at heightened frequency.
- Health Canada Guideline however requests a 30 day system start-up sampling regime which was deemed to be too burdensome for study participants.
- University samples both treated water and greywater were obtained.
- A comparison was also performed on how the systems functioned for a retrofit home where the owner was very involved and a second case where the system was gifted by the builder through the purchase of a new home.

Module 5: Social Acceptance

- Homeowner surveys, focus groups, web surveys, builder feedback was obtained.
- New homeowners tended to have the most difficulty with the system as they hadn't considered the system and may have been less interested in conservation.
- The retrofit group made the effort to sign up for the program and seemed to be more interested in conservation.

- Reasons given for getting involved included decreased water usage, being a good steward of the environment, logical step, and being ahead of the curve for increase water costs.
- There were some concerns: no way to bypass the system, payback margin is slim and there is concern about ongoing costs, the filter has to be cleaned regularly, hardships with filter types, system can be complicated to maintain and create bio film in toilets, soaps impact the system, not automated, supplies such as chlorine pucks are not readily available.
- Image feedback was positive: pride in ownership, conservation.
- Heath concern feedback included that there were no perceived health concerns amongst system users. Households with animals or children need to restrict access to toilet.
- Rebates/incentives feedback found that retrofit homeowners indicated that they would not have participated without the rebate.
- In talking with the general population, there was minimal awareness of greywater systems. Everyone seemed to be intrigued by the idea of doing something for the environment, but were not sure of implementation in their home. Costs were also a concern and the cost benefit.
- Factors influencing uptake included technology maintenance, costs, aesthetics, health issues.

Module 6: Life Cycle Analysis

- System purchase costs - $1,900-$2,300 for system, plumbing $300-500, and plumbing contractor $800-$1,100.
- O&M costs backflow devise testing, chlorine pucks, electricity, filter replacement, top-up water totalling $205 – $245 /year
- Savings were estimated at 44m3/household/year
- Variables include water and wastewater rate increases, backflow devise testing, installation type and incentives, demand offset, and system life.
- Various payback scenarios were considered of new homes with a 5% rate increase, the pay back ranged from 32.39 years to 55.72. For existing homes 26.11 -47.48 years.
- A Comparison was also considered between the costs associated with reclaimed water vs. new supply.

2.2 Introduction to Risk Management Framework

As mentioned above, the afternoon portion of the workshop included an overview risk and risk management concepts.

The Water Research Foundation defines risk as follows: “Risk is a measure of the degree of exposure to the consequences that might result from event that might happen.” Effectively risk can be expressed as a mathematical equation. It is the product of the probability of failure and the consequence of failure. The probability of failure considers how likely is it for a failure to occur, and the consequence of failure examines how sever are the long and short term impacts should a failure occur.

$$\text{Risk} = \text{Probability of Failure (PoF)} \times \text{Consequence of Failure (CoF)}$$

The basic elements of a risk management policy include the following:

- Risk register
- Accountability
- Risk management process
- Risk management framework
- Integration

The risk register records information regarding the identified risks:

- Risk owner – the person or entity with the accountability and authority.
- Risk evaluation – use risk analysis to compare risk against risk criteria and find level of risk.
- Risk treatment - process of developing, selecting, and implementing measures to modify risk.
- Risk trends - performance measures for risk and risk controls
- Record for every risk in the organization

Generally, the risk management policy states that each risk owner is accountable for that risk, the associated controls and responsibilities for monitoring of risk. A culture of accountability is required such that every owns risks that impact them.

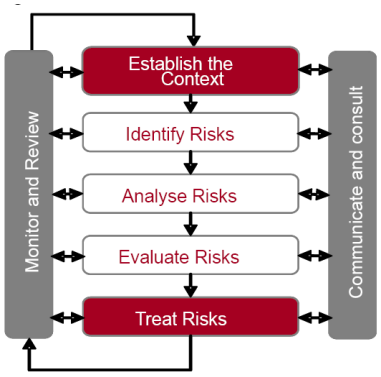

Figure 1. Key Components of a Risk Management Process

A risk management framework should include a set of components that provide the foundations and organizational arrangement for designing, implementing, monitoring, reviewing and continually improving risk management processes throughout the organization. This framework is new to ISO 31000, and follows a Plan-Do-Check-Act quality model:

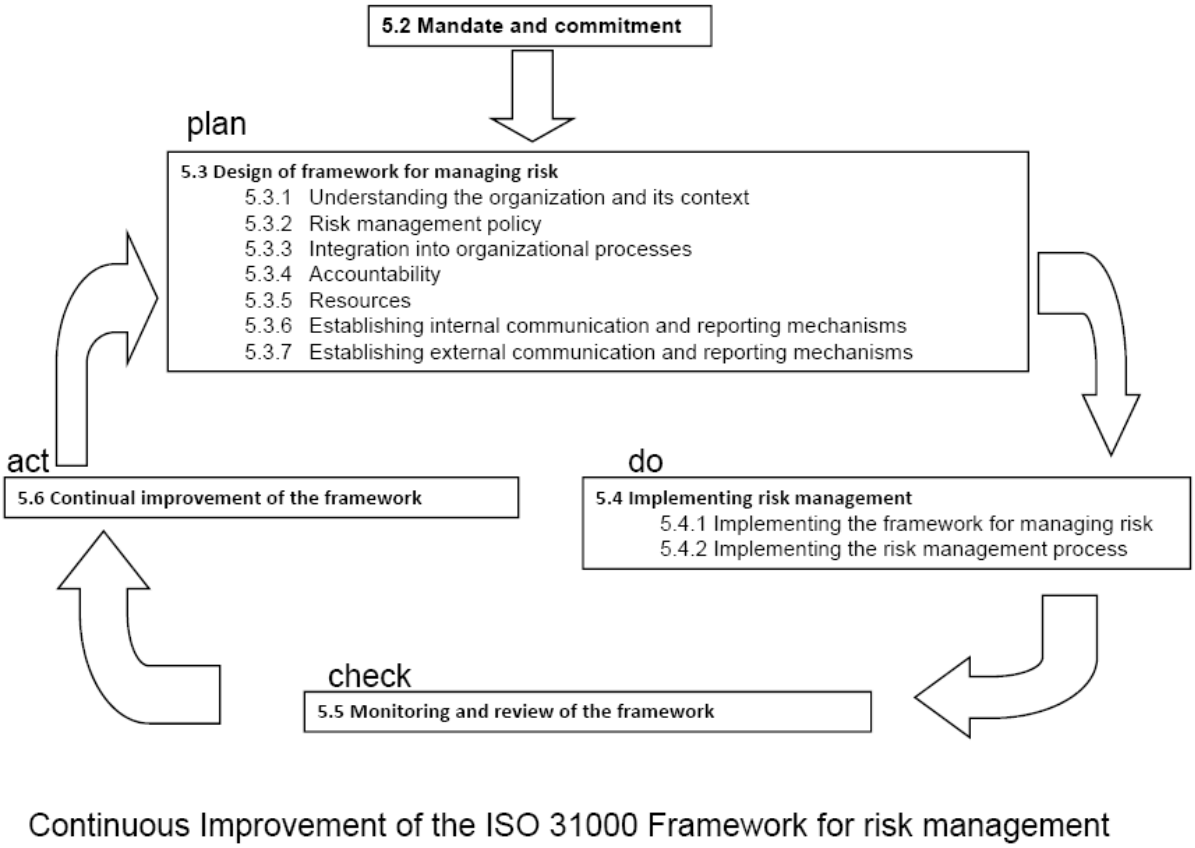

Figure 2. ISO 31000 Continuous Improvement Risk Management Framework

The concept of assigning risk gradings was also reviewed with the group. For example defining classifications such as, low, moderate or high risks:

- Low Risk: Failure can be address through normal operations. Assets can be repaired or replaced on failure.
- Moderate Risk: Failure can be accommodated by strains operations. Failure management should be practiced.
- High Risk: Failure cannot be handled in and effective manner. Failure avoidance should be practiced.

3. Greywater Reuse Risk Model Development

The following sample risk register and assessment were used to help facilitate identification of residential greywater reuse risks, causes and impacts.

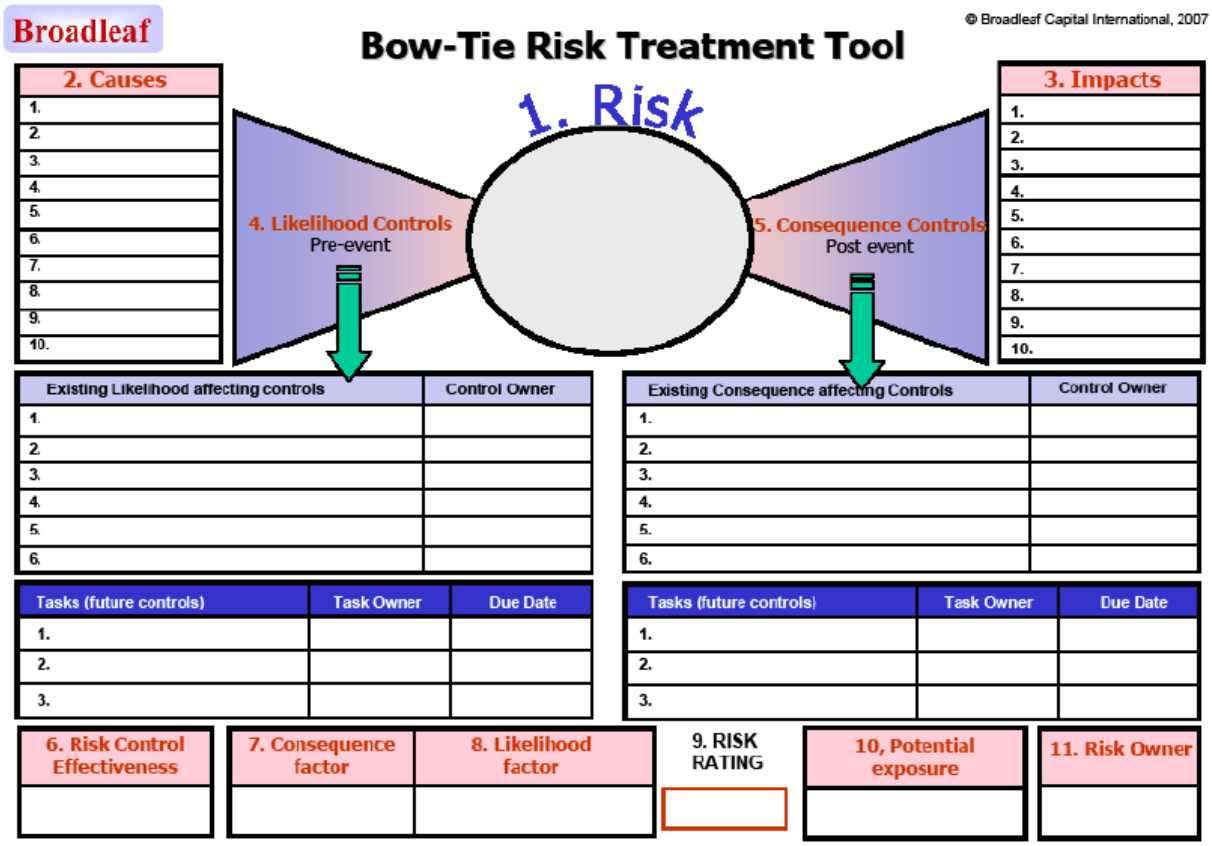

Figure 1. Sample Bow-Tie Risk Register and Assessment Tool

The above model looks at identifying the risks, potential causes, and identifies the potential impacts. While not covered during the duration of the workshop, the model also outlines identifying the controls of reducing the causes of risk as well as assigning responsibility. Similarly, the model also considers options for mitigating the impacts should a failure occur as well as assigning responsibility. For each of the risks discussed during the workshop, risk ratings for the probability of a failure and the consequences of a failure were considered. A scale of high, moderate, and low was utilized as defined above.

The risk assessment conducted during the workshop considered only risks, causes, and impacts from the City of Guelph's perspective, and not from the side of the customer. In general, the assessment also examined greywater reuse on a small scale similar to the pilot study. The risks, causes, and impacts should be re-evaluated if large-scale implementation is being considered.

The following identified risks were reviewed and discussed during the workshop:

1. Operational requirements and capacity planning
2. Potential source contamination of water system
3. Education of homeowners
4. Availability of Contractor / manufacturer to provide continuous support of greywater reuse systems
5. Existence of licensing, permitting and product performance standards
6. Not implementing greywater re-use in the City
7. Being a leader in relation to no established Canadian precedents

For each of the risks above the workshop participants discussed causes and impacts as summarized in the tables below. For the high probability / consequence of failure scenarios, mitigating measures were also discussed. The risk rating was established for both the current state and under a scenario of an expanded program (based on hundreds/thousands of installations).

Table 1. Risk Associated with Operational Requirements and Capacity Planning

RISK: Operational Requirements and Capacity Planning	
Causes: • Requirement to supply more water due to system failure / homeowner removal of system • Reduction to planned servicing capacity to area knowing systems create demand offset • Reduced wastewater conveyance flows, due to reduction in demands	**Impacts to City:** • Service interruption • Requirement to supply more water • Increased sanitary system flushing • Failure to achieve desired targets for potable water demand reduction
Risk Rating (Pilot): • Low Probability of Failure • Low Consequence of Failure	**Risk Rating (Expanded Program)** • Medium Probability of Failure • Medium Consequence of Failure
Risk Mitigation: • Increase drainage slope design • Line sewers • Look to new communal system or installation in new subdivision so you can control slopes and design standards	

Table 2. Risk Associated with Potential Source Contamination of Water System

RISK: Potential Source Contamination of Water System	
Causes: • Wrongful cross connection (potable / non-potable system) within home • Failure of backflow prevention device (testable) • Failure of backflow prevention device (non-testable) • Reduced wastewater effluent quality (High BOD, COD, Chlorine Residual)	**Impacts to City:** • Impact to water quality in home resulting in impacts to the City's reputation • Removal of system in home • Decreased desire for large scale implementation • Concern with health and safety impacts to customer • Loss of City and program reputation

• Increased presence of mould foundation (toilet tank / greywater system) • Attempting to install the device by homeowner – improperly • Home changeover / point of sale	
Risk Rating (Pilot): • Low Probability of Failure • High Consequence of Failure	**Risk Rating (Expanded Program):** • Medium Probability of Failure • High Consequence of Failure
Risk Mitigation: • Homeowner Education about internal plumbing and maintenance requirements of the system • Increased testing in system • Development and documentation of proper maintenance procedures (end user training programs) • Continue to meet with homeowners (i.e. re-education through backflow inspection by the City during the five year program, by plumbing inspectors in the future) • Ongoing review and testing of systems that are installed • Improved Standards for installation and system upkeep • Testing of backflow prevention device on regular basis	

Table 3. Risk Associated with Education of Homeowners

RISK: Education of Homeowners	
Causes: • No maintenance of system by homeowner • Wrongful disposal of household hazardous waste • Improper installation / modification of system by homeowners • Extent of information on technologies received by new home buyers from home builders	**Impacts to City:** • Increased water consumption. • System removal, and loss of investment by the City • Impact to greywater re-use effectiveness • Impact to operational costs through pumping potable water • Introduction of hazardous waste to reuse system and loss of reputation to the City as the program is endorsed by City. Although a contact is signed, there is concern for future owners. • General customer dissatisfaction with system (loss of reputation) • Loss of investment by the City • Resulting damage from improper installation or inspections • Homeowner uptake will suffer without the proper education and knowledge
Risk Rating (Pilot): • High Probability of Failure • Low Consequence of Failure	**Risk Rating (Expanded Program):** • High Probability of Failure • High Consequence of Failure
Risk Mitigation: • Homeowner education • More/enhanced education materials • More timely education (i.e. In the case of the new builds)	

- Education of those supplying the systems (builders)
- City (water efficiency) ownership with support from other departments
- Development of proper maintenance procedures
- Up front capital and operating costs, with tailored educational material from what was learned through pilot project
- Continue to meet with homeowners (i.e. re-education through backflow inspection by the City during the five year program, by plumbing inspectors in the future?)
- Consider modifying the agreement such that the systems are not removed, or are reclaimed by the City if they are removed
- Develop rules governing maintenance, home sales
- There could be more regulation of the program by the City. (will come at a financial cost for enforcement at City, and may also deter residents from participating)
- Consistent communication from the City
- The incentive can be phased in, for example if customer complies; the second phase of the grant is issued, when proper operation and maintenance is demonstrated
- Incentive for developers to take some ownership with the trade off for development
- Require notice of decommission

Table 4. Risk Associated with Availability of Contractor / Manufacturer to Provide Continuous Support of Greywater Reuse Systems

RISK: Availability of Contractor / Manufacturer to Provide Continuous Support of Greywater Reuse Systems	
Causes: • System repair by homeowner in absence of support • Lack of formal contractor certification program in Canada • Lack of local manufacture representatives to conduct repairs/ education • Warranty Issues	**Impacts to City:** • Impact to City's Reputation • Removal of System
Risk Rating (Pilot): • High Probability of Failure • Low Consequence of Failure	**Risk Rating (Expanded Program):** • High Probability of Failure • High Consequence of Failure
Risk Mitigation: • Lobbying for programs in Canada (Green Plumbers) • Certification for equipment and installation • Require notice if a backflow device is removed • City look to invest /own companies that supply and install products (trend occurring in Europe). Rent systems out to people like a water heater program – establish terms of rental	

Table 5. Risk Associated with Lack of Licensing, Permitting and Product Performance Standards

RISK: Existence of Licensing, Permitting and Product Performance Standards	
Causes: • Illegal system installation • Inability for building officials to enforce CSA standards	**Impacts to City:** • Contamination within home • System decommission, or failure • Customer dissatisfaction with program

• Lack of system owner licensing process • Lack of experience in installation • Lack of experience in Inspector training • Lack of experience in regulation side	
Risk Rating (Pilot): • High Probability of Failure • High Consequence of Failure	**Risk Rating (Expanded Program):** • High Probability of Failure • High Consequence of Failure
Risk Mitigation: • Control through installation through grant program • CSA Standard Development (wait until implementation of CSA B128.3 testing program/available certified technology). • City could lobby ministry of housing to include standards • No reference standard or tools for enforcement for initial installation although OBC contains direction on backflow requirements (i.e. no certification for installation).	

Table 6. Risk Associated with Not Implementing Greywater Re-use in the City

RISK: Not Implementing Greywater Re-use in the City	
Causes: • Risk of not implementing water conservation. (Impacts to permit to take water).	**Impacts to City:** • Loss of Reputation • Failure to meet long-term water conservation targets • Future regulatory compliance issues (Water Opportunities and Conservation Act)
Risk Rating (Pilot): • High Consequence • Low Probability	**Risk Rating (Expanded Program):** • High Consequence • Medium Probability

Table 7. Risk Associated with Being a Leader in Relation to No Established Canadian Precedents

RISK: Being a Leader in Relation to No Established Canadian Precedents	
Causes: • No widespread uptake in City/Country	**Impacts to City:** • Lack of manufacture supplier support, increase costs • Impeding market • Loss of reputation by promoting technology • Higher implementation and management costs – market conditions drive costs • If no manufacture supplier support, increased liability, decreased reputation to City.
Risk Rating: • High Probability • High Consequence	**Risk Rating (Expanded Program):** • High Probability • High Consequence
Risk Mitigation: • Continue to research and review industry practices including international programs and technologies • Solicit input from Canadian practitioners • Engage manufacturers, plumbing contractors and other agencies (consider WEAO, WEF, OWWA etc.)	

Through discussion a number of risk factors and impacts were common to the identified risks. These included the following:

- Loss of reputation by promoting technology
- Requirement to supply more water (when systems are not maintained and are be supplied by potable water)
- Increased sanitary system flushing
- Removal of system - impact to greywater re-use effectiveness: Loss of investment by the City, loss of water savings.
- Risk of contamination

4. Impact on Overall Risk Level as Program Expands

In general, the level of risk based on the consequences and probability of failure will increase as the program and acceptance of grey water systems expands beyond the current 25 pilot installations as shown in the Risk Rating Sections in Table 1 to Table 7.

For example, while the current program and staffing/financial resource levels have been established allowing the City staff to work one on one with the pilot participants as the program was implemented, the City staffing level could accommodate the required interaction levels. With widespread acceptance of the program, for example expanding the program from the current twenty five to hundreds or thousands of installations, or as communal greywater systems are implemented, the probability of system failures and overall consequence of failure levels also increase.

This in turn will put additional requirements to ensure that the recommended mitigation factors, tools and resources are in place within the City to allow for increased levels of inspection, communication, testing and education and enforcement. Ultimately, as the systems are implemented in wider areas of the City, the possible geographic areas and individual sources of contamination will also increase.

Some of this increased risk levels will be mitigated as general consumer/household knowledge of the systems functionality and use increases within the general public and as greywater reuse systems become more commonly accepted.

In addition, a large component of the risks associated to the seven risk scenarios described above is the lack of CSA Standards and Certification for the equipment and installation of systems. Similar to more widespread understanding of the systems by end users, as the manufacturing community expands development and distribution of greywater systems to the user community, research and development will also assist in developing technologies that are more user friendly and less costly.

In general, it was suggested that currently certification and training and public education are thought be the biggest risks for the City moving forward with broader implementation of programs.