City of Guelph
Guelph Residential Greywater Field Test Draft Final Report

Appendix A

York Trunk Sewer and Paisley-Clythe Feedermain Municipal Class Environmental Assessment

Final Report

June 29, 2012

York Trunk Sewer and Paisley-Clythe Feedermain Municipal Class Environmental Assessment

Please refer to the included PDF file below (PurplePipeTechMemoFinal.pdf).

York Trunk Sewer and Paisley-Clythe Feedermain Municipal Class Environmental Assessment

GENIVAR Project No. 10405017

O c t o b e r 1 9 , 2 0 1 1

Technical Memorandum - Effluent Reuse System "Purple Pipe System"

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Project No. 111-55820-00

Colin Baker
City of Guelph
City Hall, 1 Carden Street
Guelph, ON N1H 3A1

Re: York Trunk Sanitary Sewer and Paisley-Clythe Feedermain
Technical Memorandum - Effluent Reuse System "Purple Pipe System"

Dear Colin:

GENIVAR Inc. is pleased to submit the draft Purple Pipe Technical Memorandum as a supporting deliverable for the York Trunk Sanitary Sewer and Paisley-Clythe Feedermain Class Environmental Assessment Project.

This report is intended to assess the feasibility of the inclusion of a wastewater effluent reuse system "Purple Pipe" in conjunction with the York Trunk Sanitary Sewer and Paisley-Clythe Feedermain implementation.

We trust this report meets with your approval. If you have any questions or comments please don't hesitate to contact the undersigned at (519) 827-1453.

Yours truly,
GENIVAR Inc.

Jamie Witherspoon, P.Eng., LEED AP
Project Manager

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Executive Summary

As part of the York Trunk Sewer and Paisley-Clythe Feedermain Class Environmental Assessment project, a component of the project terms of reference was the review of the opportunities to include an effluent reuse or, “Purple Pipe”, system with the implementation of this project. The intent of the scope was to determine if there were synergies in terms of deferring future potable water demands and thus extending the lifespan of existing potable water supplies within the City.

Purple Pipe systems are prevalent in the southern United States due to the scarcity of water; however, in Canada, there are no significant systems and therefore the legislation controlling their implementation are minimal. The US Environmental Protection Agency delineates different categories of effluent quality as follows:

- Unrestricted Urban Reuse & Recreational Use - Unrestricted refers to the contact the general public will have with water treated to this quality. This category would include the irrigation of parks and sports fields, fire protection, decorative fountains and urban uses, such as toilet flushing.
- Restricted Urban Reuse - This category restricts use of reclaimed water to activities that result in no contact with the general public, or where the areas affected are restricted from the general public. This level of water quality could be used for private landscape irrigation, municipal works uses, such as street cleaning and sewer flushing, and for construction purposes, such as site dust control and concrete making.
- Industrial Reuse - Industrial uses of reclaimed water varies based on the requirements of the industry, this could include the use of reclaimed water for equipment washing, cooling towers, stack scrubbing, boiler feed, and process water.
- Groundwater Recharge - Groundwater recharge is used to ensure a stable, high quality, ground water supply. This process requires reclaimed water of a high quality to be pumped into a holding area, where it is allowed to infiltrate into the water table below, replenishing the ground water supply.

The City of Guelph WWTP effluent quality is amongst the highest quality released by any wastewater treatment plant in Canada. The City of Guelph WWTP Effluent currently complies with all of the effluent reuse categories except for Unrestricted Urban Reuse and Recreational Use. Minimal additional treatment, therefore, is required to provide comprehensive effluent reuse systems within the City. There would be a need to provide supplemental disinfection to achieve the highest quality of effluent reuse; however, that could be done off-line from the main sewage flows to service only the effluent reuse system. There are some issues due elevated total dissolved solids associated with water softener usage in the City which may limit the use of the effluent for extensive irrigation purposes. This is not considered a major concern, but it may also be limiting for other uses such as cooling or other processes where scale or corrosion may be an issue.

As the City has a finite water supply available currently, there will be a need to develop alternative supplies; however, effluent reuse could provide the opportunity to defer potable supply development. The lifecycle cost of development of groundwater supplies is estimated at $0.09/m^3 and surface water supplies are estimated at $0.30/m^3. For effluent reuse to be feasible in the short-term, it would need to be less expensive than groundwater supplies, and in the long term, less expensive than a surface water supply.

There are a variety of potential consumers within the City, including the Guelph Innovation District, The Cutten Fields Golf Course, City sports fields, and bulk, consumers such as street sweeping, sewer flushing and dust control uses that could benefit from an effluent reuse system combined with the York Trunk Sewer and Paisley-Clythe Feedermain project. Some of the larger users would have intermittent peak demands that could not be reasonably sustained by a municipal system and local storage and pumping would be necessary. The estimated peak daily demand would be approximately 3,050 m^3/d (excluding peak instantaneous demands for golf courses). This value represents sites that could be

serviced directly from the alignment of the proposed linear infrastructure associated with the Class EA project. Due to the types of demands, there is a significant variation from summer to winter demands and any system would need to be flexible to address this variation without additional operation and maintenance costs.

In order to implement a Purple Pipe system in conjunction with the York Trunk Sewer and Paisley-Clythe Feedermain project, the following primary infrastructure would be required:

- Effluent pumping and Treatment System
  - This would consist of screening and disinfection, located at the WWTP, drawing effluent from the outlet of the existing treatment process. The estimated cost of this component of the system is $650,000 for a design flow of 3,050 m^3/day.
- Bulk Effluent Loading Depot
  - This would consist of a metered connection to allow tankers to be filled for non-potable water use, such as street sweeping, sewer flushing, etc. The estimated cost of this component of the system is $70,000 for a basic system.
- Purple Pipe Distribution Main
  - This would consist of a 4.5 km long 250 mm diameter effluent distribution main along the same alignment as the proposed sewer and water infrastructure. The estimated cost of this component of the system is $1,125,000.

With the inclusion of miscellaneous costs associated with the design and contingencies, the estimated total cost of the basic Purple Pipe system would be estimated at $2.9 million (+50%-30%). This cost does not include the private side works required to integrate the effluent reuse system into the end users systems. The annual operation and maintenance costs for the system are estimated at $100,000 per year and the lifecycle cost for the system is estimated at $0.27/$m^3$.

From a cost perspective, therefore, the full scale Purple Pipe system would not be considered economically practical in the short term, but could become economically feasible once local groundwater supplies are fully utilized and the City is required to look towards a surface water supply.

It is recommended at this time that the City consider a pilot implementation of a bulk effluent supply system to reduce potable water use in the City and, going forward, revisit the Purple Pipe issue with each update of the Sewage and Water Supply Master Plan.

Table of Contents

Executive Summary
Table of Contents

List of Figures

List of Tables

Glossary of Terms and Abbreviations

Reclaimed water is treated effluent of a quality suitable for specific reuse application.

Water reuse is the use of treated wastewater for beneficial purposes. Direct reuse refers to a system in which reclaimed water is transported to the points of reuse. Indirect reuse implies discharge of an effluent into receiving water (surface or ground water) for assimilation and withdrawals downstream.

MOE- Ontario Ministry of the Environment

GRCA- Grand River Conservation Authority

US EPA- United States Environmental Protection Agency

AWWA - American Water Works Association

WWTP - Wastewater Treatment Plant

CFU- Colony Forming Units: is a measure of viable bacterial numbers in a sample

NTU- Nephelometric Turbidity Units: refers to method of measuring turbidity with a nephelometer

COD – Chemical Oxygen Demand: used to measure the amount of organic compounds in water

BOD5 – Biological Oxygen Demand: amount of dissolved oxygen consumed by biological organisms per litre of sample during 5 days at 20^{o}C.

TSS - Total Suspended Solids

TDS –Total Dissolved Solids

PVC - Polyvinyl Chloride

MBR - Membrane Bioreactor: is a combination of a suspended growth bioreactor and microfiltration membrane

1. Introduction

The intent of this report is to review the feasibility of the installation of a “Purple Pipe” Effluent Reuse Distribution System in conjunction with the installation of the York Trunk Sewer & Paisley-Clythe Feedermain. The Purple Pipe Distribution System could theoretically follow the proposed alignment of the York Trunk Sewer & Paisley-Clythe Feedermain to transport effluent from the City of Guelph’s Wastewater Treatment Plant (WWTP) to areas within the city that may have the capacity to utilize the reclaimed water for non-potable uses. Utilization of reclaimed water could reduce the demand on the potable water supply which would assist the City of Guelph to achieve the goals set by the 2008 Guelph Water Conservation and Efficiency Study (RMSi, 2009), to make Guelph the Canadian city with the lowest potable water usage per capita.

The Guelph WWTP currently discharges approximately 54,000 m^3/d into the Speed River (CH2MHILL, 2009). With a current population of approximately 118,000, this is an average discharge of 460 L/c/d. With the population of Guelph projected to grow to 195,000 by 2031, the discharge of the WWTP will reach over 80,000 m^3/d, this is assuming a 10% reduction in per capita water discharge. Reclaimed water is a consistent resource of non-potable water which could be utilized for non-potable uses such as non-contact sewage conveyance (toilet flushing) and irrigation. This would assist in mitigating the increased demand on the potable water supply as a result of the population growth.

1.1 Background

This section identifies the scope of report and regulations pertaining to the application of a water reuse system at the municipal level. It also outlines the potential applications within the City of Guelph based on effluent quality.

1.1.1 Scope of Work

In accordance with the Terms of Reference for the project, the secondary goal of the Class EA is to examine distribution requirements within the east-west study area for a treated wastewater effluent reuse program or “Purple-Pipe” system with the Paisley-Clythe Feedermain and/or York Trunk Sewer Upgrades.

1.1.2 Regulations

Currently there are no regulations or guidelines that encompass all aspects of wastewater reuse in Ontario. For the purposes of this report the US EPA Guidelines for water reuse will be used. The US EPA guidelines are an extensive document which identifies, in detail, types of reuse and limitations associated with them, technical planning issues, current applications, and regulations of water reuse within the United States. **Section 2.3** outlines the US EPA guidelines that are applicable to the City of Guelph water reuse program.

Additional regulations in Canada, at the national level, that could affect implementation of a water reuse system are (CMHC-SCHL, 1999):

- The Guidelines for Canadian Drinking Water Quality (1996);
- The Guidelines for Canadian Recreational Water Quality (1992);
- The National Plumbing Code of Canada (1995) ;
- Ontario Building Code (limits the use of grey water to toilet flushing);and,
- Heath Canada’s regulations for the use of reclaimed water for toilet and urinal flushing (2010).

1.1.3 Existing Guelph Effluent Quality

The City of Guelph WWTP effluent quality is amongst the highest released by any wastewater treatment plant in Canada. Guelph effluent is regarded by the GRCA as at the very top in terms of treatment and the highest effluent quality of the 26 municipalities that discharge into the Speed River. **Table 1-1** presents the monthly averages of wastewater parameters recorded by the Municipal WWTP staff in 2010.

Table 1-1: City of Guelph Wastewater Quality Data - 2010

Average Month	pH	Temp °C	DO mg/L (2011)	$cBOD_5$ mg/L	E.Coli CFU/100 mL	TKN mg/L	Total Ammonium Nitrogen mg/L	TSS mg/L	TDS mg/L (2002)	VSS mg/L (2002)
January	7.7	12.9	8.8	2.8	31	1.7	0.65	2	1295.6	2.4
February	7.8	12.7	8.9	2.2	18	1.93	0.66	2	1331.5	1.1
March	7.7	12.7	9.4	4.8	19	1.7	0.92	3	1318.5	1.1
April	7.8	14.6	9.5	2.1	12	1.44	0.22	2	1231.2	1.4
May	7.8	16.6	9.2	2.5	18	1.22	0.07	2	1217.0	1.1
June	7.8	18.3	9.0	2.0	35	1.28	0.21	2	1222.5	1.2
July	7.9	20.5	9.1	3.0	97	1.27	0.20	2	1234.8	1.4
August	8.0	21.6	8.4	2.0	46	1.28	0.11	2	1301.2	1.4
September	7.9	20.9	n/a	2.0	25	1.48	0.37	2	1291.3	2.6
October	7.8	19.1	n/a	2.1	32	2.63	1.48	2	1313.2	1.7
November	7.9	17.2	n/a	2.2	14	2.12	0.36	2	1259.5	1.7
December	7.8	14.7	n/a	2.4	18	1.58	0.35	2	1271.5	1.6
Annual Average	**7.8**	**16.8**	**9.0**	**2.5**	**30.4**	**1.6**	**0.5**	**2.1**	**1274.0**	**1.6**
Winter Average	**7.8**	**14.0**	**9.0**	**2.9**	**20.0**	**1.8**	**0.6**	**2.2**	**1295.3**	**1.6**
Summer Average	**7.9**	**18.8**	**8.9**	**2.2**	**37.9**	**1.5**	**0.4**	**2.0**	**1258.7**	**1.5**

1.1.4 Reclaimed Water Quality Guidelines

The US EPA outlines ten main water reuse categories based on the quality of the water required for specific and uses (USEPA 2004). The four categories that pertain to the City of Guelph, based on land uses within the study area would be:

- Unrestricted Urban Reuse & Unrestricted Recreational Use;
- Restricted Urban Reuse;
- Industrial Reuse; and,
- Groundwater Recharge.

1.1.4.1 Unrestricted Urban Reuse & Unrestricted Recreational Use

Unrestricted refers to the contact the general public will have with water treated to this quality. This category would include the irrigation of parks and sports fields, fire protection, decorative fountains and urban uses such as toilet flushing. The water quality requirements for unrestricted public access identified by the US EPA Guidelines are shown in **Table 1-2**. This table also includes Health Canada's regulations for the use of reclaimed water for toilet and urinal flushing (Health Canada, 2010).

1.1.4.2 Restricted Urban Reuse

This category restricts the use of reclaimed water to activities that result in no contact with the general public, or where the areas affected are restricted from the general public. This level of water quality could be used for private landscape irrigation, municipal works uses, such as street cleaning and sewer flushing, and for construction purposes, such as site dust control and concrete making. The water quality requirements identified by the US EPA Guidelines for Restricted Urban Reuse are shown in **Table 1-2**.

1.1.4.3 Industrial Reuse

Industrial use of reclaimed water varies based on the requirements of the industry. This could include the use of reclaimed water for equipment washing, cooling towers, stack scrubbing, boiler feed and process water. The water quality requirements identified by the US EPA Guidelines for Industrial Reuse are shown in **Table 1-2**.

1.1.4.4 Groundwater Recharge

Groundwater recharge is used to ensure a stable, high quality, groundwater supply. This process requires reclaimed water of a high quality to be pumped into a holding area, where it is allowed to infiltrate into the water table below, replenishing the ground water supply. The water quality requirements identified by the US EPA Guidelines for Groundwater Recharge use are shown in **Table 1-2**.

Table 1-2: Standards for Quality of Reclaimed Water and City of Guelph Effluent Quality (US EPA, 2004)

Parameter	**City of Guelph Effluent**	Unrestricted Urban Use & Unrestricted Recreational Use	Restricted Urban Reuse	Industrial Reuse	Groundwater Recharge
BOD_5	**2.5 mg/L**	5-30 mg/L	20-30 mg/L	20 mg/L	5 mg/L
TSS	**2.1 mg/L**	5-30 mg/L	5-30 mg/L	20 mg/L	5-10 mg/L
Turbidity	**-**	0-2 NTU	2-3 NTU	3 NTU	2 NTU
Fecal Coliforms (E.Coli)	**30.4 CFU/100 mL**	0-2.2 CFU /100 mL	23-200 CFU /100 mL	23-200 CFU /100 mL	2.2 CFU /100 mL
Total Nitrogen	**0.5 mg/L**	≥0.5 mg/L	-	-	12 mg/L
Total Chlorine Residual (Health Canada, 2010)	**0.02 mg/L**	5-30 mg/L	-	-	-

1.1.5 Effluent Reuse Need - Guelph

The use of reclaimed water to supplement the demand of municipal potable water would lower the current demand on the potable water supply, thus increasing the lifespan of the municipal water source. The current City of Guelph drinking water system includes 18 ground water wells, which are utilized continuously, located within the City boundaries. The system also includes a groundwater collection system located at Arkell Springs Grounds. This system collects shallow groundwater from subsurface gravel deposits. To supplement the supply, which is dependent on the annual precipitation, the City pumps water from the Eramosa River into infiltration trenches during the spring months.

Through the completion of the City of Guelph Water Supply Master Plan, in 2006, the City evaluated the lifespan of the current potable water supply and potential additional sources to address the future growth in demand. The alternative sources of potable water suggested by this report are summarized in **Table 1-3** along with a suggested time frame for implementation and the estimated cost per added capacity.

Table 1-3: Summary of 2006 Guelph Water Supply Master Plan recommendations.

WSMP Recommendation	Recommended Term	Added Capacity (m3/d)	Capital cost of capacity gained ($/L)
Groundwater in City	Short to Medium	59,017	$0.09
Groundwater Outside City	Medium	22,032	$0.30
New Local Surface Water	Medium to Long	27,123	$0.30
Great Lakes Water Supply	Medium to Long	No Limit	-

The recommendations in **Table 1-3** indicate that the City of Guelph will need to investigate future demands outside of the City boundaries within the next 10 years. The use of reclaimed water could effectively replace the use of a significant component of the demand; however, it would not be required for a minimum of 10 years depending on the cost of effluent reuse. The increase in water supply by incorporating reclaimed water in the system could postpone the installation of new water supplies outside of the city if it is economically feasible.

2. Potential Consumers

This section identifies potential uses of reclaimed water within the City of Guelph based on the location for the proposed alignment of the York Trunk Sewer & Paisley-Clythe Feedermain.

2.1 Unrestricted Urban Use & Recreational Use

The following applications could potentially be implemented within the City of Guelph, if the end users were to further disinfect the current effluent, or the quality of the WWTP effluent were to improve by reducing the Fecal Coliforms to levels consistently below 2.2 CFU/100mL.

2.1.1 Urban Applications

Urban applications would require urban buildings to be constructed with, or retrofitted with, a dual pipe system consisting of potable and non-potable piping with cross-connection control. The reclaimed water would be used for laundry and the flushing of residential and commercial toilets and urinals. This would require that the effluent be treated to unrestricted water quality, as it is not possible to control the amount of contact the general public will have with the water supply. It would be ideal to install this infrastructure throughout a new development, such as the Guelph Innovation District, to gain the most benefit from the investment of infrastructure installation.

The proposed residential population within the Guelph Innovation Districtis reported to be 5,000 with the creation of an additional 10,000 jobs in the area (City of Guelph, 2011). Assuming that 30% of the 10,000 employment positions in the areas are commercial, using 17% of the 230 L/c/d water demand (Water Management Inc., 2010). The estimated water demand for the Guelph Innovation District is 541 m^3/d based on the estimate that 30% the 230 L/c/d water demand is used for flushing toilets. **Figure 2-1** identifies the zoning areas of the proposed Innovation District.

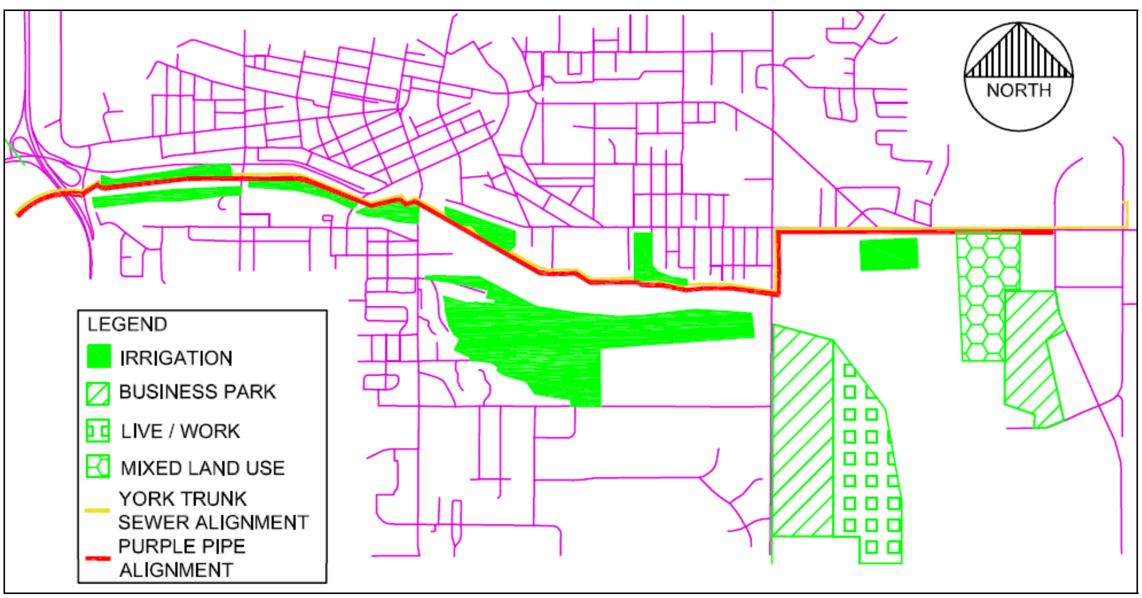


Figure 2-1: Potential Locations of Unrestricted Access Water Reuse

The use of reclaimed water for fire protection requires a consistent supply pressure, emergency storage and backup systems to meet provincial requirements. For these reasons fire flow usage for reclaimed water will not be considered for implementation within the City of Guelph at this time.

2.1.2 Construction Uses

Various aspects of construction currently use potable water for tasks such as dust control and equipment washing. Reclaimed water could easily be utilized for these tasks with limited infrastructure installation as they require only a bulk fill / washing station in a central area. It is estimated that the demand would be 102 m^3/d throughout the summer months, during business hours. This estimation is based on the application of 6.35 mm of reclaimed water over an area of 4,000 m^2 per municipal construction site. Assuming that reclaimed water is utilized at five construction sites, each lasting 20 days, it is estimated that a total of 10,160 m^3 will be used per year for dust control. This is likely a conservative estimate during a normal construction season, but is also a function of weather during the summer.

2.1.3 Municipal Irrigation

Sports fields located along the proposed sewer alignment would be ideal locations for the utilization of reclaimed water for irrigation purposes. Additional infrastructure installation beyond a central supply main would be limited due to the possibility of combined construction with the proposed alignment of the York Trunk Sewer. The cost will be minimal, in comparison to supplying irrigation to other park locations in the city.

Irrigation of planters and hanging baskets in the city of Guelph's downtown area is an activity that continues throughout the summer during regular business hours. Irrigation is preformed by a worker with a watering truck who manually waters the flowers. The infrastructure required to initiate this type of water reuse is a bulk filling station, similar to the dust control uses previously mentioned.

Irrigation of municipal sports fields along the Speed River and proposed sewer alignment, in addition to garden irrigation in the downtown area of Guelph, would require approximately 100 m^3/d for parks irrigation and up to 0.80 m^3/d used for daily irrigation of flowerpots, during four summer months of the year. The water requirement for the irrigation of the municipal sports fields is based in the application of 20 mm of water per hectare once a week. The water utilized in the irrigation of the flower planters located in the Guelph downtown core was determined based on the application of 3L/planter twice a week as recommended by industry standards. A conservative estimate of 400 planters was used; this includes hanging flower baskets (approximately every 5m throughout the downtown area) and large flower boxes located along the boulevards.

2.1.4 Golf Course Irrigation

The Cutten Fields Golf Course is located along the south bank of the Eramosa River, between Victoria Road South and Gordon Street. The course covers an area of approximately 35 hectares and is watered on a regular basis overnight. The water required for irrigation is currently drawn from the Eramosa River and held in an irrigation pond on-site until required. Currently, the course has a Permit to Take Water from the MOE. Allowing the site to take water at a minimal cost per volume, the cost of the infrastructure and conveyance of reclaimed water to the course will have to be economical for the course to consider implementation.

The average golf course irrigation system is generally operated at a higher pressure then the municipal distribution system. As a result, the golf course would have to utilize a storage pond and a booster pump system to maintain the required pressure. This infrastructure currently exists based on their current water supply.

The quantity of water used on a daily basis is in the order of 1,100 m^3/d. Irrigation of golf courses would require unrestricted reclaimed water quality, as it is not possible to ensure the public will have no access to the irrigation water.

2.1.5 Unrestricted Access Demand Summary

Below are the daily and annual estimated demands for reclaimed water that is of MOE unrestricted quality standard.

- Urban Uses: 541 m^3/d, All year (197,000 m^3/yr);
- Construction: 102 m^3/d, Summer only (9 000 m^3/yr);
- Municipal Irrigation: 100.8 m^3/d, Summer only (8 800 m^3/yr) ; and,
- Golf course Irrigation: 1100 m^3/d, Summer only (97 000 m^3/yr).

2.2 Restricted Urban Reuse

The following section identifies urban applications can utilize restricted urban use quality reclaimed water within the City of Guelph. This quality is equivalent to the current Guelph WWTP effluent.

2.2.1 Street Sweeping

Street sweeping is completed by the City of Guelph and hired contractors thought the month of April. It is estimated that 144 m^3/d would be used to sweep 500 km of asphalt roadway in one month. This estimation is based on the application of 6mm of water to every linear meter of road way over a month period in the spring. The use of reclaimed water instead of potable water for dust control could be implemented in the near future, as it requires limited infrastructure in the form of a bulk fill station.

2.2.2 Sewer Flushing

Sewer Flushing is a seasonal activity carried out by the City of Guelph operations staff. Large volumes of water are required to clean the sewers and prevent build up of sediment within the pipes. Once again, the use of reclaimed water could be implemented in the near future due to its lack of additional infrastructure requirements.

It is estimated that approximately 41m^3/d of water are used to complete the annual cleaning sewers. This is based on values used by the American Water Works Association in the *Water Audits and Leak Detection Report* (page 24).

2.2.3 Concrete Making

The use of reclaimed water for concrete making would be a viable alternative for the use of reclaimed water if there were a demand within close proximity to the proposed alignment. There are currently no concrete facilities within the City that could use this option.

2.2.4 Private Irrigation

Private irrigation includes the irrigation of residential properties, where the user of the reclaimed water has the appropriate training to handle water of the restricted quality level. It is important that the general public does not have access to the irrigated land at any point though the application of Restricted water. It is difficult to estimate the demand for reclaimed water for the use of private irrigation, but it is assumed that the volume would be minimal and is, therefore, not accounted for within this study.

2.2.5 Restricted Use Summary

Based on the current quality of the City of Guelph's WWTP effluent, all of the Restricted uses of reclaimed water can be implemented without any additional treatment of the WWTP effluent. It is estimated that the annual demand for restricted water would be approximately 21,700m^3/year comprised of the following:

- Street Sweeping; 144 m^3/d (April only), 3 200m^3/d.
- Sewer Flushing; 41 m^3/d (not during winter), 8 000 m^3/year.

Street sweeping and sewer flushing are uses that could be implemented in the near future with minimal investment. It is important to note that training and regulations would be required to minimize the likelihood of the general public coming into contact with reclaimed water of this quality.

2.3 Industrial Reuse

The water quality required by the industry would be dependent on the type of industry utilizing the reclaimed water. Unfortunately, there are limited industries within close proximity to the proposed alignment of the York Trunk Sewer & Paisley-Clythe Feedermain. Currently, Owens Corning, a fibreglass manufacturer, is the only large industry within the study area, located between the north bank of the Eramosa River and York Road. As fibreglass manufacturing is not a water intensive process there is limited demand at this facility. There is however, potential of future industries located within the proposed

Guelph Innovation District to utilize reclaimed water, as these demands are unknown at this time, industry water usage will not be considered further within this study at this time.

2.4 Groundwater Recharge

Currently, the City of Guelph utilizes groundwater recharge at the Arkell Springs Grounds, to the east of the Eramosa River, up-stream from the Guelph WWTP, for its municipal water supply. Water from the Eramosa River is pumped into infiltration areas, where the water is filtered by the soil and enters the water table.

An increase in the quality of the effluent could enable the reclaimed water to be utilized for the purpose of ground water recharge, although, along the proposed alignment there is limited space to develop such a site. There would likely be significant public concern regarding this option and it should be considered carefully before proceeding with this option.

2.5 Specific Opportunities

The potential locations, within close proximity of the York Trunk Sewer & Paisley-Clythe Feedermain where reclaimed water can be used as previously identified are outlined in **Table 2-1**:

Table 2-1: Summary of Specific Opportunities for reclaimed water within the City of Guelph

Name	Location	Description	Effluent Quality Required	Seasonal
Innovation District	Site is bound by Victoria Road, Watson Road, York Road and Stone Road.	Multi-use development with a focus on sustainable practices.	Restricted urban Access	No
Better Beef-Cargill	Watson Road between York Road and Stone Road.	Food processing Facility.	Dependent on usage	No
Municipal Solid Waste Facility	Watson Road between York Road and Stone Road.	Solid waste transfer station, recycling plant and organic composting facility.	Dependent on usage	No
Lafarge Lands	East of the Hanlon Parkway and North of Wellington Road.	Commercial development.	Restricted urban Access	No
Cutten Fields	South of the Eramosa River, bound by Collage Street, Gordon Road and Victoria Road	Private Golf Club	Restricted urban Access	Yes

2.6 Effluent Demand Characteristics

The estimated demand for reclaimed water along the York Trunk Sewer & Paisley-Clythe Feedermain alignment was estimated based on current and future land uses. This section evaluated the demand characteristics associated with the potential consumers identified in **Section 2.1**and **Section 2.2**of this report. The demand characteristics identify when the reclaimed water will be used throughout the day for each activity.

Figure 2-2 shows the comparison of estimated demands for the identified uses of the reclaimed water from the City of Guelph WWTP. This figure shows that the irrigation of the golf course is the most water demanding activity and is primarily used outside of business hours. The second largest demand is construction use (dust control and street sweeping), which would utilize reclaimed water during business hours. The demand trends for toilet flushing and commercial uses are based on the current average demands for residential and commercial water use.

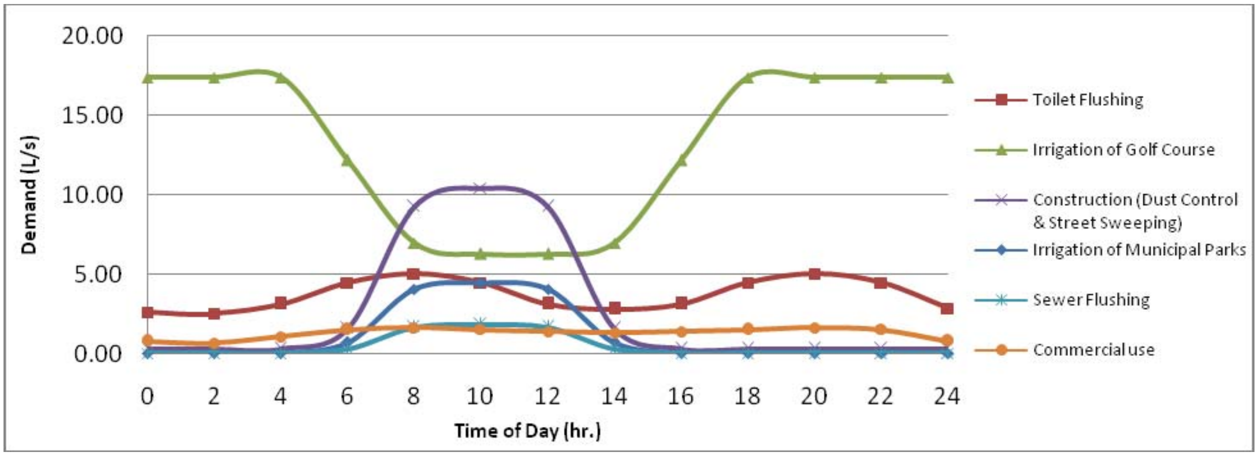


Figure 2-2: Daily Demands for reclaimed water from all estimated uses.

Most of the activities occur within the summer months, including the two activities with the highest demands (irrigation and construction). This leads to a large difference in demand when comparing the winter months to the summer months. This fluctuation in demand throughout the year is shown in Figure 2-3 as the average daily total demand increases from 4L/s in the winter to approximately 22L/s in the summer.

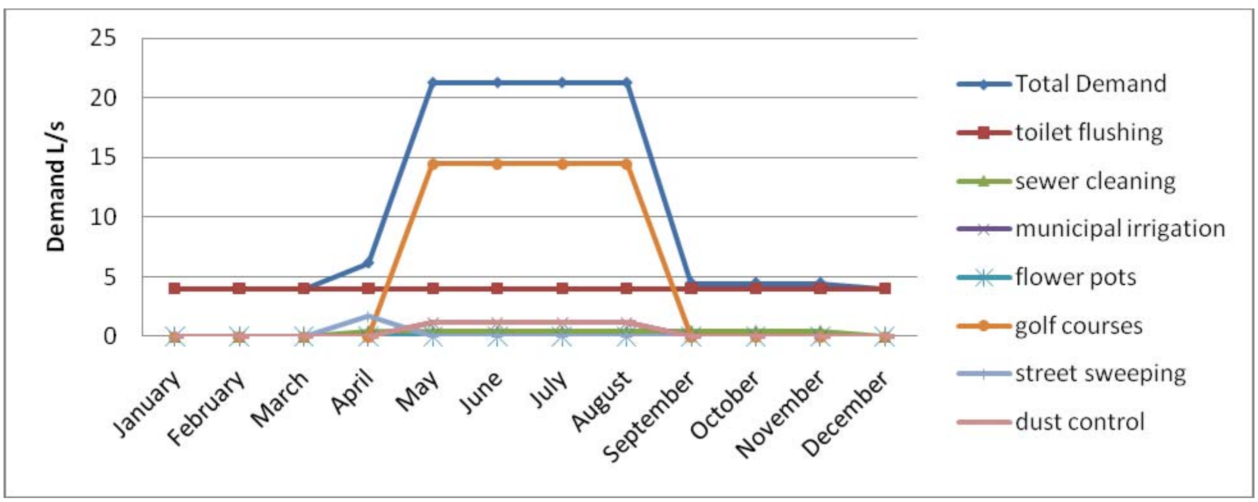


Figure 2-3: Estimated Annual Reclaimed Water Demand

Figure 2-4 and **Figure 2-5** show the daily demand trends and the average daily demand for the high demand period (summer demand) and the low demand period (winter demand). Using these figures, the design flow for the system was determined to be 22L/s, since the system design flow should be such that the average summer demand is continuously met. The storage requirements were also determined based on these trends. Storage is discussed further in **Section 2.6.1**.

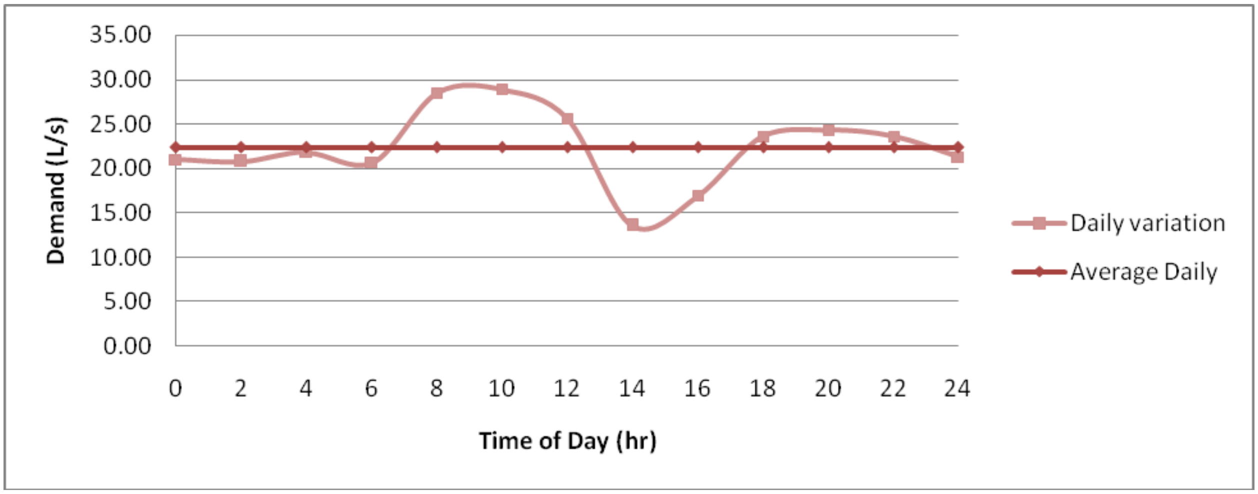


Figure 2-4: Estimated average and instantaneous demand during summer months (May to September)

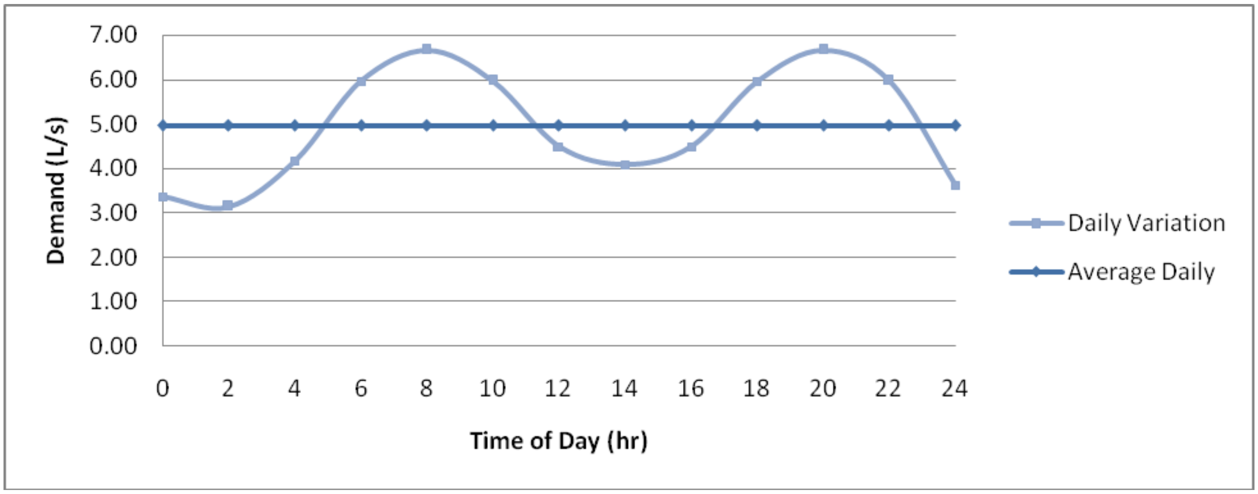


Figure 2-5: Estimated average and instantaneous demand during winter months (October to April)

2.6.1 Storage

Storage capacity within the distribution system is important to meet the potential variable reuse water demands. The estimation of the required storage was based in the demands identified in the previous section. A conservative and preliminary estimation based on the difference between the average summer demand (22L/s) and the peak summer demand (28L/s) and the length of time the demand is above the average demand (6 hours, shown in **Figure 2-4**), indicates that the system should be designed with a minimum of 254 m^3 of daily storage; however, utilizing the MOE design standard for water storage excluding fire storage, the required storage would be 635 m^3. An order of magnitude cost of the storage would vary from a minimum of $125,000 to approximately $635,000 depending on the configuration. At this cost, it may be more practical to increase the size of the treatment system rather than provide the storage, as effluent availability is not an issue.

2.7 System Limitations

This section outlines the potential limitations associated with water reuse within the City of Guelph, such as; water quality, regulations, public health, public perception, cost, and local hydrology.

2.7.1 Fecal Coliform

At the current levels of Fecal Coliforms, the potential uses of the reclaimed water are limited to the Restricted and Industrial activities. In order to meet other demands, the Fecal Coliform levels must be reduced. The cost to upgrade the WWTP treatment to reduce the total Fecal Coliforms found within the WWTP effluent would be an expensive process. The WWTP Master Plan (CH2MHILL, 2009) included recommendations for upgrades of the WWTP system to involve membrane filtration by the year 2024 to meet projected treatment requirements. The report estimates that these upgrades will have capital costs of approximately $60 million, with average operational and maintenance costs of over $400,000 per year.

It would not be necessary to upgrade the entire system to achieve the higher effluent quality, as a separate disinfection stream could be utilized to meet a higher effluent reuse standard for a smaller quantity of effluent, as detailed in **Section 3.2.1**.

2.7.2 Total Dissolved Solids

Total Dissolved Solid (TDS) are the inorganic salts and small amounts of organic matter present in solution in water, usually calcium, magnesium, sodium, chloride and sulfates. These solids can potentially accumulate within soils, damaging the soil structure and limiting the growth potential of the irrigated land. Levels of TDS found within the Guelph's WWTP effluent, in a 2002 study, are on average 1,300 mg/L. A study completed in 1999 of the effects of salinity and irrigation in the Canadian Prairies, classifies the level of TDS found in the Guelph effluent at 'possibly safe' (TDS between 700 mg/L and 1,750 mg/L). Generally, forage crops, which include grass, are the most resistant to salinity (Peterson, 1999). Limited studies have been previously completed on the topic of turf irrigation using WWTP effluent.

Currently the University of Guelph is performing a study on the effects of WWTP effluent on vegetation. This study uses municipal wastewater, after tertiary and secondary treatment, applied to three different cultivars of Kentucky bluegrass. The study is ongoing, but it has reported that preliminary results indicate that salt has a bigger effect on turf growth than any other wastewater parameter. It would not be practical to address TDS in a treatment process at this stage as a nanofiltration or reverse osmosis system would be required.

2.7.3 Regulations

The absence of existing regulations in Ontario poses a challenge to the ease of implementation for the Water Reuse Distribution System. Consultation with the MOE, GRCA and other local organizations is important for the development of a safe and effective Water Reuse Distribution System.

2.7.4 Health Risks

The health risks associated with water reuse systems are generally related to exposure to chemicals or microbial agents within the reclaimed water. Exposure can occur directly (skin contacts, ingestion of aerosols) or indirectly (ingestion of uncooked food irrigated with reclaimed water). This risk is the reason for the restricted and unrestricted classifications of reclaimed water.

2.7.5 Public Perception

It is expected that there will be a level of public reluctance towards wastewater reuse, as waste water reuse is largely unknown in Ontario. The water reuse program can be not be implemented without public approval. It is important; therefore, that the public be informed throughout the developmental stages of the water recapture design. Prior to public consultation, it is important to establish risk assessment and management practices to address health and safety concerns. It is vital that public health and safety are paramount when developing the system, as this will address the primary concern of the public.

2.7.1 Local Hydrology

Currently, the WWTP discharges an average of 54,000 m^3/d into the Speed River. This is approximately 15% of the total yearly average daily flow rate of the river, which is 375,000 m^3/d, just downstream of the plant. During low flow periods in the late summer, the assimilative capacity of the Speed River is at its lowest, resulting in the WWTP effluent flow accounting for 44% of the Speed River flow. The assimilative capacity of the river is controlled by the release of water from the Guelph Reservoir, located upstream of the WWTP. The effluent from the WWTP acts as an indirect potable water source for downstream water supplies and provides additional assimilative capacity to downstream discharges. With reduced amounts of effluent being discharged into the Speed River, the Guelph reservoir will not be required to discharge water for the purpose of increasing the assimilative capacity.

The use of reclaimed water to offset the City of Guelph's water demand will lower the overall demand on the local ground water supply. This could extend the lifespan of the current water supply system and allow the municipality to save the resources required to locate new fresh water sources.

It is difficult to determine the exact outcome the water reuse on the local water system, since the use of reclaimed water will lower the demand on the ground water system while also lowering the flow into the surface water system via the Speed River. Detailed analysis of the relations between the ground and surface water system should be completed to ensure that the lowering of the discharge to the Speed River will not adversely affect the Grand River watershed.

3. Infrastructure Requirements

This section identifies the potential infrastructure components required by the City of Guelph effluent reuse system.

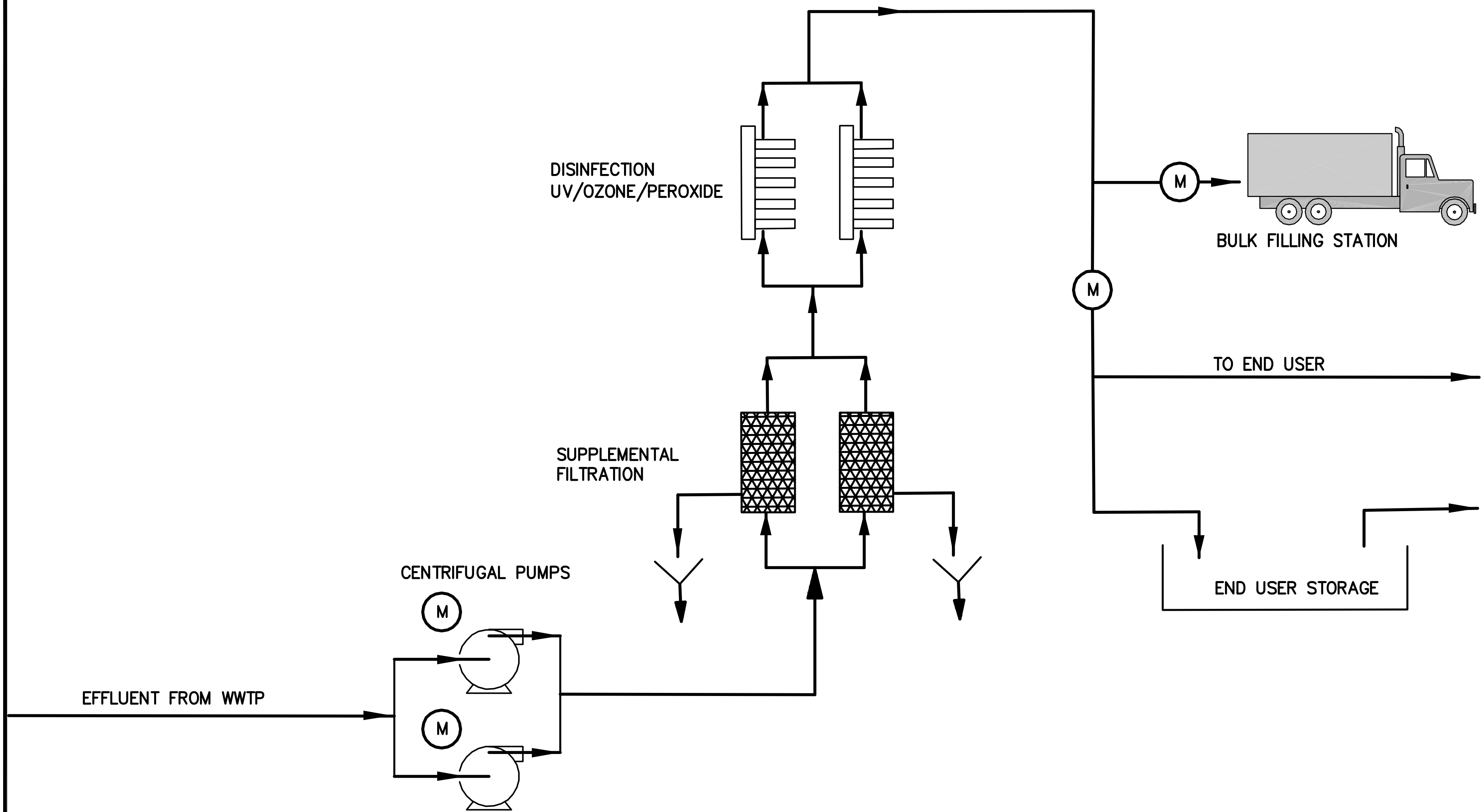
3.1 System Design Philosophy

Due to the variability of the demand, both seasonally and hourly, there may be a need for peak demand management using several techniques, as follows:

- Restricted Bulk Depot hours, limit bulk depot to operation outside of peak demand hours;
- End user storage for large users; and,
- Managed municipal uses, such as cycling field irrigation.

Based on the design flow detailed above of 11L/s the following would be the required/recommended components of the re-use system. **Figure 3-1** illustrates a block diagram of the system.

- A Diversion Structure;
- Supplementary Disinfection;
- Treated Effluent Storage (if desired);
- A High lift Pumping System;
- Automated Effluent Depot; and,
- Effluent Distribution Systems.



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PROJECT:
YORK TRUNK SANITARY SEWER AND PAISLEY-CLYTHE FEEDERMAIN – PURPLE PIPE TECHNICAL MEMORANDUM

TITLE:
PURPLE PIPE DISTRIBUTION SYSTEM PROCESS FLOW

SCALE: NOT TO SCALE

DATE: OCTOBER 6, 2011

PROJECT NO: 10405017

DRAWING NO: FIGURE 3-1

3.2 Infrastructure

The infrastructure requirements of the non-potable distribution system are similar to those of a potable water distribution system. Depending on the location and usage of the reclaimed water, the reliability, pressure, and demand may vary from the MOE standard for watermain construction. This section outlines the basic design guidelines outlined by the US EPA Guidelines for water reuse.

3.2.1 Treatment

Currently, the Guelph WWTP is classified as a conventional activated sludge system with tertiary treatment. The system includes grit removal, primary clarification, secondary treatment with an activated sludge system, secondary clarification, and tertiary treatment by Rotating Biological Contactors. This system effectively achieves the requirements of the Restricted reclaimed water use classification. Improvement would be required to achieve effluent that is of high enough quality for the unrestricted uses previously identified.

Additional treatment required to lower the Fecal Coliform levels can be provided by using UV and Ozone treatment. A benefit to this treatment application is that modular units used can be added or turned off when required to meet demands. This can allow the system to treat higher volumes of water during peak demand times, with limited negative impacts when a portion of the units are switched off. It is estimated that the additional treatment required for the system would cost approximately $200 000, this is dependant on the level and volume of treatment required. This would be enclosed within a new building as part of the pumping system.

The City of Guelph WWTP Master Plan Report (CH2MHILL, 2009) recommends the installation of membrane technology in the form of a tertiary Membrane Bioreactor (MBR) or Tertiary Membrane Filtration. The implementation of this technology would minimize the additional treatment required to achieve higher levels of reuse quality. At this stage, the treatment requirements have been selected based on current treatment.

3.2.2 Storage

As indicated in Section 3.3.1, the cost of storage at this size of system to balance flow demands is likely more costly than a modular system that can increase flow capacity to meet the peak demand. Furthermore, the provision of storage at grade would require secondary pumping, which would increase operational costs. At this time, therefore, no treated effluent storage would be provided.

3.2.3 Distribution

The optimal distribution main size would be 200mm in diameter as it would provide a minimum velocity of greater than 1.0 m/s at peak flow of 35.3 L/s. During winter demands, the peak velocity would be lower than optimal and may result in some accumulation of sediment within the pipe system, although this is unlikely due to the treatment and periodic flushing velocities. Using MOE design guidelines, this system would be limited to approximately the current peak design flow due to the length of the pipe and desirable headloss. If the main were upsized to a 250 mm diameter main, the maximum capacity would be 53.6 L/s (4,600 m^3/day) at the same velocity.

The US EPA has developed standards used in the State of Washington in regard to separation requirements between reclaimed and potable water lines. General requirements are that the minimum vertical separation between the crown of the reclaimed line, and the invert of the potable line is 0.5 meters, with the potable line above the reclaimed line or a minimum horizontal separation of 3 metres. In situations when site limitations do not allow for the identified spacing general requirements, a minimum horizontal separation of 1.5 m combined with a vertical separation of 0.5 m would provide the appropriate cross-connection prevention.

In locations where irrigation lateral lines are installed, the reclaimed water line will be at a higher elevation than the potable water line, creating the potential of cross-connections. The Washington standards suggest a minimum vertical and horizontal separation of 1.2 m. If this is not possible due to site limitations, a minimum vertical and horizontal separation of 0.5 m with the installation of an impervious barrier, such as PVC sheeting, is required.

Figure 2-1 illustrates the general location of the Purple Pipe watermain (in red) along the preferred alignment of the York Trunk sewer (in yellow). It is recommended that the watermain be installed from the City of Guelph WWTP east along the north bank of the Eramosa River and continue along York Road until the intersection with Watson Road. This will allow the watermain installation to take full advantage of the York sewer installation project and also reach the largest amount of potential consumers. It is estimated that the 250mm watermain will cost approximately $1,125,000 with the required booster pumping system estimated to cost approximately $450,000.

3.2.4 Auxiliary System Components

The components described in this section are in addition to the treatment and distribution of reclaimed water.

3.2.4.1 Bulk Filling Station

The installation of a bulk filling station will be required for the development of the street cleaning, flower irrigation, and dust control applications of reclaimed water. The location of the filling station should limit the cost of additional infrastructure. A standard bulk water depot system with metering and an accounting system would suit the application. There is also the potential for an equipment or automobile washing station to be incorporated into this facility if the water quality meets the unrestricted contaminant levels. For the purposes of this report, it is estimated that the capital cost for the bulk filling station will be approximately $50 000 based on an exterior system.

3.2.4.2 Metering

The US EPA guidelines recommend that the use of reclaimed water be metered in a similar method to potable water, with a unit price per m^3. This will allow the municipality to track the usage and still require customers to make efforts to conserve water usage. It is estimated that the capital cost for the metering system will be approximately $20,000 for the main meter into the distribution system.

3.2.5 Cost Summary

The order of magnitude cost estimate of the required infrastructure for a basic Purple Pipe system is summarized as follows:

- Treatment System - $200,000
- Pumping and Distribution - $1,575,000
- Bulk Depot and Metering - $70,000
- General Requirements (20%) – $369,000
- Contingency and Engineering (30%) - $665,000
- Total Estimate Cost ~ $2,900,000 (+50%/-30%)

Based on the capital cost per cubic metre of capacity is approximately $950. This cost does not include site specific equipment, such as service connections, hydrants, irrigation equipment or appurtenances beyond the main line. These costs would vary by site from $10,000 for a direct connection to several hundred thousand dollars for a connection across the River or into the City.

4. Conclusions and Recommendations

The following section details the conclusions regarding the Purple Pipe feasibility.

4.1 Demand

Since the installation of the Purple Pipe would be occurring prior to the demand of reclaimed water, consideration must be made for the areas that will require potential connections in the future. As previously identified, the areas along the York Trunk Sewer & Paisley-Clythe Feedermain that could utilize reclaimed water are:

- Guelph Innovation District located north of York Road between Victoria Road and Watson Parkway;
- Municipal Parks along the Speed and Eramosa Rivers between the Hanlon Expressway and Watson Parkway;
- Industry located along York Trunk Sewer & Paisley-Clythe Feedermain; and,
- Cutten Fields Golf Course located on south of Eramosa River between Gordon Road and Victoria Road.

These locations extend along the alignment of the proposed York Trunk Sewer & Paisley-Clythe Feedermain, suggesting that the Purple Pipe should extend the entire length of the York Trunk Sewer & Paisley-Clythe Feedermain to service the potential demand in the Innovation District.

Table 4-1 outlines the total potential demand for the reclaimed water uses identified within this report. The total for these demands only accounts for 4% of the total discharge from the City of Guelph's WWTP, depending on the quality of the effluent more uses of the reclaimed water can be developed and integrated in the future.

Table 4-1: Potential Demand for Reclaimed Water within the City of Guelph Proximate to Alignment.

Usage	Seasonal	Daily Demand (m^3/d)	Yearly Demand (m^3/yr)
Restricted Use			
Street Sweeping	Yes	144	3,175
Sewer Flushing	Yes	41	11,223
Unrestricted Use			
Urban Applications	No	462	168,168
Construction	Yes	101	10,160
Municipal Irrigation	Yes	100.8	8,800
Golf Course Irrigation	Yes	1250	147,000
Potential Demand for Reclaimed Water		2,131.8	348,526

Ultimately, particularly as the City of Guelph WWTP increases effluent quality, there is the potential for larger scale utilization of effluent for non-potable uses.

4.2 Cost Analysis

The following section details the cost analysis of the system relative to the deferred potable water cost savings that an effluent reuse system would permit.

4.2.1 Capital Cost

The estimated capital cost associated with the installation the basic Purple Pipe is $2.9 million This figure includes the removals, earthwork, and site work required in addition to the actual installation of the Purple Pipe forcemain if it were coordinated with the York Trunk Sewer and Paisley-Clythe Feedermain projects. It is estimated that there would be a 30-50% premium on the construction if the project were to proceed as a standalone project, due primarily to the Speed River Crossing.

4.2.2 Operation Cost

The estimated operational cost of the system will be generally limited to operation of the new treatment system and high lift pumping. There would be costs associated with the operation of the system, however. similar to the operational costs for a potable water system, excluding the testing components. At approximately $0.09/m^3 of capacity, the cost to operate the system at the estimated demand would be approximately $100,000/year. This includes power and operational costs. Maintenance costs per year would be in the $20,000 – $60,000 per year range.

4.2.3 Deferred Potable Supply Costs

As identified in **Section 1.1**, with the implementation of the Purple Pipe, the City of Guelph would effectively be increasing their potential water supply, in the form of non-potable water, by the volume of effluent discharged by the WWTP. The increase in non-potable water supply would allow the City of Guelph to defer the exploration and resulting capital cost associated with the development of a new water source. The deferred life cycle costs for the development of new potable water supplies identified in the *City of Guelph Water Master Plan* vary from $0.09/m^3 for the expansion of the ground water system within the City of Guelph to $0.30/m^3 for the development of new local surface water supplies.

The lifecycle cost of the proposed system at current design flow rate is approximately $0.27/m^3, due primarily to the cost of developing the infrastructure rather than the supply. The estimated deferred cost savings, therefore, would be limited until the City is required to pursue a surface water source in the future.

Although there are high capital costs associated with the installation of the Purple Pipe, installation of the Purple Pipe in conjunction with the York Trunk Sanitary Sewer and Paisley-Clythe Feedermain will have significantly lower costs compared to the installation of the same pipe at a later date. From an economic standpoint, although there would be value in the system, it is more cost effective to continue to develop existing groundwater supplies within the City rather than the implementation of the full scale Purple Pipe system. A smaller pilot program consisting of a bulk supply depot may be a practical method of having an impact on potable water consumption for non-potable uses with out the commitment of large amounts of capital.

4.3 Summary

Although the Purple Pipe system is technically feasible, the system is not economically feasible at this time to be implemented as a distribution system in conjunction with the York Trunk Sewer and Paisley-Clythe Feedermain. The lack of economical feasibility is due to the following key points:

Limited demand - The total of the demands estimated in this report consist of only 4% of the total potential non-potable water demand for the entire City of Guelph. Furthermore, with the exception of users that have yet to be developed (i.e. Guelph Innovation District), major users such as the Cutten Fields Golf Course would have to incur additional costs to connect and use the system and currently there is no incentive to change from their current supply.

High Lifecycle Cost - Although there are capital cost savings if the Purple Pipe were to be installed with the construction of the York Trunk sewer, the lifecycle costs are approximately three times the cost of developing existing groundwater supplies in the City and, therefore, will not be economically feasible until the City needs to look outside of the City for a surface water supply, which is estimated in the longer term (20 years).

4.4 RECOMMENDATIONS

- The effluent reuse system is technically feasible and, in comparison with similar municipalities across Canada, Guelph is likely in the best position to implement a system in the future due to their high quality of effluent from the existing WWTP. At this time, the economic comparison of a Purple Pipe system in comparison with securing alternative groundwater potable supplies does not warrant the implementation of a comprehensive Purple Pipe system in conjunction with the York Trunk Sewer and Paisley-Clythe Feedermain Class Environmental Assessment Project.

- It is recommended that the City proceed with pilot scale system providing effluent to a bulk filling depot located at the WWTP for use by non-potable bulk uses (street cleaning, sewer flushing, and dust control). The estimated cost of this system would be $75,000 - $250,000 depending on the availability of infrastructure within the plant site. This would defer potable consumption by up to 300 m^3/day during peak periods.

- It is recommended that the City revisit effluent reuse opportunities with each Water and Sewage Masterplan review, as the recommendation to not proceed is only temporary as there is a time within the 20 year horizon where effluent reuse may be an effective tool for the City of Guelph to continue growth in a more sustainable manner.

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