8. ASSET MANAGEMENT

In keeping with the City of Guelph's commitment to sustainable growth and asset stewardship, an integral component to this Master Plan is the establishment of tools to better manage linear water and wastewater assets over their life cycle. Through the development of the Master Plan, the City's decision-making process was documented and captured in these tools to ensure a consistent and defendable evaluation of each asset. In addition, the information needed to support the decision-making process was also evaluated and data capture strategies developed to ensure that both existing infrastructure and the infrastructure proposed in this Master Plan can be managed by the City and support appropriate funding levels for rehabilitation and eventual replacement. It is envisioned that the steps detailed in this section will form the basis for a comprehensive asset management plan that will used to maintain expected service levels and mitigate risk of failure for all City-owned infrastructure.

8.1. Asset Prioritization Strategy

Documented in Appendix H1 is the algorithm developed for the prioritization of the City of Guelph's linear assets. The algorithm details how decisions regarding the management of linear assets are made and what data is currently available in support of those decisions. Based on discussions with City staff the algorithm for Guelph's linear assets was used in the development of a Capital Asset Prioritization System (CAPS), and can be further used within the City's capital budgeting process.

During a workshop with City staff, parameters, criteria and weighting factors were established to evaluate and eventually prioritize the requirements of Guelph's linear water and wastewater assets. The outcome from this workshop established the approach for the development of the algorithm that would be used in the final prototype application.

The application is intended to generate a Priority Action Number (PAN) for each asset. PAN is a number that rates assets in relative priority based on their condition, performance and risk associated with failure. An asset is rated on a number of parameters (X), given a score (Y) and weighted (Z). The product of YZ is the PAN score. The sum of PANs for all parameters represents the overall PAN for each asset. PAN is calculated as follows:

$$PAN = \sum_{i}^{X} YZ$$

The total PAN score or the overall PAN score for an asset or network of assets will assist in prioritizing the assets so critical assets are addressed first and levels of service are maintained or improved in a financially sustainable manner. Higher numbers represent a higher priority. Both linear water and wastewater assets are evaluated with the following parameters:

- **Condition** – The current physical condition of the pipe
- **Performance** – A measure of a pipe's ability to operate/perform as required to meet customer needs
- **Risk** – Impact due to loss of service and the likelihood of failure

8.1.1. Linear Water System Assets

Each parameter is evaluated and ranked based on a number of criteria. The criteria were discussed with City personnel and a scoring system and range was developed to ensure the Prioritization Asset Number (PAN) calculated will identify watermains at a higher risk of failure. Figure 8.1 below identifies the parameters, criteria, score ranges, and weighting factors used to develop PANs for linear water assets.

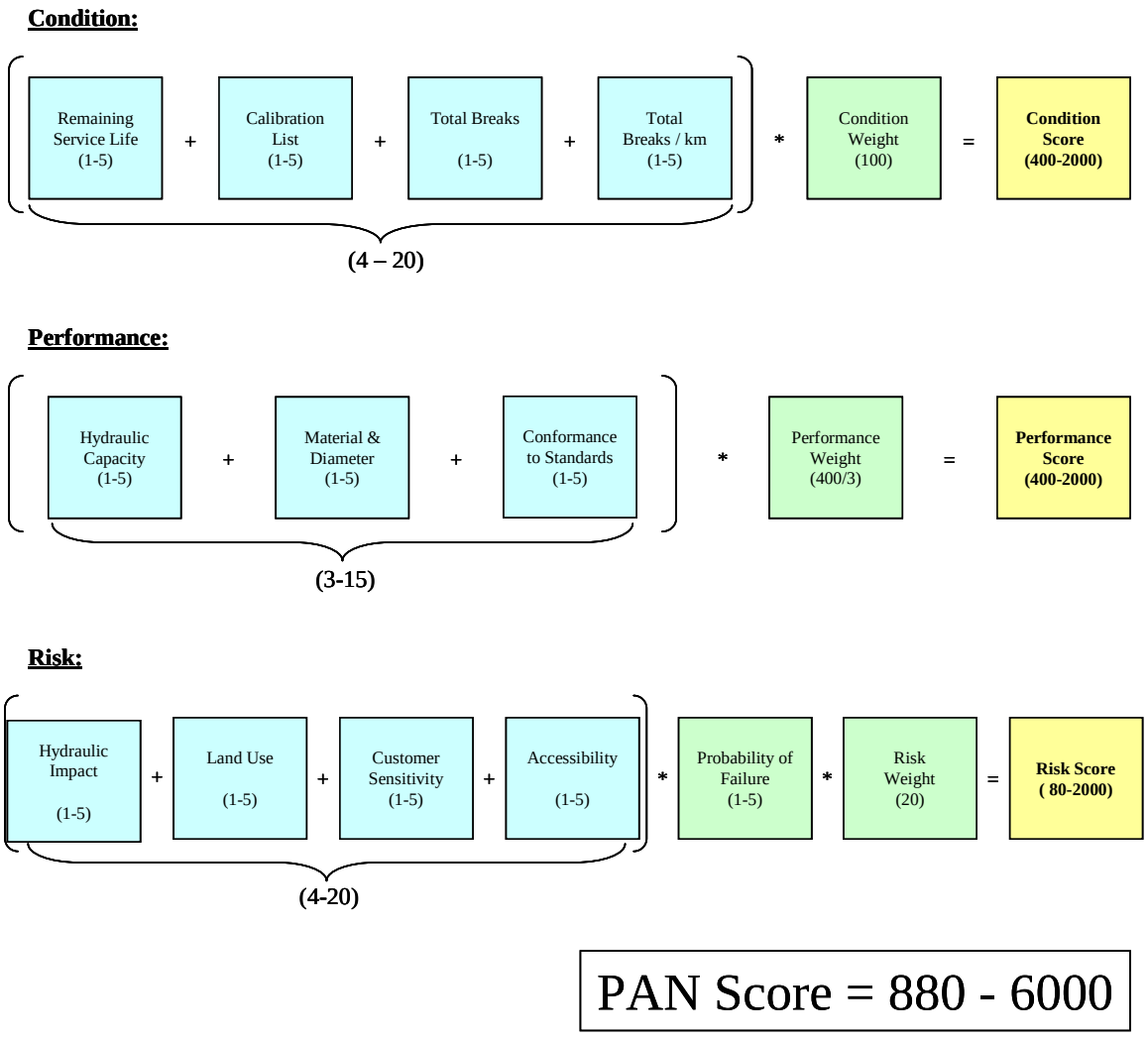

Figure 8.1 – Water PAN Calculation Criteria

The water PAN scores will range from 880 to 6000. The higher the PAN the more critical the state of the asset, or the higher in the prioritization sequence the asset will appear. The maximum PAN may change as the City's scoring/weighting system evolves. For now the City has decided to provide equal weight to each of the criteria, and the same maximum scores for each parameter. Criteria and weighting factors may change as Guelph's data collection programs and management philosophies evolve, or as operation and management of the system changes. Care should be taken if PANs are compared from one year to the next. Appendix H1 further describes how each criterion is evaluated, calculated and scored.

8.1.2. Linear Wastewater System Assets

Similar to linear water assets, each sewer parameter is evaluated, calculated and ranked based on a number of criteria. Each criterion was discussed with the City of Guelph and the following scoring system/range was developed. High PAN numbers identify a higher risk or impact of failure associated with that asset. Figure 8.2 below identifies the parameters, criteria, score ranges and weighting factors used to develop PAN scores for linear sewer assets.

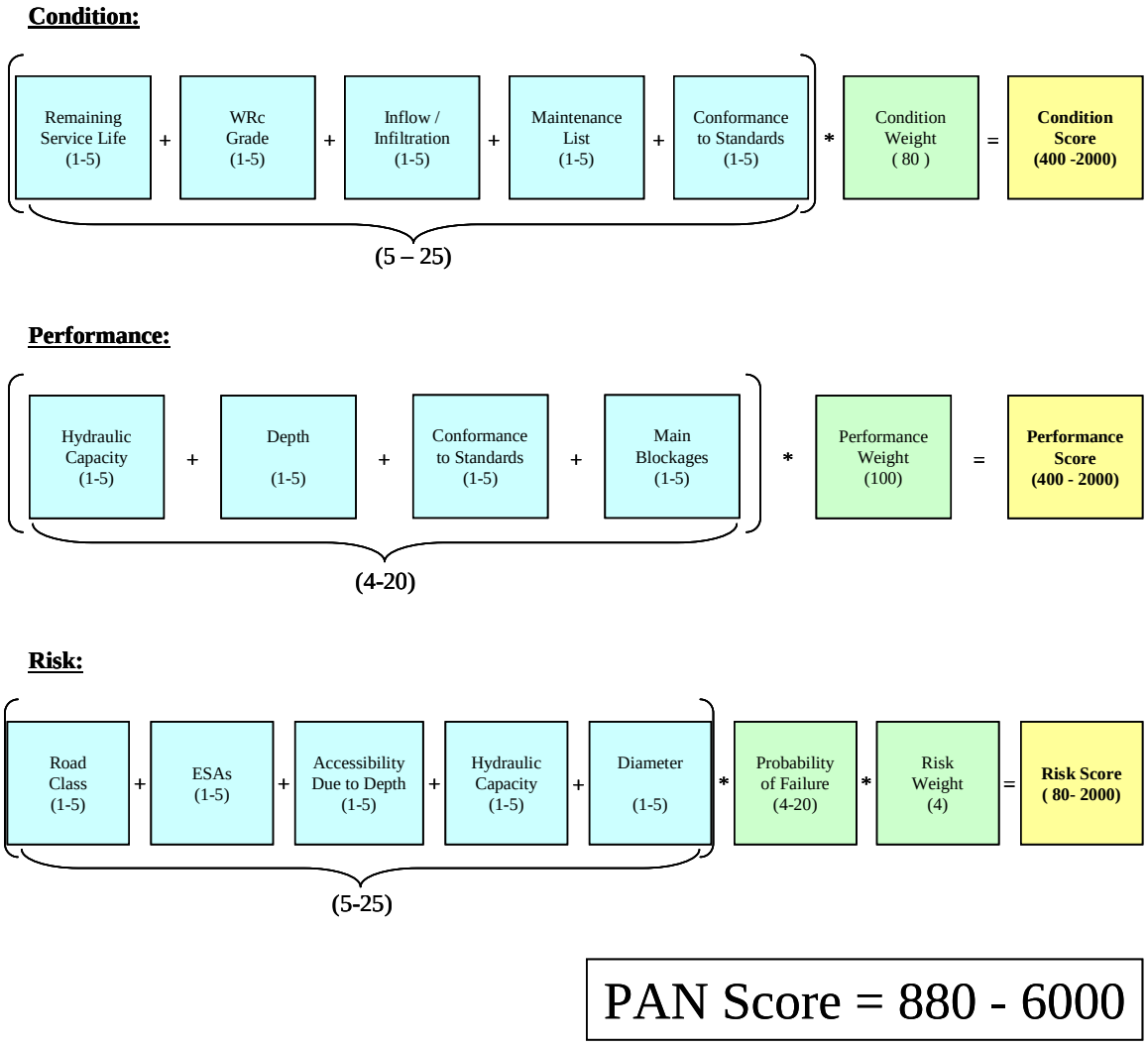

Figure 8.2 –Wastewater PAN Calculation Criteria

The current maximum PAN that an asset in the wastewater system can attain is 6000. The higher the PAN the more critical or higher in the prioritization sequence it will appear. We note that the maximum

PAN may change as the City's scoring/weighting system changes so care should be taken if PAN's are compared from one year to the next.

Appendix H1 further describes how each criterion is evaluated scored and calculated.

8.2. Condition Assessment Strategy

Condition assessment is the technical assessment of the physical condition and current operational performance of an asset. A condition assessment approach should use a systematic methodology to produce consistent, relevant information about an asset and provide sufficient information at the appropriate point in the assets lifecycle to allow informed asset planning and management decisions. Condition assessment approaches can range from a simple approach which groups major classes of assets such as roads or pipe networks and treats the assets as a "pool" of assets' (sometimes referred to as a "Top-Down Approach"), to more sophisticated approaches using multi-faceted ranking systems, destructive and non-destructive testing and prediction tools such as condition decay trends. The analysis of condition includes the evaluation of structural indicators (the physical condition of an asset), and performance indicators (most commonly the capacity but could include other indicators such as water quality or odours).

For the City of Guelph, the intent was to establish a strategy for water and sewer condition assessments, and the condition information required to support CAPS, when the information would be best utilized and most useful, and how it will be applied to make proactive decisions on asset renewal.

To assess the current condition and predict the future condition and maintenance and renewal needs, the CAPS tool outlined above was utilized and further developed beyond Technical Memorandum #1 (Appendix H1). The CAPS application is capable of performing life-cycle analysis on an asset-by-asset basis. The features include:

- Calculation of PAN trends for asset categories over time, thereby permitting the projection of an asset's PAN into the future,
- Establishment of "set points" of PAN, whereby rehabilitation or replacement of an asset is triggered based on PAN scores

CAPS embodies a condition rating and prioritization system that incorporates the physical condition of an asset, but also performance indicators as they assess functional adequacy. The Condition Assessment

Strategy documented in Appendix H2 results from the asset evaluation and prioritization strategy developed as part of Technical Memorandum #1 (Appendix H1), and as designed specifically to support Guelph's established decision-making approach.

City of Guelph staff selected condition, performance and risk parameters to help prioritize asset replacement and rehabilitation planning as shown in Figures 8.3 and 8.4 for the water and wastewater assets respectfully. The data requirements needed for CAPS are also illustrated.

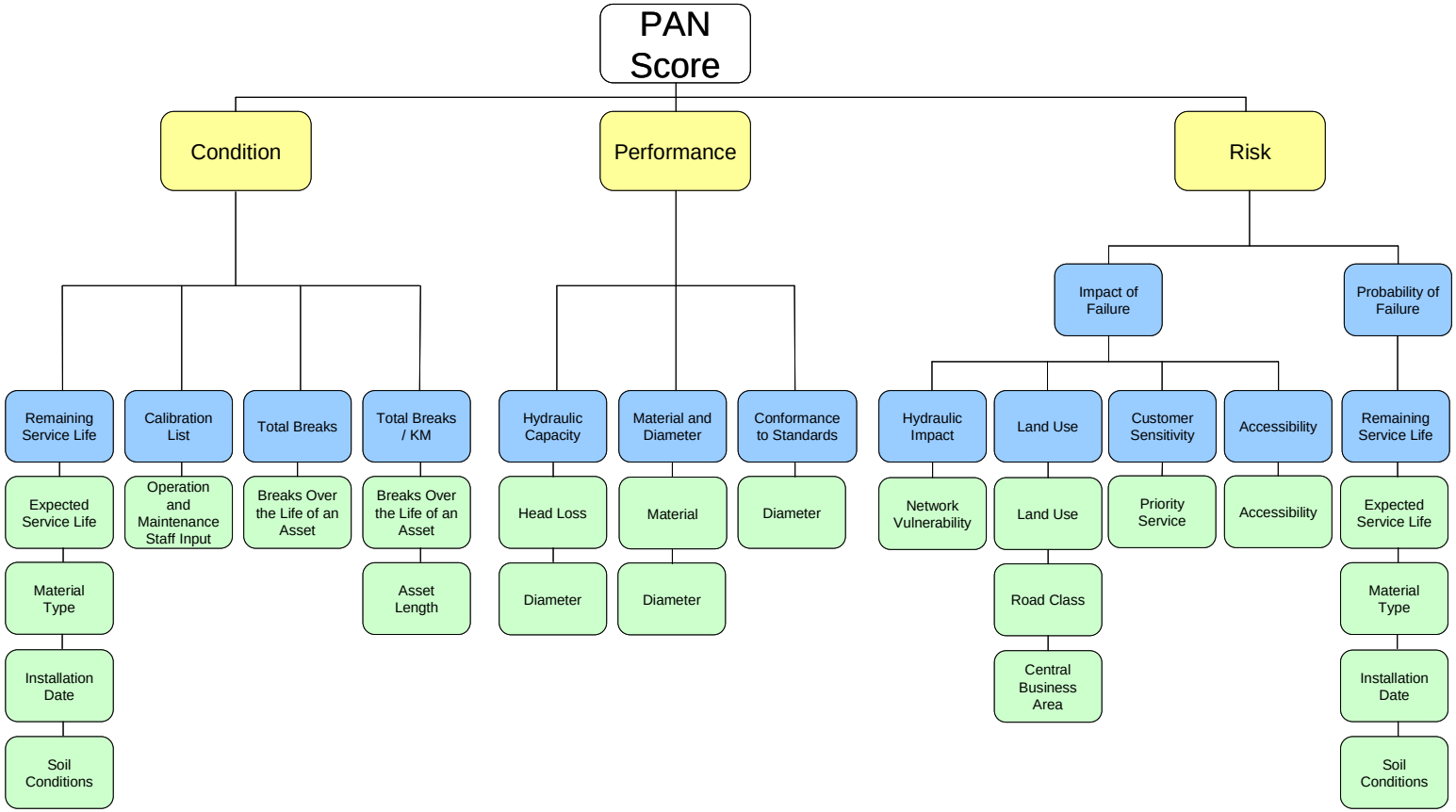

Figure 8.3 – Information Flow Diagram for Watermain PAN Scores

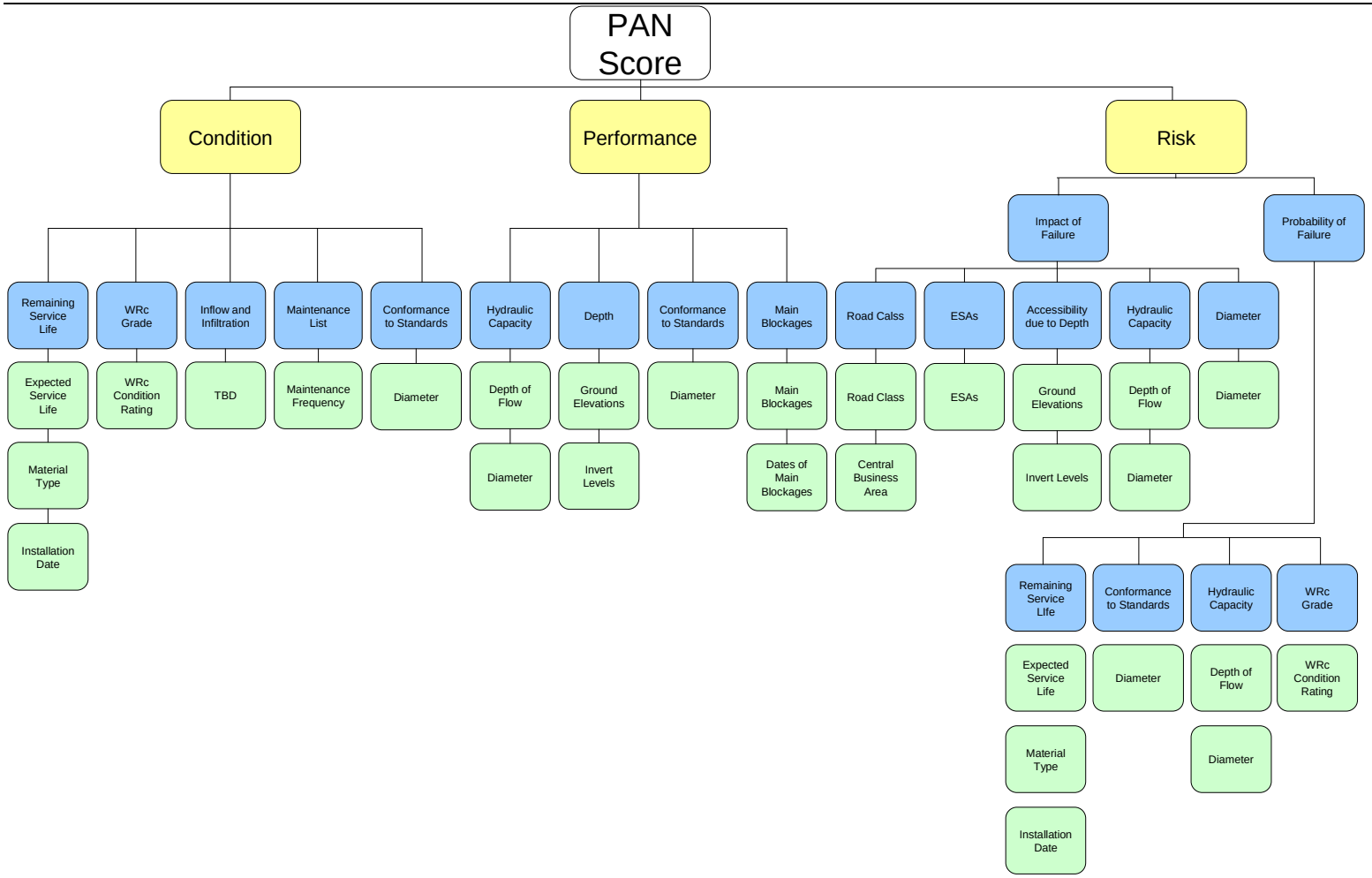

Figure 8.4 – Information Flow Diagram for Sewermain PAN Scores

As illustrated by the figures, condition assessments for linear systems are based on the collection of various pieces of data, including: material, size (diameter), age, depth, soil type, and the number of watermain breaks or sewer blockages per kilometer per year. Through the analysis of this data within CAPS, trouble areas can be determined and alternative measures can be implemented to provide the most cost effective means of improving an asset (i.e. rehabilitation programs, maintenance programs, or replacement if necessary). Data collection activities should always be coordinated with ongoing refinement of the overarching strategy (CAPS) to ensure that it continues to meet the City's needs.

The collection and maintenance of this data requires staff to undertake several activities at key intervals over the life of an asset. This involves capturing and analyzing standardized condition assessment data that will help confirm if an asset is achieving the desired level of service, is exceeding it, or if the asset might fail prematurely. These recommended activities are documented in Appendix H2.

8.3. Asset Management System Specifications

The City of Guelph recognizes that from a social, environmental and economic standpoint, one of the most important issues faced in the water industry today is sustainability. Sustainability depends on true visibility into and access to real-time and historical operations data. With this data, water and wastewater companies including municipalities can collect, analyze and disseminate information in a timely manner, leading to critical, informed and cost effective decisions about how to effectively manage their assets.

The objective of the third phase of the Water Distribution and Wastewater Conveyance Asset Management portion – "Asset Management Specification" was to document the key information sources and data collection and information sharing requirements so the City can continue to support CAPS, or develop specifications upon which commercially available software can be procured that, at minimum, duplicates CAPS functionality.

Successful planning, selection and implementation of a management system enables a utility to better integrate processes and systems, improve efficiency and effectiveness, and improve data availability for informed decision making, scheduling, resourcing and reporting.

There are numerous management system software packages available on the market today however implementing available software has often met with failure and disappointment. Successful

implementations require the planning and documentation of business requirements and specifications, rather than implementing the most popular brand of software and having software requirements dictate business processes.

The City of Guelph may choose to maintain data as indicated in the data sources shown by Figures 8.5 and 8.6, and continue to maintain the CAPS application. However should the City decide to investigate commercially available software, it is recommended that the City undertake a formal review and selection process. As a minimum, the system should have the following functionalities:

- Predict asset needs based on analysis of observed condition, performance and risk as established within this project (CAPS – TM#1, in Appendix H);
- Prioritize asset replacement/rehabilitation on the same basis;
- Forecast lifecycle needs based on trends as documented in TM#2, in Appendix H;
- Calculate related capital costs;
- Integrate with the data sources (Figure 8.5), and data listed (Figure 8.6).

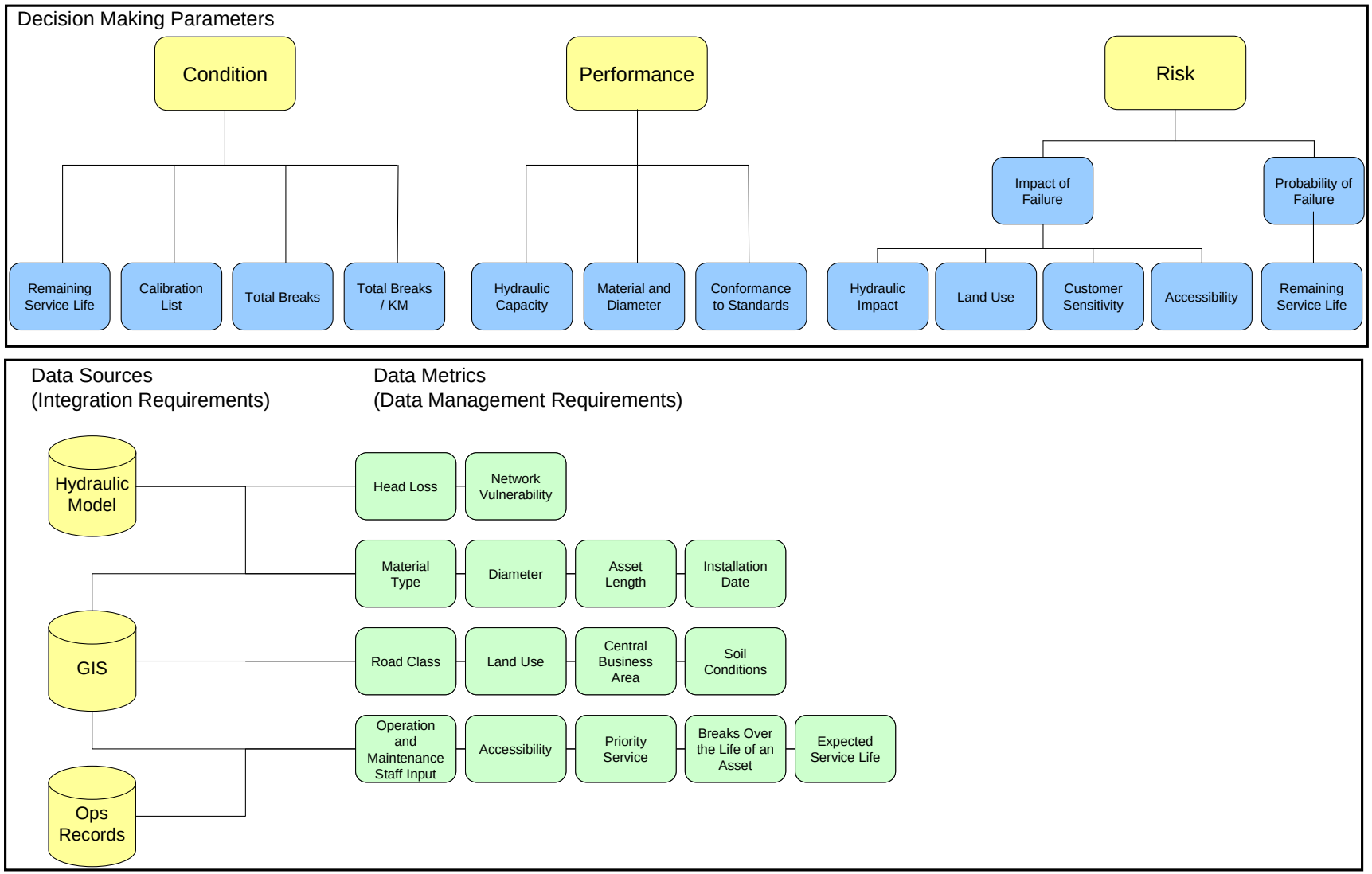

Figure 8.5 – City of Guelph Data Sources and Watermain Data Metrics for Asset Management

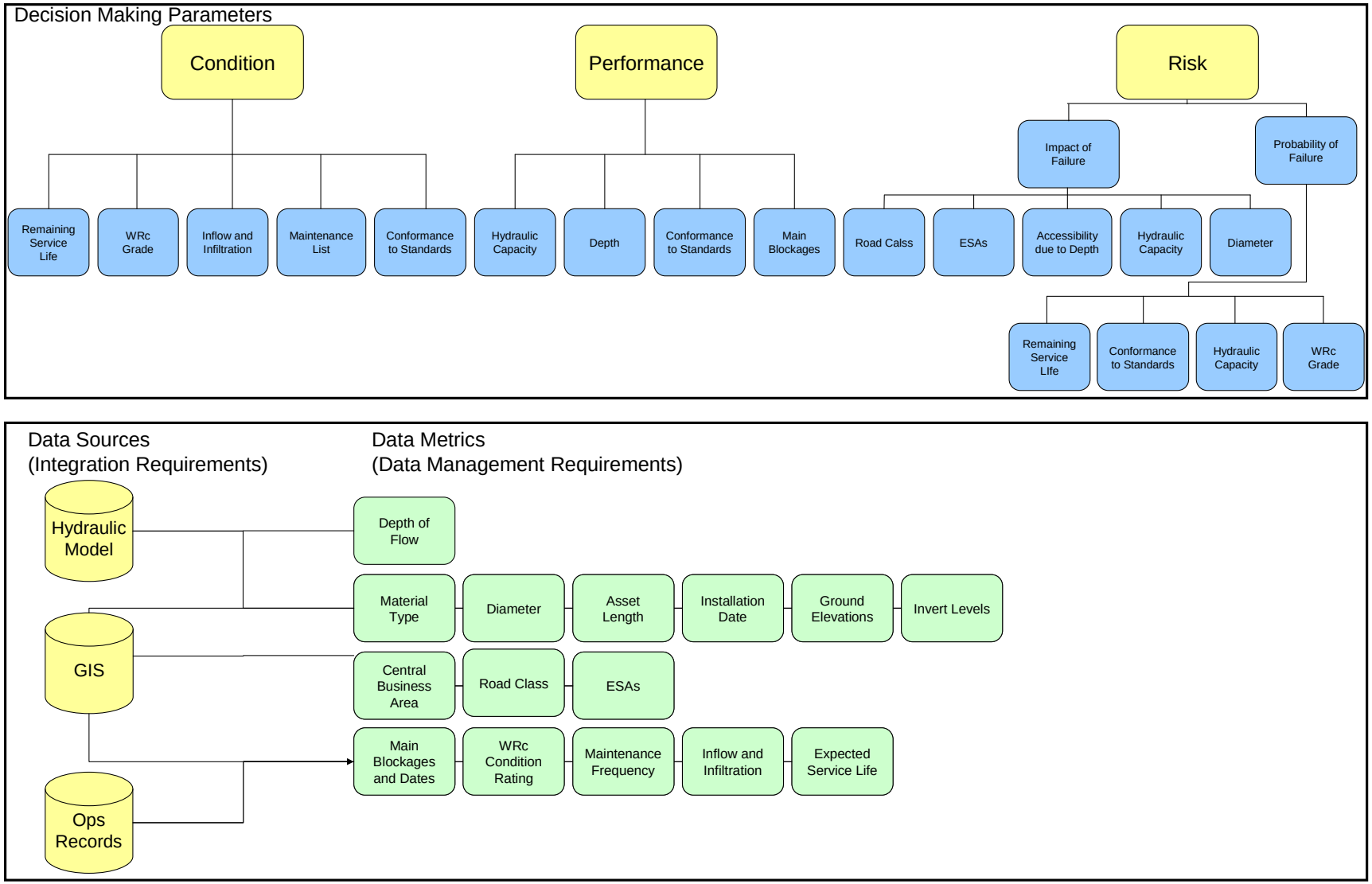

Figure 8.6 – City of Guelph Data Sources and Sewermain Data Metrics for Asset Management

8.4. Water Distribution and Wastewater Conveyance Asset Management Summary, and Budget Estimates

In the Asset Management component of the City of Guelph's Master Servicing and System Optimization Study, the three (3) Technical Memoranda summarized above and attached in Appendix H, have accomplished the following:

- Documentation of the algorithm of how decisions are made today
- Identification of data currently available and respective data sources
- Development of a prototype database application that tests/refines/and demonstrates the decision making algorithm for linear asset prioritization
- Development of a condition assessment strategy utilizing the same data as the CAPS algorithm which enables trending over time to project and help predict future levels of reinvestment
- Documentation of the minimum requirements from an asset management system that will support the City's needs

Recognizing that the City's infrastructure will change and evolve over time, the following sections provide recommendations on the minimum requirements of the business processes needed to support the replacement prioritization and condition assessment strategy, implementation options, and estimates of the required resources for each.

8.4.1. Requirements of an Asset Management System

8.4.1.1. Data Collection Requirements

Whether the City chooses to implement their asset management strategy by opting to maintain the CAPS application or by investing in commercially available software, data collection will be an essential task for successful implementation.

Phase 2C/D Asset Management Technical Memorandum #2 outlines the watermain and sewermain data elements, completeness, time dependency, update frequency, data sources, and recommendations for updating and maintaining the necessary information for the City of Guelph's documented prioritization decision making algorithm. Tables 8.1 and 8.2 provide the basis for a data collection and review program.

Table 8.1 – City of Guelph's Current Watermain Asset Information Required for Condition Assessment and Prioritization

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
Installation Date	93%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Material	93%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Diameter	94%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Length	94%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Expected Service Life	93% (based on material and installation date)	Yes	Review Annually	Currently CAPS	Can be maintained in GIS for example
Soil Conditions	332 assets with documented soil conditions	No	Review Annually	Excel	Data was provided in Excel, but should be maintained with other asset information in GIS for example
Operational Input	140 assets on Operation's	Yes	Review Annually	Excel	Data was provided in Excel, but should be

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
	calibration list				maintained with other asset information in GIS for example
Breaks	555 assets with a break history	Yes	Review Annually	GIS shape file and Excel	Breaks should be maintained in one location such as GIS, and should be attributed to the asset ID
Head Loss	93%	Yes	Review / Calculate Annually	Hydraulic Model	Calculated by the Hydraulic Model
Network Vulnerability	94%	Yes	Review / Calculate Annually	Hydraulic Model	Calculated by the Hydraulic Model
Land Use	100%	No	N/A	GIS shape file	Land use information is attributed to each asset through a spatial join
Road Class	100%	No	N/A	GIS shape file	Road Class information is attributed to each asset through a spatial join
Central Business Area	82 assets listed in the CBD	No	N/A	GIS shape file	CBD information is attributed to each asset through a spatial join
Priority Service	100% (59 high priority customers)	No	N/A	Excel	Data was provided in Excel, but should be maintained with other asset information in GIS

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
					for example, and attributed to individual assets
Accessibility	85 assets with accessibility issues	No	N/A	Excel	Data was provided in Excel, but should be maintained with other asset information in GIS for example, and attributed to individual assets

Recommendations for Watermain Data Collection and Review

- Installation dates, material, diameter, and length, are maintained in both GIS and the hydraulic model, and were generally complete. This data should be reviewed on a regular basis to address data gaps, consistency between GIS and the model, and to address anomalies such as PVC pipe with an install data prior to reasonable installation time.

- Expected service lives are an estimate based on the historical condition and performance of groups of materials. The estimated service lives should be reviewed annually to ensure they reflect typical service lives.

- Soil conditions, operational input, priority service customers, and accessibility are condition, performance and risk information assigned to assets that should be considered with a higher priority. Because these data items are not applicable for all assets, this data should be reviewed by operations staff on a regular basis to ensure that records are consistent with what is known and observed in the field.

- Breaks data and reactive maintenance information. The breaks reporting process should be reviewed to ensure that the data associated with breaks is tracked against the assets and is tracked in one common location.

- Head loss and network vulnerability are data items that are calculated within the hydraulic model. These data items should be re-calculated regularly as the model and supporting asset data is updated.

- Land use, road class, and central business area data has been assigned to linear assets through a spatial join. No data collection is required however the spatial joins should be updated with changes to the shape files or addition of assets.

Estimated resources for regular internal review, and maintenance of watermain data: 0.5 FTE/year

Table 8.2 – City of Guelph's Current Sewermain Asset Information Required for Condition Assessment and Prioritization

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
Installation Date	99%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Material	93%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Diameter	100%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Length	100%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
Expected Service Life	93% (based on material and installation date)	Yes	Review Annually	Currently CAPS	Can be maintained in GIS for example
WRc Condition Rating	0%	Yes	Review Annually	To be determined	Dummy tables were created in CAPS to support future collection this information
Inflow and Infiltration	0%	Yes	Review Annually	To be determined	Dummy tables were created in CAPS to support future collection this information
Maintenance Frequency	0%	Yes	Review Annually	To be determined	Dummy tables were created in CAPS to support future collection this information
Depth of Flow	100%		Review / Calculate Annually	Hydraulic Model	Calculated from data available from the hydraulic model
Ground Elevation	100%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model
Invert Levels	100%	No	N/A	GIS / Hydraulic Model	Maintain data in both GIS and the Hydraulic Model

Asset Data Requirements	% Complete / Number of Records	Regular Review and Update Required	Update Frequency	Data Source	Comments
Main Blockages and Dates	0%	Yes	Review Annually	To be determined	Dummy tables were created in CAPS to support future collection this information
Road Class	99%	No	N/A	GIS shape file	Road Class information is attributed to each asset through a spatial join
Central Business District	73 assets listed in the CBD	No	N/A	GIS shape file	CBD information is attributed to each asset through a spatial join
Environmentally Sensitive Areas	60 assets listed in the ESAs	No	N/A	GIS shape file	ESAs attributed to each asset through a spatial join

Recommendations for Sewermain Data Collection and Review

- Installation dates, material, diameter, length, ground elevation, and invert levels are maintained in both GIS and the hydraulic model, and were generally quite complete. This data should be reviewed on a regular basis to address data gaps, consistency between GIS and the model, and to address anomalies such as PVC pipe with an install data prior to reasonable installation time.

- Expected service lives are an estimate based on the historical condition and performance of groups of materials. The estimated service lives should be reviewed annually to ensure they reflect typical service lives.

- WRc condition ratings are a future data item, which the City wishes to include in the asset prioritization decision making algorithm. A data collection program is required.

- Inflow and infiltration, maintenance frequency, and main blockages data are incorporated in the prioritization algorithm; however the data was not available to support the application. Data format, and data collection is required. This information is assigned to assets that should be considered with a higher priority. Because these data items are not applicable for all assets, when available, this data should be reviewed by operations staff on a regular basis to ensure that records are consistent with what is known and observed in the field.

- Depth of flow is calculated within the hydraulic model and should be re-calculated regularly as the model and supporting asset data is updated.

- Road Class, Central Business Area, and Environmentally Sensitive Areas data has been assigned to linear assets through a spatial join. No data collection is required however the spatial joins should be updated with changes to the shape files or addition of assets.

Estimated resources for regular internal review, and maintenance of Sewermain data: 0.5 FTEs/year

Estimated resources for internal data collection programs for WRc Condition Ratings data: 1.0 FTEs

8.4.1.2. Regular Review of Decision Making Process

The City should regularly review their decision-making process and discuss inclusion of new parameters such as water quality parameters, and elimination of historical and irrelevant parameters as mutually agreed upon by decision makers. The selected management system should be flexible enough to incorporate the City's changing and developing requirements.

Estimated resources for regular internal review, of decision making process and parameters: 0.12 FTE/years (Based on 15 staff conducting a 2 day workshop annually)

8.4.2. Strategy Implementation Options

The City should also consider the merits of adding financial reporting to their water distribution and wastewater conveyance management system. If the City considers financial reporting with the management system to be appropriate, the linear system asset data utilized in Guelph's CAPS application or future management system software can be further developed to perform calculations to generate cost reporting and reserve forecasting for asset management and PSAB 3150 reporting requirements. This has already been developed and is being used by other municipalies (e.g. the Region of Peel).

Option 1: Maintain and utilize the exiting prototype CAPS application

The application has been developed in Microsoft Access because it is a relatively simple platform for most users to work with and is available on most PCs. The application can be maintained, updated and operated internally. A support agreement for updates to the functionality of the application and the data is also an option.

Estimated resources for maintaining, updating and utilizing the CAPS prototype application: 0.06 FTEs/year (Based on 1 FTEs time for 3weeks/year)

Estimated resources for a CAPS Support Agreement: $7500/year (Based on an estimated 5 days of effort plus travel expenses.)

Option 2: CAPS Augmentation for Cost Reporting and Reserve Forecasting

If the City considers financial reporting with the management system to be appropriate, the linear system asset data utilized in Guelph's CAPS application or future management system software can be further developed to perform calculations to generate cost reporting and reserve forecasting for asset management and PSAB 3150 reporting requirements.

The CAPS application and the data housed in the CAPS application can be further augmented to perform calculations to generate cost reporting and reserve forecasting and asset management and PSAB reporting requirements. Replacement values and annual depreciation from the year of construction and today can be calculated utilizing output from the CAPS application in conjunction with historical cost indices and the City's unit replacement costs. The sum of the net book value and the sum of the annual depreciation is calculated for PSAB reporting requirements. For asset management purposes, the today's replacement costs and annual depreciation based on today's replacement costs can be calculated. The sum of the annual replacement costs for today is essentially the reinvestment or reserve levels required for sustainability.

Estimated Cost for CAPS Augmentation: $15,000 - $25,000

Option 3: Obtain, Implement and Maintain Commercially Available Software

If the City choose to invest in commercially available software, substantial resources will be required for successful selection, acquisition, implementation, and maintenance of the application. Moreover, use of a

commercially available software package does not relieve or reduce the internal resources needed by the City to collect and maintain the data used by the software.

Estimated Cost for software acquisition and implementation: $500,000 - $1,000,000.

Estimated Cost for maintenance, training and license renewal is software dependent but is estimated at $50,000 to $100,000 per year

Bibliography

The following reports were reviewed as reference for this project.

1. Water Supply Study (WSS).
2. The Water Supply Study Distribution System Model Report Phase 2, 1992 by Braun Consulting Engineers and the Water Model Development Project, including the Users Manual 2003 by KMK Consultants Ltd.
3. City of Guelph Water System Cost of Sustainable Service – R.V. Anderson Associates Limited, December 2001.
4. Sewer Model Development Project, Users Manual 2004 by KMK Consultants Ltd.
5. City of Guelph Wastewater System Cost of Sustainable Service – R.V. Anderson Associates Limited, December 2001.
6. Water Supply Master Plan Study, Earth Tech Canada Limited.
7. City of Guelph Local Growth Management Study, Context Report, Meridian Planning Consultants Inc., September 2006.
8. City of Guelph Local Growth Management Strategy Report, Meridian Planning Consultants Inc., September 2007.
9. City of Guelph, Guelph Growth Management Strategy: Residential Intensification Analysis Report, Fall 2007.
10. City of Guelph, Development Charge Background Study, C.N. Watson and Associates Ltd., November 25, 2003.
11. City of Guelph Wastewater Treatment Strategy - Schedule C; Class Environmental Assessment, CG&S, March 1998.
12. City of Guelph Wastewater Treatment Strategy - Schedule C, Class Environmental Assessment, Post Notice of Completion Report, CH2MHill, June 1998.
13. GRCA Report: Water Quality in the Grand River: Current Conditions, June 17, 2003.
14. GRCA Memorandum & Slides: Overview of work to date to assess assimilative capacity of Speed River downstream of Guelph WWTP, July 28, 2004.
15. Modeling the Assimilative Capacity of the Speed River, GRCA, November 19, 2004.
16. Guelph WWTP Class EA Update Receiving Water Assessment Review, CH2MHill, January 2005.
17. Guelph WWTP Biosolids Master Plan – various technical memos for Tasks 1 to 4, CH2MHill.
18. Guelph WWTP Annual Reports: 2001 – 2004.
19. Inflow/Infiltration and York Trunk Sewer Assessment – final Report, CH2MHill, March 2002.
20. Annual Review of Inflow and Infiltration to the Guelph WWTP, City of Guelph, October 2001.
21. Sanitary Sewer Flow Monitoring Study 1998, CG&S, November 1999.
22. Wastewater Influent Characterization Study – Sanitary Sewer System, City of Guelph, November 2001 and January 2003.