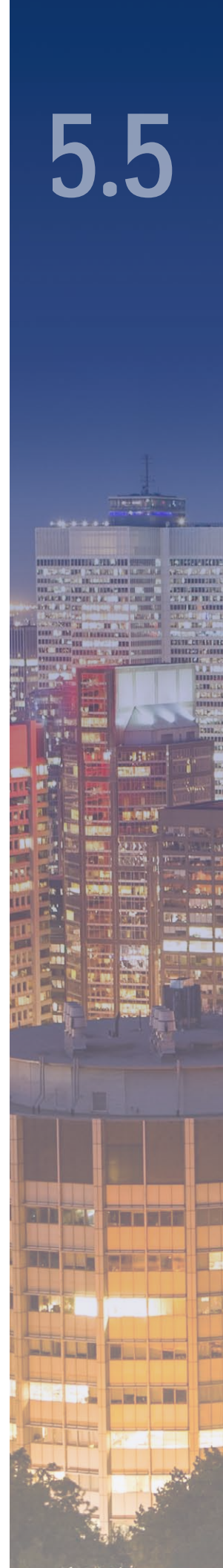


# Implementation Plan for Secondary Water and Sewer System Infrastructure Work

(Service de l'eau – Direction  
de la gestion stratégique  
des réseaux d'eau)





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## List of Acronyms

AB	as built	MAMROT	Ministère des Affaires municipales, des Régions et de l'Occupation du territoire
DEEU	Direction de l'épuration des eaux usées		
DEP	Direction de l'eau potable	PRP	partial response plan
DGSRE	Direction de la gestion stratégique des réseaux d'eau	RP	response plan
DI	Direction des infrastructures	SIS	structural integrity score
DTP	Direction des travaux publics	SITE	Service des infrastructures, du transport et de l'environnement
IDAS	integrated decision aid system	TCEP	three-year capital expenditures program
IRP	integrated response plan		
MAMR	Ministère des Affaires municipales et des Régions		

## 5.5. Implementation Plan for Secondary Water and Sewer System Infrastructure Work (Service de l'eau – Direction de la gestion stratégique des réseaux d'eau)

### 1. Introduction

The Ville de Montréal (the city) has an impressive water system that supplies drinking water to a population of 1.9 million<sup>1</sup> and an equally impressive sewer system that captures and recovers wastewater. Besides drinking water treatment plants and the wastewater treatment plant, system assets consist of fire hydrants, valves, service connections, manholes, sumps, pumping stations and several thousand kilometres of underground water mains and sewer lines that criss-cross the subsoil. The replacement value of all the water assets is \$40 billion, which includes an estimated \$24.2 billion for secondary system assets.<sup>2</sup>

Jurisdiction over water management is shared among the urban agglomeration council, the city council and the borough councils. The urban agglomeration council is responsible for water supply and wastewater treatment infrastructure and equipment, except for local lines. City council is responsible for management of local water main and sewer line systems, except for the downtown region, which falls under the purview of the urban agglomeration council. Maintenance of the lines falls under the responsibility of each of the boroughs concerned.

Depending on their locations, filtration plants draw the water they treat from Lac Saint-Louis, from Rivière des Prairies or from the St. Lawrence River. The water is then transported to the city's water system, which consists of 4,250 km of lines. On the Island of Montréal, 681 km of primary lines carry water to 3,572 km of secondary system lines on city property. Drinking water is distributed through secondary lines to residences, industries, businesses and institutions. As for the sewer system, it consists of nearly 4,234 km of secondary lines into which millions of litres of wastewater flow every day before converging towards the 689 km of sewer mains leading to interceptors, which in turn lead to the wastewater treatment plant.

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<sup>1</sup> Population in 2011 for the Island of Montréal according to the 2006 and 2011 Statistics Canada population censuses.

<sup>2</sup> *Plan stratégique 2010-2014*, Direction de l'eau of the Service des infrastructures, transport et environnement, November 17, 2009 (amounts based on market costs for the city in 2008).

Since 2010, water management-related activities have been under the authority of the Service de l'eau, whereas before, they were under the responsibility of the Service des infrastructures, du transport et de l'environnement (SITE). Responsibility for managing all water assets falls to three operational directorates of the Service de l'eau. Drinking water production plants and primary water lines fall under the jurisdiction of the Direction de l'eau potable (DEP); the sewer main system, interceptors and the wastewater treatment plant come within the remit of the Direction de l'épuration des eaux usées (DEEU); and secondary water and sewer system assets come under the purview of the Direction de la gestion stratégique des réseaux d'eau (DGSRE). Each of these directorates is responsible for investing in renewal and development and for water and sewer system maintenance planning. Each directorate is also in charge of conducting tests and inspections on water and sewer systems based on its assigned responsibilities.

Studies conducted in 2002 at the time of the municipal reorganization revealed major deficiencies in the management and funding of water services. They showed that the water and sewer systems were in a state of deterioration. The underground infrastructure had large investment and maintenance deficits due to the paltry budgets allocated to maintenance and upkeep of assets for many years. Given the condition of the lines at that time, future prospects were troubling, and major investments in asset maintenance and renewal were needed to make up for this shortfall and prevent widespread deterioration of the systems in the long term.

According to sound management practices, a rate of annual asset renewal should be maintained in order to ensure infrastructure longevity. With respect to water and sewer systems, in November 2002, the Québec government adopted a water policy that set this rate at 1% of the replacement value per year. One of the commitments of this policy was to encourage municipalities to achieve a renewal rate of 0.8% per year in 2007 and 1% per year in 2012 for their systems.

Since this commitment was made, municipalities could be eligible for government grants only if their responses were justified by a prioritization set out in a response plan (RP).

It was against this backdrop that the SITE undertook, in 2005, to develop an RP for the water and sewer systems throughout the territory of the Island of Montréal (before the reconstituted municipalities were created). The purpose of this RP was to gain a thorough knowledge of the infrastructure inventory and to produce a diagnosis of the condition of the lines. It also helped establish a process for analyzing and planning responses supporting decision-making.

As a result of five years of multidisciplinary collaboration among stakeholders from both inside and outside the city, RPs were produced from November 2009 to May 2010 for the primary water system, for the sewer main system and for secondary water and sewer systems.

To accomplish this, given the scope of the assets, the SITE, after engaging a consortium of consulting engineering firms in 2008, used an integrated decision aid system (IDAS) to model the response strategy. This modeling helps optimize responses, taking into account impacts that systems have on each other. The IDAS also incorporates a financial component to produce medium- and long-term investment scenarios.

In 2002, the city embarked on a major shift towards responsible asset management, in particular by reviewing several studies on the topic and by producing RPs. Because of the extent and deteriorated condition of the assets, combined with the underinvestment of the past few years, one of the major challenges is to determine as efficiently as possible what work needs to be carried out on underground systems. This means determining the most appropriate responses and the optimal time for implementing them, based on infrastructure life cycles, within a limited budget and with a view to offering the targeted level of service.

This challenge has become pressing since June 2012, when the urban agglomeration council approved a comprehensive 10-year vision of the strategic objectives for Montréal's water strategy.<sup>3</sup> It also adopted the objective of implementing the proposed funding plan, which provides for full self-financing of the city's water management. This ambitious project, which will extend over several years, will require a thorough knowledge of the systems and the implementation of timely, appropriate responses to ensure longevity of assets.

## 2. Audit Scope

The main objective of our audit of the infrastructure project implementation plan was to ensure that responses deployed on the city's infrastructures will be based on the establishment of priorities. Since considerable investments will be required in coming years, we targeted secondary water and sewer system infrastructures.

Accordingly, this audit report focuses on the city's responses for maintenance and renewal of the secondary water and sewer lines for which it is responsible.

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<sup>3</sup> *Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale*, September 2011.

Management of the water and sewer systems is a public health and safety issue for the city. We analyzed the processes and tools used in planning infrastructure projects implemented by the DGSRE of the Service de l'eau to ensure that priorities were well identified. The sample we used for our audit consisted of two boroughs: Le Plateau-Mont-Royal and Ville-Marie. We want to point out that the reason for this choice was that these appeared to be the boroughs with the oldest lines and for which the most substantial investments would be required in coming years.

Our audit focused mainly on investment project planning in 2010 and 2011, but we also took into account information from previous years and, when the situation required it, from the year 2012.

### 3. Findings and Recommendations

To facilitate comprehension, we have included here the following paragraphs outlining the major steps to be taken prior to RP development.

First, in the fall of 2003, the executive committee adopted a resolution to ratify the procedure for creating a water fund. Later, a master water plan introduced in 2004 included a major scheme to implement an RP in order to ensure the longevity of the city's water and sewer systems. The RP had to serve as a baseline for managers for planning short- and medium-term investments.

To implement this scheme, the urban agglomeration council awarded a 10-year contract of \$30.7 million (taxes included) in January 2005 to a consortium of consulting engineering firms. Under the contract, RPs had to be produced for the secondary water and sewer systems, the primary water system and the sewer main system. Beginning in 2005, SITE resources (the "RP project team"<sup>4</sup> and the Division de la géomatique) and the consortium of consulting engineering firms were mobilized to produce response plans for water systems.

The procedure adopted by the RP project team at that time was based on the one proposed in the *Guide d'élaboration d'un plan d'intervention pour le renouvellement des conduites d'eau potable et d'égout*, published by the MAMR.<sup>5</sup> To facilitate the work for municipalities, the MAMR proposed the procedure outlined in Figure 1. The management framework used

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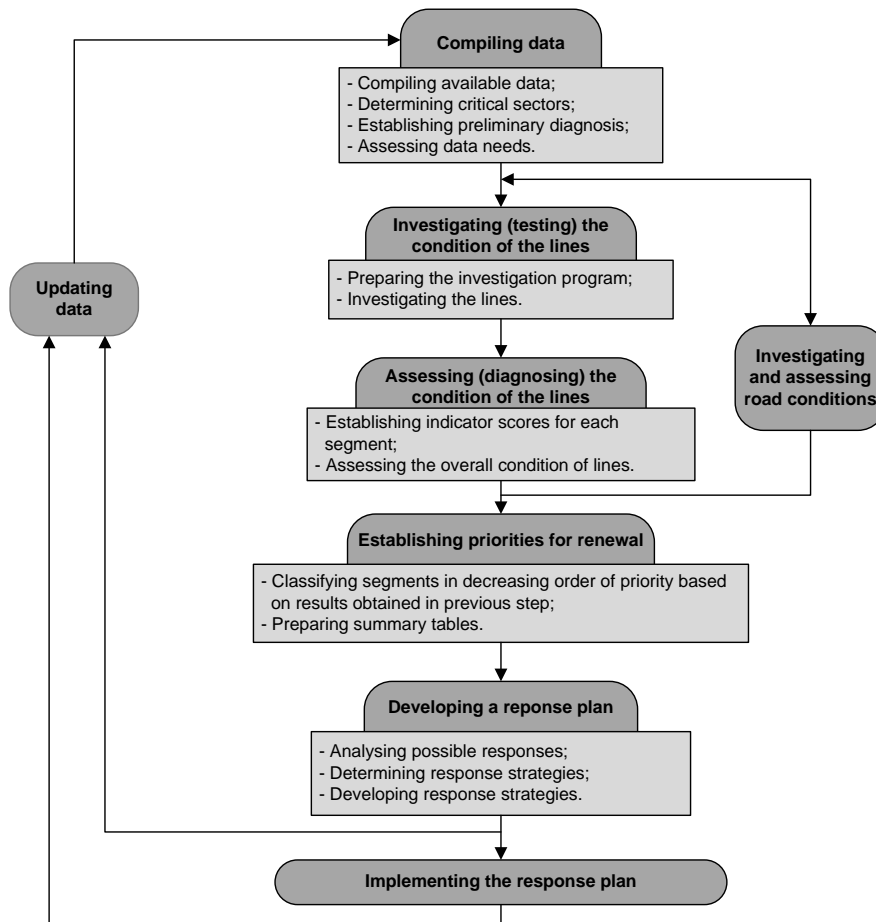
<sup>4</sup> Since its creation in 2005, the administrative unit responsible for developing the RP for water and sewer systems has undergone several name changes. For the purposes of this report, this unit will be called the "RP project team."

<sup>5</sup> Ministère des Affaires municipales et des Régions, which in 2009 became the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire (MAMROT).



was minimal, but this procedure was not supposed to replace the procedures already put in place by municipalities.

**Figure 1 – Procedure for Developing a RP**



Source: MAMR. *Guide d'élaboration d'un plan d'intervention pour le renouvellement des conduites d'eau potable et d'égout*, October 2005.

For the MAMR, the RP had to provide a systematic procedure for establishing response prioritization so that responses would be implemented at the best possible locations and in the best possible ways, thereby optimizing investments. The MAMR also considered the RP to be a planning tool that was part of a comprehensive municipal infrastructure management plan used by municipal decision-makers.

In 2006, the MAMR offered municipalities the opportunity to receive financial assistance under the programme de la taxe sur l'essence et de la contribution du Québec (TECQ) (gas tax and Québec contribution program), provided that they submit an RP no later than December 31, 2007. Since this deadline was too short for the city to produce the RP

requested, the MAMR agreed to the production of a partial response plan (PRP) for the related municipalities of the agglomeration. This led to the production of a PRP in July 2007.

In August 2008, the urban agglomeration council approved an additional budget of \$10.1 million (taxes included) for the initial contract awarded to the consortium of consulting engineering firms, both to help the city meet certain governmental requirements, including those of the MAMR, and to integrate road infrastructure data involving integrated response planning. The additional expenditure then had to be spread over a four-year period (from 2008 to 2011).

Later, in May 2010, the RP project team produced a final RP, respectively, for 1) the primary water line system, 2) the sewer main system and 3) the secondary water and sewer systems. In the case of the secondary water and sewer systems, one specific RP was also produced in December 2009 for each of the 19 boroughs, and in November 2009 for 10 related municipalities that were originally part of the territory covered by the project. (The RP was initiated before the municipal demerger in 2006). To date, the only report that the urban agglomeration council has approved is the *Plan d'intervention des réseaux d'eau secondaires de la Ville de Montréal*; this was in March 2011. Under this approval, this report was to be submitted to the MAMROT for obtaining financial assistance under various grant programs.

To date, the city has complied with the procedure proposed by the MAMR, except as it pertains to integration of surface infrastructures, including pavement. Given the importance of taking surface infrastructures into account in determining the future needs of underground systems, the city has been developing an integrated response plan (IRP) since 2010. According to the information obtained, a specific IRP was issued to each borough at the end of 2012. An IRP report should be submitted to authorities some time in 2013.

Throughout the RP development project, several managers and several DGSRE resources were invited to participate on various working committees. Resources from each borough were also called upon to validate the information appearing in the RP.

During our audit, we took into account the RPs and the degree to which human and financial resources were utilized in assessing the extent to which the responses deployed on the city's infrastructures were based on the priorities established. To do this, we first considered the inventories of both physical data and status data in the planning process. We then examined the comprehensive response strategy, the targeted level of service that was decided upon and the planning priorities that were determined for 2010 and 2011.

Lastly, we analyzed the annual response plan, in terms of investments and maintenance of secondary systems, and accountability reporting.

### 3.1. Physical Inventory Data

#### 3.1.A. Background and Findings

The project planning process must be based primarily on a complete inventory of all secondary water and sewer system assets. We wanted to assess the extent to which the DGSRE had such a complete inventory at its disposal.

First, in 2005 and in 2006, efforts were undertaken by the SITE (RP project team and Division de la géomatique) under the RP project to compile as much information as possible on water mains and sewer lines, thereby building an inventory consisting of a hundred thousand assets compiled from existing data (e.g., engineering plans, compilations of old reports). More than 128,000 hard-copy plans and more than 481,700 photogrammetric<sup>6</sup> survey points pinpoint the locations of lines and specific items in the system such as manholes, sumps, valves and fire hydrants. Software tools were developed to digitize this basic information. In addition, a geomatic application enables users (including DGSRE users) to access the database in which all data on lines are stored, including physical data (e.g., location, diameter, year of construction, type of manufacturing material) and status data.

In 2009, available physical inventory data were used to produce an inventory summary for the *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems*<sup>7</sup>, produced in 2009. This State of the Infrastructure Report assigns replacement values to these assets, and estimates the replacement value of the secondary water and sewer systems to be \$18.59 billion (see Table 1). It can be seen, then, that the sewer system alone accounts for approximately 70% of the \$18.59 billion in secondary system assets. We should point out that in order to be complete, the replacement value should also take into account pavement repair, which brings the total up to \$24.24 billion.

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<sup>6</sup> Photogrammetry is a set of techniques used to determine the shape, size and position of an object in space from photographs.

<sup>7</sup> Supplementary report in the RP that provides a descriptive overview of the condition of systems for each borough and an assessment of the responses and expenditures required for secondary water system maintenance.

**Table 1 – Inventory and Replacement Value of Secondary Water and Sewer System Assets**

Type of asset	Asset	Unit	Total <sup>a</sup>	Replacement value <sup>b</sup>	
				\$ billions	%
Water system	Water main	km	3,572	2.59	13.8
	Valve and valve chamber	units	32,348	0.34	1.9
	Fire hydrant and isolation valve	units	22,605	0.18	1.0
	Water main service connection and curb stop	units	40,746	2.41	13.0
	Subtotal			5.52	29.7
Sewer system	Sanitary sewer line <sup>c</sup>	km	632	1.30	7.0
	Storm sewer line <sup>d</sup>	km	623	0.91	4.9
	Combined sewer line <sup>e</sup>	km	2,979	8.64	46.5
	Manhole	units	64,169	0.77	4.1
	Sump and drain	units	145,443	1.45	7.8
	Subtotal			13.07	70.3
<b>Total without pavement repair</b>				<b>18.59</b>	<b>100.0</b>
Pavement repair				5.65	
<b>Total with pavement repair<sup>f</sup></b>				<b>24.24</b>	

<sup>a</sup> Data as of March 20, 2009, except water main service connections for which an estimate is provided.

<sup>b</sup> Calculation based on the budget quotation (including lines and accessories) adapted to the city's market in 2008.

<sup>c</sup> Sewer system designed to receive both domestic wastewater and process water generated by the industrial sector.

<sup>d</sup> Sewer system designed to receive rainwater only.

<sup>e</sup> Sewer system designed to receive domestic wastewater, process water and rainwater.

<sup>f</sup> Represents the replacement value of all secondary water and sewer system assets, including pavement repair costs.

Source: *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems*, 2009.

In 2009, the final RP was developed on the basis of these physical inventory data. Knowledge of the assets included in the RP facilitates the selection of future responses, provided that the database is complete and up to date.

With respect to the completeness of inventory data, we noted that the final RP informs users of certain limitations of the methodology used. Although the city validated all the data to ensure they were reliable, the RP stresses that it is possible to spot discrepancies in relation to basic plans, reality on the ground, type of material used in manufacturing, year of installation or diameter of lines. According to the information obtained, this situation could have been avoided if as-built (AB) plans had been available for all the lines inventoried.

AB plans are engineering documents produced following the construction, reconstruction or rehabilitation of an engineering or architectural work, and they take into account changes made to original construction plans. They confirm compliance with plans and specifications and are signed by the person in charge of monitoring the work.

According to the information obtained when the inventory used to produce the RP was compiled, the SITE was unable to identify AB plans for all the lines without undue effort, because some of them were too old. The impact of this situation is felt especially during project prioritization. In fact, it is not possible to have accurate knowledge of the composition of materials or the exact position of underground assets using physical inventory data. Such a situation can cause complications during emergency excavations (maintenance work), when unknown factors are discovered in underground infrastructures, which is likely to lead to longer execution times and higher costs. Furthermore, the absence of AB plans during reconstruction or rehabilitation work means that more exhaustive field surveys must be produced before a project goes to tender.

In order to have up-to-date physical inventory data for developing future RPs, measures must be in place so that AB plans are obtained systematically when projects are carried out, and also so that these plans are taken into account in the databases concerned.

For this purpose, in July 2011, the Direction générale approved a guideline called “Préparation et transmission des plans tels que construits / Plans TQC,” which applies to all central departments and boroughs when they exercise a delegated power under a central authority. Its objective is as follows:

*[TRANSLATION] The purpose of this guideline is to optimize project costs by maintaining an up-to-date shared central data warehouse, through a spatially referenced geographic information system, of all underground public data, including subsoil on the territory, as well as to enact standards, terms and conditions to be complied with in data identification and the transmission of as-built plans (AB), response sketches and guarantees, in order to ensure data reliability, integrity and longevity.<sup>8</sup>*

According to this guideline, the Division de la géomatique of the Direction des infrastructures (DI) is responsible for developing terms, conditions and special procedures, for formulating appropriate recommendations to ensure update and access management for the spatial geographic information system and optimal implementation of these recommendations for all infrastructures, both existing and planned, of underground public land.

One of the conditions set forth in the guideline when it came into force was that AB plans and response sketches must be delivered to the Division de la géomatique within a

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<sup>8</sup> The guideline is Directive C-OG-SDO-D-11-001 entitled “Préparation et transmission des plans tels que construits / Plans TQC,” July 15, 2011. The updated guideline came into force on October 15, 2012 (C-OG-DG-D-12-011).

maximum of three months following provisional acceptance of the work by the manager (or authorized representative) of the unit responsible for execution of the work. The guideline further stipulates that the city manager can request accountability reports on its enforcement at any time from the Division de la géomatique.

Also, in July 2011, the Direction générale approved a procedure<sup>9</sup> for specifying rules for preparing AB plans for all water and sewer systems. Each administrative unit (e.g., DGSRE, Direction des travaux publics<sup>10</sup>) is responsible for implementing this procedure, integrating its provisions into current activities and enforcing them.

It is very important that these administrative frameworks be adhered to, since their purpose is to ensure the integrity of the underground infrastructure inventory; this is all the more crucial in view of the consequences of not having this inventory available, let alone the costs incurred to produce it.

However, according to the information obtained, AB plans are not systematically sent to the Division de la géomatique after work is performed, even since the guideline produced by the Direction générale came into force. This compromises the integrity of inventory data, an especially serious problem considering that they are used for developing the RP and that managers use them for project selection.

At the time of our audit, the manager of the Division de la géomatique was unable to obtain an accurate assessment of compliance with the guideline since it was adopted. However, he recognized that efforts should be made to increase the awareness of the stakeholders involved. Even though the guideline came into force in July 2011, data compiled for work performed on secondary water and sewer systems from 2009 to 2011 show that only a small percentage of AB plans (11%) were completed and sent to the Division de la géomatique (see Table 2).

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<sup>9</sup> Procedure C-OG-SDO-P-11-002 entitled “Règles d’élaboration des plans tels que construits / Plans TQC pour l’ensemble des réseaux d’aqueduc et d’égouts,” July 15, 2011. An updated procedure came into force on October 17, 2012 (C-OG-SITE-P-12-001).

<sup>10</sup> The Direction des travaux publics, or DTP, reports to the SITE, and, since August 2012, has been known as the Direction des infrastructures.

**Table 2 – Profile of the Production of AB Plans for Work Performed on Secondary Water and Sewer Systems (2009–2011)**

Projects	Number	%
<b>Outsourced</b>	<b>27</b>	<b>29</b>
AB plans completed	0	0
AB plans not completed	27	29
<b>Implemented by the city</b>	<b>65</b>	<b>71</b>
AB plans completed	10	11
AB plans not completed	55	60
<b>Total</b>	<b>92</b>	<b>100</b>

Source: Data produced by the Division de la géomatique.

It should be mentioned that when the guideline was updated in October 2012, the deadline for submission of AB plans and response sketches was revised to six months.

Since projects are implemented by the DGSRE, by the DI or by a borough, as the case may be, we think that every administrative unit responsible for performing work on secondary system assets should submit AB plans to the Division de la géomatique within the allotted deadlines.

Since the usefulness of the RP is based largely on the integrity of inventory data, and since considerable resources have been allocated to this area, we think that an evaluation should be carried out on the status of the enforcement of the guideline regarding preparation and submission of AB plans. Subsequently, an action plan accompanied by a deadline should be produced so that the necessary corrective action can be taken to ensure the integrity of physical inventory data input into the RP.

### 3.1.B. Recommendation

**We recommend that the Direction générale obtain from the Division de la géomatique a status report on the enforcement of the guideline entitled “Préparation et transmission des plans tels que construits / plans TQC” for all water and sewer systems, along with an action plan, accompanied by a deadline, for having all physical inventory data available, so as to facilitate project planning.**

#### Business unit’s response:

*[TRANSLATION] Prepare a status report on enforcement of the guideline entitled “Préparation et transmission des plans tels que construits / plans TQC” for all water and sewer systems.*

*Submit to the city manager a plan, accompanied by a deadline, for having all physical inventory data available. (Planned completion: September 2013)*

## 3.2. Infrastructure Condition Data

### 3.2.A. Background and Findings

Asset management is based on keeping a detailed inventory, including physical data, and on accurate knowledge of the condition of each secondary system line.

Data on the condition of lines are used to evaluate the age of the inventory and the associated risks. For the water system, they are characterized, for example, by the number of breaks, water quality complaints, the number of low-pressure sections and the presence of lead service lines. For the sewer system, data on the condition of lines include structural deficiencies and backups.

In 2002, before the RP was launched, a preliminary theoretical finding of the overall condition of the system made by consulting engineering firms showed that:

- One third of underground water infrastructures had passed their estimated expiry date (useful life);
- Another third would meet the same fate in the next 20 years if nothing were done;
- The remaining third did not show any signs of deterioration, more because the infrastructures were new than because of sound maintenance management.

Following the establishment of a new organizational structure for water management, the DGSRE became responsible in 2005 for ensuring the compilation of factual data used to describe with greater accuracy the condition of the secondary systems inventory. These new data had to gradually replace the first theoretical estimates (calculated on the basis of useful life).

As part of the RP project, data used to describe the condition of systems were integrated into the inventory database beginning in 2005. For the purposes of this project, the methodology used was to evaluate each line in the secondary systems (water and sewer) using an overall condition score, calculated according to a weighted grading system using indicators recognized by the MAMR. Table 3 presents a summary of these indicators and the data used for assessing the condition of the lines.



**Table 3 – Indicators and Data Retained**

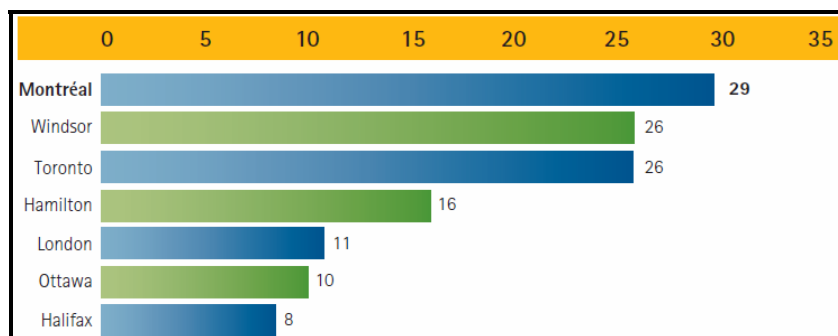
Local systems	Indicators	Data retained
Water mains	Repair rate (breaks)	Number of repairs (breaks)/5 years/1 km ( <i>January 1, 2004, to December 31, 2008</i> ).
	Brittleness index	Based on the material and its year of installation.
	Prioritization	Identification of sensitive environments: critical sections and critical users.
	Functional deficiencies	Based on a combination of the presence of low pressure, complaints about drinking water quality and/or the possibility of lead service lines.
Combined and sanitary sewers	Functional deficiencies	Based on the number of backup complaints according to the number of buildings affected.
	Structural deficiencies	Structural integrity score (SIS).
	Prioritization	Identification of sensitive environments: critical sections and critical users.

Source: *Plan d'intervention des réseaux d'eau secondaires de la Ville de Montréal*, Service de l'eau, May 2010.

Since then, data compiled on the condition have been used to draw up several profiles. We tracked down an initial profile<sup>11</sup> that was produced in 2009, before the final RP was produced. This RP revealed that:

- Factual data existed for the 3,572 km of the secondary water system and the breakage rate for this system was 29 breaks per year per 100 km, which was higher than in most comparable cities (see Figure 2).
- Roughly 50% (2,300 km) of the sewer system had been inspected. Of the sections inspected, 147 km were in an advanced state of deterioration and 30 km in a very advanced state of deterioration (technically designated as a state of imminent collapse).

**Figure 2 – Secondary Water System Breakage Rate/100 km/Year in Seven Major Canadian Cities in 2009**



Source: *Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale*, September 2011.

<sup>11</sup> *Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale*, September 2011.

The final RP, produced in 2010, referred to a profile of 687 km of lines—184 km of water mains<sup>12</sup> and 503 km of sewer lines<sup>13</sup>, or roughly 8.8% of the city’s secondary systems—that required short-term responses. The total investments for responses to be implemented over a five-year period (2009 to 2013) were valued at more than \$1.451 billion, of which nearly 79% was attributable to sewer lines.

**Table 4 – Summary of Investments Provided for in the Short-Term RP Over a Five-Year Period (2009 to 2013)**

Types of secondary lines	Scope	Priority lines <sup>a</sup>		Total investment – 5 years	
	km	km	%	\$ billions	%
Water	3,572	184	5.2	0.313	21.6
Sewer	4,234	503	11.9	1.138	78.4
<b>Total</b>	<b>7,806</b>	<b>687</b>	<b>8.8</b>	<b>1.451</b>	<b>100.0</b>

<sup>a</sup> Lines requiring investments in the next five years.

Source: *Plan d'intervention des réseaux d'eau secondaires de la Ville de Montréal*, Service de l'eau, May 2010.

Essentially, a deteriorated line is a major risk. In the case of water mains, breaks can occur, causing large water spouts and flooding, which can deprive essential services (e.g., hospitals, schools) of water. In the case of sewers, a line in poor condition can ultimately collapse, which can cause road collapse and even sewer backups. Such situations have major consequences and require very costly emergency responses. Furthermore, such situations impact on adjacent infrastructures, to say nothing of the considerable drinking water losses and risks related to public safety and citizens’ quality of life (e.g., floods, rerouting of traffic, interruption of services).

Table 4, which was supplied by the Service de l’eau, is relevant, but does not provide a profile of all water mains and sewer lines. According to the information obtained, the data needed were accessible in the database, but the profile could not be extracted without undue effort. In our opinion, a profile would have had to be easily accessible and show the number of kilometres of critical lines for which short-term responses are required as well as lines that are not yet critical but for which other types of responses would be necessary in order to ensure their lastingness.

It is essential to have accurate knowledge of the condition of the system in order to be able to judge the gravity of a situation, determine the most critical sections, decide on the most appropriate responses based on their condition and plan their implementation in a timely, optimal manner.

<sup>12</sup> Data compiled from 2004 to 2008.

<sup>13</sup> Inspection data as of December 31, 2008.

During our audit, we assessed the extent to which accessible data enabled the DGSRE to determine the condition of lines when the responses to be implemented had to be selected.

Initially, the DGSRE had at its disposal PRPs (produced in 2007) and specific RPs for each borough (produced in December 2009). For secondary sewer system lines, status data originated mainly from inspections carried out up to December 31, 2008, and submitted to the DGSRE prior to February 2009. For this purpose, the SITE awarded six inspection contracts with a total value of \$8.1 million to outside firms in 2007 and 2008. Two of these were three-year contracts (2008 to 2010), totalling \$6.6 million, which made it possible to conduct inspections on an ongoing basis after the RPs were produced.

According to the information obtained, when the final RP was produced (in May 2010), 54% of the territory had been inspected (for the sewer system). For the rest of the inventory—lines on which no tests were performed—assessment of their condition was made possible thanks to a simulation based on the age of the lines and other relevant physical data (e.g., brick lines and diameter of lines). In this regard, the RP includes a warning to managers not to use RP results without conducting additional tests to confirm the condition of sewer lines (e.g., conventional camera inspections).

For the secondary water system, the overall condition score was based on the number of breaks compiled by the boroughs over a five-year period, from 2004 to 2008. When the RP was produced, the consortium of consulting engineering firms working on the project had brought to light a major disparity in the historical data compiled from the boroughs that made it impossible to report with reliability on the condition of all the water mains listed.

Since the RP produced in May 2010 was a profile on a specific date and the status data taken into account were not complete, we reviewed the efforts that were expended to complete knowledge of the condition of each system (sewer and water).

On this subject, in the final RP the RP project team proposed the adoption of strategies for structuring and prioritizing inspection activities, in order to update status data, determine the most critical sections and decide on the most appropriate responses.

## Condition of the Sewer System

First, a sewer line inspection involves using a zoom camera<sup>14</sup> to perform an initial scan. If the results reveal an imminent or probable risk of collapse, or if the line needs to be monitored, these results must be validated with a conventional camera.<sup>15</sup> This second inspection can confirm or refute the first results obtained.

The inspection strategy prescribed by the RP produced in May 2010 by the RP project team targeted:

- Lines that have never been inspected and need to be inspected for the first time (zoom camera inspection);
- Lines for which the results of the first inspection revealed the presence of a risk of imminent (SIS<sup>16</sup> 5) or probable (SIS 4) collapse, as well as monitored lines (SIS 3) (conventional camera inspection);
- Follow-up inspections.

The timeline for conducting such inspections can vary from 1 to 20 years, depending on the type of inspection (e.g., a first inspection), the criticality of the structural condition or the line prioritization.

The strategy integrated the concept of prioritization, determined on the basis of consequences of breakdowns, interruptions of service or responses on lines that were unacceptable to the public, both economically and socially. Based on the sensitivity of line segments, system prioritization is divided into three categories:

- Category A: sensitivity level – high
- Category B: sensitivity level – average
- Category C: sensitivity level – low

To continue the inspections and after a public call for tenders was issued, the DGSRE awarded four new three-year contracts (covering the years 2010 to 2014) totalling close to \$13 million to specialized firms.

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<sup>14</sup> Zoom camera inspections are used to determine the condition and the clogging potential of manholes, to evaluate the clogging potential of lines and to assess the internal structural condition of lines.

<sup>15</sup> Conventional camera inspections help visualize the condition of the line over the entire section, determine the precise locations of anomalies identified during a zoom camera inspection and determine the types of corrective actions that should be taken.

<sup>16</sup> The SIS (structural integrity score) is an evaluation of anomalies that can affect the structural condition of a line, such as cracks, breaks, displaced or open joints, missing bricks or mortar, distortions, collapses or deterioration.

In order to assess the extent to which these contracts made it possible to gain complete knowledge of the condition of lines, we attempted to obtain an overview as of December 31, 2011. In response to our request, the Division plan directeur<sup>17</sup> referred to inventory databases to produce an overview of the condition of inspected lines.

Referring to Table 5, we note that, to date, 71% of the lines have been inspected. This does not include storm sewer lines (623 km), which have not yet been inspected because they were not covered by a government grant program. Inspections to date have therefore focused solely on combined and sanitary sewers. Of the lines inspected, 8% were critical and 9% needed to be monitored. Some of these inspections were the first conducted with a zoom camera and the results will need to be validated as required. Accordingly, as of December 31, 2011, a higher percentage of lines were inspected (71%) than was reflected by data available in the final RP (54%), but the fact remains that the DGSRE still does not have a complete overview of the condition of the lines.

We would also have liked to assess the progress of the condition of the secondary sewer system as of December 31, 2011, in relation to its condition at the time the RP was prepared (December 31, 2008). In the course of our audit, we noted that the DGSRE had no such information at its disposal. According to information obtained, the profile of the condition of the system in past years can be generated from the database, but this involves a great deal of work. As a result, the DGSRE had not assessed changes, for better or worse, in the profile of the condition of secondary lines.

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<sup>17</sup> Since 2012, the “RP project team” has been under the responsibility of the Division plan directeur, which reports to the DGSRE.

**Table 5 – Inspections of Secondary Sewer Lines as of December 31, 2011**

Conditions of associated risks		km	%
<b>Lines inspected</b>		<b>2,580</b>	<b>71</b>
SIS 1 Acceptable structural condition	Section not critical	1,341	37
SIS 2 Minimal risk of collapse in the short term but potential future deterioration		634	17
SIS 3 Collapse unlikely in the near future but possible future deterioration	Section being monitored	308	9
SIS 4 Probable collapse in the foreseeable future	Critical section	243	7
SIS 5 Collapse or imminent collapse		54	1
<b>Uninspected lines</b>		<b>1,043</b>	<b>29</b>
<b>Total</b>		<b>3,623<sup>a</sup></b>	<b>100</b>

<sup>a</sup> The difference between the 3,623 km of lines as of December 31, 2011, and the 3,611 km in the inventory appearing in the *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems* (3 611 km = 632 km of sanitary sewer lines + 2,979 km of combined sewer lines) is accounted for by changes in the inventory since this Report was produced.

Source: Profile compiled by the master plan unit, DGSRE.

It should be noted that the percentage of lines that were inspected differs from one borough to another. According to the information obtained, the proportion of the territory inspected as of December 31, 2011, was 56% for Ville-Marie borough and 82% for Le Plateau-Mont-Royal borough. Of the lines inspected, the percentage of lines requiring short-term responses was more than 42% for Ville-Marie borough and more than 47% for Le Plateau-Mont-Royal borough, according to estimates. Since these two boroughs represent a vital sector, the situation is very troubling, especially in view of the high percentage of uninspected lines that are suspected of being in an even more deteriorated condition than those that have already been assessed.

In conclusion, even though inspections continued after the final RP was produced, we were not given any assurance that they were conducted according to the inspection strategy planned. We think it is imperative that the Service de l'eau adopt an implementation plan that includes timelines for continuation of the testing strategy to complete its knowledge of the condition of the system so that it can plan responses based on actual priorities.

## Condition of the Water System

With respect to the water system, the testing strategy proposed in the final RP produced in 2010 provided that the following activities should be carried out to determine the structural and functional condition of lines:

- Compilation of responses deployed on the system;
- Leak detection;
- Testing of fire hydrants;

- Testing of valves;
- Static pressure measurement;
- Compilation of complaints.

According to the strategy, these activities must be carried out according to frequencies established by boroughs. Some of them correspond to current maintenance activities appearing in annual partnership agreements with each borough. It should be mentioned that maintenance activities are performed either by the boroughs' blue collars, or by outside firms. Some line repair work is also contracted out to entrepreneurs.

After the RP was produced in 2010, priority was nonetheless given to the entry of data on water main breaks. According to the information obtained, this decision is directly related to government grant programs.

We attempted to assess the extent to which knowledge of the condition of lines had increased since the RP was produced. As was the case with the sewer system, it was in response to our request that we obtained this profile from the Division plan directeur. According to this profile, lines were grouped into two categories: critical lines and non-critical lines. Critical lines are lines that had three or more breaks per kilometre per year in the past five years. For the purposes of this indicator, a break is equivalent to repair work performed by a borough.

The profile provided to us shows a high percentage of non-critical lines; nevertheless, as of December 31, 2011, 142 km of lines were considered critical because of the number of repairs carried out. The comparison presented in Table 6 between data as of December 31, 2011, and data that were used in the RP (December 31, 2008), shows that the number of critical lines rose by 2%.

**Table 6 – Percentage of Critical Lines  
as of the Final RP<sup>a</sup> and as of December 31, 2011<sup>b</sup>**

Secondary water mains	Final RP		2011-12-31	
	km	%	km	%
<b>Critical lines</b>	66	2	142	4
<b>Non-critical lines</b>	3,506	98	3,430	96
<b>Total</b>	<b>3,572</b>	<b>100</b>	<b>3,572</b>	<b>100</b>

<sup>a</sup> Data compiled over five years (2004–2008).

<sup>b</sup> Profile compiled by the DGSRE.

All the activities provided for in the testing strategy are necessary in order to have an in-depth knowledge of the condition of the secondary water system inventory, but only data on water main breaks have been taken into account to date. According to the information obtained, data on other activities are not compiled systematically and rigorously by all boroughs.

Because of this problem, the DGSRE, through partnership agreements with boroughs, insists on compliance with procedures for updating status data in digital systems. The agreements also stress the need for using institutional tools that were developed to feed digital systems and other institutional databases.

In its 2009 user's guide to digital water and sewer systems, addressed to the boroughs, the DGSRE outlines a procedure for sending it the required information. Boroughs therefore play an important role in the integrity of data processed by the DGSRE. When data are not listed, especially data used for corrective responses to seal leaks, the wrong signal is sent to the system, i.e. "no break on a line," and therefore no response is necessary, thereby allowing lines that actually require a possibly high-priority response to deteriorate.

According to the information obtained from the DGSRE, it has been a priority in the past few years to make boroughs aware of the importance of carrying out maintenance activities, measuring them with the aid of indicators to detect any problematic situation and entering the necessary information in digital systems. Follow-up performed by the DGSRE revealed that the use of software tools by some boroughs was inadequate. In fact, several boroughs were behind in their data entry, forcing the DGSRE to do the data entry itself. In addition, for the two boroughs reviewed, the DGSRE alleviated the problem temporarily by allocating funds from its own budget in order to catch up on data entry, in 2011, for Ville-Marie borough and, in 2012, for Le Plateau-Mont-Royal borough.

Failure to update data has direct consequences for the reliability and completeness of the profile of the condition of assets. Lack of access to a complete profile of the condition of assets can result in poor decisions, especially when responses are selected and prioritized. In our opinion, efforts must be stepped up to increase boroughs' awareness in this area so that they will enter the information required using institutional tools.

During follow-up work, the DGSRE detected a problem more serious than the use of digital tools: the boroughs' ability to detect leaks, as a result of high staff turnover.

In producing the State of the Infrastructure Report, RP project team committees established maintenance activities reflecting good practices and the frequency with which they should



be carried out. They were later validated in interviews conducted with managers in boroughs. In the case of leak detection, this frequency should have corresponded to a complete inspection of the territory twice a year. However, in the targets set by the DGSRE, boroughs must cover 100% of their territory every year tracking leaks, which, according to good practices, is equivalent to only half the effort needed.

According to results compiled by the DGSRE, the leak detection rate for all boroughs was 91% in 2010 and 87% in 2011 (see Table 7). With respect to the two boroughs surveyed, we noted an alarming situation for Ville-Marie borough with results of 40% in 2010 and 6% in 2011. As for the percentage of the territory covered by Le Plateau-Mont-Royal borough, a problem was noted in 2010 (result of 10%), but the borough reached the target in 2011 (result of 100%). We also noted a serious problem in reaching the leak detection target set by the DGSRE, especially for Ville-Marie borough. This problem would be even more serious if the target to be reached had to be in line with good practices (200%). The consequence of such a situation is that leaks go undetected and are therefore not repaired, which can lead to major breaks that inconvenience the public and require major, costly repairs. Furthermore, if not all leaks are detected, then not all the repairs are carried out and, as a result, the percentage of critical lines is underestimated and does not reflect the reality.

**Table 7 – Percentage of Secondary Water Mains Inspected for Leak Detection as of December 31, 2010, and December 31, 2011**

Borough	2010-12-31	2011-12-31
<i>According to good practices (twice a year)<sup>a</sup></i>	<b>200%</b>	
The whole city	91%	87%
Ville-Marie	40%	6%
Le Plateau-Mont-Royal	10%	100%

<sup>a</sup> *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems.*

Source: Data compiled by the DGSRE.

To deal with this situation, the DGSRE set up a working committee made up of representatives of the Service de l'eau and the boroughs. Possible solutions were proposed to the Service du capital humain et des communications to resolve this issue. The solution that was decided upon was to establish a new body in charge of systematic leak detection that would report to the DGSRE. According to the information obtained, the new body should be operational some time in 2013.

In conclusion, while progress was made on sewer line inspections, and while the DGSRE made efforts to help boroughs carry out activities enabling them to describe the condition of water mains, we deplore the fact that the Service de l'eau does not have reliable knowledge of the condition of all secondary systems.

The addition of factual information to inventory data is likely to change the established response prioritization. However, the fact that up-to-date status data are not available affects decisions as to which lines require responses. Some lines requiring responses may not be detected, but should be, and continue to deteriorate as a result, unless a major break occurs requiring an emergency response. Conversely, in some cases the RP calls for an "immediate" response when the situation does not require it, because more extensive testing shows that the condition does not justify this response level.

Finally, we believe that an overview of current knowledge of the condition of the systems should be produced periodically. We believe that the Service de l'eau should produce this overview for the Direction générale, specifying any problems encountered in producing this information and their consequences. This overview should make it possible to monitor changes in the health of the system and determine the effects of responses on its condition.

### 3.2.B. Recommendation

**We recommend that the Direction de la gestion stratégique des réseaux d'eau prepare an implementation plan accompanied by a timeline for implementing the testing strategy on the sewer system so that it will have a complete, up-to-date overview of the condition of the inventory and can then decide on appropriate, timely responses.**

#### Business unit's response:

*[TRANSLATION] Note: The testing strategy developed as part of the RP is aimed at establishing a systematic sewer inspection program, but the RP criteria used for recurrences and priorities are based on the assumption that an initial scan of the entire system has already been performed.*

*Our plan calls for gradual implementation of the testing strategy in 2013. The testing strategy criteria must be revised to take into account initial inspections that have yet to be conducted and the backlog in return inspections that we have been facing. The plan we propose is as follows:*

- *Adjustment of testing strategy criteria based on the number of inspections required and suppliers' ability to provide the service. (Planned completion: June 2013)*

- Production of lists for the annual sewer system testing program using the testing strategy. **(Planned completion: January 2014)**
- Annual report on achievements. **(Planned completion: March 2015)**

### 3.2.C. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau take the necessary steps to ensure that a minimum level of leak detection activities are deployed on the secondary water system as per the targets fixed in partnership agreements and that it produce an action plan accompanied by a timeline for revising those targets gradually until they are in line with rules of good practices, thereby improving its knowledge of the condition of the system.

#### Business unit's response:

*[TRANSLATION] Establishment and deployment of a team to track leaks systematically in the secondary water system. **(Planned completion: July 2013)***

*Start of systematic scanning of the secondary water system by the team assigned. **(Planned completion: July to December 2013)***

*Systematic inspection of the water system based on best practices. **(Planned completion: January to December 2014)***

### 3.2.D. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau focus on efforts to make boroughs aware of the need to update inventory status data using management tools provided for this purpose in order to improve planning, thereby improving their selection of projects to be implemented.

#### Business unit's response:

*[TRANSLATION] The DGSRE will develop an action plan to raise the awareness of its own employees and borough employees. This plan will consist of two parts:*

- *Training that focuses on reviewing objectives that involve data updating and using the different tools, and distribution of a training guide along with updates.*
- *Periodic reminders issued to borough administrations about commitments regarding data compilation that were made when partnership agreements were signed. **(Planned completion: May 2013)***

### 3.2.E. Recommendation

We further recommend that the Direction de la gestion stratégique des réseaux d'eau periodically produce an overview of the condition of sewer lines and water mains for the Direction générale to promote appropriate, timely decision-making. This overview should:

- Reflect changes in the situation following inspections and responses deployed on systems;
- Specify any problems that boroughs encounter in updating data and state how the situation affects the selection of projects to be implemented.

#### Business unit's response:

*[TRANSLATION] The Service de l'eau compiles all the data needed to produce an overall assessment of its systems, but does not report systematically to the Direction générale. To meet the auditor general's requirement, the DGSRE will produce an assessment every year for the Direction générale. (Planned completion: December 2014)*

## 3.3. Comprehensive Response Strategy

### 3.3.A. Background and Findings

As part of the planning process, the determination of asset preservation needs consists in identifying responses considered necessary following inspections, then classifying them according to their priority.

According to the *National Guide to Sustainable Municipal Infrastructure*<sup>18</sup> (a reference tool for good practices), it is preferable to follow a comprehensive response strategy by reviewing all the assets of a given system. It is recommended that this strategy be followed for reconstruction, rehabilitation and maintenance responses alike.

The city's Politique des équipements et des infrastructures (which came into force in January 2009) runs along the same lines as these good practices:

*[TRANSLATION] In view of the condition of its assets, the Ville de Montréal must assess the risk that components will break down or wear out prematurely. This evaluation will help determine the preventive and corrective measures needed in the short, medium and long terms. The analysis work must include a cost estimate, which is necessary for decision-making. This analysis should also make it possible*

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<sup>18</sup> InfraGuide.

to classify assets under one category or another, depending on whether the decision made is to:

- Replace the asset;
- Keep the asset, but carry out major short-term or long-term repairs;
- Keep the asset and do routine maintenance on it;
- Stop maintenance work on the asset, postpone repairs and conduct more in-depth studies.

The purpose of this classification is to make a decision for each asset as well as to set budget allocation priorities.

The city's policy also recommends the [TRANSLATION] "design of a structured preventive maintenance program giving specific information on work that must be done to protect and maintain the quality of assets."

To help visualize this classification, we identified the types of responses possible based on the life cycle of lines in Tables 8 and 9 using the *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems* as a guide.

**Table 8 – Examples of Responses Associated with the Four Stages in the Life Cycle of Water System Assets**

Assets	Examples of responses			
	Stage 1 Routine maintenance	Stage 2 Major maintenance	Stage 3 Structural rehabilitation	Stage 4 Reconstruction
<b>Water mains</b>	Detecting leaks, rinsing, thawing lines, repairing breaks, Hazen-Williams coefficient measurements.	Projection of mortar or non-structural epoxy.	Cladding or tubing, spot repairs, installing anodes.	Complete replacement of a line with or without trench.
<b>Valves and valve chambers</b>	Checking water tightness, inspection and complete handling of valves, cleaning housings.	Repairing the mechanism, repairing the chamber.	Partial replacement, installing anodes.	Replacement.
<b>Fire hydrants and isolation valves</b>	Complete inspection of fire hydrants, pressure and flow measurements, snow removal, painting, installing a fire hydrant indicator.	Repairing the mechanism.	Partial replacement, installing anodes.	Replacement.
<b>Water main service connections and curb stops</b>	Minor repairs, thawing service connections.	Replacing a rod.	Partial replacement.	Replacement.

**Table 9 – Examples of Responses Associated with the Four Stages in the Life Cycle of Sewer System Assets**

Assets	Examples of responses			
	Stage 1 Routine maintenance	Stage 2 Major maintenance	Stage 3 Structural rehabilitation	Stage 4 Reconstruction
<b>Sewer lines</b>	Inspection, cleaning, rat extermination, minor repairs.	Sealing of joints, root control.	Cladding or tubing, spot repairs.	Replacement of the line between two manholes with or without trench.
<b>Sanitary sewer manholes</b>	Inspection, cleaning.	Sealing cracks, repairing rungs, replacing frames and plugs.	Cladding or projection of resins or mortar, replacing of grids, heads and frames.	Complete replacement.
<b>Sumps and drains</b>	Inspection, cleaning.	Sealing cracks, replacing frames and grids.	Cladding or projection of resin or mortar, replacing grids, heads and frames.	Complete replacement.

We noted that for critical lines and lines requiring monitoring, there was only partial compliance with the Politique des équipements et des infrastructures. The RP is used to classify each line according to an overall condition score for both sewers and water mains and contains a list of assets that will need to be rehabilitated or replaced over the next five years. In the case of the final RP produced in 2010, the lines are critical. However, as we mentioned in the previous section, in order to be able to determine and prioritize responses, the condition of all the assets must first be known. However, the exact condition is not known because, for most lines, inspections have not yet been done. If all the status data had been complete, the prioritization established in the RP would have turned out completely differently.

In the case of less critical lines or lines requiring maintenance responses, compliance with the Politique des équipements et des infrastructures is no better. In fact, we were unable to track down a list identifying corrective action or preventive measures to be taken, whether on lines or on other assets (e.g., valves, fire hydrants). Although the types and frequency of maintenance activities was established when the State of the Infrastructure Report was prepared, we noted that a structured preventive maintenance program had not been set up for all boroughs.

A preventive maintenance program is recognized as a best practice, both for asset management and for use of public funds. Preventive maintenance activities are valuable because they help avoid premature degradation requiring costly responses and premature replacement of infrastructures at considerable expense.

For these reasons, good practices stress the importance of a preventive maintenance program as part of an infrastructure management approach to protecting and maintaining the quality of infrastructures, thereby ensuring that the targeted level of service are attained in a sustainable, economic way. According to the *National Guide to Sustainable Municipal Infrastructure*, \$1 of timely prevention will postpone the spending of \$5 in rehabilitation.

Splitting responsibilities among the DGSRE and the 19 boroughs does not make it any easier to implement a comprehensive response strategy. The DGSRE is responsible for selecting responses that can be considered as investments (rehabilitation and replacement), while the boroughs are independently responsible for planning operating expenditures (maintenance activities and minor repairs). In essence, this division of responsibilities, with boroughs in charge of operating budgets and the DGSRE in charge of capital budgets, is not conducive to integrated planning. It is important that a borough handle preventive maintenance through its operating budget, but this may be less obvious when the consequences of failure to do preventive maintenance are reflected in the DGSRE capital budget.

In short, asset preservation needs and priority planning are not determined according to a comprehensive response strategy, contrary to the process recommended in:

- The *National Guide to Sustainable Municipal Infrastructure*;
- Management practices prescribed in the city's Politique des équipements et des infrastructures.

At present, planners manage emergencies and engage in rehabilitation, reconstruction or maintenance activities without receiving any assurance that these responses are prioritized properly, on the right lines, or in a timely manner so as to optimize infrastructure life cycle.

However, it should be mentioned that partnership agreements are concluded every year between the DGSRE and each borough. In section 3.6 we will discuss in greater detail what is included in partnership agreements. We should mention, however, that they cover investment projects (reconstruction and rehabilitation) that are under the responsibility of the DGSRE or a borough (such as Ville-Marie borough), and additional budgets under the responsibility of the DGSRE for certain current maintenance activities considered loss-making or problematic. Such agreements allow boroughs to formalize their commitment to carrying out maintenance work and to provide support to the DGSRE for implementing infrastructure projects.

In conclusion, despite the existence of the RP and partnership agreements and the DGSRE's efforts to follow up on maintenance activities by means of a targets table,



knowledge of the condition of assets at this time does not allow response prioritization involving rehabilitation, reconstruction or maintenance work. Consequently, response determination and priority planning are not done according to a comprehensive response strategy.

### 3.3.B. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau, in collaboration with the boroughs, develop a comprehensive response strategy for determining and prioritizing responses that integrates both maintenance work (preventive and corrective) and major rehabilitation and reconstruction work in order to keep the structures in a desirable condition at the lowest possible cost. This strategy must be accompanied by an action plan and a timeline for its implementation.

#### Business unit's response:

*[TRANSLATION] The DGSRE prioritizes and establishes responses in accordance with the city's various issues and objectives, which involve all water assets, and in accordance with the budget placed at its own disposal and at the disposal of the boroughs for systems maintenance.*

*Develop a strategy for coordinating maintenance activities with infrastructure renewal planning. (Planned completion: December 2014)*

## 3.4. Level of Service

### 3.4.A. Background and Findings

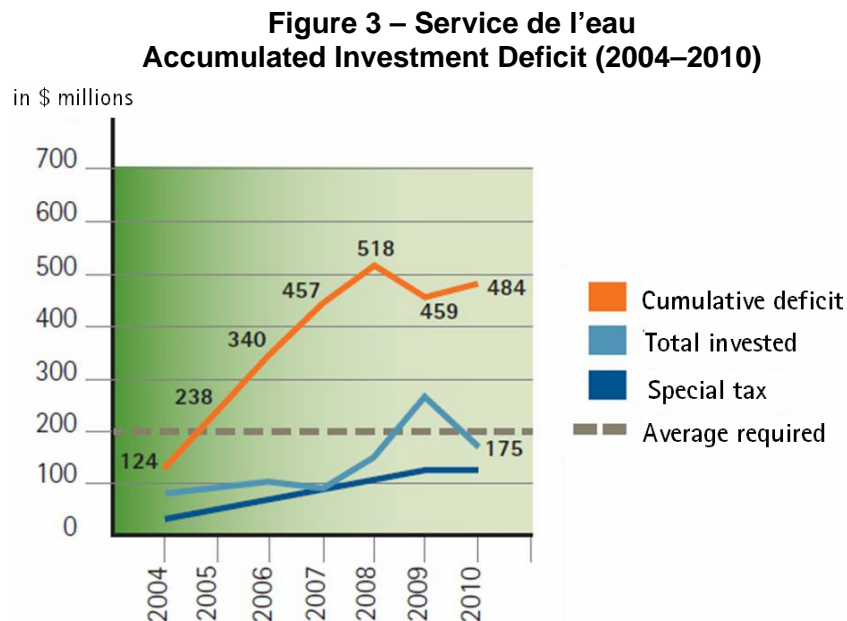
Knowledge of the condition of assets is the basis upon which a business unit proposes a level of service that is aligned with the assets' desired condition. If all the efforts and resources required are to be channelled towards reaching this targeted condition, it is essential that authorities make a clear commitment regarding a level of service. To do this, they must make choices regarding the safety and reliability of these assets. Clearly, there must be a strong correlation between the desired level of service and the investment level established.

In the case of water assets, in 2003 the SITE commissioned a study by consulting engineering firms that found that, according to theoretical estimates, \$200 million/year was the average level of investment that would be required over a 20-year period to recover an accumulated investment deficit of \$1.5 billion and to ensure renewal of assets. According to the Service de l'eau, these investments would allow all water infrastructures to be



preserved, including those in the secondary systems. This investment level was not associated with a level of service defined or determined by authorities.

As shown in Figure 3, the average investment level (\$200 million/year) could not be reached in the period from 2004 to 2010, which led to a \$484 million increase in the investment deficit, for a total of close to \$2 billion, despite the \$917 million invested during this period.



Source: *Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale*, September 2011.

Then, in 2010, the Direction générale launched a project for developing a 10-year investment plan. The mandate of this project, which targeted all business units, including the Service de l'eau, was to establish a planning process for developing:

- The RPs necessary for the maintenance and development of their assets over a 10-year period;
- Investment management policies, to ensure, among other things, maintenance of the condition of assets at an optimum level.

As a result of this work, business units (except the boroughs) submitted reports on long-term investment planning to standing committees on finance in September 2010.

In its report entitled *Plan d'investissement sectoriel à long terme*, the Service de l'eau showed that the theoretical estimate of \$200 million/year for 2003 no longer reflected the

current reality. At that time, the average investment level was underestimated because some costs were omitted due to lack of information, and because new needs emerged. Indeed, as a result of work carried out since then, including the RP, the Service de l'eau had a more accurate, detailed inventory of the water and sewer systems (e.g., length, age, diameter, manufacturing materials) that enabled it to correlate investment needs with the condition of its underground infrastructures.

As a result of this more accurate diagnosis, it became possible in 2010 to establish an annual investment level of \$400 million/year, or double the theoretical estimate of \$200 million/year.<sup>19</sup> This new annual target for all Service de l'eau infrastructures was equivalent to 1% of the replacement value of the assets, over and above the deficit inherited from previous years, which was \$1.5 billion. Since annual investments of \$400 million/year would have been required, the accumulated deficit as of December 31, 2011, would then be roughly \$3.6 billion.

Since the scope of our audit was limited to secondary systems, we noted that, according to the *Plan d'investissement sectoriel à long terme* submitted in 2010 by the Service de l'eau, investments of \$2.456 billion would be required over a 10-year period (2010 to 2020) to ensure the continuity of secondary water and sewer systems. In its presentation, the Service de l'eau described the level of priority or urgency given to this investment need as "immediate response." The annual investment level was then set at \$246 million, compared to the estimated level of \$127 million in 2003. Table 10 shows a comparison between investments made and the deficit that accumulated from 2004 to 2011.

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<sup>19</sup> *Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale*, September 2011.

**Table 10 – Secondary Water and Sewer Systems  
Percentage of the Target Reached by Investments from 2004 to 2011  
(in millions of dollars)**

Target and actual investments – DGSRE										
	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Total invested	41	53	54	44	68	133	55	71	519	65
Target according to the 2003 studies <sup>a</sup>	127	127	127	127	127	127	127	127	1,016	127
Deficit	86	74	73	83	59	-6	72	56	497	62
Percentage of the target reached	32%	42%	43%	35%	54%	105%	43%	56%	51%	51%
Revised target 2010 <sup>b</sup>	246	246	246	246	246	246	246	246	1,968	246
Corrected deficit	205	193	192	202	178	113	191	175	1,449	181
Percentage of the revised target reached	17%	22%	22%	18%	28%	54%	22%	29%	26%	26%

<sup>a</sup> Estimated target in 2003: \$1,267 million/10 years, or \$127 million/year.

<sup>b</sup> Estimated target in 2010: \$2,456 million/10 years, or \$246 million/year (revised amount that should have been invested beginning in 2004).

Source: Presentation given to members of the joint committees on finances, Service de l'eau, September 28, 2010.

We note that the investments made from 2004 to 2011 were well below the targets, attaining only 26% of the (revised) average investment level needed to eliminate the deficit. Furthermore, the average level of investments from 2004 to 2011 was nearly \$65 million/year, well below the investment level required in accordance with good practices, which is equivalent to 1% of the replacement value of the assets, or \$185 million/year<sup>20</sup> (see Table 11). Finally, the underinvestment seen from 2004 to 2011 would have been even greater if the calculation had taken into account investments proposed in the final RP produced in May 2010, or \$290 million/year (\$1.451 billion for five years). Imagine how great the deficit would be if all the systems (primary and secondary) had been considered.

**Table 11 – Comparison of Targeted Investment  
(in millions of dollars)**

Annual investments				
Target according to the 2003 studies	According to good practices (1%)	According to the 2010 target	Target according to the final RP	Actual averages (2004 to 2011)
127	185	246	290	65

No matter which target is used, whether it be the 2003 target, the revised 2010 target, the target equivalent to 1% of the replacement value of the assets or the target calculated in the RP (2009–2013), underinvestment since 2004 has resulted in a heightened deterioration of

<sup>20</sup> Calculation based on a replacement value of \$18.59 billion.

the condition of the systems, which is far from complying with the government's water policy commitments. The consequences of this underinvestment will be very serious in the years to come if the situation is not rectified, because the number of lines in poor condition will increase and the number of emergency responses for the system will also increase. Furthermore, over the years, projects required will be on a greater scale, not just because of the types of work involved (e.g., in the short term, a line will require rehabilitation work, but in the medium term, reconstruction work will be required), but also because of the costs. Indeed, reconstruction is more costly than rehabilitation. What is more, this situation is likely to have major disruptive effects for citizens.

During our audit, we would have liked to assess the impact of underinvestment on the condition of the systems, but, as we mentioned in previous sections, the Service de l'eau did not have complete information. In order for such an analysis to be workable, the condition of the systems should have been evaluated periodically so that its evolution could be measured. In section 3.2, we referred to the profile of the known condition of inspected water mains and sewer lines as of December 31, 2011. It was incomplete, and we were unable to compare it with a similar profile for a previous period.

In June 2012, the urban agglomeration council approved the comprehensive 10-year vision of Montréal's water strategy and its related strategic objectives. It also adopted the implementation of the proposed funding plan (2011–2020), which provides for full self-financing of water management in 2020. Gross investment needs for water assets for 2011 to 2020 now total \$4.6 billion, while net investment needs, which are presented in Table 12, total \$3.2 billion. To fund these net investments, the Service de l'eau is proposing a funding plan based on an annual indexing rate of 9% of water management revenue, on additional grants that will be obtained, on the use of accumulated reserves and on recourse to loans for the first five years. The Service de l'eau expects Montréal's water management to be fully self-financing by 2016, without having recourse to loans.

**Table 12 – Service de l'eau  
Comprehensive Funding Plan for Montréal's Water Strategy (2011–2020)  
(in millions of dollars)**

10-year timeframe (2011–2020)	Amount	Comments
<b>Needs</b>		
<b>Total operating needs</b>	<b>3,844</b>	
Gross investment needs (without development)		
Drinking water production	1,021	
Wastewater treatment	1,127	
Secondary systems (downtown) – agglomeration	540	
Secondary systems (local)	1,916	
<b>Total investment needs (indexed at 2%)</b>	<b>4,604</b>	
(Grants)	(829)	Grant programs in force (2011–2015)
Theoretical net funding needs	3,775	100% of needs
<b>Net investment needs, actual total</b>	<b>3,020</b>	Assumption: needs implementation rate of 80% (based on past experience)
<b>Total needs (operating and investment)</b>	<b>6,864</b>	
<b>Revenue</b>		
Revenue required	6,864	Investment and operating
Revenue programmed	3,618	Based on the year 2010
<b>Funding</b>		
Additional funding required	3,246	
Sources of funding		
Additional grants required	836	Additional grants required (2014–2020)
Annual indexing of 9% of water management revenue	2,011	Revenue increased by 9% per year (over 10 years)
Use of accumulated reserves	95	Balance of the \$95 million reserve used in the first two years
Actual loan required (implementation capacity of 80%)	304	Recourse to loans for the first five years (2011–2015)
<b>Total sources of funding</b>	<b>3,246</b>	

Source: Rapport du Comité de suivi du projet d'optimisation du réseau d'eau potable – Version intégrale, September 2011.

Even though this funding plan is itemized every year for 10 years (from 2011 to 2020), the urban agglomeration council has still not made a clear commitment to maintain the annual planned investment level if the assumptions used in the funding plan are not realized (e.g., grants obtained or water revenue increased). Indeed, if, one of the funding sources is lower than expected in any given year, another source must be favoured; otherwise all the investments planned cannot be made, which will delay the elimination of the accumulated deficit. A similar situation occurred when the 2013 budget was adopted, when authorities did not authorize a tax increase for water management. This raises serious questions for us regarding the realism of this strategy.

The TCEP<sup>21</sup> is prepared over a three-year period and adopted on an annual basis. Underground infrastructure continuity management requires very-long-term planning, with the assurance that funds will be available over a similar timeframe.

Because of the deteriorated condition of the water and sewer systems, the investment level established will depend on two major factors. The first is authorities' orientations concerning deficit elimination and the routine maintenance level for business units. The second is funding scenarios for sustaining these investments. In the current context, such scenarios must be drawn up as realistically as possible, taking into account cuts to infrastructure grant programs announced by the government, the city's budget, which eliminates the water tax increase for 2013, and the recent allegations about 30% cost inflation. In our opinion, the amounts required will need to be re-evaluated in light of these new data and the updated RP in order to offer a level of service that is in line with authorities' orientations.

Accordingly, before the necessary long-term investments are approved, clear commitments should be made concerning the desired level of service or condition for all water assets. As we mentioned above, the Service de l'eau has given several presentations to date to inform authorities about the investment deficit and to request the estimated investment amounts. In its various presentations, the Service de l'eau stated that the investment it needs would help preserve infrastructures. This assertion raises several questions that have remained unanswered. What is meant by "preserving infrastructures"? Does it mean maintaining them in their current condition? Does it mean having a targeted percentage of lines that are "in good condition"? In our opinion, the orientations of the Service de l'eau regarding secondary systems should be expressed in precise terms. It would then be possible to reconcile the current investment level, the projected investment level and the condition of the systems.

To date, the disparity persists between the level of investments established and the intention of the Service de l'eau to keep the infrastructures in good condition. Authorities did not make clear commitments concerning the level of service and the concomitant long-term investment level that will be required. Nevertheless, several references agree on the importance of making decisions in these areas:

- According to the *National Guide to Sustainable Municipal Infrastructure*, levels of service must be established based on the condition of systems before responses are determined and prioritized. Responses must be based primarily on the condition of the system, but other factors as well, such as the city's strategic orientations (e.g., large

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<sup>21</sup> Three-year capital expenditures program.

projects such as Griffintown) and financial resources available. The Guide further specifies that city council must approve the level of service before formalizing it.

- In June 2010, standing committees on finance and administration established 15 guidelines concerning the municipal administration's orientations and the city's financial framework for 2011. One of these is the need for clearly determining levels of service.
- The Direction générale, in its Politique des équipements et des infrastructures, which came into force on January 30, 2009, pointed out the need for setting clear objectives regarding the condition in which property holdings must be kept.
- As part of the work of developing a 10-year investment plan, the Service des finances planned to develop a new financial policy addressing financial goals to help determine a desirable investment level. Such a policy was to be approved in August 2010, but this did not occur.

Consequently, without specific objectives, it is difficult to determine what investment needs must be met, plan response prioritization for the system over the long term and reconcile all this with an investment plan.

To reverse the underinvestment trend and slow the deterioration of systems, authorities must determine the level of service to be achieved and concomitant long-term investment levels to be targeted. They must also come to a decision about a realistic funding method. These commitments will enable managers to:

- Plan the implementation of all priority responses in a timely manner as part of a comprehensive response strategy;
- Assess the attainment of objectives.

#### **3.4.B. Recommendation**

**We recommend that the Direction générale:**

- **Express the Service de l'eau orientations that were retained by authorities in terms of precise goals concerning level of service;**
- **Set the required long-term investment level;**
- **Obtain approval from authorities concerning the targeted level of service and the corresponding long-term investment level and funding method;**
- **Evaluate the results on a yearly basis;**

**to enable it to plan and implement responses in a timely manner, slow the further deterioration of secondary water and sewer systems and curb the investment deficit, thereby minimizing disruptive effects for citizens.**

**Business unit's response:**

*[TRANSLATION] Prepare an information document and submit it to authorities, structuring the investment plan according to the levels of service defined, and a mechanism for evaluating results at an appropriate frequency. (Planned completion: March 2014)*

*Submit to authorities the investment plan according to the levels of service. (Planned completion: June 2014)*

*Note: The information document will be submitted to authorities. It will be up to authorities to approve or not the levels of service and associated investments.*

### 3.5. Priority Planning

#### 3.5.A. Background and Findings

The state of the inventory is an essential data component that can be used to assess risks of deficiencies in infrastructures. Knowledge of the state of the inventory must also be sufficient to determine and prioritize responses for the purpose of implementing them in the short, medium or long term. In a context in which budgets are not sufficient to eliminate the investment deficit that has accumulated in the past few years, it is essential to prioritize projects that will help improve the condition of assets, especially in cases considered critical. During our audit, we assessed the extent to which projects selected truly reflected priorities.

According to the information obtained, responses involving secondary water and sewer systems are determined in conjunction with the response priorities for other city assets, such as the road system and the primary water system, as well as major projects and boroughs' priorities.

It should be clarified at this stage that the RP is not the only source of responses for the DGSRE. In fact, the priorities and needs of DGSRE partners (SITE, other directorates of the Service de l'eau, etc.) can account for new sources of responses, whether or not they appear in the RP. We list other examples of possible sources of responses below.

- Emergency responses

Some projects arise from emergency responses, triggered by recurring malfunctions (breaks, leaks or backups) on the same line that cannot be repaired by minor responses implemented by boroughs.



- Road works

Surface work can have an impact on underground infrastructure. In fact, work performed on pavement can weaken or cause major damage to underground lines. It is therefore important that the condition of underground infrastructures be considered before pavement work is undertaken so as to avoid repeated responses on the same section in a short period of time. Because of the close relationship of these two types of infrastructures, it is essential that the DGSRE coordinate responses with road repair projects.

For each planned response involving a road repair project, whether it originates from a borough or from the Direction des transports of the SITE (beginning in 2013, road repair projects will fall under the purview of the DI of the SITE), DGSRE stakeholders must determine whether or not a response at the underground level is necessary.

- Water projects (primary system)

Other responses may be warranted by planned projects for the primary water system under the management of the DEP for the water system and of the DEEU for the sewer system.

- The authorities' priorities

Another factor that triggers responses on secondary systems involves major projects in progress or in the planning stages, such as the Quartier international de Montréal, the Quartier des spectacles or the Griffintown project. Large-scale projects such as these were implemented as a result of commitments made by authorities, and responses associated with these projects on secondary systems are therefore prioritized. These large projects require that the DGSRE analyze the condition of existing underground structures and their capacity to meet new needs.

- Real estate development projects

Finally, real estate development projects are also considered in response planning, mainly because they necessitate extension of the network and a greater capacity for existing lines, for both drinking water distribution and wastewater recovery.

The priorities of authorities and other stakeholders must be taken into account when projects are selected, but in most cases the source of projects selected should still be the

RP, since it lists the priority responses. The responses retained should be selected based on their order of priority, in line with what authorities were told when the RP development contract was awarded.

Each borough's final RP forms the basis for deciding on responses since it includes a list of sections classified according to their priority. These priorities are established on the basis of the importance of an integrated overall condition score. For each section, this score is equal to a combined overall condition score for the sewer line and a combined overall condition score for the water main. For each section, the types of responses (rehabilitation or replacement) and their costs are proposed on the basis of the data used to establish overall condition scores. Since these are high-priority responses, they are planned for the next five years for one or both of the lines, as the case may be. Although the RP of each borough lists responses in order of priority based on an integrated overall condition score, in section 3.2, we addressed the fact that data on the condition of the inventory were not always complete. Such a situation affects the degree to which the order of priority should be relied upon. As a result, the DGSRE cannot place undue reliance on the classification of sections provided for in the RP when selecting projects to be implemented. It can identify lines for which the overall condition score shows a problem, but it must confirm those results through inspections and hydraulic studies.

During our audit, we therefore wanted to assess the extent to which investment projects appearing in partnership agreements were provided for in the RP, since these are the most high-priority projects. In the following paragraphs, we will first describe the major steps in the investment project selection process currently used at the DGSRE at the time of our audit. Second, we will analyze the sources of responses planned in 2010 and 2011.

Every year, DGSRE engineers first draw up a preliminary list of lines, referring to the RP. According to the information obtained, the RP informs the choice of projects.

These engineers then check the data in the inventory database to describe the condition of lines and confirm the need for a response and, if necessary, the type of work to be carried out. They take into account lines that have reached the threshold criteria. For the water system, for example, this threshold corresponds to more than three breaks/100 km/year, while for the sewer system, the threshold criterion corresponds to a SIS of 4 or 5 and, in the case of brick lines, to a SIS of 3. Other lines located in high-priority sections may be selected when they have reached the end of their theoretical useful life.

The DGSRE conducts inspections on sewer lines for which data are missing. When potential projects are analyzed, engineers determine whether responses can be deployed on water or sewer systems at the same time.

Engineering project leaders make a selection from the potential projects retained, taking into account the priorities of other stakeholders (e.g., the Direction des transports of the SITE, boroughs, major project leaders, other directorates of the Service de l'eau). According to the information obtained, the selection is also made to minimize the impact on traffic.

For each of the projects selected, engineers produce a project information sheet giving reasons why sections require responses. Information such as the condition of assets, type of work, technical design data and estimated budget for the work appear on this sheet. The engineering project leader then signs this project information sheet.

Next, the DGSRE, in collaboration with each borough, selects the investment projects to be carried out for the year based on the budget provided. This project selection is then communicated to the various stakeholders involved (e.g., the Direction des transports of the SITE) so that they in turn can review them and take them into account in developing their TCEP.

As the planning process continues, the design parameters of selected projects are defined. At this stage, the type and scope of projects are adjusted on the basis of inspections and other studies conducted (e.g., hydraulic studies demonstrating the need to review the capacity of existing lines, soil characterization studies). At this stage, projects may be postponed or delayed in light of results obtained.

When projects are chosen definitively, they are included in partnership agreements concluded between the DGSRE and the boroughs concerned.

We note that projects are determined and prioritized on the basis of the expertise and judgment of DGSRE engineers and take into account a combination of a large volume of technical and qualitative data and a set of constraints. Although the investment project selection process used was described to us, the only proof that these were high-priority projects came from the corresponding project information sheets. We observed that these project information sheets included reasons for supporting project selections. However, we could not track down any documents showing that analysis of all the projects formed the basis of the preliminary list.

In our opinion, for all the projects selected for planning purposes in 2010 and 2011, project information sheets should have been produced, both for the projects selected and for those not selected. These sheets should have included cost/benefit analyses that:

- Evaluate the impact of an accelerated or postponed response on both the related cost estimates and the quality of life for citizens;
- Evaluate compromises between less costly responses that must be paid for now and more expensive responses that must be paid for later.

For the investment project selection process established by the DGSRE, we assessed the extent to which projects appearing in partnership agreements matched priorities established by the DGSRE for Le Plateau-Mont-Royal and Ville-Marie boroughs in comparison to those established by other stakeholders. To produce this comparison, we asked the division head at the DGSRE in charge of these two boroughs questions about the source of each of the projects provided for in the 2010 and 2011 partnership agreements. Table 13 shows the source, number and estimated costs of the projects. We note a net increase in the percentage of projects initially retained by the DGSRE: 34.2% in 2010, compared to 69.5% in 2011. As for costs, they climbed from 33% in 2010 to 68.6% in 2011. This suggests that the DGSRE initially favours a greater number of projects after better knowledge of systems is acquired.

**Table 13 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Source of Projects Provided for in the 2010 and 2011 Partnership Agreements  
(amounts in thousands of dollars)**

Source of projects	Partnership agreements – 2010				Partnership agreements – 2011			
	Amount	%	No.	%	Amount	%	No.	%
DGSRE	10,021	33.0	14	34.2	23,856	68.6	32	69.5
Boroughs (emergencies)	4,489	14.8	5	12.2	2,309	6.6	3	6.5
Direction des transports	205	0.7	1	2.4	692	2.0	4	8.7
DEP	5,119	16.9	6	14.6	5,439	15.6	4	8.7
Residential development	1,674	5.5	2	4.9	1,671	4.8	1	2.2
Large-scale projects	6,845	22.5	12	29.3	594	1.7	1	2.2
Parc Jean-Drapeau	2,011	6.6	1	2.4	222	0.7	1	2.2
<b>Total for projects</b>	<b>30,364</b>	<b>100.0</b>	<b>41</b>	<b>100.0</b>	<b>34,783</b>	<b>100.0</b>	<b>46</b>	<b>100.0</b>

In view of the resources (financial and human) that have been deployed by the RP project team since 2005 to develop the RP, we also examined the extent to which the projects selected corresponded to priorities set out in that RP. To do this, we checked whether projects retained in the partnership agreements of Ville-Marie and Le Plateau-Mont-Royal boroughs (regardless of their origin) appeared in the final RP concerned. Table 14 shows

that 80% (33/41) of 2010 projects and 65% (30/46) of 2011 projects appeared in the RP. Implementation of these projects within five years was thus considered a priority. But the percentage of projects not appearing in the RP (20% [8/41] in 2010 and 35% [16/46] in 2011) shows that they were not given priority responses according to the criteria used when the RP was developed. Of those projects not included in the RP, we note that 21% were selected by the DGSRE in 2011. As well, 7% (2010) and 2% (2011) of these projects corresponded to emergency responses reported by either the boroughs concerned or the Société du parc Jean-Drapeau. According to the information obtained, these responses were not listed in the RP when it was developed because inspection data were missing.

**Table 14 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Comparison of Projects Provided for in  
Partnership Agreements with Projects Proposed in RPs**

Projects	Partnership agreements – 2010			Partnership agreements – 2011		
	Le Plateau-Mont-Royal	Ville-Marie	Total	Le Plateau-Mont-Royal	Ville-Marie	Total
<b>Provided for in the RP</b>	13	20	33	17	13	30
<b>Not provided for in the RP</b>	1	7	8	4	12	16
<b>Total</b>	<b>14</b>	<b>27</b>	<b>41</b>	<b>21</b>	<b>25</b>	<b>46</b>

Along the same lines, the priorities established in the RP raised questions for us when three major water main breaks occurred on secondary systems in Ville-Marie borough in May, June and July 2012. Lines requiring major repair work were not identified when the RP for Ville-Marie borough was developed, nor were they selected during the project selection process in the 2010, 2011 and even the 2012 partnership agreements. According to the DGSRE, these breaks were apparently not foreseeable.

Accordingly, we noted that boroughs' final RPs are not used for selecting projects to be included in partnership agreements based on an order of priority. We extended our analysis to include selected projects appearing in RPs in order to assess the extent to which this information was useful for deciding on responses to be implemented (e.g., rehabilitation or replacement of lines). To do this, we compared the types of work proposed by RPs with those provided for in partnership agreements to see whether they were similar.

Table 15 shows that in more than half the cases, the types of responses provided for in partnership agreements were different from those proposed in RPs: 67% (22/33 projects) in 2010 and 63% (19/30 projects) for 2011. Our audit showed that in almost all cases, the RP recommended rehabilitation work, but that when a project was included in a partnership agreement, reconstruction work was provided for instead, which represents higher costs.

Accordingly, we note that even when selected projects appeared in the final RPs of the boroughs concerned, information that could have been useful for planning the work (types of responses and estimated costs of work) are usually changed. This leads us to question the usefulness of data provided in RPs to managers when they decide on responses, since it takes additional time and effort to analyze such data. We understand that responses recommended in RPs can be changed as a result of further inspections and analyses. However, this situation leads us to question the accuracy of the investment needs set out in the RP for the next five years.

**Table 15 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Comparison of Work Provided for in RPs with Work Provided for in Agreements**

Type of work provided for in partnership agreements	Partnership agreements – 2010			Partnership agreements – 2011		
	Le Plateau-Mont-Royal	Ville-Marie	Total	Le Plateau-Mont-Royal	Ville-Marie	Total
Similar to RP	6	5	11	10	1	11
Not similar to RP	7	15	22	7	12	19
<b>Total</b>	<b>13</b>	<b>20</b>	<b>33</b>	<b>17</b>	<b>13</b>	<b>30</b>

In closing, the RP was to be a tool for determining potential responses to be implemented according to an order of priority. However, our audit showed that when the time came to select projects to be included in partnership agreements, managers did not systematically use the RPs of the boroughs involved, since many selected projects are not found in them. Furthermore, some major projects needed to be implemented even though they were not included in the RP or in the DGSRE process. Also, projects included in partnership agreements that appear in RPs were not selected according to the priority set forth in the RPs, because this order is inaccurate as a result of inspections that were not completed and because some boroughs did not perform rigorous data entry. Also, information in RPs on the type of work and on project costs is not always reliable or used by managers because many changes are made to projects when they are included in partnership agreements.

In short, we did not feel that this mode of operation ensured that all priority responses were identified, or that short-term work was carried out, or would be carried out within a short timeframe, on water and sewer lines identified as critical since the RP was developed. We think that it would be necessary to show evidence of a correlation between priority work identified in the RP and its inclusion in partnership agreements. Given the large number of potential responses in the final RP to be implemented, it is essential that responses be classified according to their priority over a time line of a few years. A reliable classification could be used to create an implementation plan to guide annual project planning when

partnership agreements are concluded. Clearly, this implementation plan should be followed up to ensure compliance. If projects not appearing in the RP need to be undertaken, a rationale should be provided.

As we mentioned in the previous section, such a situation justifies the continuation of inspections with a view to upgrading the system, because when a line breaks or sewer collapses, the costs of emergency repairs are very high.

### 3.5.B. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau integrate, in an implementation plan covering a definite timeframe, the responses to be implemented following analysis of the priorities emerging from the response plan to guide the selection of projects when partnership agreements are concluded with boroughs.

#### Business unit's response:

*[TRANSLATION] The DGSRE will put in place a three-year plan based on available data. This plan will take into account both the responses identified in the IRP, new structural data corresponding to emergencies, road repair projects (local and arterial), large-scale projects and other outside stakeholders, all with the ultimate goal of optimizing responses from technical and financial standpoints. (Planned completion: December 2014)*

### 3.5.C. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau document, during the annual planning stage, postponement of projects provided for in the implementation plan (arising from the response plan) or decisions to implement projects that are not provided for in the response plan so that it will be able to justify the decisions made. This documentation should include, in particular, an assessment of the impact of project postponement and the decisions to implement unplanned projects on the related cost estimates and on the quality of life for residents.

#### Business unit's response:

*[TRANSLATION] To make it possible to document all projects that appeared on a preliminary list, we plan to produce a project follow-up document as soon as a project is analyzed. A project follow-up document will be created, both for projects retained and for projects not retained during the planning stage. (Planned completion: December 2013)*



### 3.6. Planning Investment Projects and Maintenance Expenses

As part of the implementation of the organizational model for water management, approved by the executive committee in 2003, the DGSRE, in collaboration with each borough, was mandated to develop and ensure the progress of the master plan management. In the case of secondary water systems, this mandate involved both renewal and maintenance.

For renewal, the master plan for water asset management is in fact the RP, while for maintenance, the master plan is based instead on responses required for maintenance of the systems of the whole city appearing in the 2009 *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems*. This State of the Infrastructure Report focused on evaluation of the responses and investments required for maintenance of secondary water systems, while the RP presented more complete analyses of responses and capital investments.

To carry out its mandate, the DGSRE has been concluding an annual partnership agreement with each borough since 2007, for capital investments as well as for certain maintenance expenses.

For capital investments, these agreements list the projects planned for the year according to their types (reconstruction, rehabilitation) and estimated costs. Generally, these investment projects should be found in the annual plan of the DGSRE and the resources needed to implement them should be provided.

Maintenance activities come under the jurisdiction of the boroughs, in accordance with the *By-law concerning the delegation of city council powers to borough councils (02-002)*. In fact, since the new Ville de Montréal was created in 2002, boroughs have been carrying out maintenance activities using the budgets allocated to them. However, since 2006, the DGSRE also pays for some of these activities out of its budget, either to compensate for the lack of resources or to correct problems noted in boroughs. Partnership agreements provide a list of certain maintenance activities for various components (e.g., fire hydrants, valves, sumps), specify whether these activities are under the responsibility of the borough or the DGSRE and set targets for each of them.

During our audit, we first assessed the extent to which the projects provided for in these partnership agreements in 2010 and in 2011 had been implemented. Second, we looked at the extent to which resources were allocated to boroughs so that they can assume the responsibilities entrusted to them concerning maintenance activities.



### 3.6.1. Investment Project Planning in 2010 and 2011

#### 3.6.1.A. Background and Findings

During our audit, we assessed the extent to which the projects provided for in the 2010 and 2011 partnership agreements had been implemented. To do this, we conducted a comparative analysis of the total investments provided for in the partnership agreements, the budgets allocated during the year for project implementation and actual spending.

First, we note that the DGSRE's TCEP budget was lower than the investment amounts provided for in partnership agreements (see Table 16). In fact, the original DGSRE budget was \$100 million for 2010 and \$127 million for 2011, while partnership agreements provided for total investments of \$129 million for 2010 and \$138 million for 2011.

**Table 16 – Investments Planned for 2010 and 2011**  
(amounts in millions of dollars)

Year	Partnership agreements		TCEP	
	No of projects	Amount	Original budget	Amended budget
2010	234	129	100	102
2011	238	138	127	109

Such a situation arose because the DGSRE budget had not yet been confirmed at the time the partnership agreements were prepared. Partnership agreements are developed on the basis of a projected investment value for implementation costs. According to the information obtained, partnership agreements are not reviewed if the TCEP is lower. Consequently, despite all the efforts that go into selecting projects, it is the annual investment budget allocated to the DGSRE that is used to set the limits for project planning.

Because of the budget limit set, not all projects that were initially planned under partnership agreements can be implemented.

In the course of a year, the initial budget (original gross budget) may be amended as the result of decisions made by the management of the Service de l'eau. This is the amended investment budget for the DGSRE, which is allocated to projects as they are undertaken. According to Table 17, the budgets allocated to investment projects was \$64 million for 2010 and \$74 million for 2011, compared to the total for projects provided for in partnership agreements, which was \$129 million for 2010 and \$138 million for 2011.

**Table 17 – Allocation of Capital Budgets and Implementation Rate**  
*(amounts in millions of dollars)*

Year	Partnership agreements		TCEP						
	Projects		Amended budget <sup>a</sup>		Budget allocated to projects		Actual expenditures		
	No.	Amount	Amount	% agreements	Amount	% agreements	Amount	% agreements	% amended budget
2010	234	129	102	79	64	50	55	43	54
2011	238	138	109	79	74	54	71	51	65

<sup>a</sup> Amended gross budget corresponding to amounts allocated to projects provided for in partnership agreements between boroughs and the DGSRE.

Only 50% of the amounts provided for in partnership agreements for 2010 and 54% of the amounts for 2011 were allocated specifically to projects during the year. Moreover, close to 63% (\$64/\$102) of the 2010 budget and 68% (\$74/\$109) of the 2011 budget was allocated during the year to projects when they were started. Such a situation reveals that a considerable portion of the budget is not used to start investment projects. However, partnership agreements were to reflect the investment needed for the implementation of priority projects following a long, complex planning process.

To assess the reliability of investment project planning, we calculated the implementation rate of these projects by reconciling actual expenditures with the amounts initially projected in partnership agreements. This gives an average implementation rate of only 43% for 2010 and 51% for 2011 for all boroughs. However, since the DGSRE's amended budget was lower than the amount of investments provided for in these partnership agreements, it was the basis we used for calculating the implementation rate. This new implementation rate is 54% for 2010 and 65% for 2011.

Since our audit focused more specifically on Le Plateau-Mont-Royal and Ville-Marie boroughs, we did a similar comparison to determine whether these boroughs were different from the average. We therefore compared the total investments provided for in the partnership agreements, the budgets allocated to them and the amount of actual spending (see Tables 18 and 19). We made the same comparisons for the number of projects.

**Table 18 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Capital Budget Allocations and Implementation Rate – 2010 TCEP**  
(amounts in thousands of dollars)

Borough	Partnership agreements		2010 TCEP					
	No.	Amount	Budget allocated to projects <sup>a</sup>				Actual expenditures	
			No.	% agreements	Amount	% agreements	Amount	% agreements
Le Plateau-Mont-Royal	14	12,564	5	36	2,722	22	1,723	14
Ville-Marie	27	17,800	15	56	9,752	55	8,811	50
<b>Total</b>	<b>41</b>	<b>30,364</b>	<b>20</b>	<b>49</b>	<b>12,474</b>	<b>41</b>	<b>10,534</b>	<b>35</b>

<sup>a</sup> Amended gross budget for amounts allocated to projects provided for in agreements.

**Table 19 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Capital Budget Allocations and Implementation Rate – 2011 TCEP**  
(amounts in thousands of dollars)

Borough	Partnership agreements		2011 TCEP					
	No.	Amount	Budget allocated to projects <sup>a</sup>				Actual expenditures	
			No.	% agreements	Amount	% agreements	Amount	% agreements
Le Plateau-Mont-Royal	21	16,165	14	67	10,237	63	10,516	65
Ville-Marie	25	18,618	11	44	3,527	19	4,612	25
<b>Total</b>	<b>46</b>	<b>34,783</b>	<b>25</b>	<b>54</b>	<b>13,764</b>	<b>40</b>	<b>15,128</b>	<b>43</b>

<sup>a</sup> Amended gross budget for amounts allocated to projects provided for in agreements.

Overall, for both years, the comparison confirms that approximately 40% of investment amounts provided for in the 2010 and 2011 partnership agreements were allocated directly to specific projects. As for the number of projects, the comparison shows that close to half of them were started (49% for 2010 and 54% for 2011). However, half the projects were not started, even though the secondary systems of these two boroughs are the most deteriorated. Not only are the projected annual investments insufficient to make up for the investment shortfall, but such a situation contributes to increasing this deficit.

We also assessed the reliability of planning for these two boroughs using the implementation rate. We calculated this rate by comparing actual spending with the total amount of investments provided for in partnership agreements. We note that this rate is lower (35% for 2010 and 43% for 2011) than for all the boroughs (43% for 2010 and 51% for 2011).

For projects provided for in partnership agreements, Table 20 shows the progress of projects for the two boroughs in our sample. We noted that a considerable percentage of

projects were actually postponed or cancelled. Out of 41 projects in 2010 and 46 projects in 2011, all chosen because of their priority, less than 40% (39% in 2010 and 33% in 2011) were terminated during the year, while close to half the projects were postponed or cancelled (51% in 2010 and 46% in 2011). The number of projects in progress at the end of the year was equivalent to a rate of 10% in 2010 and 21% in 2011. We did not obtain evidence that projects begun in 2010 or in 2011 had been selected according to priority.

**Table 20 – Le Plateau-Mont-Royal and Ville-Marie Boroughs  
Status of Projects Provided for in Partnership Agreements for 2010 and 2011**

Project status	Le Plateau-Mont-Royal				Ville-Marie				Total			
	2010		2011		2010		2011		2010		2011	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Completed	4	29	8	38	12	44	7	28	16	39	15	33
In progress	1	7	6	29	3	12	4	16	4	10	10	21
Postponed	7	50	4	19	12	44	13	52	19	46	17	37
Cancelled <sup>a</sup>	2	14	3	14	0	0	1	4	2	5	4	9
<b>Total projects</b>	<b>14</b>	<b>100</b>	<b>21</b>	<b>100</b>	<b>27</b>	<b>100</b>	<b>25</b>	<b>100</b>	<b>41</b>	<b>100</b>	<b>46</b>	<b>100</b>

<sup>a</sup> Projects for which the types of responses were revised and for which implementation was postponed indefinitely.

Because of the large number of postponed or cancelled projects and the impact that this has had on the accumulated investment deficit, we asked the division head responsible for each borough in our sample whether the main causes had been systematically determined and analyzed. According to the information obtained, this is not done in a structured way that would enable the evaluation of the consequences and costs. As a result, we noted, the percentages of postponed or cancelled projects could not be compared with all boroughs, since this information was not compiled.

We were informed of several problems, both operational and administrative, that limited the full implementation of projects planned for the two boroughs (Ville-Marie and Le Plateau-Mont-Royal). Below, we have classified the causes under three headings: lack of coordination, limited ability to implement projects by the stakeholders involved in project implementation and, lastly, administrative constraints.

- Lack of coordination

Projects covered by the partnership agreements of the two boroughs in 2010 and 2011 were postponed because of difficulties in coordinating them with the investment projects

of other city stakeholders. For example, large-scale projects such as the CHUM<sup>22</sup>, the MUHC<sup>23</sup>, the Bonaventure Highway, the Griffintown district and the Turcot Interchange limited the DGSRE's scope of action on streets bordering these projects, even though responses had been planned. Other projects had to be postponed because they restricted traffic or because of the adverse affects they had on citizens and merchants.

According to the information obtained, projects involving different administrative units also had to be postponed because of the way budgets were allocated by each business unit. For example, if a project is part of DGSRE planning and involves the Division de la gestion des actifs de voirie (DI of the SITE), it is not certain that this project will necessarily be completed with the budget intended for this division. Even if it can be completed within this budget, unforeseen events can occur to affect its implementation.

- Limited ability of stakeholders involved to implement projects

According to the information obtained, some projects were postponed or cancelled because the business units involved in planning, designing or implementing projects did not have the ability to carry out the requests received.

Some projects were postponed or cancelled as a result of changes in the type of work involved; for example, the response needed was rehabilitation rather than reconstruction, as per the plan, or vice versa. According to the information obtained, the results of hydraulic studies requested, which could be used to decide on types of projects to be planned, were received late by the DGSRE because the stakeholders involved lacked the necessary resources. The DGSRE would have contributed additional resources for conducting hydraulic studies to help the units involved respond to the request. We were unable to assess the consequences of these actions.

Capital works planning is carried out on the basis of the needs determined, up to the established budget limit, but with no regard for the DI's ability to implement projects. (The DI was formerly known as the DTP when the projects reviewed for 2010 and 2011 were implemented.) Thus, in 2010 and 2011, projects were postponed or cancelled because of a lack of ability to implement them, either during the preparation of plans and specifications or during execution of the work. For projects provided for in partnership agreements, the DGSRE itself manages rehabilitation contracts, but leaves this task up to the DI for reconstruction work. In some cases, boroughs carry out

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<sup>22</sup> Centre hospitalier de l'Université de Montréal.

<sup>23</sup> McGill University Health Centre.

reconstruction work. Of the projects provided for in the partnership agreements of the two boroughs in our sample, 68% of projects were awarded to the DI (28/41 projects) in 2010 and 57% (26/46 projects) in 2011. However, we were unable to assess the extent to which these project postponements and cancellations were attributable to the DI, to the DGSRE or to the boroughs.

The DGSRE would be well advised to submit a list of projects provided for in partnership agreements as promptly as possible to the DI during the planning phase so that it can assess its ability to provide the services requested according to the planned schedule.

- Administrative constraints

As we mentioned above, in 2010 and 2011, budgets were allocated to the city's business units in the first few months of the year. Only then were partnership agreements with boroughs approved, from February to May, thereby delaying the contract awarding process. Since the contract awarding process demands adherence to strict administrative deadlines, work performance contracts could be awarded only late in the spring and in some cases, even after the summer period. Such a situation affects project launching and sometimes requires that projects be postponed.

Furthermore, once projects that were delayed or cancelled because of the abovementioned deficiencies were ready to go to tender, they were delayed once again because of administrative constraints.

According to the information obtained, it is unlikely that budgets freed by postponed or cancelled projects will be reallocated to other projects in the same year, since other important deadlines must be met. At the time of our audit, the DGSRE had a list of projects that were included in partnership agreements, but did not have a more comprehensive log of projects that were ready to be implemented to replace cancelled or postponed projects. It had set the objective of creating a project bank over a three-year period, which would speed up project implementation. We encourage the DGSRE to take the necessary steps to achieve this objective.

Managers deplore the impacts that these administrative constraints have on work performance and their inability to make commitments for the following year, since such commitments can be made only after annual budgets are approved.

In closing, all project postponements and cancellations have serious consequences. Not only do they affect project implementation rates for all stakeholders, they entail additional costs as a result of mitigation measures that must be adopted, sometimes for long periods. Furthermore, planning these projects in future years will once again require project coordination with partners. This problematic situation has not been resolved because it was postponed, leading to the deterioration of assets, risks of system breakdown for the population served and public safety risks. Finally, postponed responses are likely to be more costly in the future.

In our view, determination and analysis of the causes and consequences of project postponements and cancellations and the evaluation of costs arising therefrom constitute important management information. The DGSRE does not conduct such analyses in a structured way even though they would be useful for supporting accountability reporting on postponement of projects considered high-priority, given the size of the investment deficit and the extent of investments that will have to be made over the next few years.

#### 3.6.1.B. Recommendation

**We recommend that the Direction de la gestion stratégique des réseaux d'eau develop tools to provide it with up-to-date information on the progress status of investment projects included in partnership agreements so that it can rigorously follow up projects planned and find solutions to irritants that delay project implementation. In particular, this information should include:**

- **the progress of investment projects;**
- **the causes and consequences of postponed and cancelled projects;**
- **future costs of such postponements and cancellations;**
- **temporary measures put in place to ensure public safety.**

#### **Business unit's response:**

*[TRANSLATION] Ensure follow-up on the degree of progress of investment projects provided for in partnership agreements.*

*Produce a project follow-up document as soon as a project is analyzed. A project follow-up document will be created, both for projects retained and for projects not retained during the planning stage. This document will also serve to document the causes and consequences of postponed and cancelled projects, future costs of such postponements and cancellations, and temporary measures adopted to ensure public safety. (Planned completion: December 2013)*

### 3.6.1.C. Recommendation

We recommend that the Direction de la gestion stratégique des réseaux d'eau draw up a list of replacement projects when unforeseen events force it to postpone or cancel projects that were originally provided for in partnership agreements so that it will be able to make adequate use of the budgets allocated to it for asset maintenance.

#### Business unit's response:

*[TRANSLATION] The DGSRE is busy drawing up a plan for the three years ahead so that it will have the flexibility it needs to achieve its mission. (Planned completion: December 2014)*

## 3.6.2. Maintenance Spending

### 3.6.2.A. Background and Findings

In 2009, as part of the contract awarded to the consortium of consulting engineering firms, the DGSRE requested that a State of the Infrastructure Report be produced, as part of the RP development, in accordance with a procedure recommended by good practices.<sup>24</sup> The work consisted in compiling inventory data on secondary systems (from the RP) and in obtaining a qualitative evaluation of the condition of these groups of assets from managers of the systems. As a result of this procedure, a state of the infrastructure report on secondary systems was produced for each borough and for the city as a whole. It included the following objectives:

- Provide the city with a descriptive overview of the condition of the systems for each borough;
- Define additional investment needs for maintenance required by each borough in order to attain required levels of service;
- Make managers aware of results from the RP.

In keeping with this procedure, a list of activities required for maintenance of the various secondary system assets was established, and the response frequency associated with each activity was determined. These maintenance activities had to apply to all boroughs for all assets. Accordingly, a level of maintenance expenses was established for each borough.

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<sup>24</sup> "Developing a Water Distribution Renewal Plan," *National Guide to Sustainable Municipal Infrastructure*, InfraGuide, November 2003.



Good practices define water and sewer system maintenance as an essential need that must be accompanied by response planning and funding. The establishment of maintenance activities increases the likelihood that lines that are not yet deteriorated will reach their probable maximum useful life, thereby preventing premature deterioration of the system. Conversely, deficient routine maintenance could potentially lead to greater investments for asset renewal.

According to the 2009 State of the Infrastructure Report, the funding required to implement the annual maintenance program was evaluated using average unit costs determined for each maintenance activity selected. The theoretical costs of annual maintenance were \$68.3 million, including \$36.8 million for water system maintenance and \$31.5 million for sewer system maintenance (see Table 21).

**Table 21 – Theoretical Annual Costs of Maintaining Secondary Water and Sewer System Assets for all Boroughs**  
(in millions of dollars)

Type of asset	Asset	Theoretical annual maintenance costs
<b>Water system</b>	<b>Water mains</b>	<b>11.9</b>
	Valves and valve chambers	12.5
	Fire hydrants and isolation valves	6.1
	Water main service connections and curb stops	6.3
	<b>Subtotal</b>	<b>36.8</b>
<b>Sewer system</b>	<b>Sanitary, storm and combined sewer lines</b>	<b>17.0</b>
	Manholes	3.9
	Sumps and drains	10.6
	<b>Subtotal</b>	<b>31.5</b>
<b>Total</b>		<b>68.3</b>

Source: City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems.

During our audit, we examined the extent to which budgetary resources were allocated to boroughs to enable them to assume the responsibilities delegated to them. We then assessed the DGSRE's level of knowledge of the maintenance activities performed by boroughs and whether they were in line with expectations.

To do this, we compared the theoretical maintenance costs (\$68.3 million), set out in the 2009 State of the Infrastructure Report, with annual budgets for maintenance activities (boroughs and DGSRE). For the purpose of this comparison, presented in Table 22, we

took into account actual spending since 2006. This comparative evaluation revealed that actual maintenance fell considerably short of the level required, based on standard costs estimated at \$68.3 million per year.

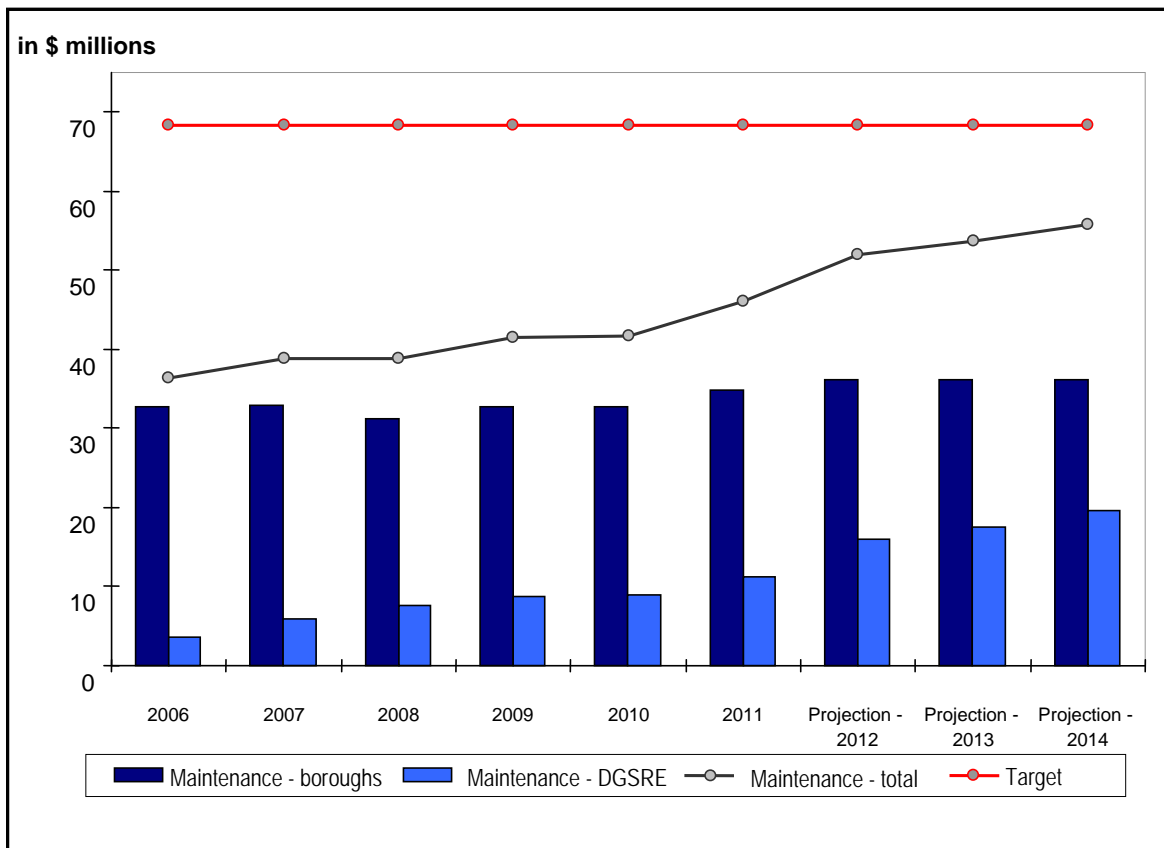
**Table 22 – Actual Spending for Maintenance of Water and Sewer Systems for all Boroughs**  
(in millions of dollars)

Year	Expenses assumed by		Total	Objective	% of the spending objective
	the DGSRE	the boroughs			
<b>Actual spending</b>					
<b>2006</b>	3.7	32.7	36.4	68.3	<b>53</b>
<b>2007</b>	5.9	33.0	38.9	68.3	<b>57</b>
<b>2008</b>	7.7	31.2	38.9	68.3	<b>57</b>
<b>2009</b>	8.7	32.8	41.5	68.3	<b>61</b>
<b>2010</b>	8.9	32.8	41.7	68.3	<b>61</b>
<b>2011</b>	11.2	34.8	46.0	68.3	<b>67</b>
<b>Total</b>	<b>46.1</b>	<b>197.3</b>	<b>243.4</b>	<b>409.8</b>	<b>59</b>
<b>Projections</b>					
<b>2012</b>	15.9	36.1	52.0	68.3	76
<b>2013</b>	17.6	36.1	53.7	68.3	79
<b>2014</b>	19.6	36.1	55.7	68.3	82

Source: DGSRE presentations: “Rétrospective de l’année 2011” and “Objectifs 2012.”

Figure 4 gives a visual breakdown of the accumulation, from 2006 to 2011, of the total maintenance deficit of \$166.4 million, which is the difference between budgets allocated to boroughs for their maintenance activities (\$243.4 million) and financial needs (types and frequency of activities) (\$409.8 million). This maintenance deficit accounts for 41% (100% – 59%) of the additional amounts that should have been invested according to the theoretical annual maintenance costs presented in the 2009 State of the Infrastructure Report.

**Figure 4 – Theoretical Needs (Target) Compared to Actual Maintenance Spending for Secondary Water and Sewer Systems (2006–2014)**



Source: *City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems* and DGSRE presentations: "Rétrospective de l'année 2011" and "Objectifs 2012."

In view of the crucial role that system maintenance plays in the useful life of assets, it is essential for the DGSRE to know the type and frequency of current maintenance activities achieved with operating budgets. Any maintenance activities that are not carried out must also be identified so that the consequences can be assessed.

According to the information obtained, the few boroughs whose systems are in good condition devote their resources to maintenance activities and even to refining their activities, often through new techniques designed to protect assets. Conversely, most boroughs whose systems are among the oldest and in the most deteriorated condition or for which the necessary responses are the most complex operate more in reactive mode and do not manage to carry out all routine maintenance work.

Under the partnership agreements, the DGSRE sets targets for each borough every year, based on the number of inspections to be conducted on different assets, the number of

assets to be replaced (e.g., fire hydrants, valves) or the territory to be covered for leak detection.

Throughout the year, each borough must complete a monthly “targets table.” In looking over these tables, we noted that they provide information on whether each borough reached the targets set (e.g., percentage of the territory covered to detect leaks, number of fire hydrants inspected). Other items include the number of repairs carried out on different assets and the amounts spent every month to carry out all maintenance activities.

Follow-up performed with the aid of this targets table, combined with monthly meetings with boroughs, enables the DGSRE to detect problems and propose corrective action, if necessary (e.g., additional financial support through the DGSRE operating budget, institutional procedures to make up for the lack of human resources for leak detection).

Thanks to this follow-up, the DGSRE noted a disparity in the methods used by boroughs. For example, for some boroughs, inspecting an asset means simply confirming its existence, while, for others, it means conducting tests and repairing or replacing the asset, if necessary. According to the information received, this situation can be explained by the difference in the level of qualifications in the workforce, by the lack of resources in some sectors and by the lack of rigour in the execution of certain maintenance activities.

Every year, the DGSRE completes the targets table by showing the standard cost of activities performed by boroughs. The comparison shows significant variances between this standard cost and what boroughs actually spent (see Table 23). For 2010 and 2011, we note that the amounts that boroughs actually spent for maintenance activities were higher than the average expected cost for the execution of those same activities. For Ville-Marie and Le Plateau-Mont-Royal boroughs, we note that variances are larger than for the boroughs as a whole. Such a situation contributes to the annual maintenance deficit.

**Table 23 – Comparison of Maintenance Costs  
for Activities Performed by Boroughs  
(in thousands of dollars)**

Borough	2010			2011		
	Standard cost <sup>a</sup>	Actual cost	Overrun (actual/standard)	Standard cost <sup>a</sup>	Actual cost	Overrun (actual/standard)
The whole city	28,573	33,336	17%	34,552	40,665	18%
Ville-Marie	2,663	4,043	52%	3,242	5,565	72%
Le Plateau-Mont-Royal	1,197	2,166	81%	1,360	2,686	98%

<sup>a</sup> Established according to the annual theoretical maintenance costs appearing in the 2009 State of the Infrastructure Report.

Source: 2010 and 2011 Targets Tables, DGSRE.

According to the information obtained, it is not possible for the DGSRE to know with certainty the reasons for this situation, mainly because of the accounting methods used by boroughs for their maintenance activities. While it is important to take the accumulated maintenance deficit into account when future maintenance expense needs are established, we think that an analysis of boroughs' maintenance activities must also be carried out to determine what they actually accomplish with these expenditures, in order to justify variances between these and the average cost of activities.

During our audit, we also examined the by-laws under which powers are delegated to borough councils for maintenance of secondary systems. This delegation of powers is set out in the general by-law entitled *By-law concerning the delegation of city council powers to borough councils (02-002)*. This by-law is not specifically aimed at the maintenance of secondary water and sewer systems, unlike the *By-law concerning the sub-delegation to borough councils of the maintenance of waterworks and sewer systems (05-090)* or the *By-law concerning the delegation to borough councils of certain powers relating to the arterial road system (08-055)*. Accordingly, the delegation of powers associated with maintenance activities for secondary systems is not accompanied by specific conditions, such as:

- Performing maintenance activities in accordance with instructions in the maintenance guide accompanying the by-law;
- Keeping separate accounting for the system's maintenance activities so as to provide a full follow-up of related activities;
- Producing reports on the delegated activities.

Such a situation could explain in large part the disparity among boroughs in the performance of maintenance activities. We think it would be beneficial for the delegation of powers for the secondary water and sewer systems to be covered by a separate delegation-of-powers by-law. Under such a by-law, conditions could be imposed on the performance of delegated activities, just as they are for maintenance of the primary water

and sewer systems and maintenance of the arterial road system. This would help standardize the execution of maintenance activities, facilitate comparisons among boroughs and thereby better equip the DGSRE to perform thorough follow-up on delegated activities.

#### 3.6.2.B. Recommendation

**We recommend that the Direction de la gestion stratégique des réseaux d'eau periodically evaluate the boroughs' accumulated maintenance deficit for the secondary water and sewer systems so that it can decide on steps to be taken in order to comply with the comprehensive response strategy that was developed.**

#### Business unit's response:

*[TRANSLATION] Periodically define the variance between maintenance activities (in accordance with best practices) already identified in the 2009 City of Montreal State of the Infrastructure Report for Water Distribution and Wastewater Collection Systems and the activities carried out in boroughs. (Planned completion: March 2014)*

#### 3.6.2.C. Recommendation

**We recommend that the Service de l'eau take the necessary steps to ensure that city council adopts a separate delegation-of-powers by-law for boroughs concerning maintenance activities for secondary water and sewer systems so that they are standardized, thereby facilitating follow-up by the Direction de la gestion stratégique des réseaux d'eau so that assets may be preserved in accordance with the comprehensive response strategy. This delegation of powers should be accompanied by specific conditions governing the execution of maintenance activities (e.g., maintenance guide, separate accounting and accountability reporting).**

#### Business unit's response:

*[TRANSLATION] The DGSRE, in collaboration with the Service des affaires juridiques et de l'évaluation foncière and the boroughs, will develop a separate delegation-of-powers by-law for boroughs regarding maintenance activities carried out on secondary water and sewer systems in order to have it adopted by city council. (Planned completion: December 2015)*

## 3.7. Accountability Reporting

### 3.7.A. Background and Findings

In order to ensure that the Direction générale and authorities can stay informed about the progress of the master plan for the management of secondary system assets, in terms of both renewal and maintenance, accountability mechanisms must be introduced. To do this, management reports containing relevant information must be produced periodically so that it is possible to assess changes in the condition of assets. These reports must be useful for informed decision-making.

We examined the extent to which the DGSRE reports to the Direction générale on the progress of the master plan for the management of secondary water system assets as it pertains to renewal and maintenance and the extent to which boroughs account for powers delegated to them.

While perusing partnership agreements with boroughs, we noted that the DGSRE made a commitment to submit an annual report on achievements for all 19 boroughs to the municipal administration, and to report to it in the course of the fiscal year as needed. According to the information obtained, however, no such reports highlighting annual achievements have been produced to date.

We think that the DGSRE should report on an annual basis to the Direction générale on the implementation of investment projects provided for in partnership agreements. This accountability reporting should also cite project postponements and cancellations and describe the consequences associated with them.

We also noted that the Service de l'eau gave several presentations to make authorities aware of the scale of investments that will be needed in coming years to eliminate the accumulated investment deficit and to preserve assets. Since 2002, the amounts required have been rising steadily as a result of better knowledge of the systems and their needs. However, reports showing the progress of the master plan, in terms of both renewal and maintenance, were not produced since the final RP was produced in May 2010. In view of the high direct and indirect costs incurred by the city for developing the RP, for updating the information it contains (e.g., the results of sewer system inspections) and for maintenance activities carried out by boroughs, we think that the Service de l'eau should report periodically to the Direction générale and to authorities on the progress of this master plan. The Service de l'eau should also clearly report any variances between investments and maintenance expenses required under the strategy established and actual spending, and it should produce scenarios accordingly. The reporting should also include an assessment of

the funding method obtained, especially as it pertains to grants contributed by various partners. Of course, the reporting should also establish correlations with the overall condition of secondary system assets, taking into account renewal and maintenance expenditures, so that any necessary adjustments can be made.

### 3.7.B. Recommendation

We recommend that the Service de l'eau periodically report to the Direction générale and authorities on the current status of secondary water and sewer system management to ensure informed decision-making with respect to expected results.

In particular, this accountability report should:

- Focus on the degree of implementation of investment projects provided for in partnership agreements with boroughs, including costs incurred;
- Identify the status of maintenance activities that have been delegated to boroughs, including costs incurred, with respect to set targets;
- Report on the progress of the master plan in terms of both renewal and maintenance, including the degree of progress made in implementing projects considered critical and relating this to the overall condition of assets;
- Clearly show any variances between actual expenditures and investments and maintenance expenses required under the strategy established and draw up scenarios accordingly;
- Include an evaluation of the funding method obtained, especially with respect to grants contributed by various partners.

#### Business unit's response:

*[TRANSLATION] Establish structured accountability reporting that is compliant with the recommendation:*

- *Status report on investment projects provided for in partnership agreements with boroughs.*
- *Status report on maintenance activities (allocation of boroughs and the DGSRE).*
- *Incorporation into the status report of the extent to which the different grant programs are used. (Planned completion: March 2014)*

### 3.8. Overall Conclusion

The first studies, conducted in 2002 by a consortium of consulting engineering firms, highlighted the deterioration of water systems. They also made the municipal administration aware that substantial investments would be required over the next few years to maintain and rehabilitate these systems.



Since then, the city has allocated substantial resources to produce a detailed inventory of the systems, assess the condition of those systems, produce an RP according to the methodology proposed by the MAMR for the city and related municipalities and use an IDAS. In 2005, a \$30.7 million 10-year contract was awarded for the development of an RP for all the water and sewer systems (primary and secondary systems). In 2008, an additional \$10.1 million budget was required in order to complete the work and integrate road assets. Since the RP project began, the city has also awarded contracts for the testing of secondary sewer lines totalling nearly \$20 million. Finally, city employees, mainly from the Division de la géomatique, the DGSRE and the boroughs, helped compile the data necessary for developing, updating the RP and developing institutional management tools.

Over time, a better knowledge of the systems made it possible to assess investment needs to preserve secondary system assets. For this purpose, the Service de l'eau gave several presentations to make authorities aware of the large sums involved. Capital budgets allocated by the city were insufficient and as a result, the accumulated investment deficit has continued to rise. For secondary systems alone, the estimated investment deficit jumped from \$0.9 billion in 2003 to \$2.3 billion in 2012. Looking at the system as a whole, the deficit surged from \$1.5 billion to \$3.8 billion.

Because of the gulf that exists between investment needs and the budgets allocated, projects to be implemented must be selected on the basis of the priorities established. When the Service de l'eau had its final RP approved by the urban agglomeration council in March 2011, it stated in its decision-making summary that this management tool was useful for rational, discerning and effective decision-making, that it gave it the ability to make informed decisions. The Service de l'eau also stated that now that this report has been submitted to the government, the city had a thorough knowledge of the condition of its infrastructures and that response planning was based on the priorities established by the MAMR and on a diagnosis of the structural and functional condition of lines.

However, our audit revealed that potential responses to be implemented were not selected entirely according to either the prioritization set forth in the RP or the integrated overall condition scores. Furthermore, a large number of projects identified in the planning stage were not identified in the RP. As a result, we are not confident that the responses deployed on secondary systems were those with the highest priority. In order for RP data to be able to detect real priorities as effectively as possible, considerable, ongoing efforts must be expended to have complete information (e.g., data on system inspections, standardized compilation of data on water main repairs). Later, sustained efforts will be required to update these data to make them useful for planning.

Besides the selection of responses based on priorities established by the RP, we also noted that nearly half the projects that are selected at the end of a planning process and included in partnership agreements with boroughs are not implemented in the year in which they are planned. A great many projects must be postponed or cancelled, which contributes to the accumulated investment deficit. Worse still, the amounts provided for in these agreements are well below the amounts they should correspond to in the RP established to implement short-term priority responses.

We noted a similar problem concerning the maintenance of secondary systems. Over the years, low levels of actual spending in comparison to the targets established on the basis of good practices will heighten the accumulated maintenance deficit and consequently affect the level of future investments.

We are aware that the final RP produced in 2010 has not yet been completed and that considerable efforts have been made to acquire management tools. However, given the substantial resources invested in this project, we think that a timeframe should be established to accelerate completion of the RP so that it can be used as a planning tool for determining and implementing virtually all short-, medium- and long-term priority responses.

Finally, at present the large number of unforeseeable factors (level of service to be established, insufficient budgets allocated, uncertain method and level of funding, etc.) lead us to believe that this situation is not about to be corrected. The fact remains that the amounts currently invested are not sufficient to reach the investment level set by the Service de l'eau and to become self-financing within the time limits set by authorities.

This issue is all the more important in light of the fact that a similar situation exists for all infrastructures (bridges and tunnels, water systems and road systems).

The solution requires deep reflection. That is why the municipal administration must make wise choices in developing its strategy to slow and ultimately counter the deterioration of the infrastructure system.