



4.5.

LEAK SEARCH PROGRAM

May 4, 2018

AUDIT SUMMARY

PURPOSE

Ensure that the *Leak Search Program* efficiently and effectively reduces leaks in the waterworks system in accordance with the *Stratégie montréalaise de l'eau* and the *Stratégie québécoise d'économie d'eau potable*.

In addition to these results, we have made various recommendations to the business units.

The details of these recommendations and our conclusions are outlined in our audit report, which is presented in the following pages.

Note that the business units have had the opportunity to formulate their comments.

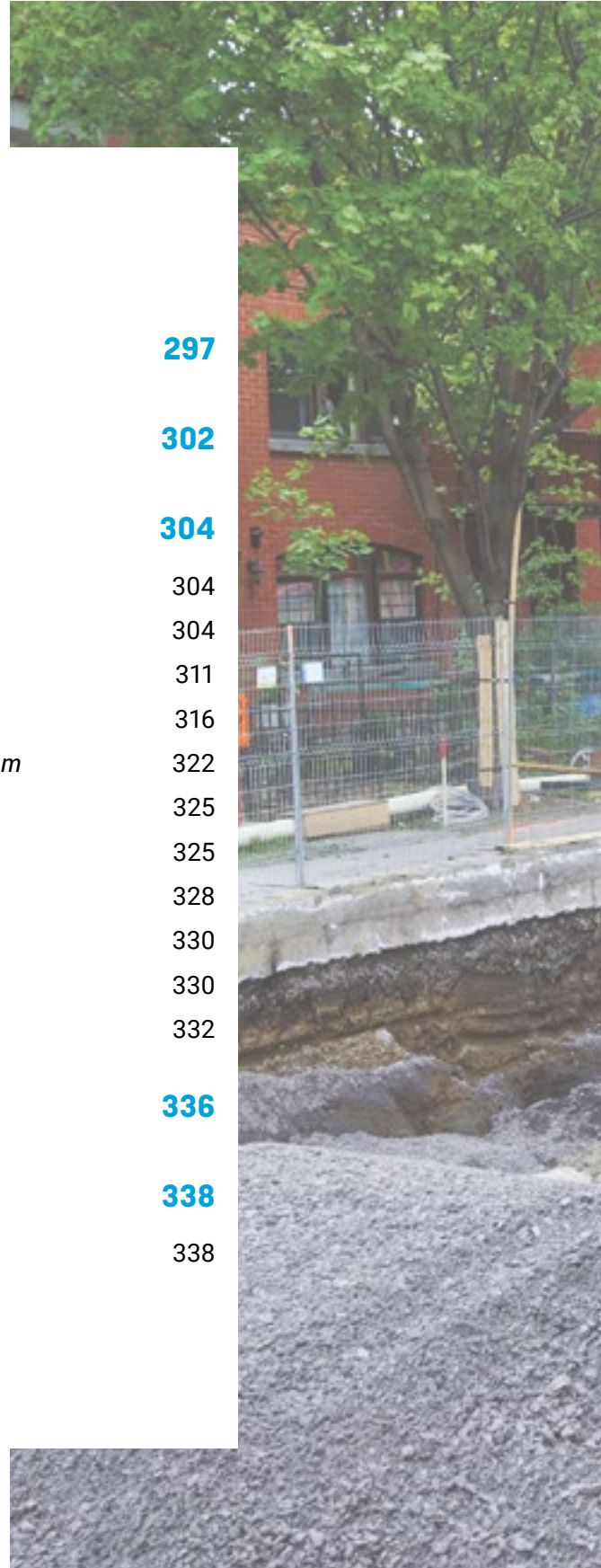
RESULTS

In 2011, the Government of Québec adopted the *Stratégie québécoise d'économie d'eau potable*. In June 2012, the urban agglomeration council approved the *Stratégie montréalaise de l'eau*. To achieve certain objectives and aims set out in these two strategies, the Ville de Montréal (the "city") implemented a number of measures to detect and locate leaks in order to repair them and thus conserve drinking water while reducing deterioration of the waterworks system. Nevertheless, given that the leakage rate still remains high, we believe that improvements should be made in the following main areas:

- No actual *Leak Search Program* targeting the leak search and location work of the units involved (within the Service de l'eau and the boroughs) has been developed;
- The roles and responsibilities of all units involved in leak search and location activities have not been clearly defined;
- The use of multiple computer applications for tracking leak files poses a risk of work duplication and confusion, which means that good practices are not being followed;
- Documented short- and long-term planning has not been put in place for the units involved in leak search and location activities;
- Located leaks are not always included in a work plan according to an established priority and set repair time that would facilitate the completion and follow-up of repairs;
- The leak search and location activities of units involved are not subject to periodic performance evaluation nor evaluation of expected benefits. Consequently, this lack of knowledge affects decision-making;
- Accountability to the authorities with the aim of facilitating informed decision-making, including all activities related to leak searches by all stakeholders, has not been demonstrated.

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LIST OF ACRONYMS

ARSO

Analyse réseau soutien aux opérations

DEP

Direction de l'eau potable

DGSRE

Direction de la gestion stratégique
des réseaux d'eau

GDT

Gestion des demandes de travail

GEA

Gestion d'entretien des actifs

km

kilometre

$m^3/(d*km)$

cubic metre per day per kilometre
of pipe

MAMOT

Ministère des Affaires municipales
et de l'Occupation du territoire

SQEEP

*Stratégie québécoise d'économie
d'eau potable*

1. BACKGROUND

Water has become one of the major global issues of the 21st century since fresh water represents only a tiny part of the earth's surface¹. The conservation of drinking water is therefore a central concern of governments and municipalities.

In light of this important issue, the Government of Québec adopted in 2002 the *Politique nationale de l'eau*², which included over 50 commitments. One of these commitments (Commitment No. 49) was to develop a *Stratégie québécoise de conservation de l'eau potable*, which makes the granting of all financial assistance to Québec municipalities conditional on the adoption of measures to conserve drinking water and reduce leaks. In 2012, the government adopted this strategy, which is called the *Stratégie québécoise d'économie d'eau potable*³ (hereinafter SQEEP).

Thus, for Québec as a whole, SQEEP's objectives were set as follows with a target date of December 31, 2016:

- Reduce the amount of water distributed per person by at least 20% compared to 2001;
- Reduce the leakage rate for all drinking water distribution systems to a maximum of 20% of the total volume of water distributed and to a maximum of 15 cubic metres per day per kilometre of pipeline ($m^3/(d*km)$).

To help achieve these objectives, the government has made a commitment to match its financial assistance for water-related infrastructure projects to the adoption and implementation of five measures with which municipalities must comply. One of them, Measure 2 – "production of a water use report," stated in particular:

*[TRANSLATION] Effective April 1, 2012, if the report shows a leakage rate in the distribution system greater than 20% of the volume of drinking water produced, or 15 $m^3/(d*km)$, the municipal body must put in place a leak detection and leak repair program for its drinking water distribution system⁴.*

Thus, like all Québec municipalities, the city is faced with the problem of preserving and conserving water, and must comply with SQEEP.

¹ Represents 2.5% according to the *Politique nationale de l'eau, gouvernement du Québec*, 2002.

² *Politique nationale de l'eau, gouvernement du Québec*, 2002.

³ SQEEP, *gouvernement du Québec*, 2011, 37 pages.

⁴ SQEEP, *gouvernement du Québec*, 2011, page 22.

In order to act on these issues, in June 2012, the agglomeration council approved⁵ the global ten-year vision (2011-2020) of the *Stratégie montréalaise de l'eau*, which was included in a document titled "*Enjeux, orientations et objectifs, pour une nouvelle stratégie de l'eau, compteurs ICI et optimisation des réseaux.*" According to this document:

[TRANSLATION] ...the city is still in a phase of water infrastructure rehabilitation, and the deterioration factors identified in 2001 and 2003 are still relevant due to the still-high average age of the infrastructure and an accumulated maintenance deficit⁶.

This strategy was adopted with the objective of optimizing drinking water systems and reducing the leakage rate.

The strategy identifies five major issues for the city:

- Public safety and security;
- Responsible asset management and optimal use of assets;
- Sustained funding and responsible financial management;
- Increased environmental responsibility through sustainable water management;
- Adoption of sound management and operational practices.

These issues were reflected in a series of strategic objectives, to which was attached an action plan including a number of measures to be taken up to 2020. Some objectives specifically concern leaks and various actions aimed at their detection with a view to reducing their numbers.

The *Stratégie montréalaise de l'eau* identifies six major projects with the greatest strategic impact and of which the population must be made more aware. One of these projects concerns: *Leak detection and repair⁷.*

The city has an impressive waterworks system that supplies drinking water to a population of approximately 2 million people⁸. The water is transported from filtration plants to the city's waterworks system, which consists of nearly 4,410 km of mains. Thus, some 770 km of mains of the primary water main system, located on the island of Montréal (the agglomeration), transport water to nearly 3,640 km of mains of the secondary system located within the city's territory (the 19 boroughs). Secondary mains then distribute drinking water to homes, industries, businesses and institutions. The secondary system is also made up of nearly 1,500 km of municipal service entries and fire hydrant supply lines.

⁵ Resolution CG12 0166, 2012-06-21.

⁶ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 131.

⁷ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 126.

⁸ Institut de la statistique du Québec, "Estimated population of administrative regions, July 1, 1996, 2001 and 2006 to 2009 (geographical breakdown as at July 1, 2009)", Government of Québec, February 4, 2010 (consulted March 28, 2010).

When leaks occur, they can affect a pipe, a service entry (on the city's or citizen's side), a fire hydrant and accessories.

The mission of the Service de l'eau is to respond to the Ministère des Affaires municipales et de l'Occupation du territoire (MAMOT) with respect to SQEEP requirements. Its mission is also to implement the actions planned to achieve the objectives set out in the *Stratégie montréalaise de l'eau*. It should be noted that many SQEEP requirements are to be found in the *Stratégie montréalaise de l'eau*. Two branches of the Service are specifically involved in the *Leak Search Program*:

- the Direction de la gestion stratégique des réseaux d'eau (DGSRE), mainly with regard to the secondary system⁹, and;
- the Direction de l'eau potable (DEP), with regard to the primary water main system.

The boroughs responsible for maintaining the waterworks system are also involved in the *Leak Search Program*.

In 2002, drinking water losses within the city's waterworks system were estimated at 40% (of volume distributed)¹⁰. When SQEEP was adopted by the Government of Québec, the estimated potential water loss was 33% and the estimated potential water loss per day per kilometre of pipe was 117 m³. In 2016, or 14 years later, the drinking water use form submitted to MAMOT in accordance with SQEEP requirements indicates a potential water loss rate throughout the system (the agglomeration) that was estimated at 34.7% of the volume of water distributed, as well as potential water losses estimated at 116.8 m³ per day per kilometre of pipe. Tables 1 and 2 below show that estimates have not changed significantly since the adoption of SQEEP.

⁹ As of May 1, 2018, this branch has been called the "Direction des réseaux d'eau," following the city manager's approval of a new organizational structure. For the purposes of this report, we have retained the abbreviation that was in effect at the time of our audit.

¹⁰ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 113.

TABLE 1 – ESTIMATE OF POTENTIAL WATER LOSSES (FOR ENTIRE SYSTEM)

YEAR	PERCENTAGE
2002 ^[A]	40.0%
2011 ^[B]	33.0%
2012	32.9%
2013	30.0%
2014	33.2%
2015	31.3%
2016	34.7%

[A] Source : The *Stratégie montréalaise de l'eau* and the water use report for 2016 (for the city's territory).

[B] Source : for 2011 to 2016: Drinking water use forms required by MAMOT.

In addition, for 2016, the Service de l'eau states in its report on water use presented in June 2017 to the agglomeration council that the rate of potential water losses is in fact 29%, since it uses the method espoused by the American Water Works Association (AWWA) rather than that of MAMOT¹¹. The Service de l'eau states that the method used by MAMOT to estimate losses will be changed in 2018 during the next revision of SQEEP.

TABLE 2 – ESTIMATE OF POTENTIAL WATER LOSSES PER CUBIC METRE PER DAY PER KILOMETRE OF PIPE (m³/(d*km))

ANNÉE	m ³ /(d*km)
2011	117 m ³ /(d*km)
2012	116.8 m ³ /(d*km)
2013	98 m ³ /(d*km)
2014	112.4 m ³ /(d*km)
2015	98.4 m ³ /(d*km)
2016	116.8 m ³ /(d*km)

Source for years 2011 to 2016: Drinking water use forms required annually by MAMOT (submitted to MAMOT for the previous year).

¹¹ Bilan de l'usage de l'eau potable (pour l'année 2016), Service de l'eau, Ville de Montréal, 2017, page 9. The calculation includes only the waterworks system of the city and four related municipalities (Montréal-Est, Town of Mount-Royal, Westmount and Dollard-des-Ormeaux).

Leak search helps prevent minor and major breaks that can lead to higher repair costs. In addition, it aims to conserve drinking water by repairing these leaks, which also has the effect of reducing water production costs.

According to the latest annual report on drinking water use, tabled by the government in 2017 for the year 2015, the first SQEEP objective (reducing the quantity of water distributed per person) has been achieved by all municipalities, thus meeting the December 31, 2016 deadline. As for the second objective related to leaks, this has still not been achieved with only 77% of municipalities meeting the potential water loss objectives, whereas the requirements of the strategy concern all municipalities. MAMOT states in its report:

*[TRANSLATION] ...although 77% of municipalities have met the potential water loss targets, the overall objective of the Strategy in this regard, namely to limit these losses to a maximum of 20% of the total volume of water distributed and to a maximum of 15 m³/(d*km), has not been met. Municipalities, especially the larger ones, will therefore have to continue the work already begun in order to reduce the losses¹².*

MAMOT states that significant potential drinking water losses have several impacts. For example:

- Additional variable costs for drinking water treatment and distribution as well as wastewater collection and treatment;
- Unnecessary investments in increasing the capacity of filtration plants;
- Damage to public and private property resulting from leaks;
- Damage to the image of the distribution system operator following repeated leaks¹³.

To help the municipalities, MAMOT has made available the guide "*L'économie d'eau potable et les municipalités*." This sets out the best water conservation practices related to SQEEP, some sections of which are more specific to leaks. In the 2013 to 2016 editions, MAMOT provides some definitions in order to clarify the terminology used on the subject of leaks¹⁴. Thus, the following distinctions are made regarding three types of leaks:

- *[TRANSLATION] Detected leaks that appear on the surface. In previous editions of the guide, these leaks were called "breaks".*
- *Undetected leaks that do not appear on the surface or escape the attention of the person responsible, but can be detected using current technology.*

¹² Rapport sur l'usage de l'eau potable, gouvernement du Québec, (SQEEP), 2017 (for the year 2015), page 7.

¹³ *Stratégie québécoise d'économie d'eau potable : L'économie de l'eau potable et les municipalités*, volume 1, 5^e édition, 2016, MAMOT et Réseau Environnement, page 54.

¹⁴ *Stratégie québécoise d'économie d'eau potable : L'économie de l'eau potable et les municipalités*, volume 1, 5^e édition, 2016, MAMOT et Réseau Environnement, page 56.

- *Undetectable leaks* so small that current technology cannot detect them. In the specialized literature, they are referred to as "background leaks"¹⁵.

MAMOT is of the view that:

[TRANSLATION] Leak search is a set of activities that begins with the aim of finding any leaks on a given territory and ends when the excavation sites are outlined on the ground. MAMOT also favours the term active leak search as opposed to the location of leaks already visible on the surface or in the form of various clues (such as noises at a user site).

In view of these clarifications made by MAMOT, we therefore used the term "leak search" in this audit report, although the term "detection" was used in the 2011 SQEEP and in the *Stratégie montréalaise de l'eau* to describe one of the six major projects.

In conclusion, it must be noted that the leakage rate still remains high despite a decrease relative to the estimates of the early 2000s. SQEEP's second objective, which concerns the leakage rate, still has not been met for all Québec municipalities. Regarding the city, although a great deal of investment has been made in recent years, the system is aging, which means there is still much work to be done to reduce the leakage rate and the costs associated with these losses of drinking water. Consequently, leak search work must continue and indeed be intensified in order to meet both SQEEP requirements and the objectives set out in the *Stratégie montréalaise de l'eau*, as well as contribute to reducing water losses in the waterworks system. We believe it is the right time for the city to evaluate the efforts made since SQEEP came into force, in order to make any necessary adjustments.

2. PURPOSE AND SCOPE OF THE AUDIT

In accordance with the provisions of the *Cities and Towns Act*, we conducted a value-for-money audit of the *Leak Search Program*. This audit was performed in compliance with the Canadian Standard on Assurance Engagement (CSAE) 3001 of the CPA Canada Handbook – Assurance.

The purpose of this audit is to ensure that the *Leak Search Program* efficiently and effectively reduces leaks in the waterworks system in accordance with the *Stratégie montréalaise de l'eau* and SQEEP.

The role of the Auditor General of the Ville de Montréal is to reach a conclusion regarding the purpose of the audit. To do so, we have collected sufficient relevant evidence on which to base our conclusion and achieve a reasonable level of assurance. Our evaluation is founded on criteria we have deemed valid for the purpose of this audit. They are presented in Appendix 5.1.

¹⁵ *Stratégie québécoise d'économie d'eau potable* : L'économie de l'eau potable et les municipalités, volume 1, 5^e édition, 2016, MAMOT et Réseau Environnement, page 53.

The Auditor General of Ville de Montréal applies the *Canadian Standard on Quality Control* (CSQC 1) of the CPA Canada Handbook – Assurance and, consequently, maintains a comprehensive quality control system that includes documented policies and procedures with respect to compliance with ethical guidelines, professional standards and applicable legal and regulatory requirements. The Auditor General also complies with regulations on independence and other ethical guidelines of the *Code of Ethics of Chartered Professional Accountants*, which is governed by fundamental principles of integrity, professional competence, diligence, confidentiality and professional conduct.

Our audit work focused on the years 2013 to 2017 (up to August 31, 2017). However, for some aspects, data prior to these years were also considered. Most of the audit work was carried out between June 2017 and February 2018, but we also took into consideration information given to us up to March 2018.

This work was performed primarily with the following business units:

- Service de l'eau (DGSRE and DEP);
- Lachine borough;
- Le Plateau-Mont-Royal borough;
- Le Sud-Ouest borough.

Upon completing our audit work, we presented a draft audit report to the managers of each of the audited business units for discussion purposes. The final report was then forwarded to the Direction générale and to each of the business units involved in the audit in order to obtain action plans and timetables for their implementation. A copy of the final report was also submitted to the Directrice générale adjointe au développement, and for information purposes to the Directeur général adjoint à l'arrondissement de Ville-Marie et à la concertation des arrondissements, as well as to the directors of the boroughs not directly targeted by our audit, so they can implement recommendations when the situation warrants it.

3. AUDIT RESULTS

3.1. LEAK SEARCH PROGRAM

3.1.1. IMPLEMENTING A LEAK SEARCH PROGRAM

3.1.1.A. BACKGROUND AND FINDINGS

As mentioned in the introduction, one of the SQEEP measures related to the second objective concerning leaks provided that:

*[TRANSLATION] ...as of April 1, 2012, if the report produced showed a leakage rate of 20% in the distribution system greater than 20% of the volume of drinking water produced, or 15 m³/(d*km), the municipal agency must implement a leak detection and repair program for its drinking water system.*

The 20% rate and the 15 m³/(d*km) requirement are two different criteria, which must be addressed separately.

However, the 2011 water use form submitted to MAMOT by the city in April 2012 shows a leakage rate greater than 20%, as well as a value in m³/(d*km) of pipe greater than the limit set by MAMOT. As a result, the city had an obligation to implement such a program as of that date in accordance with SQEEP requirements.

Additionally, Table 3 below presents the objectives set out in the *Stratégie montréalaise de l'eau* as adopted by the agglomeration council in 2012, confirming the willingness of the city to implement a *Leak Search Program*.

TABLE 3 – SUMMARY EXTRACTS FROM THE STRATÉGIE MONTRÉALAISE DE L'EAU AIMED AT LEAK DETECTION

ISSUE #2: MANAGEMENT RESPONSIBLE FOR ASSETS AND OPTIMIZATION OF THEIR PERFORMANCE		
STRATEGIC OBJECTIVE	SPECIFIC OBJECTIVE	TASKS AND PROGRAMS
Set up a Leak Search Program in every borough.	Increase the proportion of preventive repairs (leaks identified through the Leak Search Program) vs. emergency repairs (surface leaks). ¹⁶	<p>Primary system:</p> <ul style="list-style-type: none"> Field research activities, technical support and engineering for repairs. <i>(Timeframe: 2011-2020)</i> <p>Secondary system:</p> <ul style="list-style-type: none"> Field research work (operations and repairs). <i>(Timeframe: 2011-2020)</i>
Implement a programme d'auscultation du réseau des conduites primaires.	Determine the number of kilometres of primary water mains made of pre-stressed reinforced concrete C-301 ¹⁷ that remain to be auscultated and plan their testing.	<ul style="list-style-type: none"> For the West Island: complete the inventory of pipes to be auscultated. <i>(Timeframe: 2011)</i> For the agglomeration: award a contract to auscultate any C-301 water mains remaining to be done. <i>(Timeframe: 2011-2012)</i>
	Set up a short-term plan for auscultation of primary water mains in cast iron and steel and evaluate future needs.	<ul style="list-style-type: none"> For the agglomeration: award a contract to detect leaks over 10 km of primary water mains of cast iron and steel. <i>(Timeframe: 2011-2012)</i> For the agglomeration: evaluate future needs in detecting leaks of primary water mains of cast iron and inner steel. <i>(Timeframe: 2011)</i>
ISSUE #3: SUSTAINED FUNDING AND RESPONSIBLE FINANCIAL MANAGEMENT		
STRATEGIC OBJECTIVE	SPECIFIC OBJECTIVE	TASKS AND PROGRAMS
Reduce water main breaks in distribution systems by 20%.	Establish and carry out an action plan to efficiently manage a programme de contrôle de fuites for the primary and secondary water main systems.	Not available.
ISSUE #4: INCREASED ENVIRONMENTAL RESPONSIBILITY THROUGH SUSTAINABLE WATER MANAGEMENT		
STRATEGIC OBJECTIVE	SPECIFIC OBJECTIVE	TASKS AND PROGRAMS
Reduce the amount of water withdrawn at source.	Reduce the volume of drinking water lost in distribution systems.	<ul style="list-style-type: none"> Increase proactive detection of leaks in all boroughs. Reduce intervention response time for breaks in the systems.
ISSUE #5: ADOPTION OF SOUND MANAGEMENT AND OPERATIONAL PRACTICES		
STRATEGIC OBJECTIVE	SPECIFIC OBJECTIVE	TASKS AND PROGRAMS
Properly organize the work and encourage the workforce to become more flexible.	Implement a système de gestion de l'entretien (système Maximo) in all plants and within the primary and secondary distribution systems.	<p>Primary system:</p> <ul style="list-style-type: none"> Launch the système de gestion de l'entretien and other work management applications. <i>(Timeframe: 2011-2012)</i> Plan maintenance of the primary system. <i>(Timeframe: 2011-2020)</i> <p>Secondary system:</p> <ul style="list-style-type: none"> Launch the système de gestion de l'entretien. <i>(No timeframe)</i>
	Organize implementation of Maximo application software in the boroughs	Not available.

¹⁶ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 84.

¹⁷ Water main of pre-stressed reinforced concrete-steel, including steel casing and steel wire under tension.

As part our audit work, we wanted to know to what extent the *Leak Search Program* had been implemented, in accordance with SQEEP requirements and with the objectives set out in the *Stratégie montréalaise de l'eau*.

To better identify the SQEEP requirements and the *Stratégie montréalaise de l'eau* objectives, we pondered the meaning of the word "program," as mentioned in both SQEEP and the *Stratégie montréalaise de l'eau*.

Since the MAMOT guide has not explicitly defined what it means by "Program," we will offer a definition so as to better express and clarify this idea. Essentially, what we mean by "Program" is a group of structured and concerted actions of several complementary activities aimed at meeting a common objective. All activities that need to be completed to meet the objective must be supported by documented management processes. A program consists of grouping together all the components that have a significant influence on its effectiveness. For example, a program should include objectives, strategy, an action plan, performance indicators, roles and responsibilities of the units involved, training and accountability.

In order to evaluate to what extent a *Leak Search Program* had been implemented, in terms of SQEEP requirements and *Stratégie montréalaise de l'eau* objectives, we met with each of the stakeholders involved, that is, the Service de l'eau managers (DGSRE and DEP) and the audited boroughs.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

The DGSRE is responsible for managing the secondary water main and sewer system. With the aim of accomplishing the actions called for in the *Stratégie montréalaise de l'eau* and SQEEP, the DGSRE created a team in 2012 called the Analyse réseau soutien aux opérations (ARSO). This team, which mainly began its work in 2013, is tasked with carrying out a systematic search for leaks in the secondary water main system. Composed of nine people, including eight technicians and a principal technician, the team is divided into four sections to cover the entire city. Its task is to look for undetected leaks, i.e., those underground that do not appear on the surface. Leaks are found by using several different techniques, in particular by applying listening devices to the ground and to fire hydrants.

In the leak detection process, ARSO must locate any leaks that have been detected so as to determine the exact site that the borough needs to excavate to undertake the repair. Every city borough is visited each year.

The Service de l'eau indicates in its *Stratégie montréalaise de l'eau* that, according to good maintenance practices, leaks must be tracked over 100% of the city's territory annually¹⁸. The systematic search for leaks covered some 72% to 86%¹⁹ of the secondary system

¹⁸ *Stratégie montréalaise*, Ville de Montréal, page 37.

¹⁹ Bilan de l'usage de l'eau (for 2016), Service de l'eau, Ville de Montréal, 2017, page 16.

each year, over the period January 1, 2013, to December 31, 2016. The team also detected 1,555 leaks in the secondary water main system during the same period. Table 4 below shows the evolution of the number of leaks detected during this period.

TABLE 4 – NUMBER OF LEAKS LOCATED BY ARSO FOR 2013 TO 2017

YEAR	LEAKS IDENTIFIED BY ARSO	FILES OF LEAKS SENT TO CITY BOROUGHS FOR REPAIRS ²⁰	FILES OF LEAKS SENT TO THE <u>THREE AUDITED BOROUGHS</u> FOR REPAIRS
2013	102	98	19
2014	279	261	56
2015	401	354	68
2016	488	392	36
2017 (8 months)	354	276	36
TOTAL	1,555	1,381	215

Source : DGSRE data.

As part of our audit work, we obtained evidence of the ARSO team being set up and of a program of systematic leak detection being applied to the secondary system. Thus, we learned of:

- the mandate of the ARSO team created within the SQEEP framework;
- a presentation document intended for the boroughs;
- Excel files showing the planning of leak detection activities;
- Excel files showing the total number of leaks located and the territory covered.

Lastly, we confirmed that the city's computer applications were being used to send work requests to the boroughs and to record the number of leaks and any repairs carried out (GDT²¹ and GEA²²). We also found evidence that leaks detected by the ARSO team were taken into account in the "Table of Targets," which served as a tool for compilation, monitoring and planning, thus unifying the boroughs.

²⁰ Some leaks are fixed at the time they are identified.

²¹ GDT : Gestion des demandes de travail.

²² GEA : Gestion d'entretien des actifs.

THE DIRECTION DE L'EAU POTABLE

In terms of asset management, the DEP is essentially in charge of the primary system, and based on the information we obtained, it carries out leak detection work on this system. Since this system is made up of pipes with specific properties, notably in terms of their materials and width, acoustic technology used by the ARSO team would be more difficult to apply to these pipes. Although the ARSO team occasionally participates in detection work on the primary system at the request of the DEP, the latter mainly awards contracts to specialized external firms to carry out leak detection and auscultation work. Auscultation is used to determine the structural status of a pipe, whereas leak detection specifically aims at locating existing leaks using specialized technology for large-diameter water mains. However, interventions on the primary system are complex because of its size and due to operational constraints with this type of pipe. Consequently, before auscultation and leak detection are undertaken, certain preparatory work must be carried out involving internal DEP resources. Table 5 below shows that leak detection work found 51 leaks in the primary system during the period January 1, 2013, to August 31, 2017.

TABLE 5 – NUMBER OF LEAKS LOCATED BY THE DIRECTION DE L'EAU POTABLE IN THE PRIMARY SYSTEM FOR 2013 TO 2017

YEAR	LEAKS IDENTIFIED BY THE DEP
2013	10
2014	1
2015	8
2016	11
2017 (8 months)	21
TOTAL	51

Source : DEP Excel file.

As part of our audit work, we obtained evidence of documents related to auscultation and leak detection on the primary system. We thus became aware of an Excel file that included various elements, in particular pipe inspection objectives, a compilation of breaks and urgent repairs, inspection contracts, a compilation of auscultation results and leak detection results.

THE BOROUGHES

The boroughs also participate in the detection of leaks. However, this mostly results from requests to detect and locate leaks coming from borough employees, central services or citizens. The boroughs therefore work at seeking out and locating "detected" and

"undetected leaks," mainly in the secondary system. According to the information we obtained, systematic leak detection (not resulting from requests) does go on, but is more limited in scope. It is sometimes carried out at roadwork construction and reconstruction sites. Le Plateau-Mont-Royal and Le Sud-Ouest boroughs employ a full-time leak tracker who uses a truck and specialized equipment. Lachine borough uses the services of private companies to search for and locate leaks. In the three audited boroughs, Table 6 below shows that leak detection work found 1,889 leaks in the systems for the period January 1, 2013, to August 31, 2017.

TABLE 6 – NUMBER OF LEAKS LOCATED BY AUDITED BOROUGHS FOR YEARS 2013 TO 2017

YEAR	LACHINE BOROUGH	LE PLATEAU-MONT-ROYAL BOROUGH	LE SUD-OUEST BOROUGH	TOTAL
2013	49	189	149	387
2014	48	278	109	435
2015	68	207	176	451
2016	93	175	121	389
2017 (8 months)	54	99	74	227
TOTAL	312	948	629	1,889

Source : DGSRE data.

The ARSO team occasionally comes to the aid of a borough in order to locate a leak, but as mentioned earlier, its primary mandate is to systematically search for leaks and not to provide operational support to help boroughs meet random requests.

As part of our audit work, we obtained evidence of documents related to search and location work on the secondary system. They essentially consisted of:

- Excel files, mainly used to compile descriptions of the leaks located and their repair dates;
- Documents issued by computer applications managed by the DGSRE, used to carry out work requests in the boroughs (GDT) and to record the number of leaks and the repairs carried out (GEA and the "Table of Targets"). These applications are used as compilation and monitoring tools.

Even though many leak search and location activities were initiated by each of the units involved to meet SQEEP requirements and *Stratégie montréalaise de l'eau* objectives, and even though these activities may be presented in some documents, as well as in computer applications and in various forms, our audit work did not reveal any evidence of a real,

structured and documented *Leak Search Program* for any of the units of the city involved, or for any of these activities. For example, except for the ARSO team, we found no evidence of a document showing the roles and responsibilities of each of the other units involved in such a program, nor of strategies for actions to be taken for the various categories of leaks in different water main systems, these being the primary and secondary systems. The ARSO team carries out a systematic search for leaks in all boroughs, but this is mainly for undetected leaks. In our opinion, the *Leak Search Program* must include the categories of leaks likely to be identified in a search for leaks; in this case, detected and undetected leaks²³. We found no evidence in any audited borough of a document outlining a *Leak Search Program* appropriate to it, or of any action plan detailing all leak detection activities. And yet one of the objectives of the *Stratégie montréalaise de l'eau* stipulates [TRANSLATION] "that a *Leak Search Program* be in place in every borough...". Even though several of the objectives related to the search for leaks outlined in the *Stratégie montréalaise de l'eau* were implemented, we think it is important that the Service de l'eau ensure that all the objectives related to the detection of leaks be implemented.

In our opinion, a city-wide *Leak Search Program* would make it possible to have a global view of all aspects to be implemented in this regard, and to meet the objectives set out in the two strategies.

Lastly, it is worth noting that in light of SQEEP requirements and *Stratégie montréalaise de l'eau* objectives, the Service de l'eau should be the contact point designated to indicate whether a *Leak Search Program* has been implemented over the entire city territory. It is imperative that all detection work be grouped together under one program to more easily demonstrate the city's efforts to authorities and to the Government of Québec the efforts being made by the city, as well as to shed light on the significant contribution made by all parties involved in meeting the target objectives, namely a reduction in water leakage.

RECOMMENDATIONS

3.1.1.B. We recommend that the Service de l'eau, along with the boroughs of Lachine, Le Plateau-Mont-Royal and Le Sud-Ouest, set up a real, structured and documented *Leak Search Program* for all city units involved, as well as all activities related to searching for and locating leaks, in order to demonstrate all the efforts being made by the city in satisfying government requirements, so as to meet the objectives set out in the *Stratégie québécoise d'économie d'eau potable*.

²³ For undetectable leaks, aside from replacing or restoring a pipe, the only solution for reducing the amount of water leaking is to reduce the water pressure. It is more about intervention related to monitoring than detecting leaks.

3.1.1.C. We recommend that the Service de l'eau ensure that all objectives set out in the Stratégie montréalaise de l'eau regarding leak searches have been taken into consideration and that a specific action plan be developed, in accordance with established deadlines, in order to demonstrate that the decisions taken by officials have been followed.

3.1.2. ROLES AND RESPONSIBILITIES OF THE UNITS INVOLVED

3.1.2.A. BACKGROUND AND FINDINGS

Implementation of a *Leak Search Program* requires that the roles and responsibilities of units involved in leak searches be clearly defined. Therefore, as several units are involved in leak detection and location work, we wanted to know if their role and responsibility had been clearly defined and communicated.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

At the time of our audit work, we became aware of a written mandate for ARSO, specifying that the team had been created to meet SQEEP requirements, that is to say, in connection with the implementation of a leak detection and repair program. Following the creation of the ARSO team, presentations were made to the boroughs to acquaint them with the team's roles and work. As we stated in the preceding section, the ARSO team searches for and locates undetected leaks. In concrete terms, the ARSO team sends a list of located leaks to the boroughs via work requests using a computer application (Oracle – GDT) so they can take care of the repairs.

THE DIRECTION DE L'EAU POTABLE

The DEP is responsible for the primary water main system, particularly concerning the auscultation of leaks in this system. As we mentioned earlier, it executes the auscultation and leak search work on this system via contracts with private firms. The repair of these leaks is also mostly carried out by private firms, since it is specialized work. This choice is explained by the degree of complexity surrounding this type of pipe. Nevertheless, some repairs and certain other steps are delegated to the borough concerned. During our audit work, we did not find any document or any presentation whose purpose was to make the boroughs aware of the roles and responsibilities of the DEP regarding leak search work on the primary system. However, according to the people we met at the DEP, the boroughs know their role. As for the audited boroughs, they say that they communicate with the DEP when they intervene on the primary system after a leak has been located.

THE BOROUGHS

The boroughs are responsible for maintenance work on the primary and secondary water main system in accordance with the by-law on the delegation of powers.

Since the agglomeration council has jurisdiction over the primary water main system, it has delegated maintenance to the related municipalities, including the city (RCG 05-002). The city has, in turn, sub-delegated maintenance to the boroughs (05-090). In this same regulation, articles 2 and 4 of By-law 05-090 provide for the following:

- Article 2: *[TRANSLATION] The city council sub-delegates to each borough council the maintenance work on the waterworks and sewer systems listed in Schedule A of the Règlement du conseil d'agglomération sur la délégation de l'entretien du réseau principal d'aqueduc et d'égout aux municipalités liées (RCG 05-002).*
- Article 4: *[TRANSLATION] The borough council must, with regard to the sub-delegation referred to in article 2: 1° carry out all maintenance work on the primary waterworks and sewer systems in accordance with instructions in the maintenance guide in Schedule C of the Règlement du conseil d'agglomération sur la délégation de l'entretien du réseau principal d'aqueduc et d'égout aux municipalités liées (RCG 05-002), adapting as necessary, in particular by replacing the words "central municipality" by "city of Montréal," and "related municipality" by "borough"; 2) coordinate maintenance operations in accordance with the instructions given.*

Included in the list of delegated maintenance work of the primary waterworks and sewer systems in Schedule A of By-law RCG 05-002 is the task:

- Search and repair of leaks and breaks in the pipes and valves (1.1.3).

As for the maintenance guide presented in schedule C of this by-law, the guide shows the list of work included in the activity "Search and repair of leaks and breaks."

The work includes provision of the workforce, materials, equipment and services necessary for search and repair of leaks and breaks in the primary water mains. The work is carried out by day labour or by contract. This work includes:

- service calls;
- tracking and locating the leak;
- securing the site;
- excavation;
- shutting off the water;
- repairing the leak;
- disinfection;
- restoring the service;
- backfill;
- surface repairs.

City council has delegated maintenance of the secondary waterworks system to the borough councils through By-law 02-002²⁴. This delegation concerns:

[TRANSLATION] ...maintenance of water main and sewer systems that are not part of the waterworks and sewer systems, as defined in the Règlement du conseil de la Ville sur la subdélégation de l'entretien du réseau principal d'aqueduc et d'égout aux conseils d'arrondissement (05-090).

We note that the by-law is silent on what is meant by "maintenance" and provides no details on how this maintenance should be carried out. It also provides no details on the list of delegated tasks, including leak search and location.

In addition, the boroughs have concluded service partnership agreements with the DGSRE. These agreements, signed by the DGSRE and by each borough (the borough director and its Direction des travaux publics), concern maintenance of the secondary system, among other things. An examination of agreements concluded with the audited boroughs in 2017 refers to a delegation by-law and a maintenance guide for secondary water and sewer systems called *Guide d'entretien des réseaux secondaires d'aqueduc et d'égout pour les activités déléguées aux arrondissements*. However, based on the information obtained from people we met and contacted at the DGSRE, this by-law and guide are still in the project stage and have not yet been adopted by the city officials concerned. They have nevertheless been presented to the boroughs. The initiative concerning the by-law and guide are in response to a recommendation by the Auditor General of the Ville de Montréal as part of the audit, *Plan de réalisation des travaux d'infrastructures – réseaux secondaires d'aqueduc et d'égout*, which formed part of the 2012 annual report.

Even though these service partnership agreements for 2017 distinguish and report on work related to preventive and corrective maintenance, we noted that they did not specifically deal with leak search and location work, nor did they set out the roles and responsibilities for each unit related to these activities. Yet, according to the managers we met at the DGSRE, this work forms part of the maintenance.

For their part, the people we met in the audited boroughs told us they wanted to be more involved in the ARSO team's leak search process and strategy. Even though the Service de l'eau is the first contact point with MAMOT and with city authorities regarding actions envisaged and taken in accordance with SQEEP requirements and *Stratégie montréalaise de l'eau* objectives, we believe it is important that all related units in these actions be informed of all the requirements and objectives of these two strategies, so they can fully grasp the purpose and the role they have to play and also to properly coordinate their respective interventions.

In concrete terms, our audit work showed us that the boroughs carry out leak search and location work mostly on the secondary system, but also on the primary system.

²⁴ *Règlement intérieur de la Ville sur la délégation de pouvoirs du conseil de la Ville aux conseils d'arrondissement*, city council, By-law No. 02-002, adopted December 18, 2001, paragraph 4.

This work concerns both reported and unreported leaks. In 2016, nearly 390 leaks were located for the three audited boroughs. Hence the boroughs do play an important role in leak search and location work. According to the people we met at the DGSRE and in the boroughs, it is essential that such work continue in the boroughs, either managed internally or by using private firms.

Also, during our audit work, people we met told us that the roles and responsibilities of borough leak trackers are not clearly defined and that this function is not fully recognized. According to them, the leak tracker is more like a specialized technician. As a result, the pay scale and remuneration of leak trackers in both boroughs (Le Plateau-Mont-Royal and Le Sud-Ouest) are not the same as those of technicians on the ARSO team. The people we met in the boroughs expressed concern that retaining leak trackers may be difficult. We believe that an examination of the roles and responsibilities of borough water leak trackers should be undertaken in order to find solutions that may help reduce these concerns.

In light of the interviews we conducted and the documentation we examined, including by-laws, our audit work revealed to us that the roles and responsibilities of units involved in leak search and location are not clearly defined. In particular:

- The documentation reviewed, including the by-laws, seemed insufficiently explicit on the subject of leak search and location work as it relates to the roles and responsibilities of the units involved;
- The service partnership agreements between the DGSRE and the boroughs concerning the secondary water main system provide few details on leak search and location work as it relates to the roles and responsibilities of the units involved in this work;
- Since maintenance of the secondary waterworks system is delegated to the boroughs by virtue of a by-law, and, according to the people we met at the DGSRE, leak search and location work should be included in maintenance, we note that the DGSRE (via the ARSO team) does carry out some leak search and location work;
- Even though the DGSRE disseminates its mandate during borough presentations and has recently sent letters to inform the boroughs about the advancement of the ARSO team's systematic search program, there is insufficient mention of the roles and responsibilities of the units involved in relation to SQEEP requirements and *Stratégie montréalaise de l'eau* objectives.

We have concerns about the service partnership agreements concluded with the boroughs, in particular about the content and approval procedure. On the one hand, they do not report on the work done by the ARSO team in the boroughs with regard to the systematic search for leaks, even though the boroughs have a delegated jurisdiction over maintenance. On the other hand, although the agreements were signed by the parties, they were not submitted for approval to the decision-making bodies in accordance with the procedure set

out in the *Charter of Ville de Montréal*²⁵. We are also concerned about the fact that the DEP and DGSRE do search and location work in the boroughs without having signed a service agreement with them, although the boroughs have jurisdiction over maintenance of this system as a result of the transfer of powers set out in the by-law.

We believe that the Service de l'eau should examine the approval procedure for service partnership agreements concluded with the boroughs in order to determine whether the procedure is compliant with the by-law and with the procedure set out in the *Charter of Ville de Montréal*. The Service de l'eau should also determine whether search and location work carried out in the boroughs by the DEP and DGSRE should be subject to a service agreement as required under the *Charter of Ville de Montréal*.

As mentioned earlier under Background, MAMOT has proposed a terminology for leaks. We believe that the Service de l'eau should examine the possibility of using this terminology in documentation related to leak search and location work, in order to harmonize the vocabulary in this area and avoid confusion. It would be useful to review all the documentation used by the Service de l'eau and the boroughs in addressing the subject of leak searches, and modify it to reflect this new terminology. It would also be useful to ensure that proposed draft regulations include a maintenance guide that takes the secondary system into account. Currently, examination of the documentation produced by the city, including the regulations in force, shows that there are no clear and consistent definitions of these activities, and that words like "leaks, breaks, detection, search and location" are being used, which risks creating confusion. We believe that the word "maintenance" must be more clearly defined with respect to this work, so as to determine what is and isn't part of it. We believe that by clarifying these definitions, the roles and responsibilities of the units could also be better defined, including in the framework of the *Leak Search Program*.

In our view, the fact that the roles and responsibilities of the units involved are not clearly defined poses many risks, in particular the risk of duplicating work, of non-compliance to by-laws and of confusion when undertaking interventions.

RECOMMENDATIONS

3.1.2.B. We recommend that the Service de l'eau use the terminology proposed by the Ministère des Affaires municipales et de l'Occupation du territoire regarding water leak searches and ensure that it is reflected in the documentation so as to promote better understanding of the terms used and avoid any possible confusion in the work undertaken by the units.

²⁵ Article 85, first paragraph, Charter of Ville de Montréal, RLRQ, c. C-11.4 : "The city council may, subject to the conditions it determines, provide a borough council with a service related to a jurisdiction of the borough council; the resolution of the city council shall take effect on passage by the borough council of a resolution accepting the provision of services".

<p>3.1.2.C.</p>	<p>We recommend that the Service de l'eau ensure that the roles of all units involved in leak search and location work be clearly defined so as to avoid any confusion regarding responsibilities among responders, and to maximize the outcomes of the <i>Leak Search Program</i>.</p>
<p>3.1.2.D.</p>	<p>We recommend that the Service de l'eau ensure that maintenance service partnership agreements concluded with the boroughs obtain all the required approvals before they are applied, in compliance with the usual authorization process with authorities.</p>
<p>3.1.2.E.</p>	<p>We recommend that the Service de l'eau examine whether leak search and location work carried out in the boroughs requires that a service agreement be concluded in compliance with the stipulations of the <i>Charter of Ville de Montréal</i>, in order to comply with the by-laws in force.</p>
<p>3.1.2.F.</p>	<p>We recommend that the boroughs of Le Plateau-Mont-Royal and Le Sud-Ouest make representations to the city's Service des ressources humaines to compare the responsibilities of their leak trackers with those of the Analyse réseau soutien aux opérations (ARSO) team in order to harmonize their salary scales, if needed, in light of the responsibilities of the two groups.</p>

3.1.3. PLANNING AND IMPLEMENTING GOOD PRACTICES

3.1.3.A. BACKGROUND AND FINDINGS

Developing a Plan

As mentioned earlier, leak search work has to be carried out because it helps meet SQEEP objectives. It is also carried out because the *Stratégie montréalaise de l'eau*, developed by the Service de l'eau, consists of five issues and an action plan over 10 years (2011-2020), which includes strategic and specific objectives. Some of these objectives concern leak searches on both the primary and secondary systems.

At this point in our work, we wanted to know whether leak search and location activities were subject to long- and short-term planning by the units concerned, and to what extent these objectives were being met. We also wanted to know whether good practices were being employed in order to ensure that actions were optimized.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

The programme de recherche systématique des fuites implemented by the DGSRE applies to the entire city territory, including all the boroughs. The program is primarily aimed at unreported leaks, or underground leaks requiring technology to detect. Even though the boroughs are not directly involved in this program, according to the information obtained from people we met at the DGSRE, they are still informed and consulted during visits by the ARSO team.

In the *Stratégie montréalaise de l'eau* adopted in 2012, the Service de l'eau referred to the fact that, according to good maintenance practices, leaks must be tracked every year over 100% of the city's territory²⁶. Since 2013, MAMOT also requires that any system exceeding one of the potential water loss objectives (20% and 15 m³/(d*km)) must be 100% auscultated every year²⁷.

Under the *Leak Search Program* implemented by the ARSO team, the 19 boroughs are divided into four sectors. In the execution of this work, an annual objective is set in terms of the number of fire hydrants to be listened to, which determines the percentage of the territory that is subject to leak searches. Each year, the team plans the number of days required to listen to water hydrants on each borough's territory and to correlate the location of detected leaks. An Excel spreadsheet is prepared to this effect.

According to the information we obtained, the annual objective determined by the ARSO team may not cover 100% of the territory. In fact, in some boroughs, only some of the hydrants are listened to, i.e., those in the part of the system most at risk, mainly the oldest part. Table 7 below shows the annual percentage of the city's secondary system (for all the boroughs) that has been subject to a systematic search for leaks since the adoption of SQEEP in 2011.

TABLE 7 – PERCENTAGE OF SECONDARY SYSTEM SUBJECT TO A SYSTEMATIC SEARCH FOR LEAKS (FOR ALL BOROUGHS)

YEAR	PERCENTAGE
2011	87%
2012	90%
2013	80%
2014	72%
2015	86%
2016	83%

Source: Water use reports submitted to decision-making bodies: 2011 to 2016.

²⁶ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 37.

²⁷ Rapport annuel de l'usage de l'eau potable, gouvernement du Québec, MAMOT, (année 2015), 2017, page 5.

In its 2016 water use report submitted to the city's decision-making bodies, the Service de l'eau:

[TRANSLATION] ...maintains that the stratégie d'auscultation du réseau d'eau potable must allow for a suitable frequency of system inspections. This frequency must be based on the risk of a break in a given water line. It is therefore neither optimal nor desirable to inspect 100% of the lines annually, since a portion of the system lines are recent and have a low probability of breaks. Talks are under way so that the formulation of the next version of the SQEEP acknowledges Montréal's experience and allows municipalities to efficiently use their human resources in sectors most at risk, rather than try to cover everything every year.

In our view, in cases where MAMOT requirements concerning the scope of leak search work on the waterworks system allow the targeting of sectors most at risk, DGSRE should document these sectors, identifying and describing them, in order to enumerate the fire hydrants concerned and calculate the percentage of territory covered to enable planning. We believe that planning should also clearly present and justify any sectors deemed not at risk and not requiring leak searches in the short term. For these sectors, the planning process should provide for the integration of leak searches into a longer-term timeframe, with the aim of meeting the set objectives.

THE DIRECTION DE L'EAU POTABLE

Based on the type of pipe in the primary water main system, the inspection is done via leak searches on concrete-steel, steel and cast iron mains (590 km) and by auscultation on C-301 mains (161 km). Based on information we obtained from people we met at the DEP, the objectives set out in the Stratégie montréalaise de l'eau concerning auscultation and leak searches on the primary water main system have been integrated into the planning. According to the initial plan, inspection of concrete-steel, steel and cast iron mains must be done over a period of 15 years (close to 40 km/yr), whereas inspection of C-301 mains is done over a period of 10 years (close to 15 km/yr). With the aid of an Excel file, we observed that the DEP has established a long-term plan, in terms of kilometres, for leak auscultation (2012 to 2021) and leak searches (2007 to 2023).

However, the DEP report shows that for both leak auscultation and searches, the number of kilometres inspected remains clearly below the set objectives. To date, as of 2017, 48 km (8%) of concrete-steel, steel and cast iron mains and nearly 40 km (some 25%) of C-301 mains had been inspected.

The people we met at the DEP told us that planning leak auscultation and detection on the primary water main system presented significant difficulties and constraints. At the same time, they acknowledge that these inspections are not advancing quickly enough, and they are currently reviewing them to evaluate any approaches that could help speed them up. To date, no detailed studies or analysis have been done.

In our view, the DEP should carry out a documented analysis of various approaches that could accelerate the auscultation and leak searches on the primary water main system, in order to meet the set objectives.

THE BOROUGHS

The DGSRE has set up a monitoring system for the boroughs, focusing on leak location activities for secondary water mains and service entries located on city property, with the help of the "Table of Targets." Each borough is required to complete this table monthly and send it to the DGSRE management unit responsible.

According to information we obtained, the boroughs respond to requests from different sources requiring the detection and location of leaks. In the boroughs of Le Plateau-Mont-Royal and Le Sud-Ouest, where a leak tracker is employed, the planning of leak search and location activities can be summed up as organizing the work in the short term, while prioritizing responses to requests deemed urgent. Leak trackers in these boroughs do not do systematic leak detection work, with the exception of construction sites (on roadways) within their territory. But even for these construction sites (which come under borough or central department responsibility), it is not always a planned activity, mainly due to contractors' work hours and difficulties coordinating with contractors, and also because the trackers are not given sufficient advance notice about the existence of these construction sites.

Lachine borough relies on the services of private firms to carry out leak search and location work. These firms conduct active searches for leaks on the systems and also respond on demand. For the years 2013 to 2016, we noted that leak search work focused not only on secondary water mains, but also on large-diameter water mains (primary water main system). As for construction sites (on roadways) in the territory of Lachine borough, the people we met said that they did not do systematic leak search, but that this was planned for 2018.

In the three audited boroughs, we did not find any evidence of documented planning with respect to leak search and location work on construction sites. We believe that the boroughs should implement such documented planning. This would help manage priorities, coordinate responses with other units and aid in meeting the objectives set out in SQEEP and the *Stratégie montréalaise de l'eau*.

Implementing Good Practices

The DGSRE is currently working on a project that will allow the boroughs and Service de l'eau units to improve several aspects, mainly the planning and follow-up of repair work. This project primarily concerns the implementation of a computer application called "Maximo" that will replace existing computer applications, in particular:

- the GEA application: in which data on water leakage in mains or other waterworks assets are captured, at the time the leaks are located;
- the Table of Targets: completely monthly by the boroughs for reporting to the DGSRE. For example, the boroughs indicate the number of repairs carried out on various assets (e.g., secondary mains and service entries);
- the GDT application: manages work requests from the boroughs.

In fact, for several years, the boroughs and DGSRE have been using these three computer applications in addition to in-house monitoring tools, assisted by the Excel application. The first two applications (GEA and the Table of Targets) are managed by the DGSRE. Based on information we obtained, the GEA application and the Table of Targets have some limitations, despite their usefulness, especially in planning and follow-up. As for the GEA, it does not include all the data related to searching for and locating leaks, particularly those in the private system. It also does not allow you to preserve a history of leak searches not resulting in repairs.

As for the DEP, it does not use these three tools, but mainly in-house tools, with help from the Excel application. According to information obtained from people we met at the DEP, data about leaks that were detected and located by the boroughs in the primary water main system are not kept on in-house tools, but in other computer applications, i.e., GDT and an application used for geomatics called SIGS (système d'information géographique).

In our opinion, the use of several computer applications, including in-house applications, creates the potential for duplication of work and confusion in managing the leak search and location work. It is important that all responses be compiled in a way that ensures the service data is complete, in order to provide an accurate picture of the work carried out, even if no repairs were done.

In short, leak search and location work is mainly being done with three different applications, and some in-house tools. The "Maximo" application will be able to replace these three applications and allow more possibilities in planning, specifically in planning the work to be done, identifying the staff concerned and ordering parts. It will also be useful for following-up since it allows the creation of follow-up reports in various forms. However, the application is currently not functional for the boroughs. Implementation of this project in the boroughs was to begin in 2018. The DEP uses it, but only for part of its leak search work as the application is not yet fully functional.

Another component of the "Maxim'eau" project primarily concerns reorganization of the maintenance work carried out by the boroughs. Its purpose is to provide oversight through good planning. The project provides for the presence in the borough of a planner for maintenance work, including repair. A training centre has been set up and working procedures are designed so as to allow the city to utilize the expertise thus gained in its work. Vehicles, equipment used for repairs and parts for replacement of defective ones will all be standardized. However, this project mainly concerns maintenance work and blue-collar employees. Even though leak trackers will have to use the "Maximo" application, they are not yet included in the "Maxim'eau" project.

Although the "Maxim'eau" project was begun in 2014, the training component for all the boroughs did not start until 2018. For now, employees assigned to new maintenance work duties have begun their training at the recently established training centre.

The "Maxim'eau" project is an excellent initiative in promoting the implementation of good practices. We believe that the Service de l'eau should examine the possibility of integrating leak search and location work into the "Maxim'eau" project, so that the trackers involved in these activities will also benefit from good practices in their execution of the work, in particular in work procedures, standardizing equipment and customizing training.

Our audit work also revealed that the ARSO team uses various reference documents, including presentations, for different purposes such as training, learning and as reference tools in leak search work. In the audited boroughs, trackers also use a number of reference documents. However, according to information obtained from the people we met at the DGSRE and in the boroughs, there is no formal training for water leak trackers that would provide the knowledge and expertise they need to carry out their tasks, nor any guides to support them. In our opinion, since this expertise in leak search is mainly acquired internally and needs to be preserved, we believe that mechanisms similar to those developed for maintenance work as part of the "Maxim'eau" project (e.g., production of a guide, work procedures and training documents), should be put in place.

RECOMMENDATIONS

- 3.1.3.B.** **We recommend that the Service de l'eau document the planning of systematic leak search work for the secondary system, both in areas at risk and at less risk, in order to ensure proper allocation of resources and to demonstrate the extent to which the city is integrating the objectives of the *Stratégie québécoise d'économie d'eau potable* and those of the *Stratégie montréalaise de l'eau* into its short and long-term planning.**

<p>3.1.3.C.</p>	<p>We recommend that the Service de l'eau carry out a documented analysis of the various approaches to speeding up leak auscultation and detection on the primary water main system, in order to choose suitable scenarios to be applied in meeting the objectives of the <i>Stratégie québécoise d'économie d'eau potable</i> and the <i>Stratégie montréalaise de l'eau</i>.</p>
<p>3.1.3.D.</p>	<p>We recommend that the boroughs of Lachine, Le Plateau-Mont-Royal and Le Sud-Ouest apply documented planning to leak search and location work, in order to better coordinate these activities with contractors.</p>
<p>3.1.3.E.</p>	<p>We recommend that the Service de l'eau, along with the boroughs of Lachine, Plateau-Mont-Royal and Le Sud-Ouest, ensure that the computer application being used allows the recording of all leak search and location work, so as to ensure that the relevant data is complete and to provide better knowledge of the work carried out, thereby optimizing operations.</p>
<p>3.1.3.F.</p>	<p>We recommend that the Service de l'eau examine the possibility of integrating into the "Maxim'eau" project the leak search and location work carried out by leak trackers in the boroughs, so that this work can receive the same type of supervision that benefits repairs, thereby optimizing operations.</p>

3.1.4. EVALUATING THE PERFORMANCE OF THE LEAK SEARCH PROGRAM

3.1.4.A. BACKGROUND AND FINDINGS

Implementing a *Leak Search Program* requires that it be periodically evaluated to determine whether it meets SQEEP requirements and *Stratégie montréalaise de l'eau* objectives. Analysis of the results obtained demands that we ask some questions about the operation of the program and its application.

In our audit work, we wanted to know whether leak search and location activities had been evaluated by the units involved, and also if the entire program itself had been evaluated.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

Concerning performance evaluation of leak search work on the secondary system, we obtained documents from the DGSRE demonstrating that they evaluate the results

relative to the established plan. As mentioned earlier, targets for fire hydrants needing to be listened to are set according to the number of hydrants within the territory in question. Performance is measured based on the percentage of the system investigated. As we have observed, this is an annual evaluation, mainly concerning systematic leak search work by the ARSO team on the secondary system.

We found no evidence that all aspects were being evaluated in a documented manner. Considering that the boroughs concerned are notified of located leaks to be repaired, we believe it would have been useful to compare the number of leaks located by ARSO with those repaired by the boroughs. The results obtained would have enabled us to highlight situations requiring improvements, in particular regarding the equipment and devices used, and the working methods.

THE DIRECTION DE L'EAU POTABLE

Regarding the primary water main system, the DEP sent us documents demonstrating that it is evaluating the performance of leak auscultation and search work relative to the established plan. Targets are being set, both for auscultation of the system and for leak detection, based on the number of kilometres of pipe to be covered and the percentage of the system to be inspected. By comparing these targets with what has been completed (in kilometres and in percentage), the inspection deficiency can be established. We did not find any evidence that all aspects had been evaluated in a documented manner, in particular the techniques being used and all interventions carried out by the DEP and the boroughs on the primary system, in matters of leak search and work undertaken by private firms.

THE BOROUGHS

As for the boroughs, we found no evidence that their leak search and location work was being evaluated in a documented manner.

However, since the boroughs are taking charge of leaks detected and located by ARSO with a view to repairing them, they are in a position to evaluate the accuracy of the data being sent. We believe that after five years of the ARSO team's operations, it would be appropriate for such an evaluation to be carried out, in order to make any necessary improvements to the working methods. An evaluation of leak location by the boroughs would also be appropriate. Although they do use some tools for monitoring, we found no evidence of any documented evaluation of leak search and location work.

To conclude, regarding the entire *Leak Search Program*, it should be noted that since the adoption of SQEEP, municipalities are required to produce an annual report on water use and have it approved by the authorities. However, the Service de l'eau submitted its last water use report to city authorities in August 2017. This performance evaluation compared the principal SQEEP requirements to the results. As for the objective of reducing the leakage rate to 20% of total volume distributed, the report indicates that this was not

met. The report, however, does not mention any performance evaluation of the entire *Leak Search Program*.

In December 2017, the Service de l'eau also produced a progress report on the *Stratégie montréalaise de l'eau* for the 2011-2015 period. In terms of the progress of the major "Leak Search and Repair" project, the report mainly details the leak search work of the ARSO team. It indicates the percentage of the system that has been investigated, the number of km investigated and the number of leaks detected for this period.

Despite the fact that significant effort has been invested by the Service de l'eau, we found no evidence that all the work and all the relevant aspects related to leak search and location for all the units involved have been periodically evaluated in performance terms. In our opinion, although the setting up of the ARSO team constitutes an important aspect within the framework of systematic leak search work, they alone cannot be considered to be the *Leak Search Program*. As mentioned earlier, we see this program as including all the units involved in this work, and believe that a number of components need to be evaluated, in particular the equipment and devices used, techniques applied, staff training, planning and strategies deployed, and response times for leak detection and location.

In our opinion, the Service de l'eau, along with the boroughs, should take responsibility for all these components of the *Leak Search Program* in order to enumerate and periodically evaluate them. In the same spirit of the efforts made by the Service de l'eau to evaluate leak search and location work, we believe the boroughs should also invest in periodic evaluations of this same work.

RECOMMENDATIONS

3.1.4.B. We recommend that the Service de l'eau periodically evaluate the performance of the *Leak Search Program* with regard to all activities of the units involved, in order to obtain an overview of the city and make any necessary adjustments, as needed, with a view to improving working methods and contributing more effectively toward achieving the objectives set by the Government of Québec and the city.

3.1.4.C. We recommend that the boroughs of Lachine, Le Plateau-Mont-Royal and Le Sud-Ouest periodically evaluate leak search and location work in order to obtain an overview of this work and make any necessary adjustments, with a view to maximizing their results.

3.2. PLANNING REPAIRS

3.2.1. INCORPORATING LOCATED LEAKS INTO A WORK PLAN

3.2.1.A. BACKGROUND AND FINDINGS

Leak search and location activities are the first steps in the major project "Leak Detection and Correction" of the *Stratégie montréalaise de l'eau*. Thus, it is essential to include located leaks in a work plan so that the necessary interventions can be undertaken to make repairs within an appropriate timeframe. A work plan should therefore include time-bound levels of priorities for the repairs.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

Although the planning of repairs is not the responsibility of the ARSO team, it still carries out leak search and location work mainly on the secondary system and transmits information to the boroughs concerned. Leak location consists of accurately determining the location of the leak. Using colour markings, the ARSO team indicates on the pavement the location of the leak and where the borough is to excavate and ultimately repair the leak once the water main is clear. A leak location record is then prepared by an ARSO technician. This record is generally accompanied by a sketch and photo and includes various information such as the name of the borough, location, asset concerned (e.g., main, service entry or terminal), as well as an indication of a "repair priority" based on four types of responses: immediate, urgent (1-3 days), short-term (7 days) and medium-term (14 days). The ARSO technician can then determine the type of response needed by checking one of the four intervention types. On a sample basis, we examined 15 files in the selected boroughs to assess how often a priority was indicated. We found that this section had not always been completed (7 out of 15 cases) in order to determine the intervention priority.

The location record also includes a file number for a "Work Request" related to the GDT computer application. This work request includes various details about the leak, including the location, the asset where the leak has occurred (e.g., water main or service entry) and the date of the request. This work request is automatically sent to the borough concerned for processing. Attached to the request are the location record, sketch and photo.

This information, which is sent to the boroughs, should allow the located leaks to be incorporated into a work plan.

THE DIRECTION DE L'EAU POTABLE

The DEP conducts leak detection work on the primary water main system using private firms. These firms produce a report on their work and identify the existence or absence of leaks in the pipes. These results are recorded by the DEP in an Excel file, which serves as a work plan. It includes the number of leaks detected in the sections of the pipe, their location and other information, including the pipe's year of manufacture and its composition.

According to the information obtained from the people we met, leak repairs are generally outsourced to contractors, through contracts managed by the DEP. In some cases, however, the work is managed by the borough concerned. The Excel file referred to above not only serves as a work plan, but is also used for follow-up purposes. To this effect, the file includes a section relating to repairs, which provides various types of information, including the status of the leak, type of repair, year of repair and contract with the company responsible for the repair. Our review of the Excel file showed that it does not include a priority level with a completion time for each leak file to ensure leaks are repaired quickly, to minimize damage.

In our opinion, it is important that the DEP ensure that it includes in its work plan an order of priority with a desired timeframe for each leak detection file for the repairs to be carried out, in order to plan the work to be done and allow for appropriate follow-up.

THE BOROUGHES

With regard to the boroughs, some leaks are located by ARSO, and the data transmitted via the GDT. Other leaks are located by them as a result of requests received on a daily basis. In the latter case it is the boroughs that undertake the search and location.

The service partnership agreements signed with the DGSRE set out an order of priority to guide the boroughs in carrying out repairs. The 2017 agreement provides seven priority levels depending on the type of asset:

- L1 Repair of breaks and leaks in drinking water mains;
- L2 Repair of collapses and major defects in sewer mains;
- L3 Repair of breaks and leaks in water service entries;
- L4 Repair and/or replacement of end-of-life fire hydrants;
- L5 Repair and/or replacement of end-of-life valves;
- L6 Repair and/or replacement of fire hydrants and valves according to restoration priorities depending on the type of anomaly;
- L7 Repair and/or replacement of other assets with major anomalies.

As can be seen, repairs to drinking water pipes and water service entries must be carried out as a priority.

In the three selected boroughs, we noted that in general the files on leaks that had been located either by the ARSO team or the boroughs were included in their Excel house files, which were serving as a sort of work plan. In the case of Le Sud-Ouest borough, leaks located by the ARSO team are the subject of a separate file, while for the other two boroughs, all located leaks are compiled in their Excel file without any distinctions being made. In all cases, we found that it was possible to trace the date that the request for intervention had been received, the date that repairs began and the date they ended. When the repair had been carried out, a breakage file is recorded in the GEA computer application.

In the course of our work, we looked at how repairs were being prioritized. For Le Plateau-Mont-Royal borough, based on the information obtained, the work crew supervisor prepares a work plan for the waterworks personnel responsible for repairing leaks. A dashboard including the work to be done is also prepared and displayed in the workplace. The tracker and crew supervisor work together to prioritize leaks for repair based on their expertise. In Le Sud-Ouest borough, according to the people we met, the crew supervisor and tracker work together daily to plan repairs and identify priorities. Thus a prioritization method was established by the tracker based on his/her expertise in the field. We found that the Excel file used indicates a priority level from 1 to 5 (1 being the most urgent and 5 the least urgent) for the leaks located. However, we found that this file does not give any indication or explanation supporting this approach or the repair time associated with it.

In Le Plateau-Mont-Royal and Lachine boroughs, we found no evidence that priorities and repair times had been established by the boroughs in the documents and Excel files being used as work plans.

Although efforts are being made by the units involved in the planning of leak repairs to determine a priority level that describes the urgency of the response, we found that various approaches are taken. The tools and means used do not always include a documented work plan with a priority level to indicate the degree of urgency, along with a deadline for the repair.

Once again, we observed that the use of multiple computer applications to process leak files increases the risk of confusion, which can hinder effective response planning, particularly with regard to response times and priorities. Although it is good practice for the ARSO team's technicians to enter an order of priority in the location record, it is important to remember that, under regulations regarding delegation, the boroughs are responsible for maintaining the secondary system, which also includes repairing leaks. In our opinion, it is therefore important that the boroughs ensure their work plans include a priority order for repairs, as well as a timeframe for the work to be completed. We also believe that the DGSRE (ARSO) should ensure that a repair priority is assigned in all location records

in order to facilitate the work of the boroughs and maintain a good understanding of the work to be done.

As mentioned earlier, the DGSRE is currently working on the "Maxim'eau" project. Based on the information and documentation obtained, the project should include the items outlined above. The project mainly concern maintenance activities done by blue-collar employees in the boroughs.

The principal aim of the "Maxim'eau" project is to standardize leak repair work in the boroughs and, at the same time, to manage this work through a repair planning process so that it can be better organized. The position of planner is being created in the borough, whose job would be to plan daily repair activities. The computer application will make it possible to produce a work plan of the repairs to be carried out by incorporating priority levels, as well as a schedule.

RECOMMENDATIONS

3.2.1.B. We recommend that the Service de l'eau define priority levels for repairs to the primary and secondary water main systems, and indicate desired repair timeframes, in order to standardize repair planning and better delineate the scope of the work.

3.2.1.C. We recommend that the Service de l'eau and the boroughs of Lachine, Le Plateau-Mont-Royal and Le Sud-Ouest ensure that leaks located in systems be included in a work plan, along with the priority levels and associated repair times, in order to effectively carry out planned repair work.

3.2.2. FOLLOW-UP OF LOCATED LEAKS AND THEIR REPAIR

3.2.2.A. BACKGROUND AND FINDINGS

According to MAMOT's 2016 guide, "*L'économie d'eau potable et les municipalités*" the speed and quality of leak repairs is one of AWWA's pillars²⁸ in reducing actual water losses. Development of a strategy to minimize the duration of water losses is therefore essential.

Once located leaks are incorporated into a work plan, mechanisms must be put in place to ensure follow-up, particularly regarding the response to the priority given to a file, as well as the deadline set.

We reviewed the mechanisms in place used by the units involved to follow up on located leaks and their repair.

²⁸ American Water Works Association.

THE DIRECTION DE LA GESTION STRATÉGIQUE DES RÉSEAUX D'EAU

First, the needs of the DGSRE in terms of repair follow-up are specific. As mentioned above, after leaks are located in the secondary system, the ARSO team sends the information to the boroughs via the GDT, so they can undertake a repair. Although the ARSO team is not responsible for following up on the repair, it does, however, have an interest in knowing to what extent the located leaks have been repaired and within what timeframe. Using the information available in the GDT and GEA applications, the ARSO team produces reports for each borough, indicating the number of leaks reported during the year, the number of leaks repaired and the average number of days to complete the repair.

According to the information obtained, the GDT application does have some limitations in its ability to follow up. For example, the timelines between the creation of the file and the repair date are not always reliable, because a repair date may have been entered after the actual date or because the work request was closed without the repair being completed. The GEA application is also used for follow-up; however, the borough is responsible for entering breakage files into this application. Therefore, the DGSRE does not always use this application to follow up on its leak files as they are sent to the boroughs.

In addition, the three DGSRE management units, sharing supervision of the boroughs, also monitor repairs through the "Table of Targets" tool and the GEA computer application, in order to obtain an overview of the city. The statistics compiled in the "Table of Targets" correspond to leaks located by ARSO and by the boroughs. Monitoring, conducted by field units on a monthly basis, focuses more on the number of leaks located versus the number of repairs. However, we did not find any evidence of a follow-up relating to the planning and schedule that had been given for each of the identified leaks.

THE DIRECTION DE L'EAU POTABLE

Once the reports are obtained from the private firm handling the leak search and location, the leaks are recorded in an Excel file. A contractor or sometimes a borough takes care of the repair. The information resulting from the repair is entered by the DEP in the house Excel file that is used for tracking purposes, including type of repair, year of repair, contract number and amount. However, we did not find any evidence of follow-up by the DEP between the date of detection and the date of repair, in order to determine whether repair deadlines were being met.

THE BOROUGHS

The tools currently available to the boroughs to follow up on repairs are the house Excel files and the GEA application. As for Lachine borough, the house Excel file does not track located leaks, since it only includes repair dates. There is no file creation date or location date.

In its monitoring of leak repairs, Le Plateau-Mont-Royal borough uses an Excel file to track the completion of open files. It includes the date of receipt of the intervention request, the date of the tracker's report and the date of repair.

Le Sud-Ouest borough also uses an Excel file to track leak repairs. The file includes the date that the leak was recorded and the date of the repair work, as well as the priority level. The file also includes monthly statistics of leaks waiting to be repaired versus those that have been repaired.

For all the audited boroughs, the GEA application is also used to enter the breakage files. The application includes the location and repair dates, as well as various details on the nature of the leak. Monthly statistics of the number of locations versus the number of repairs are also available.

However, for all of these files, we found no evidence of any calculation of a timeline for execution.

While efforts are being made to put in place mechanisms to track repairs of located leaks, we believe it is important that these mechanisms compare the established and actual timeframes. According to the information we obtained from people we met at the DGSRE, the "Maximo" computer application allows for entering a priority level and a schedule. Follow-up reports can also be produced to determine what has been done. In our opinion, when this application becomes operational, the Service de l'eau must ensure that such mechanisms are used.

RECOMMENDATION

3.2.2.B. We recommend that the Service de l'eau and the boroughs of Lachine, Le Plateau-Mont-Royal and Le Sud-Ouest put mechanisms in place to determine the degree of compliance with the timeframes for repairs to located leaks, to ensure that repair work is completed as planned.

3.3. EVALUATION OF PROGRAM BENEFITS AND ACCOUNTABILITY

3.3.1. EVALUATION OF PROGRAM BENEFITS

3.3.1.A. BACKGROUND AND FINDINGS

While the implementation of a *Leak Search Program* is one of the measures required by SQEEP, and while the *Stratégie montréalaise de l'eau* has identified leak detection as a major priority, we believe it is important to evaluate the benefits of such a program. MAMOT, in its recent 2016 documents related to SQEEP, recommends the following: *[TRANSLATION]*

"Calculate cost-effectiveness: annual costs of leak search relative to the value of water saved each year". And regarding possible improvements in the optimization of methods and equipment, it adds: [TRANSLATION] "...to always check the cost-effectiveness by comparing the costs of leak search with the value of the water saved on the basis of an average leak duration of 6 months, for annual campaigns²⁹".

Thus, leak search work does help minimize impacts, whether minor or major, which could generate significant costs. The *Leak Search Program* allows them to be detected and located for repair before they cause more damage.

As part of one of its major projects titled "Leak Detection and Correction," the *Stratégie montréalaise de l'eau* states that: [TRANSLATION] "More than \$30 million will be devoted to these detection activities by 2020³⁰". In our opinion, this is a large sum of money and there is good reason to question the benefits gained.

The leak search and location work of the units involved is partly carried out in-house and partly by private firms specializing in this field.

Our audit work revealed that efforts are being made by the DGSRE, the boroughs and the DEP to compile the amounts spent on leak search and location work. However, we were not able to find a full compilation of the direct costs (internal and external) of these activities for all units involved. This situation means that we cannot determine whether the projections have been realized and therefore we cannot evaluate the benefits of the program. In our opinion, the *Leak Search Program* should include a compilation of all these costs, to allow for an evaluation of the benefits of the program. According to the information we obtained from the people we met at the DGSRE, the "Maximo" computer application could make it possible to compile more detailed actual costs that could be useful when evaluating benefits.

In addition, an analysis to assess the possible economies was conducted when the ARSO team was created (2013) in a fact sheet on the team's systematic water leak detection activity. This fact sheet shows the savings related to the costs of claims associated with major waterworks breaks and the production of water lost in the ground. It also deals with other aspects, notably issues and problems related to this work. However, this analysis mainly concerns the tracking activity carried out by the ARSO team.

While efforts have been made to assess the savings potential associated with the ARSO team's leak detection work, we did not find an equivalent analysis for the Leak Search Program as a whole and involving all units.

It appears to us that the Service de l'eau acts as the first point of contact; it should conduct an evaluation of the benefits of the *Leak Search Program* for all units involved.

²⁹ *Stratégie québécoise d'économie d'eau potable* : L'économie de l'eau potable et les municipalités, volume 1, 5^e édition, 2016, MAMOT et Réseau Environnement, pages 61 and 64.

³⁰ *Stratégie montréalaise de l'eau*, Ville de Montréal, page 126.

We believe that such an evaluation is necessary, on the one hand, given the MAMOT's recommendations on the importance of cost-effectiveness and, on the other, given the large sums invested in the *Stratégie montréalaise de l'eau*. This evaluation would undoubtedly demonstrate the usefulness and need to carry out these activities and even to inject additional resources into them in view of the anticipated results.

RECOMMENDATION

3.3.1.B. We recommend that the *Service de l'eau* compile the total direct costs for all the leak search and location work of all the units involved, in order to be able to evaluate the benefits of the program and thus help make informed decisions about the resources to be allocated.

3.3.2. ACCOUNTABILITY

3.3.2.A. BACKGROUND AND FINDINGS

When a unit is required to comply with government requirements or when it has to implement guidelines approved by authorities, it must periodically monitor and report on its progress. Accountability mechanisms must be put in place within the structure, so that informed decisions can be made at the right time.

In the case of the *Leak Search Program*, the *Service de l'eau* must comply with SQEEP's requirements. SQEEP requires that requires municipalities produce documents to report to their decision-making bodies and to MAMOT.

Thus, SQEEP anticipates that:

- As of April 1, 2012, all municipal organizations will be required, when submitting a request for financial assistance, to file a water use report based on 2011 data, with an update for subsequent years (Measure 2);
- As of 2012 (for the subsequent year), municipal agencies will be required to submit an annual water management report to their municipal council (Measure 5).

To aid the municipalities, MAMOT has produced a water use form, stating the annual percentage of potential water losses in the distribution system. Our audit work revealed that this annual form was filed with the city's decision-making bodies and forwarded to MAMOT for the years 2011 to 2016.

The Service de l'eau has also been submitting a water use report to the city's decision-making bodies since 2011³¹. This report details the many activities carried out in the water sector, including progress in implementing the measures required by SQEEP, the status of the water loss situation, system renewal and repairs, and leak search work.

In addition, since the adoption of the *Stratégie montréalaise de l'eau*, the Service de l'eau produced a progress report for the period 2011-2015 in December 2017. The report outlines the work done in meeting the objectives set out in the strategy.

Other documents regarding leak search and location work are also produced to report to the heads of administrative units and bodies on the work carried out, the achievement of set objectives and the progress of major projects, in particular:

- Annual presentation of the operating budget and the Three-Year Capital Works Program to the city's Commission sur les finances et l'administration (Committee on Finance and Administration);
- "Table of Targets" compiled by the boroughs and forwarded to the Service de l'eau;

The Service de l'eau also reports annually to the decision-making bodies in accordance with the regulations governing the delegation of authority for maintenance work on the waterworks system assigned to the related municipalities and boroughs.

Efforts are therefore being made by the Service de l'eau and the boroughs to provide accountability to meet SQEEP requirements, to present the progress of the objectives set out in the *Stratégie montréalaise de l'eau* and to report on maintenance work in order to keep the decision-makers informed.

However, a review of the water use report for 2016 filed by the Service de l'eau with the decision-making bodies in the summer of 2017 shows that it does not give an account of the boroughs' work concerning leak search and location. The report covers the 490 undetected leaks located by ARSO across the territory, but does not mention the leaks located by the boroughs. Our audit work revealed that, in 2016, the three audited boroughs detected and located nearly 390 leaks within their territory, excluding leaks located by the ARSO team.

In addition, review of the progress report on the *Stratégie montréalaise de l'eau* for the period 2011-2015, which includes leak search information, demonstrates that this information relates almost exclusively to the ARSO team's leak search work.

However, our audit work revealed that the boroughs play an important role in leak search and location work. According to the information obtained from the people we met at the DGSRE and in the boroughs, it is important that leak search work be done and maintained

³¹ The water use report corresponds to the annual report required by SQEEP (the measures).

in the boroughs. We therefore believe that the accountability report should include leak search and location activities carried out by the boroughs in order to demonstrate their participation in the *Leak Search Program* and the specific features that concern them individually. In addition, according to the *Stratégie montréalaise de l'eau*, "Leak Detection and Correction" is one of the six major projects. Thus, accountability would apply to the *Leak Search Program* for all units involved.

Lastly, we believe that the Service de l'eau should ensure that data concerning borough leak search and location work be compiled separately in the computer application that is or will be used for comparison, evaluation and accountability purposes.

RECOMMENDATIONS

3.3.2.B. We recommend that the Service de l'eau ensure that data concerning borough leak search and location work be compiled separately from those of the *Analyse réseau soutien aux opérations* for purposes of comparison, evaluation and accountability.

3.3.2.C. We recommend that the Service de l'eau include in the accountability report it produces, regarding the *Stratégie québécoise d'économie d'eau potable* and the *Stratégie montréalaise de l'eau*, the leak search work of all the units involved, in order to present a complete picture of the *Leak Search Program* to aid informed decision-making.

BUSINESS UNITS RESPONSE

[TRANSLATION] The detailed action plans from the business units are expected on June 11, 2018. However, the Lachine, Plateau-Mont-Royal and Sud-Ouest boroughs and Service de l'eau have confirmed that they agree with the recommendations addressed to them.

4. CONCLUSION

The *Stratégie québécoise d'économie d'eau potable* adopted by the Ministère des Affaires municipales et de l'Occupation du territoire in 2011, under the 2002 Québec water policy, set out drinking water conservation requirements for municipalities receiving government financial assistance for their water-related infrastructure projects. These requirements take the form of objectives to be achieved and measures to be put in place. The strategy imposed a two-pronged objective to reduce the leakage rate of all drinking water distribution systems in Québec to a maximum of 20% of the water volume distributed and a maximum of 15 cubic metres per day per kilometre of water main. One of these measures was to implement a programme de détection et de réparation des fuites as of April 1, 2012.

The *Stratégie montréalaise de l'eau* presented to the city's decision-making bodies and adopted by the agglomeration council in 2012 formulated guidelines over a 10-year period (2011-2020) around five issues, including an action plan to meet strategic and specific objectives, some of which concern leak search in the waterworks system. This strategy also identified six major projects in the major water project, one of which is leak detection and correction.

Since then, several actions have been taken to meet the requirements of these two strategies, including:

- A team from the Direction de la gestion stratégique des réseaux d'eau of the Service de l'eau undertakes systematic leak detection work in the secondary system, mainly to detect undetected leaks;
- The Direction de l'eau potable of the Service de l'eau conducts leak detection and testing work on the primary water main system;
- The boroughs conduct leak search and location work on their territory, but mainly following requests from various sources.

Despite these achievements, it must be noted that the rate of potential water losses on the agglomeration system as a whole remains high (34.7%), according to the 2016 data on the drinking water use form submitted to the Ministère des Affaires municipales et de l'Occupation du territoire in 2017.

To conclude, although the *Stratégie québécoise d'économie d'eau potable* was adopted nearly 7 years ago and the *Stratégie montréalaise de l'eau* almost 6 years ago, and meanwhile, the waterworks system continues to age, we note that the *Leak Search Program* currently in place is not optimally reducing leaks in the waterworks system in accordance with the requirements and directions taken. Efforts will need to be redoubled and processes put in place that meet the requirements of good management practices.

To this end, the city should, in particular:

- Set up a real *Leak Search Program* covering the leak investigation work of all units involved;
- Better define the roles and responsibilities of the units involved in leak search and location work;
- Develop long-term and well-documented planning of leak search and location work to ensure that all objectives are met;
- Speed up the implementation of the "Maximo" computer application for the processing of leak and repair files and encourage the use of relevant management reports;
- Develop work plans, following the location of leaks, that reflect established priorities and the repair deadlines, to improve repair performance;
- Periodically assess the performance and expected benefits of the *Leak Search Program* to provide guidelines for informed decision-making in areas needing improvement and the level of resources to be allocated;
- Improve accountability, including the work of all units involved in the program, in order to provide an overall picture for better decision-making.

Water management as a whole is a major challenge for the city. This resource, while abundant, is not inexhaustible. Every effort must therefore be made to preserve it. The *Stratégie québécoise d'économie d'eau potable* and the *Stratégie montréalaise de l'eau* are a big step in that direction. In both cases, objectives have been established to prevent wasting this resource. It is from this perspective that we undertook this audit and are making our recommendations.

5. APPENDIX

5.1. PURPOSE AND CRITERIA FOR EVALUATION

PURPOSE

Ensure that the *Leak Search Program* efficiently and effectively reduces leaks within the waterworks system, in accordance with the *Stratégie montréalaise de l'eau* and the *Stratégie québécoise d'économie d'eau potable*.

EVALUATION CRITERIA

- The *Leak Search Program* was strategically planned in line with the *Stratégie montréalaise de l'eau* and the second SQEEP objective.
- The roles and responsibilities of the units involved in the *Leak Search Program* are clearly defined.
- The *Leak Search Program* is supported by best practices, including documentation of detection work and all identified leaks.
- Detected and located leaks are subject to a plan with a view to repairing them and are included in a work plan in accordance with established priorities.
- An evaluation of the performance and cost-effectiveness of the *Leak Search Program* is conducted periodically and reported on.