3.6.

Managing the Quality of Geolocation Data

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Auditor General of the Ville de Montréal

Managing the Quality of Geolocation Data

Background

Access to geolocation data, such as the exact location of a sewer line, with additional information, such as the date of its last inspection and an indication of its structural condition, is an asset for project planning and management at the Ville de Montréal (the City). In a survey conducted as part of our work, 89% of respondents said they use geolocation data recorded in the City's SIGS (Système d'information géographique et spatiale). However, this data must be of good quality, i.e., complete, accurate and up to date. The absence of such quality assurance for geolocation data could result in users turning to other data sources, leading to an inefficient approach. Worse yet, they could base their decisions on inaccurate information.

At the time of our audit, the SIGS contained 366 data layers, consisting of datasets on different themes, including water and sewer systems, the road network and bike paths, road signage, the municipal real estate inventory (e.g., buildings, lots, park benches, garbage cans), the inventory of parks and natural areas, as well as the network of electric vehicle charging stations.

Purpose of the Audit

The purpose of this audit was to ensure that the City's geolocation data is of good quality and that it is made available to all of the business units.

Results

Due to several deficiencies in the governance of the geolocation data, including with respect to the assignment of roles and responsibilities, the lack of defined minimum data quality criteria, and incomplete attributes for the geolocation data, we conclude that not all of the geolocation data made available to City employees as part of their operations and activities is of good quality. In addition, due to the lack of an inventory of all geolocation data, not all of the data is known and available to employees.

The *Directive sur la gouvernance des données de la Ville de Montréal*, in force since 2016, tends to be oriented more towards the dissemination of open data accessible on the City's website. This leaves the business units to decide how to treat the geolocation data throughout its processing cycle for dissemination to the SIGS. There is no single, formal structure for ensuring and communicating the quality of geolocation data available to the employees in the SIGS. Adjustments are necessary, including the development of an administrative framework specific to the geolocation data that defines the roles and responsibilities of the various business units involved in processing geolocation data and the quality criteria that must be met for this type of data. Finally, the SIGS needs to be cleaned up, and only the necessary layers kept.

Main Findings

Governance

- The roles and responsibilities of the various business units involved in the geolocation data processing cycle are not perfectly aligned with the *Directive sur la gouvernance des données de la Ville de Montréal*, particularly with respect to responsibility for data quality.
- The person responsible for the geolocation data layer is unknown for 60% of the layers in the SIGS making it difficult to determine its utility.
- There is no comprehensive documentation describing the process for creating a geolocation data layer, from the collection of the data to its dissemination.
- Approximately 4% of geolocation data layers contain metadata, i.e., global information that applies to all data—thereby limiting the ability to know who is responsible for the layer and how often it is updated.

Generation, Update and Dissemination Ensuring the Quality of Information

- There are no minimum quality criteria that must be met for the geolocation data, which may limit users' confidence in the data and encourage the use of parallel databases.
- The absence of a requirement to document the geolocation data processing cycle is not conducive to knowledge of all the steps leading to its dissemination and thus limits quality controls during this process.
- Regarding the geolocation data layers examined, the correspondence between the data collected by the business units responsible for the activity or asset and the data available in the SIGS is not perfect. The SIGS is therefore not an accurate representation of reality, and any decision based on the data could be wrong.
- For all of the geolocation data layers examined, not all data attributes contain values, thus limiting the usefulness of viewing such geolocation data.
- Automated scheduling of a data display update in SIGS is not performed for all observed data layers. In the case of two of the five layers examined, the updates dated back to 2012 and to 2016. Consequently, the risk that the data is not up to date is significant.

Accessibility of the Geolocation Data

- There is no catalogue available to enable all of the employees to inquire about the existence of geolocation data available to the City.

In addition to these results, we have made various recommendations to the business units, which are presented in the following pages. These business units were given the opportunity to agree to the recommendations.

List of Acronyms

BU	business unit
City	Ville de Montréal
DEPS	*Division du développement, exploitation et pilotage de systèmes*
Directive	*Directive sur la gouvernance des données de la Ville de Montréal*
MUIL	Montreal Urban Innovation Lab
PDQ	postes de quartier
Policy	*Politique de données ouvertes de la Ville de Montréal*
SCA	Service de concertation des arrondissements
SE	Service de l'eau
SIGS	Système d'information géographique et spatiale
SIM	Service de sécurité incendie de Montréal
SIRR	Service des infrastructures du réseau routier
SPVM	Service de police de la Ville de Montréal
STI	Service des technologies de l'information
SUM	Service de l'urbanisme et de la mobilité

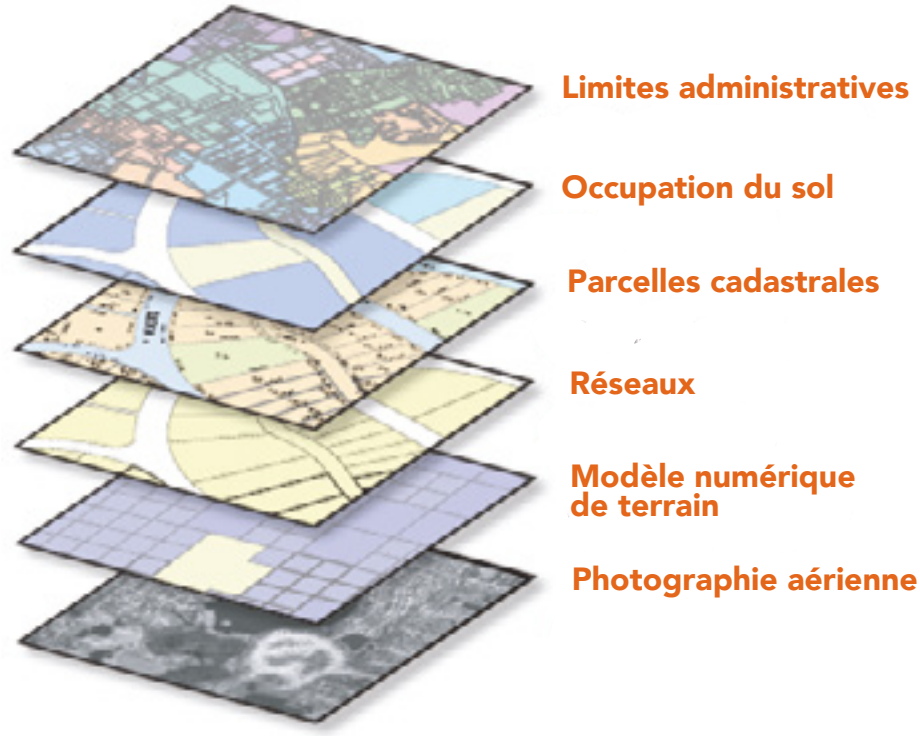
Table of Contents

1. Background

Geolocation is defined as a technique that determines the precise geographical location of a static or mobile object or place by referring to its spatial coordinates expressed in terms of latitude and longitude. Geolocated data can be organized, structured and stored in databases in such a way that the physical locations of objects and their descriptions can be used in a geographic information system.[1] The advantage of such a system is that it can be used to make a cartographic representation of the territory by superimposing different layers of information relative to the geolocalized objects, as shown, for example, in Figure 1.

FIGURE 1

Example of Superimposed Geolocation Information Layers



Source: Géo Arch.

1 Portail de l'information géographique du Québec.

The Ville de Montréal (the City) has been using a geomatics system called the Système d'information géographique et spatiale (SIGS) for around ten years. This system provides a cartographic representation through 366 layers[2] and sub-layers of thematic information concerning various sectors of activity. The geolocation data contained in the SIGS may be derived from aerial photography, GPS systems, field surveys, other functional systems of the City or the digitization of existing documents (e.g., maps). For example, it is possible to consult the SIGS for data related to:

- water and sewer systems;
- the road network, including bicycle paths;
- road signage (e.g., traffic lights, signs);
- real estate inventory (e.g., buildings, lots, park benches, garbage cans);
- the inventory of parks and natural areas;
- the network of electric vehicle charging stations.

A tool such as the SIGS can be used to improve knowledge of the City's assets (inventory and specific locations) and to support operational activities (e.g., construction planning) based on physical data and asset conditions, while protecting the infrastructure and ensuring its sustainability.

When properly documented, a layer of geolocation data provides several types of information (called attributes) related to the geolocated object. For example, the layer titled "Fire hydrants" provides the date of the last inspection of each hydrant and the expected water flow. The layer titled "Water main breakages" includes the date a given water main broke as well as the date on which the repair was made. These attributes are information that may be useful to the City's different business units to plan or manage their interventions. According to a survey of the 19 boroughs and 7 central departments[3] conducted as part of this audit, 89% of respondents use the SIGS in their operations.

In order for a data item to be geolocalized, several business units will be involved at different key stages of the processing cycle, the main ones of which can be summarized as follows:

- The data item collected or produced by a central department or a borough;
- The data item digitally transformed and compiled with others to spatialize it (primarily the responsibility of the Service des technologies de l'information [STI] and the Service des infrastructures du réseau routier [SIRR]);

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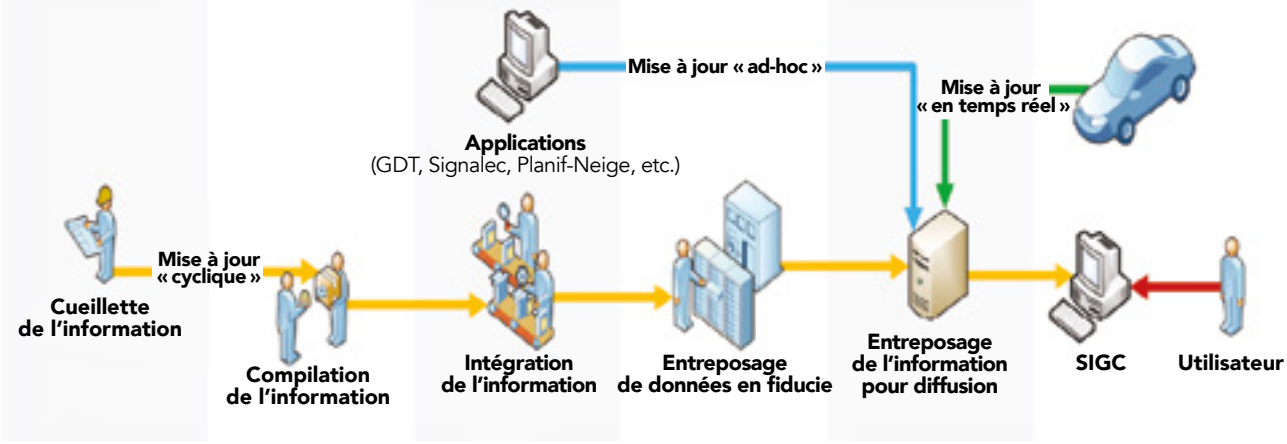
2 At the time of our audit, the Service de concertation des arrondissements (SCA) provided the latest SGIS inventory, completed in November 2019, which contained a total of 366 layers of varied information.

3 115 responses were obtained from 13 of the 19 boroughs as well as from the STI, the SIRR, the Service de l'urbanisme et de la mobilité (SUM), the Service de l'eau (SE), the Service de police de la Ville de Montréal (SPVM) and the Service de sécurité incendie de Montréal (SIM).

- Storage of data in trust at a business unit that ensures its availability in central databases;
- Data storage in a dedicated database specifically within the SIGS (the STI is responsible for maintaining the SIGS as well as for data security and integrity);
- Geolocation data consulted by users via the SIGS.

FIGURE 2

Processing Cycle of a Geolocation Data Item, from Its Collection to Its Dissemination



Source: Service de concertation des arrondissements.

In addition to the above-mentioned responsibilities, the SIRR, through its Division de la géomatique, produces a basic map of the Montréal territory (e.g., roads, buildings, parks). It is also responsible for producing the water system and road networks and keeping them up to date.

The SCA, through its Division du développement, exploitation et pilotage de systèmes (DEPS), supports users in the boroughs by identifying and prioritizing functional needs in terms of geolocation data, by following up on the development of solutions with the STI and by playing an advisory role to the boroughs that use geolocation data in their activities.

Given the use of geolocation data across the City and the breadth of information this data contains, we decided to undertake a review of how the geolocation data is managed in order to provide assurance as to the quality of the data available in the SIGS.

2. Purpose and Scope of the Audit

Under the provisions of the *Cities and Towns Act*, we conducted a value-for-money audit of the management of the quality of geolocation data. We performed this mission in accordance with the *Canadian Standard on Assurance Engagement* (CSAE) 3001 described in the *CPA Canada Handbook – Assurance*.

The purpose of this audit was to ensure that the City's geolocation data is of good quality and that it is made available to all of the business units.

The role of the Auditor General of the Ville de Montréal is to provide a conclusion regarding the objectives of the audit. To do so, we collected sufficient and appropriate relevant evidence on which to base our conclusion and obtain a reasonable level of assurance. Our assessment is based on criteria we deemed valid for the purposes of this audit. These criteria are presented in Appendix 5.1.

The Auditor General of the Ville de Montréal applies the *Canadian Standard on Quality Control* (CSQC) 1 of the *CPA Canada Handbook – Assurance* and, accordingly, maintains a comprehensive quality control system that includes documented policies and procedures with respect to compliance with ethical requirements, professional standards and applicable legal and regulatory requirements. The Auditor General also complies with the independence and other ethical requirements of the *Code of ethics of chartered professional accountants*, which are based on fundamental principles of integrity, professional competence and due diligence, confidentiality and professional conduct.

Our audit work covered the period from October 1, 2018, to September 30, 2020. However, for certain aspects, data from before and after this period was also taken into consideration. Our work was mainly carried out between September 2020 and May 2021. We also took into account information that was sent to us up to March 1, 2022. Our work consisted of conducting interviews with employees, reviewing various documents and conducting surveys that we deemed appropriate to gather the evidence we needed. In addition, we excluded from the scope of our mission a review of the control mechanisms in place to ensure the integrity, confidentiality and availability of data in the SIGS's environment, as this was covered in the Geomatics Systems Management mandate contained in the 2020 Annual Report. Therefore, while connections can be established between the geolocation data accessible through the SIGS and the data made available to the public by the City through the *Données ouvertes* portal, this audit covers only the processes leading to the dissemination of data in the SIGS.

Most of the work was carried out with the following business units:

- Direction générale (Montreal Urban Innovation Lab [MUIL[4]]);
- STI (Direction gestion du territoire, Direction engagements numériques, Bureau de projets TI);
- SCA (Direction programmes et systèmes);
- SIRR (Direction gestion du portefeuille de projets–Division de la géomatique);
- SE (Direction des réseaux d'eau, Direction de l'épuration des eaux usées and Direction de l'eau potable);
- SUM (Direction de la mobilité and Direction de l'urbanisme);
- The Verdun borough (Direction du développement du territoire et études techniques and Direction des travaux publics);
- The Ville-Marie borough (Direction de l'aménagement urbain and Direction des travaux publics).

At the end of our work, a draft audit report was presented for discussion to the relevant managers in the audited business unit as well as to the Direction générale. The final report was then sent to the management of each of the business units concerned and to the Direction générale to obtain action plans and timelines for the implementation of the recommendations. A copy of the final report was also sent to the deputy director-general of the Service aux citoyens and to the deputy director-general of Mobilité et attractivité as well as to the directors of the boroughs not directly concerned by our audit work, for information purposes and to enable them to implement the recommendations where the situation warrants it.

3. Audit Results

3.1. Lack of Accurate Data Governance Specific to the Geolocation Data

3.1.1. Differences in Interpretation of Roles and Responsibilities

Geolocation data is governed by the City's *Directive sur la gouvernance des données de la Ville de Montréal* (the Directive). The purpose of this Directive is to clarify the ownership of City data, define data management principles, determine the various business units' roles and responsibilities with respect to data management and formalize data governance. This applies primarily

4 In February 2022, the MUIL was integrated into a new business unit reporting directly to the Direction générale and known as the Service de la planification stratégique et de la performance organisationnelle.

to data for which the City owns the intellectual property, but also to data for which the City has acquired rights of use. The Directive was adopted in December 2015[5] and took effect in 2016, in support of the *Politique de données ouvertes de la Ville de Montréal* (the Policy) which, as its name implies, focuses on opening up data and making the City's geolocation data and non-geolocalized data available to the public through the *Données ouvertes* portal on the City's website.

Although provided for in the Directive, the Direction générale, responsible for data management, or its representative in this matter, i.e., the MUIL,[6] has not appointed the stewards responsible for the acquisition and management of the dataset. At the time of our audit, the MUIL was still in the process of identifying the data coordinators, namely the individuals within a business unit who oversee the unit's data inventory, including identifying the datasets the business unit produces and the respondent for each dataset. Indeed, the MUIL had not identified the coordinators for 27% of the central departments and, among those that were identified, they were not up to date for 29% of the central departments and 47% of the boroughs. One of the reasons for the lack of coordinators or the failure to update coordinators, which is the reference point for the first step in the geolocation data processing cycle, is that there is no structured process supported by the MUIL for each business unit to designate such a resource and subsequently communicate the information to the MUIL.

In 2019, the SCA produced, for the purpose of piloting the SIGS system, a diagram titled *Les rôles dans le cycle de l'information à référence spatial* in which both the SCA and the SIRR play key roles. However, the titles and roles of the various actors differ from those presented in the Directive. In the case of the Directive, only the Direction générale, the MUIL, the STI and the person responsible for an informational resource are explicitly named as actors in the dissemination of data to the City. However, as shown in Table 1, the notion of steward differs between the Directive and the SCA's document. In the Directive, this notion is associated with the business unit that produces the data. The business unit's role is therefore to ensure the integrity of the data and the information related to this data. In the case of the SCA, the steward is an actor that intervenes between the collection of data by a business unit and its dissemination in the SIGS by the STI. The steward accumulates information in various databases that is transferred to the SIGS's database. The distinction is important, because, in the case of the SCA, the steward is not responsible for the quality of the stored information. In their opinion, the producer of the data is responsible for providing quality assurance.

5 Resolution CM15 1499 of the municipal council.

6 In 2015, at the time the Directive was drafted, the administrative unit (an administrative unit is a subdivision of a business unit) that is today the MUIL was referred to as the Bureau de la ville intelligente et numérique.

Thus, the responsibility for data quality is not attributed to the same entity depending on what can be seen in the field and the Directive in place to govern what happens in the field.

The notions of steward and custodian of the Directive are also a source of confusion among the key business units involved in the dissemination of geolocation data. The STI's Direction de la gestion du territoire considers itself to be the steward of the data for which it is responsible. The SIRR's Division de la géomatique considers itself the owner of the data related to its mission and the custodian of the data it processes on behalf of other business units where this has been agreed, such as the SE. This division uses the term custodian in the context of data that it does not own, but manages for another business unit. However, the Directive is explicit on this point. The City delegates responsibility for data management to the Direction générale, which is the custodian of the data, while the business units are the stewards of the data and are responsible for the proper administration of the datasets entrusted to them. Under the Directive, the role of the steward is to produce and manage data and to ensure its integrity.

This confusion over roles and responsibilities can lead to different interpretations of the Directive, which, to date, has been the only administrative framework for the City's data, whether geolocalized or not. However, the simple fact that the notion of steward in one case includes the integrity of the data while, in another, it covers only the availability of the data is problematic when it comes to assigning responsibility for ensuring the quality of geolocation data.

TABLE 1

Roles and Responsibilities of the Actors in the Governance of Geolocation Data According to the *Directive sur la gouvernance des données de la Ville de Montréal* and the Service de concertation des arrondissements

Actor	Directive	Document of the Service de concertation des arrondissements
Producer	---[a]	The BU[b] or external partner collects the information, models it and translates it into computer-readable data.
Integrator	---	The STI[c] and SIRR[d] analyze the information to improve its structure and make it usable.
Steward	The BU that is mandated to produce, manage and ensure the integrity of an information resource.	The STI[c] and SIRR[d] act as concentrators and warehouses of information from several sources and guarantee its availability.
System driver	---	The SCA[e] represents the interests of users by supporting them in their operations.
Disseminator	---	The STI[f] makes information available to consumers[g] via the SIGS dissemination application.
Custodian	An entity that is mandated by the City to manage its data (i.e., the Direction générale or its representative).	---
Content respondent	An individual within a steward BU who is responsible for managing a dataset and ensuring that the data is current, complete, valid and of good quality.	---
Technical respondent	An individual who is responsible for the information system or tool hosting a dataset.	---
Data coordinator	An individual who coordinates a BU's data inventory by identifying the BU's datasets and their respondents.	---
Information resource manager	The person who manages the fiduciary BU's documents, files and databases.	---

[a] No mention of this actor in the document reviewed.
[b] Business unit (central department or borough).
[c] The STI's Centre d'expertise en géomatique.
[d] The SIRR's Division de la géomatique.
[e] The SCA's Division du développement, exploitation et pilotage de systèmes.
[f] The STI's digital solution.
[g] User of the information as part of their duties to solve a problem, make a decision or accomplish a task.

3.1.1.A. Recommendation

We recommend that the Direction générale adopt a directive to guide the entire geolocation data processing cycle, in which the roles and responsibilities within the Ville de Montréal's business units are clearly defined, in collaboration with the business units concerned, or adjust the *Directive sur la gouvernance des données de la Ville de Montréal* in this sense, in order to promote a common understanding and sound data governance.

3.1.2. Lack of Accountability for the Implementation of the *Directive sur la gouvernance des données de la Ville de Montréal*

The Directive stipulates that the MUIL is the administrative unit[7] responsible for ensuring the application of the Directive and related decisions of the Direction générale. It must also guide and control the production, management and use of data as well as the dialogue between the various stakeholders involved with the data. With such responsibilities, good governance practices would dictate that the MUIL periodically report on the progress made with respect to implementing the Directive. However, our work highlights the fact that no follow-up and accountability mechanism has been implemented to make it possible, at the very least for the Direction générale, to evaluate the extent to which the orientations of the Directive have been adequately understood and deployed within the business units and to take corrective measures if necessary. Furthermore, in the absence of such accountability, not only for the implementation of the Directive but also for the entire process of disseminating geolocation data across the City, it is difficult for the Direction générale to appreciate the growing gap between the Directive dating back to 2016, which is strongly oriented towards open data, and the work that central departments such as the SCA, SIRR and STI do in the field to ensure that City employees have access to high-quality geolocation data as part of their work.

Reportedly, efforts to publicize the Directive have been limited and it has not been fully implemented. The MUIL worked more on identifying datasets that would be used to populate the open data portal. For example, the only accountability we were able to observe was through the annual submission by the Direction générale of its budget to the Commission sur les finances et l'administration. This presentation illustrates the evolution of the number of datasets available on the City's open data portal, some of which is geolocation data.

7 A business unit is a central department or a borough. An administrative unit is a team within a business unit. Reporting directly to the Direction générale, the MUIL is considered an administrative unit.

3.1.2.A. Recommendation

We recommend that the Direction générale require business units, which will be responsible for ensuring the application of the directive specific to geolocation data, to put in place the necessary monitoring mechanisms to fulfil this responsibility and to report periodically to the Direction générale to enable it to assess how well this directive matches the reality in the field.

3.1.3. Lack of Documentation and Information on Geolocation Data Layers

Lack of a Protocol for Disseminating Geolocation Data

In order for data entered by a business unit to be available for consultation in the SIGS along with relevant and useful attributes, several steps are necessary and different departments must collaborate. However, the data producer, the first link in this chain, is usually not a geomatics expert, just as these experts who will intervene in the subsequent steps leading to dissemination in the SIGS are not specialists in the subject related to the data to be disseminated. There is therefore a communication issue to ensure that those who will be entering the data into the SIGS understand the needs of the data producer, who, in turn, knows what to provide so that the geomatics teams can adequately structure its information.

The steps that need to be taken to put a geolocation data layer into production in the SIGS are clear to the SCA:

- Request made to the SCA for a layer to be created by the applicant (data producer);
- Relevance of the request assessed by the SCA (usefulness of the layer);
- Layer's specifics established by the applicant and the SCA;
- Request to create the layer transmitted by the SCA to the STI;
- Technical feasibility of creating this layer from the planned data assessed by the STI;
- Layer parameterized in test mode by the STI;
- Test performed on the layer by the applicant;
- Layer commissioned by the STI.

However, no documented protocol exists detailing these steps, the criteria the SCA uses to assess the suitability of the request, those the STI uses to assess technical feasibility and the information to be provided by the applicant.

It may be useful to develop a reference document on creating a geolocation data layer in the SIGS detailing the steps, actors and requirements for creating uch a layer. This document could also suggest that the applicant have a schematic process for collecting and handling the data involved.

For example, the SE's Direction des réseaux d'eau has mapped the process and produced a methodology in conjunction with the geolocation of water main breakages which details the activities to be carried out in four phases, namely, in this case:

- Data extraction;
- Data processing, analysis and preparation for geolocation;
- Geolocation;
- The creation of the data table for display in the SIGS.

However, the process stops at communication with the SIRR's Division de la géomatique to inform them of the data update so that they can validate the file format and migrate it to the SIGS with the assistance of the STI. A similar mapping was also done by the SE's Direction des réseaux d'eau for sewer inspections.

These processes could also be enhanced by the interventions and actions of the SCA, SIRR and STI to complete the data processing cycle up to dissemination in the SIGS. Documenting a complete process would allow anyone wishing to do quality control on geolocation data to follow the path of a data item from its collection to its dissemination and to ask the different business units involved for the inputs and outputs of the steps they have performed. Such quality control would contribute to improved data quality.

Metadata Defining an Entire Data Layer

Metadata in geomatics is additional information applicable to all of the data in the layer and not to each data item as is the case with the attributes. Of the 366 layers contained in the SIGS, only 16 at the time of our audit, or about 4%, contained metadata. This is because it is only in 2018 that the SCA put in place a form allowing the applicant to specify the metadata related to the layer they seek to produce. This form is used to collect the following information:

- The contact information of the data layer's resource person;
- The description of the information and the use that will be made of the data in the SIGS;
- The applicant's business field (e.g., asset management, work management, assessment roll management, environment, sports and leisure);
- The nature, origin and format of the data provided by the applicant (e.g., tabular data, geometry and attributes, image);
- The frequency at which the data is updated;
- The expected number of data users.

In the absence of specific information about a layer, the SCA is unable to identify who is responsible for the layer, how often it is updated or the format in which the information was originally obtained from the requesting business unit. In the case of geolocation data, it is important to be able to demonstrate that the data is up to date since that is a concern for users. The survey conducted as part of this audit revealed that 34% of the users consider the frequency of data updates in the SIGS to be inadequate. In addition, of the 366 layers contained in the SIGS, at the time of our audit, the people responsible for 221 (60%) of these layers were not known. This means that more than half of the layers can be qualified as orphans for which we do not know who to contact to find out whether an update of the basic data has been done recently or whether the data has evolved since the last collection. At the time of our audit, the SCA had undertaken a project to clean up the SIGS by eliminating redundant, outdated and orphaned layers.

Establishing Service Agreements to Formalize Collaborations

The SIRR's Division de la géomatique, the Division de l'intelligence d'affaires et géomatique of the STI's Direction de la gestion du territoire and the SCA's DEPS take responsibility for maintaining geolocation data layers up to date for other departments. For example, the SE and SIRR have agreed that the SIRR is responsible for establishing a geolocalized inventory of water and sewer systems as well as other water assets such as fire hydrants and valves and keeping it up to date. The STI receives data from the SIM and the SPVM for five layers[8] and geolocates it before depositing it on a specific server on which the SIGS can read it and display the information. A similar situation also exists between the SIM and the SCA for the layers of information related to snow removal operations on emergency routes for which the SCA is responsible.

In all of these cases where a partnership exists between two departments, no formal document has been produced. From the perspective of the audited business units, the partnership operates on the basis of verbal agreements. However, in the absence of formal agreements, there is a risk that changes in leadership or priorities over time will result in service disruptions that can impact the quality of the geolocation data disseminated in the SIGS. In our opinion, formalizing this partnership with respect to the processing of geolocation data on behalf of other business units would mean:

- document the shared roles, responsibilities and commitments of the parties;
- to ensure the sustainability of the actions to be taken by both parties to ensure the reliability of the information disseminated in the SIGS;
- to provide for accountability mechanisms with respect to the responsibilities conferred in this area.

8 The five layers are as follows: Caserne du SIM, Territoires opérationnels de casernes SIM, Secteur administratif SIM, Postes de quartier (PDQ) SPVM, Limites des territoires de PDQ SPVM.

3.1.3.A. Recommendation

We recommend that the Direction générale mandate a business unit to develop a document explaining the steps to be taken to create a geolocation data layer, as well as the required metadata, so that the business units know what information to provide at the beginning of the layer creation process and that the layer, once created, is adequately documented to ensure the quality of the disseminated data.

3.1.3.B. Recommendation

We recommend that the Service de concertation des arrondissements continue and complete the project, on the basis of predetermined criteria, to eliminate from the Système d'information géographique et spatiale data layers that are no longer useful or have no known owners in order to offer users only relevant data layers.

3.1.3.C. Recommendation

We recommend that the Direction générale take the necessary steps to ensure that each business unit involved in a geolocation data layer documents its portion of the data processing, from collection to dissemination, to ensure consistent and recurring data processing and business continuity in the event of staff movement.

3.1.3.D. Recommendation

We recommend that the Service des infrastructures du réseau routier, the Service des technologies de l'information and the Service de concertation des arrondissements enter into written service agreements with the business units for which they are responsible for updating and disseminating information layers in the Système d'information géographique et spatiale, in order to formalize the sharing of roles, responsibilities and commitments of the parties involved and thus ensure the sustainability of the actions to be taken on both sides to obtain reliable data for this system.

3.2. Geolocation Data Whose Quality and Integrity Cannot Be Guaranteed

3.2.1. Geolocation Data with No Quality Criteria

One of the major shortcomings observed in this audit was the lack of quality criteria for the geolocation data. Through this policy, the City adheres to the principles of transparency and quality as set out by a US organization,

the Sunlight Foundation,[9] with respect to data dissemination. The Policy lists ten of these principles including a commitment to publish:

- **comprehensive data:** datasets should be as complete as possible and reflect all that is collected on a given topic;
- **primary data:** the data should include the original information collected and any available details on how the data was collected;
- **timely data:** data made available should be published or updated in a timely manner.

Adherence to the primary data principle should ensure that, unlike what was observed, the geolocation data transformation process (i.e., the various steps the data goes through from the time it was generated to the time it can be accessed on the SIGS) is documented and that metadata is associated with a high proportion of the data layers (not just 4%).

With respect to the principle of timely data, at the time of this audit, of the 366 layers contained in the SIGS, 177 (48%) had not been updated for at least three years. If an update of a layer dating back more than three years can be explained in some cases, for example the layer which contains the orthophotographs[10] of spring 2002 and which was last updated in April 2002, other cases are more difficult to justify. This is the case, for example, with the "Luminaires" layer, which was last updated in June 2016, even though, since 2016, the City has upgraded its street lighting system.

Thus, while the Policy is intended for the City's open data, certain quality principles apply to the geolocation data. However, there are no tags for each of the layers in the SIGS that define what is acceptable to be able to consider that these principles are respected.

In a manner more applied to geomatics, the ISO 19157 standard *Geographic information — Data* quality addresses five main categories of quality criteria for geolocation data, namely:

- **completeness:** the presence or absence of a geolocation data item or of one of its attributes in a layer;
- **logical consistency:** a date must be expressed in the format YYYYMMDD, but it is entered in the format DDMMYYYY;
- **temporal quality:** a pipe cannot break before it is installed;
- **thematic accuracy**: a residential building cannot be classified as an industrial building;
- **positional accuracy:** the accepted margin of error for the position in space of the object.

9 This organization is working to make the civil service more transparent to citizens by sharing guides and tools to publish data that meets citizens' needs and concerns.

10 Geometrically rectified and radiometrically equalized aerial images.

While there is no requirement for the City to adopt such quality criteria in relation to this standard, 36% of the respondents to the survey conducted as part of this audit partially or completely disagreed with the statement that there were attributes for all geolocation data in the SIGS. Such a statement is directly related to the **completeness** criterion. In the same survey, 33% of the respondents partially or completely disagreed with the statement that the geolocation data they access in the SIGS is accurate and precise. This can be an issue with the temporal quality, thematic **accuracy** or positional accuracy criterion.

The lack of specific quality criteria specific to the geolocation data and/or the lack of guidance on the minimum quality that can be found when viewing geolocation data in the SIGS could result in City employees being disinclined to use this data, not trusting it, and instead creating their own parallel databases.

3.2.1.A. Recommendation

We recommend that the Direction générale integrate into the directive governing the entire processing cycle of geolocation data quality criteria for the data that will have been defined jointly by the Montreal Urban Innovation Lab, the Service de concertation des arrondissements, the Service des infrastructures du réseau routier and the Service des technologies de l'information, in order to guarantee users of the Système d'information géographique et spatiale a minimum level of quality with respect to the geolocation data.

3.2.2. Impact of Poor Governance on the Quality of the Geolocation Data

The purpose of the audit was to assess whether the City is in possession of quality data. Concurrently, we sought to assess whether the observed shortcomings with respect to the lack of governance specific to the geolocation data might actually affect the quality of the data disseminated in the SIGS. To do this, based on a purposive sample[11] of five geolocation data layers presented in the SIGS, the data processing cycle was reviewed in order to understand its specific path from collection to dissemination.

The following sampled data layers were selected to represent topics of importance or current for the City:

- "Plans" (representation of the City's infrastructure according to the plans as built);
- "Bris d'aqueducs" (water main breaks);
- "Inspection d'égouts" (sewer inspections);
- "Pistes cyclables" (bicycle paths);
- "Luminaires" (lighting).

11 Unlike a statistical sample, a purposive sample is based on selection criteria. As part of this audit, the layers were reviewed with regard to the relevance of the subject in relation to the services to citizens.

Each of these layers was reviewed according to the following four indicators:

- Existence of a documented process detailing the geolocation data processing cycle, related to the Policy's primary data principle;
- Integrality of geolocation data, in line with the Completeness criteria of the Policy and ISO 19157 standard;
- Integrality of the attributes of the geolocation data, in connection with the criterion on the Completeness of the ISO 19157 standard;
- Update of the geolocation data layer, in line with the Policy's timely data principle.

Process Detailing the Geolocation Data Processing Cycle

The objective of this indicator was to determine whether, for each geolocation data layer, there was a document explaining or schematically representing all of the data processing, from its collection to its dissemination in the SIGS. The existence of such a document promotes recurrence and consistency in the way data is handled from one update to the next. This also ensures business continuity in the event of staff movement within the business units concerned.

TABLE 2

Assessment of the Level of Process Documentation Representing the Geolocation Data Processing Cycle

Layer	Full documentation	Partial documentation	No documentation
"Plans"[a]		•	
"Bris d'aqueducs"		•	
"Inspection d'égouts"		•	
"Pistes cyclables"			•
"Luminaires"		•	

[a] The "Plans" layer is one of the data sub-layers related to the "Eau" asset information layer[12] in the SIGS. Our audit was thus oriented towards the review of the processing of plans relating to the construction or reconstruction of water and sewer mains only.

With the exception of the "Pistes cyclables" layer, for which no documentation was identified for the process of populating the SIGS from the applicant's data, the other four layers have varying degrees of documentation.

12 The water assets in the SIGS are made up of 27 sub-layers of data including "Conduites d'aqueduc et d'égouts," "Vannes," "Bornes d'incendie" as well as "Bris d'aqueducs" and "Inspections d'égouts."

For the "Plans" layer, the *Directive Préparation et transmissions des plans tels que construits/Plans TQC*[13] and a methodology for the preparation of final plans specific to water and sewer systems exist.

The first is an administrative document that informs all business units of their obligation to transmit final plans to the SIRR's Division de la géomatique so that it can deposit them in the "Plans" layer, which is a sort of warehouse where received plans are stored, and subsequently digitize them in order to update all of the data layers in the SIGS relating to the assets impacted by the work carried out (e.g., the addition or relocation of a water main). While the final plans stored in the "Plans" layer are useful for users to view when working on the City's water system, digitizing their content in the SIGS is critical to ensure that all layers relating to the various water assets impacted by the work can be adequately reflected in the SIGS.

The second document is more technical and describes the steps involved in making the final plans. It also assigns responsibilities to each business unit concerned. However, the written steps end with the transmission of these final plans to the SIRR's Division de la géomatique. The documentation of the process is therefore incomplete and does not allow for a review of the entire geolocation data processing cycle as it relates to the final plans.

With respect to the "Bris d'aqueducs" layer, as mentioned earlier in this report, a process documented by the SE illustrates in some detail the processing cycle for the geolocation data collected for dissemination in the SIGS and a methodology details what needs to be done—both of which were produced in 2019. This is the "geolocation data" layer examined that has the most complete documentation. Even the validation by the SE, to ensure that the water main break data sent to the SIRR after processing has been reflected in the SIGS, is included. However, this random validation operation is not documented. It was therefore not possible for us to corroborate its existence.

Concerning the "Inspection d'égouts" layer, the situation observed is similar to that for the "Bris d'aqueducs" layer, with a schematic process produced by the SE in 2020 and a document explaining where and how to save the inspection data so that the SIGS can read the information and display it. However, unlike the "Bris d'aqueducs" layer, the process for the "Inspection d'égouts" layer does not include a validation of the data to ensure that it is adequately reflected in the SIGS. It seems this validation is nevertheless done, without the exercise being documented.

Finally, for the "Luminaires" layer, a document produced in 2016 describes what the SIGS was to display as information and what files the SIGS was to point to in order to access the data. It is more of a preparation document for the production of a new geolocation data layer than a document explaining how and how often to perform the steps required to update the data in this layer.

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13 The expression "Plans tels que construits/plans TCQ" is now known as "Plans finaux."

Due to the absence of any requirement to document the steps to be performed throughout the processing cycle of a geolocation data item to have it displayed in the SIGS, we noted a fairly significant disparity in the documentation of the geolocation data processing cycle for the information layers reviewed. This has the effect of limiting the assurance that the data that is to constitute a layer will always be processed in the same way and that it will be of good quality, even up to date, for its transfer to the final database to which the SIGS points for displaying the data.

Completeness of the Geolocation Data

The review of this indicator made it possible to ensure that the data available in the SIGS represented all of the data that was collected by the applicant at the beginning of the processing cycle. To carry out these tests, a corroboration was established between data randomly selected from the source files produced by the applicants—primarily from the Ville-Marie and Verdun boroughs—and the data displayed in the SIGS.

TABLE 3

Assessment of the Completeness of the Geolocation Data in a Layer Within the Système d'information géographique et spatiale

Layer	High completeness	Partial completeness	Low completeness
"Plans"		•	
"Bris d'aqueducs"	•		
"Inspection d'égouts"		•	
"Pistes cyclables"			•
"Luminaires"			•

For both "Luminaires" and "Pistes cyclables," although data is displayed in the SIGS for these layers, none of the selected sample items could be tracked in the SIGS.[14] For the "Luminaires" layer, it should be noted that the data displayed in SIGS only shows high-pressure sodium lamps, whereas by March 2020, 67% of the City's 132,000 lighting fixtures had been replaced with light-emitting diode (LED) lighting systems.[15] The data for these 2 layers is therefore incomplete.

14 Due to the deployment of an updated version of the SIGS, which was scheduled to occur in the spring of 2021, a moratorium was established such that new layers of information could not be added to the SIGS and changes could not be made to the SIGS without a special dispensation. According to the information obtained, the SUM did not apply for a special dispensation for this purpose. Consequently, although the SUM's database containing the information on the bicycle paths had been updated in June 2020, the SIGS was not extensively updated.

15 The lighting fixture conversion project is scheduled to end in 2023 and it is only then that the SUM will consider updating the data making up this layer.

For the "Plans" layer, it is the SIRR's Division de la géomatique that deposits the final plans when they are received from the business units responsible for the projects. This division maintains a register of the projects under way on the City's territory for which final plans are required. That allows it to follow up on the receipt of these plans, so that it can start processing them to update the "Plans" layer as well as all the other data layers relating to the water assets that are impacted by the work performed. However, shortcomings were observed in the follow-up of these plans to be received. For example:

- the calls for tenders for two projects in the Verdun borough were cancelled without the SIRR's Division de la géomatique being informed, which meant that it was still waiting to receive these plans;
- the SIRR's Division de la géomatique was waiting for the plans for a project under the responsibility of the Verdun borough, which had already transferred the plans to it;
- the SIRR's Division de la géomatique was also waiting for plans for three projects in the Ville-Marie borough. However, it was not the borough that was responsible for these projects, but the SIRR's Direction des infrastructures.[16]

Such deficiencies create delays in processing plans and result in the water asset data layers that are impacted by the work underlying the plans being out of date.

The Division de la géomatique produces the final plans for its own department, the SIRR. According to the documents obtained, in January 2021, it was behind in the production of its various final *TQC* plans in connection with work performed between 2015 and 2020. This same division must update the different layers of data according to the changes reflected on the final plans it has produced and received from the other business units. While it is able to process anywhere from 200 to 400 updates per year, it had a backlog of over 1,400 plans to update. This has a direct impact on the quality and completeness of the geolocation data in relation to the plans in the SIGS and the water assets. The survey conducted in conjunction with this audit confirms the following:

- there are delays in updating layers due to final plans not being forwarded to the SIRR's Division de la géomatique;
- there is a certain delay in updating data after final plans have been submitted.

For the "Bris d'aqueducs" layer, all of the breakdowns selected in the Verdun borough were tracked in the SIGS and 92% of those selected in the Ville-Marie borough were also tracked. Of the layers we examined, this one had the highest level of data completeness.

16 In the case of large-scale work, for example, involving roadway resurfacing and the construction or reconstruction of water mains, the work is carried out in an integrated manner and is coordinated by the Direction des infrastructures.

In the case of the "Inspection d'égouts" layer, sewer inspection reports from 2018, 2019 and 2020 were selected. The reports of the first two years were fully tracked in the SIGS. Regarding 2020, five inspection reports were selected for the Verdun and Ville-Marie boroughs. None of these reports were tracked in the SIGS. This is an exceptional situation that the SE explains as the result of a human resources issue that occurred in 2020 and that resulted in the procedure for transferring sewer inspection reports performed by private firms not being followed. The SIRR confirms that it did not have to process any data in relation to sewer inspections conducted in 2020.

Even considering that the "Inspection d'égouts" layer contains all the data, leaving aside the year 2020, the "Plans," "Pistes cyclables" and "Luminaires" layers are not complete with respect to the data they contain. As discussed earlier in the section on process documentation, there is no evidence that random validations are made between the data submitted by applicants and the data displayed in the SIGS. Implementing such a procedure on a regular basis would allow cases like these to be identified and corrected. SIGS users must be able to trust the data they consult without questioning whether the data is complete and up-to-date.

Completeness of the Attributes of the Geolocation Data

One of the advantages of working with geolocation data is having access to information that is complementary to the specifically observed data. However, these additional fields must contain information. The purpose of this indicator was to ensure that, regardless of the number of attributes defined per layer, information was available for each attribute and each layer.

Regarding the "Bris d'aqueducs," "Plans" and "Luminaires" layers, we obtained from the STI an extraction of all the data in the SIGS as well as its attributes. For each attribute of these layers, the number of non-empty fields was compared with the total number of data items in the layer. For the "Pistes cyclables" layer, the extraction obtained from the STI did not contain the attributes that are found in the SIGS. Regarding the "Inspection d'égouts" layer, the STI was unable to finalize the operation after attempts lasting more than an hour, as it was significantly slowing down the system and the department did not want to jeopardize the stability of the system on a City-wide scale. A random extraction of 12 sewer inspection records that are required to be in the SIGS reveals that those from 2018 and 2019 (representing a total of 7 of the 12) contain data in the attribute fields. However, 4 of the 5 records from 2020 are missing from the SIGS and the 5th, although present in the system, has no attribute values. Given the context, only the three layers for which the extraction was complete were reviewed.

TABLE 4

Assessment of the Completeness of the Geolocation Data Attributes in a Layer Within the Système d'information géographique et spatiale

Layer	High completeness	Partial completeness	Low completeness
"Plans"		•	
"Bris d'aqueducs"		•	
"Luminaires"		•	

In the case of the "Plans" layer, the SIGS allows 30 attributes to be consulted per data item. Among these 30 attributes, 9 had no value for at least 10% of the layer's data. This represents 30% of the attributes. Among the missing attributes, there is the name of a file associated with this data item, the plan's name and the project number. It is possible that some of these attributes are not directly useful to users, which explains why there are missing values. The question then arises as to why this is an attribute that continues to be associated with this layer.

For the "Bris d'aqueducs" layer, there are only three attributes. Only one of these attributes had no value for 16% of the data (representing 33% of the attributes). According to the indicator's name, this is the reference number related to the intervention plan.

For the "Luminaires" layer, out of a total of 12 attributes, 5 had no values for at least 10% of the data, including lamp and ballast installation dates as well as ballast types. While a value was provided for the lamp type attribute in 91% of cases, in all cases the lamp type indicated was a high-pressure sodium lamp, which, as mentioned earlier, is less and less the case in the City as a large proportion of the lighting fixtures have been converted to LED technology.

Based on these observations, SIGS users do not systematically have access to all of the additional information when viewing a layer's data in the SIGS. This is consistent with the result of the survey conducted as part of this audit, whereby 26% of the respondents were in partial or full disagreement with the statement that the attributes related to the data they are viewing are complete. Ensuring that each data item in the current layers has documented attributes is a long-term endeavour that should be undertaken as the layers are updated.

Updating the Geolocation Data Layers

The last indicator assessed addressed updating the layers and, more specifically, whether there was programming for an automatic update of the geolocation data layers. This programming is related to the frequency with which the SIGS will update the reading it makes of the data in the different databases from which it obtains data. It is not about how often applicants update their own data collected in the field.

TABLE 5

Assessment of the Programming of Updates of the Geolocation Data Layers Within the Système d'information géographique et spatiale

Layer	Programmed	Not programmed
"Plans"	•	
"Bris d'aqueducs"	•	
"Inspection d'égouts"	•	
"Pistes cyclables"		•
"Luminaires"		•

For the "Plans," "Bris d'aqueducs" and "Inspection d'égouts" layers, an update frequency is programmed (weekly for water main breakages and daily for the other two). The readings obtained show that the updates were made as programmed.

In the case of the "Pistes cyclables" and "Luminaires" layers, the update is done manually. In addition, at the time of our audit, the "Pistes cyclables" layer had not been updated since April 2012, and the "Luminaires" layer had not been updated since June 2016. This explains why one attribute still refers to high-pressure sodium lamps despite the change in technology the City made in recent years.

Based on this observation, we do not have assurance that the geolocation data is automatically updated at a given frequency to ensure that the SIGS always displays the data in the databases. However, in and of themselves, these updates are not useful if these same databases have not been updated with data representative of the current situation in the field. Thus, the frequency at which the SIGS readings are updated is not in itself a sufficient indicator of the timeliness of the geolocation data.

These findings, in conjunction with the four indicators, demonstrate that the shortcomings observed in the governance of the geolocation data have a direct impact on the quality of this data and justify a tighter supervision of the entire geolocation data processing cycle.

Some of the findings also lead to more specific recommendations in direct connection with the layers selected in this audit so that these layers' data processing cycles may be improved to promote the dissemination of quality geolocation data.

3.2.2.A. Recommendation

We recommend that the Ville-Marie and Verdun boroughs, as well as the Service de l'eau, the Service des infrastructures du réseau routier, the Service de l'urbanisme et de la mobilité and the Service des technologies de l'information, include in their respective geolocation data processing processes a random validation step to ensure the adequacy of their dissemination in the Système d'information géographique et spatiale and document this step to ensure the data in any given layer is complete.

3.2.2.B. Recommendation

We recommend that the Service de l'urbanisme et de la mobilité take the necessary steps to update the "Luminaires" and "Pistes cyclables" layers so that users of the Système d'information géographique et spatiale have access to reliable data when they consult these layers.

3.2.2.C. Recommendation

We recommend that the Service des infrastructures du réseau routier reassess its methodology for locating the final plans needed to update water assets in the Système d'information géographique et spatiale, thereby enabling it to generate a more accurate report for tracking missing plans.

3.2.2.D. Recommendation

We recommend that the Service des infrastructures du réseau routier take the necessary steps to ensure that the backlog in the production of its final plans and their entry into the Système d'information géographique et spatiale is eliminated so that users of this system can access up-to-date information for their activities.

3.3. Lack of Knowledge of the Geolocation Data Layers Available to the Ville de Montréal

Proper and adequate use of the SIGS requires that users know what it contains so that they do not go looking for information elsewhere in parallel systems. In the survey conducted as part of this audit, 34% of the respondents said they could not find the information layers they needed in the SIGS. Among the needs expressed were knowledge of closed alleyways, the condition of the road network (condition of the pavement), signage, zoning maps in the boroughs, sewer pumping stations and interceptor structures. In addition, 4% of respondents mentioned that they are familiar with the SIGS but use other tools that contain the information they need or that are directly connected to their own databases. However, according to a compilation produced by the SCA of all of the geolocation data layers in the SIGS, as of November 2019, among the 366 layers there are a series of layers dealing with signage and more specifically layers on no-stop zones, traffic signals, sign posts and morning and evening mobility routes. Among a set of layers grouped under the heading "Découpages réglementaires," there is a layer on the borough zoning bylaw. These are just a few examples of layers of information the SIGS contains that some users may not even know exist.

However, this lack of awareness of the layers available in the SIGS may be due to the fact that users do not have access to all of the layers the SIGS contains. Indeed, according to an August 2018 STI summary containing 318 geolocation data layers, only 153 (less than half of the layers) had public access permission to allow users of the SIGS to view them in the application.

To access the other layers, requests must be made to the STI justifying the reason for the request based on the nature of the employee's operational activities. For example, the "Règlement de zonage" layer in the boroughs does not figure among the 153 layers that are accessible.

Thus, users who consult the SIGS only see the layers for which they have been given permission. It is not possible for them to see the wording of other data layers that they could access if they had the necessary permission. There is therefore a lack of an inventory or catalogue that allows everyone to know what they could potentially access, subject to being granted the necessary permission, by consulting the SIGS. However, in the Directive dating back to 2016, the STI was responsible, in collaboration with the MUIL, for developing and maintaining a consistent data architecture as well as a catalogue of available data. Such a project is reported to be under development by the STI.

In addition to the STI and the MUIL, the SCA could be involved in the development of such a catalogue, given its involvement in the management of the geolocation data layers and the work it undertook in the summer of 2020 to clean up the geolocation data layers for which there was little or no information on the data's owner or the date of the last update. If some layers were to be removed by the SCA, the STI's catalogue would need to reflect this.

The survey also highlighted that users may need data not found in any existing layer of the SIGS. For example, the SIGS contains no layer on the City sewer system's retention ponds. The existence of such a layer would allow the SE to quickly identify ponds that could take over in the event of major floods. Although such a layer on retention ponds is not available in the SIGS, it exists in digital form in the SIRR. However, it is not sent to the SIGS for dissemination. There is potential for useful information for City employees that exists and is already digitized, but the final step of dissemination has not been completed.

Without knowledge of the data layers available in the SIGS, employees may undertake internal or external steps to obtain the data they need, which is inefficient.

3.3.A. Recommendation

We recommend that the Service des technologies de l'information, in accordance with the *Directive sur la gouvernance des données de la Ville de Montréal*, and in collaboration with the Service de concertation des arrondissements and the Montreal Urban Innovation Lab, create and make available to all employees a catalogue of the geolocation data available at the Ville de Montréal and ensure that the software is updated so that all employees can refer to it to request the necessary permissions to access it.

4. Conclusion

Overall, our audit work highlights sufficient shortcomings for us to conclude that the quality of the geolocation data in the Système d'information géographique et spatiale (SIGS) is not fully assured. Moreover, at the time of our audit, of the 366 layers contained in the SIGS, 177 (48%) had not been updated for at least three years. The results of the survey we conducted with various business units of the Ville de Montréal (the City) also confirm this finding, with 33% of respondents being in partial or complete disagreement with the statement that the geolocation data they access in the SIGS is accurate and precise. Considering the number of layers that are not up to date, it would be appropriate to clean up the layers and keep only those that are still required for City operations.

Although there exists an administrative framework titled *Directive sur la gouvernance des données de la Ville de Montréal* (the Directive), it is clear that its implementation is geared towards the dissemination of data on the City's open data portal and that it is not adapted to the geolocation data in the SIGS. This has implications for the quality of the geolocation data, which is subject to several deficiencies in governance. Indeed, the Directive, which dates back to 2016, is not at all explicit as to the guidance that should be implemented to help ensure the quality of the geolocation data currently available to employees through the SIGS.

Based on the work performed during our audit, there is a discrepancy between the roles and responsibilities of the different business units in the field with respect to the geolocation data processing cycle and what is stipulated in this administrative framework. The very notion of who is responsible for ensuring the quality of a data item is not uniformly interpreted. In addition, certain business units, such as the Service de concertation des arrondissements and the Service des infrastructures du réseau routier, which play key cross-functional roles, are not mentioned in this administrative framework.

The Directive makes no mention of the quality criteria that apply to the data. It is necessary to refer to the *Politique de données ouvertes de la Ville de Montréal* (the Policy), which is supported by the Directive, to ensure that principles of quality and transparency are addressed.

Tests on a sample of geolocation data layers revealed concrete deficiencies in the documentation of processes, in the completeness of data and attributes and in the scheduling of updates, all of which are fundamentally linked to poor governance of the geolocation data, and undeniably have an impact on the quality of the data in the SIGS.

Finally, knowing all of the geolocation data layers available through the SIGS is neither simple nor straightforward. Users do not see the titles of the layers to which they do not have access. This leaves them in the dark about the potential the SIGS might offer for their operational activities. In addition, there is no comprehensive, up-to-date catalogue of the City's available datasets, geolocalized or otherwise.

More specifically, our major findings in relation to the evaluation criteria are as follows:

Evaluation Criterion – Governance

The roles and responsibilities defined in the Directive are not reflected in the field, as the main business units involved in managing the geolocation data have different interpretations of their respective roles and of who owns the data, who is responsible for ensuring its quality, and who is responsible for ensuring its accessibility.

There is no official documentation describing the overall process for creating a geolocation data layer, from data collection to data dissemination.

Only a very small fraction (about 4%) of the geolocation data layers contain metadata that define, for example, who is responsible for the data, how often it is updated and in what format the data is generated. It is only since 2018 that business units seeking to have a geolocation data layer created in the SIGS must fill out a form in which they identify the metadata associated with the layer.

In more than half of the cases, the people responsible for the layers are not known, making it difficult to update them since the business units responsible for compiling the geolocation data do not know whom to contact. The City is still in the process of identifying coordinators in each business unit who serve as a lever to identify and coordinate the inventory for all of the business units.

Evaluation Criterion – Generation, Update and Dissemination Ensuring the Quality of Information

There are no minimum quality criteria that must be met in the case of geolocation data. The Directive refers to the Policy, which refers to principles of transparency and quality without making them explicit at the operational level.

There is no requirement to document, for each layer, the specific process to be followed from data collection to data dissemination, even though this is a process that involves several business units, each of which possesses specific expertise.

Not all the layers evidence correspondence between the data collected in the field and the data displayed in the SIGS. Thus, the consultation of a geolocation data layer in the SIGS does not systematically and accurately reflect what

is observable in the field. Also, while certain business units claim to do random checks of the data posted in the SIGS, no documentation or demonstration of this was found.

The attributes, i.e., the additional data associated with a geolocation data item, do not all contain values, or they contain erroneous values.

The SIGS does not automatically read data at a defined frequency from the databases that store them. Some layers have not been updated since 2012 or 2016, even though the situation in the field has changed.

Evaluation Criterion – Accessibility of the Geolocation Data

There is no list of all of the City's geolocation data layers that can be made available, with or without permission. This makes it impossible for employees to know what they may have access to and how to obtain permissions to consult a layer that could be useful for their operational activities.

5. Appendix

5.1. Objective and Evaluation Criteria

Objective

To ensure that the City's geolocation data is of good quality and that it is made available to all of the business units.

Evaluation Criteria

- Geolocation data governance has been developed to enable the business units to manage activities related to the generation, maintenance and dissemination of geolocation data according to a City-wide protocol or process.
- The generation, updating and dissemination of geolocation data respect established guidelines designed to ensure the quality of the information.
- Geolocation data is accessible to all of the business units, allowing them to facilitate the management of their operations in accordance with their needs.