User's guide to the cartographic data of the island of Montreal's former watercourses, thalwegs, and watersheds

Copyright © **Valérie MAHAUT**

Assistant professor at the school of architecture
Faculté de l'aménagement, Université de Montréal

With the collaboration of Pascale Busseau and Lora Casasola
Master's students in architecture at the Université de Montréal

Reference for citation
Mahaut, Valérie (2016). *Guide d'utilisation des données cartographiques des anciens cours d'eau, lignes de creux et des bassins versants de l'île de Montréal. User's guide to the cartographic data of the island of Montreal's former watercourses, thalwegs, and watersheds.*

The present study on the « *Cartography of the island of Montreal's former watercourses, thalwegs, and watersheds* » is the first step in a more comprehensive research project which aims to promote the integrated management of surface waters in the urban environment.

The results of this cartography are of interest to numerous disciplines and a very diverse set of potential users: in the university sector (students and researchers in architecture, urbanism, urban planning, landscape architecture, history, archaeology, geography, civil engineering, geology, hydrology...), private sector (preventive archaeology, heritage, architecture, landscape architecture, and civil engineering firms), non-profit sector (various existing associations, current and future neighbourhood committees), and administrative and cultural sectors (heritage associations, museums, libraries, archives, historical societies...).

The data collected during research and its interpretation have been rendered accessible through the production of the following 17 maps and their publication online:

- *Map of the island of Montreal's former watercourses*, with Chinese ink
- *Map of the island of Montreal's thalwegs, crest lines, and road network*, 1:20.000
- *Map of the island of Montreal's thalwegs, crest lines, and altimetry*, 1:20.000
- *Cartographic survey of the island of Montreal's former watercourses showing thalwegs and crest lines*, Index Map 1:50.000, Tiles A4, B3, B4, C3, C4, D1, D2, D3, D4, E1, E2, E3, E4, 1:10.000.

This guide was created in order to offer users of the maps a good comprehension of the context, definitions, methodology, and hypotheses related to their production. The establishment of cartographic data on Montreal's former watercourses happened within a particular context which must be taken into account in order to properly understand the methodological choices made in the study.

New Urban Rivers

An architectural engineer by training, Valérie Mahaut has been working in the field of sustainable architecture since 2000, and more specifically on issues surrounding water in the existing urban environment. This problematic is unfortunately regularly in the headlines during heavy rainfall events or flash floods. Traditional water management has incontestably improved urban public sanitation conditions, and continues to provide a certain level of comfort. However, it has limitations, which are mainly

environmental, but also social, and economic. Progressive soil sealing, induced by urbanization, leads to increases in rainwater runoff volumes, which, along with the historical choice of a combined sewer system,[1] cause inefficiencies in wastewater treatment, sewer overflows, floods, discharges of raw sewage into the environment, a decline in water quality, soil erosion, and lower groundwater levels.

Valérie Mahaut's research focuses on the creation of knowledge and conceptual tools for developing improved water management in inhabited territories, while working to provide not only technical solutions, but also to maintain the most holistic conception of landscape architecture possible, integrating a more complete strategy in terms of watersheds, natural, social, and built heritage, the poetics of space,[2] and tectonics,[3] according to the principles outlined in her thesis on the creation of New Urban Rivers.[4]

The goal of creating this new hydrographic network would be to disconnect rainwater runoff created by impermeable surfaces in the city from the combined sewer system, to collect overflows from both the private and public sectors, manage the water quality, reintroduce those waters to a natural cycle (infiltration, evaporation, transpiration by vegetation), and transport them through a surface network that would adapt to the constraints of collective space in a way that is pleasant and conducive to recreation, as well as to the creation of urban promenades and quality public spaces.

New Urban Rivers in Montreal?

Montreal is the largest of the numerous islands in the archipelago of Hochelaga, situated at the mouth of the Ottawa River in the Saint-Lawrence River flowing from the south-west towards the north-west. Its southern border is formed by the Saint-Lawrence River, and its northern border by the Rivière des Prairies. 50 km long and 15 km wide, at its western extremity upriver the shoreline has an altitude of 24 m above mean sea level (MSL), and at its eastern extremity downstream, an altitude of 7 m. Mount Royal, its summit, reaches an altitude of 234 m. Aside from this abrupt massif, the island has a landform of marine terraces that are somewhat hilly, and that were at one time traversed by numerous watercourses.

Historically, Montreal underwent the same transformations as most other western cities in terms of urban water management. Urbanization led to the drainage of wetlands as well as the canalization of most of the former watercourses underground for sanitation reasons and to facilitate the mobility of goods and people. City sewer systems, at their origins, were often built utilizing or integrating existing watercourses. As a consequence, it is sometimes very difficult to imagine daylighting[5] these watercourses because of their poor water quality, resulting from mixture with city wastewater. Two thirds of the island of Montreal is connected to a combined sewer system, which primarily covers the most densely populated zones.

Water and relief are in permanent interaction. Water is one of the factors that modifies relief at the geological scale, while relief, for its part, imposes the direction in which water flows. Every watercourse, according to the location of its outlet, is associated with a watershed.[6] The adaptation of urban spaces through the alternative management of rainwater runoff ideally must be based on a comprehensive vision at the watershed scale. It is necessary to gain an excellent knowledge of the relief and of the small valleys (thalwegs) where surface waters naturally accumulate if they have not been drained through the sewer network.

The island's relief has changed very little since the beginning of its urbanization, except of course for the large urban infrastructures (highways, rail network, the canal, the aqueduct, the airport, some large parking lots, quarries, and landfills) which, because of their size, are fairly easy to recognize. The construction of

[1] A combined sewer system mixes rainwater with wastewater in the same network. A separated sewer system has two networks: one exclusively reserved for rainwater, and the other for wastewater.

[2] Gaston Bachelard, *La poétique de l'espace*, 1957.

[3] Kenneth Frampton, *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*. MIT Press, Cambridge (Massachusetts), 2001.

[4] Valérie Mahaut, *L'eau et la ville, le temps de la réconciliation. Jardins d'orage et nouvelles rivières urbaines*, Université catholique de Louvain, 2009. This thesis was nominated for the *Doctoral Thesis Award for Future Generations* in 2011.

[5] bringing these watercourses back to the surface

[6] See definition further on in the document.

the road network has also caused slight changes in relief,[7] but these modifications are for the most part negligible at the scale considered in this study or easily noticeable when viewing contour lines.

Since it continues to rain and snow on the island and the law of gravity remains in effect, the accumulation of surface waters still occurs near the banks of former watercourses, even though they are now periodically interrupted by dikes, railway embankments, or canals. Knowledge of the positioning of the network of former watercourses will make it possible to identify the potential locations of major branches of *New Urban Rivers* in Montreal.

Maps to better understanding the island's past, and to better conceive of its future

It is in this context that the present study of the cartography of the island of Montreal's former watercourses was undertaken. It aims to improve historical and physical knowledge of the island of Montreal. The surveying of former watercourses and the plotting of thalwegs and crest lines are merely the first steps in a broader project which aims to create tools to facilitate the implementation of *New Urban Rivers*. Starting with this first stage of research, the documentation of the history of these watercourses and the study of the evolution of urban forms through time will reveal the typologies of urban development relating to the management of surface waters. This research will create new knowledge about the contemporary city's natural and cultural heritages with the aim of promoting it as part of the identity of the island and its neighbourhoods. This focus on the city's hydrological and altimetric environment is rooted in a desire for more a sustainable management of the island of Montreal by extracting from the past the potential to build the future with a new comprehension that is in harmony with the urban fabric.

Indeed, a watercourse is not merely a physical and geographic entity. It also comes with a history, sometimes very long, of human activity: subsistence, transportation, trade, industrial development, leisure... Human activity and watercourses have mutually influenced each other. Watercourses have been discovered, navigated, named, dammed, diverted, embellished, filled with earth, or hidden throughout the thousands of years of human occupation of the island of Montreal. It is useful, essential even, that any projects to modify or revitalize these watercourses, which have been more or less neglected in the last few decades, be accompanied by an effort to document and promote their cultural heritage, along with their value as elements of natural heritage[8].

These future research projects will lead to the development of tools that are complementary to existing technical and legal ones[9] in order to conceive of a new mode of rainwater management on the island, at the island scale, and in detail. In sum, it is a matter of *gaining a better view of the city in order to improve the quality of life within it*.[10]

Surveying Montreal's former watercourses

To date, the cartography of the island of Montreal's former watercourses is lacking. Two maps are generally used as references: *Carte topographique de l'île de Montréal de 1542 à 1642* [Topographic map of the island of Montreal from 1542 to 1642], drawn around 1930 by architect and researcher Aristide Beaugrand-Champagne, for which sources were not provided, and which contains numerous hydrographic incoherencies; and *Montréal - Ruisseaux et fossés* [Montreal - Streams and ditches], drawn by the Eaux et Assainissement [Water and Sanitation] division of Montreal's Public Works Department in 1958, which covers part of the island, and for which some of the sources referenced on the map have disappeared from the city's archives. Our research found that these are the only two maps that attempt to provide an

[7] Dany Fougères, *Des eaux indésirables : Montréal et ses eaux de surface, 1796-1840*, Revue d'histoire de l'Amérique française, vol. 60, n° 1-2, 2006, p. 95-124., URI: http://id.erudit.org/iderudit/014596ar

[8] Christian Gates-Saint-Pierre, 22 sept 2016.

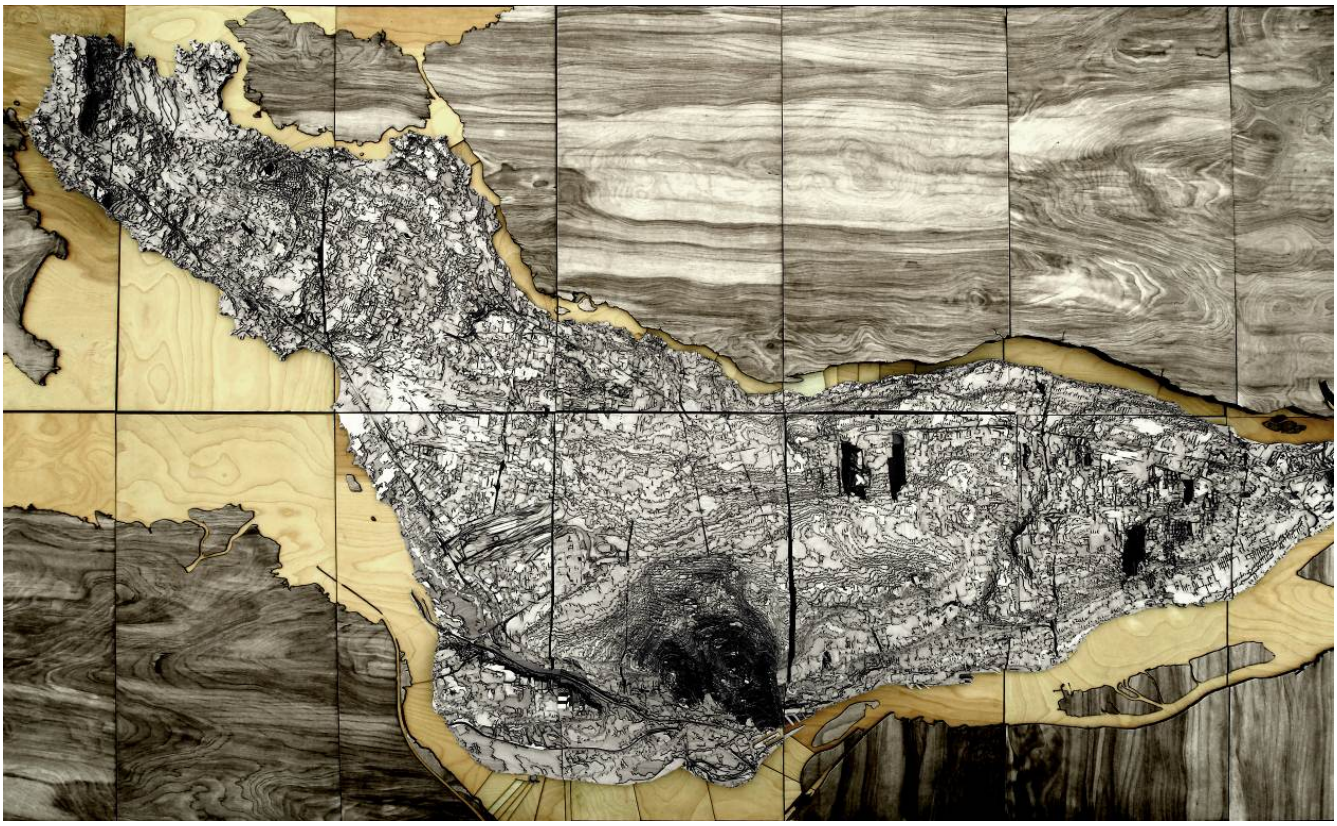
[9] MAMROT, *La gestion durable des eaux de pluie; Guide de bonnes pratiques sur la planification territoriale et le développement durable*, rédaction Boucher I., 2010, guide, 120p.; MDDEP et MAMROT, *Guide de gestion des eaux pluviales. Stratégies d'aménagement, principes de conception et pratiques de gestion optimales pour les réseaux de drainage en milieu urbain*, 2011, guide, 387p.

[10] Philippe Poullaouec-Gonidec, Sylvain Paquette*, Montréal en paysages*, Presses Université de Montréal, 2011, livre, 258p.

overview of Montreal's former watercourses. Neither of these two maps shows the boundaries of watersheds. This fragmentary and partially erroneous surveying work must be redone in the most documented and transparent way possible. As a result of their lack of sources, these two maps did not serve towards the production of the cartographic data in the present study. Original historical maps presenting the situation at a particular date were our main sources for the production of the data in this study. The overlapping of information coming from these historical maps,[11] the use of a large wooden altimetric model of the island, digital knowledge of its current relief, and its geological information allowed us to produce an interpretation of the position of elements that are indispensible in the creation of *New Urban Rivers* in Montreal: thalwegs and crest lines. [12]

The large wooden altimetric model, an indispensible spatial tool

Errors in the positions of watercourses on historical or survey maps are most often altimetric in nature. This ignorance of relief compromises the credibility of the map or of the author in terms of hydrography.

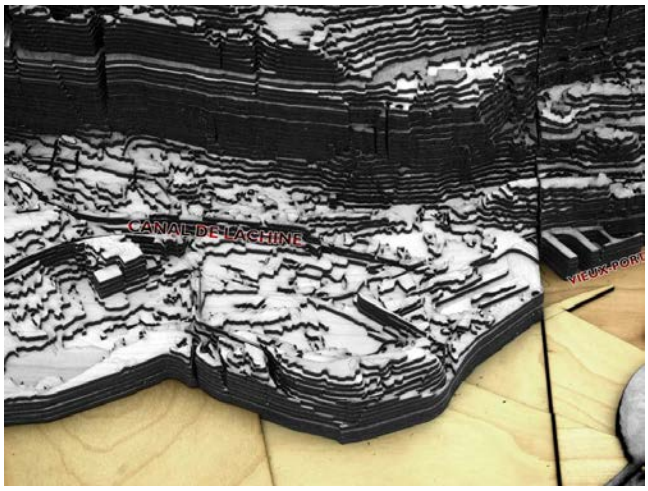


View from above of the altimetric model that has been lightly redrawn in order to better show the Saint-Lawrence and the island's other surrounding rivers.

Using altimetric data from 2009, a large wooden model was produced in 2012 with the relief multiplied by sixty. The vertical scale is 1:333, while the horizontal scale is 1:20.000 (ratio of 1/60). This model was central to the methodology as an instrument for establishing the precise boundaries of thalwegs and crest lines and to validate the trajectories of former watercourses drawn on historical maps. It was an indispensable tool for our work: it allowed us to make determinations regarding difficult questions that previous surveyors had not resolved. It provided both a very precise idea of the thalwegs and crest lines we were trying to locate and an overview of the relief and of the appearance of their watersheds. Moreover, it facilitated the identification of local modifications to relief linked to infrastructure.

[11] See bibliography in the annexed document.

[12] See definition further on in the document.



Top left: close-up of the wooden model showing Pointe-Saint-Charles. The Saint-Jacques cliff, the Lachine Canal, the Old Port, as well as the flood-protection dikes of Pointe-Saint-Charles, among other things, are visible. Below left and right: overall views of the model. Mount Royal, with its altitude increased by sixty times, emerges dramatically from the centre of the island.

Hybrid maps

This prospective context surrounding *New Urban Rivers* inevitably leads to the production of hybrid maps. The objective is two-fold: firstly (production of data section), to provide a portrait of the island of Montreal's hydrography in the 17th century; and secondly (interpretation section: plotting of thalwegs and crests), to extract the necessary information to facilitate the creation of *New Urban Rivers* in the 21st century. We deliberately chose to use the altimetry of 2009 (the most recent), since these New Urban Rivers need to be created in harmony with the current altimetry, and we believe that they could traverse the infrastructures that have diverted, dried out, or canalized former watercourses. The maps thus present the trajectories of watercourses depicted on historical maps from the 18th, 19th, and 20th centuries with the altimetry of the 21st century in the background.

The island's shoreline has evolved throughout the centuries, especially those sections of it close to downtown, the old and modern ports, and Pointe-Saint-Charles. The island's current shoreline has been drawn, although the mouths of former watercourses, in some cases, never reached it because they were canalized before the shoreline was modified.

The boundaries of watersheds were estimated without taking into account large infrastructures (highways, rail network, canals, the aqueduct, the airport, some large parking lots, quarries, and landfills) without necessarily having perfect knowledge of the details of the altimetry that preceded these modifications. Hypotheses and interpretations were made during the production of this data.

It is important to note that the consultation of the various historical maps of Montreal in no way reconstitutes a chronology of the positioning of its watercourses: the difference in the location of watercourses from one historical mention to the other is primarily due to the imprecision of

cartographic drawings of the time and to the methods of georeferencing historical maps used in this study. Consequently, we did not side with any one of the trajectories of watercourses as depicted on historical maps. In our study, we chose to consider the current small valleys (thalwegs) the closest to the oldest historical mentions of it that have been validated. We deemed it useful to mention certain former deviations that were known by specialists and useful for the overall comprehension of the former network.

The 17 new maps produced have been made accessible online free of cost in order to benefit the most broad array of users possible. The format of publication has necessitated the choice of certain data and/or a certain degree of precision. The maps do not present some of the data collected, for example the embankments mentioned on certain historical maps, the supposed location of mills, forts, wells, certain reservoirs, the trajectories of watercourses as depicted on maps that could not be validated, the trajectories as depicted on the survey maps of Beaugrand-Champagne (~1930) and of Montreal's Travaux Publics [Public Works] department (1958)

The following are descriptions of the documents produced as a part of the study *Cartography of the island of Montreal's former watercourses, thalwegs, and watersheds.* (click on the title to view the map)

Title	**Map of the island of Montreal's thalwegs, crest lines, and road network**
Scale	1:20.000
Size	252 x 119 cm
Description	Map of the island of Montreal showing the current thalwegs closest to the trajectories of former watercourses as they appear on historical maps, the boundaries of the watersheds of each former watercourse, the current road network, the borough boundaries, contour lines ever 5 m simplified, and the QPCS's reference grid.

Title	**Map of the island of Montreal's thalwegs, crest lines, and altimetry**
Scale	1:20.000
Size	252 x 119 cm
Description	Map of the island of Montreal showing the current thalwegs closest to the trajectories of former watercourses as they appear on historical maps, the boundaries of the watersheds of each former watercourse, contour lines every metre, and the QPCS's reference grid.

Title	**Cartographic survey of the island of Montreal's former watercourses showing thalwegs and crest lines**
Subtitle	**Index map**
Scale	1:50.000
Size	119 x 84 cm
Description	**Maps A4, B3, B4, C3, C4, D1, D2, D3, D4, E1, E2, E3, E4**
Scale	1:10.000
Size	119 x 84 cm
Description	Ensemble of 13 detailed maps covering the island of Montreal in its entirety. This group of maps presents the trajectories of former watercourses using selected historical maps, the current thalwegs the closest to their trajectories, the boundaries of their watersheds, the current road network, contour lines every 5 m simplified, and the QPCS's reference grid. Each of these 13 maps offers a cartouche containing the legend showing the colours and symbols used. Their index map shows all of the island of Montreal, divided into 13 tiles, the current thalwegs closest to the trajectories of former watercourses, the boundaries of their watersheds, contour lines every 5 m simplified, the most frequently used names of watercourses, the names of watersheds, and their features.

Title	**Scientific report on the cartography of the island of Montreal's former watercourses, thalwegs, and watersheds**
Size	Colour pdf in letter format
Description	Complete scientific report presenting the sources, references, methodology, hypotheses, and limitations of the cartographic works described in "User's guide to the cartographic data of the island of Montreal's former watercourses, thalwegs, and watersheds." This document will be produced at a later date.

Basic definitions[13]

Contour line On an altimetric map, the line that represents points of the same altitude. We sometimes use the terms **isohypse**, altitude above mean sea level (MSL), or **isobaths**, altitude below mean sea level (MSL).

Thalweg A line that represents the lowest points in a valley. A watercourse may flow if weather permits.

Crest line Also known as **ridge line**, a line that represents the chain of summits that determine the sharing of waters between two watersheds.

Pass Low point in a crest or ridge, often constituting a former passage between two watersheds.

Watershed The surface of a territory for which all rainwater runoff converges towards the same primary watercourse, and shares the same outlet. The boundaries of a watershed are defined by crest lines. More generally, a watershed corresponds to the surface of the territory where all slopes are inclined towards the same thalweg, which may be water-filled if the weather and surrounding infrastructure permit. We refer to an **altimetric watershed** when the crest lines are established through relief measurements of the land (the object of this study) or a **hydraulic watershed** when the crest lines are established using the configuration and the characteristics of the wastewater network.

Definitions specific to this study

Thalwegs

Thalwegs that follow watercourses present on one or more historical map(s) in our georeferenced database, including the most recent maps showing current hydrography. The plotting of thalwegs is based on the author's interpretation: the lines drawn correspond to the altimetric thalwegs of 2009 (most recent data) that were the closest to the trajectories of watercourses as shown on the historical maps retained by the author for the constitution of this study.

Connecting thalwegs

Thalwegs that connect two portions, separated by a lack of data, to the thalwegs drawn according to the above definition, in order to avoid incongruences and discontinuities in the hydrographic basin. The lines represented by connecting thalwegs are most often straight because of a lack of information.

Deviated thalwegs

Portion of a watercourse, found on several historical maps, that follows a different trajectory than the one we have interpreted as potentially from the 17th century but that we consider important to mention. They essentially consist of probable deviations or new tributaries of watercourses, whether natural or artificial.

Marshy thalweg

Zone interpreted as a former wetland (marsh, swamp, peat bog). Wetlands may be located on higher grounds, occupying wide passes or flat areas where watercourses begin. The plotting of crest lines is difficult in this case because the watercourses are also located underground.

An explanation of the choices made when plotting certain thalwegs can be found in the document entitled *Explanation of the plotting of certain thalwegs and crest lines* (forthcoming).

Methodology of the "production of data" section

The production of the cartographic data of the island of Montreal's former watercourses is the result of the selection and georeferencing of historical maps, the plotting of hydrographic elements, and the establishment of altimetric data.

[13] Inspired by the OQLF's large terminological dictionary, http://gdt.oqlf.gouv.qc.ca/

1. Georeferencing historical maps

A database of historical maps of the island of Montreal, shown it in its entirety or only partially, was constituted through the consultation of the collections of Library and Archives Canada (LAC), the Bibliothèque et Archives nationales du Québec (BAnQ), the archives of the Religious hospitallers of Saint-Joseph, McGill University Library's Rare Books and Special Collections, the cartothèque of the Université de Montréal, the archives of the City of Montreal (AVM) and of its Géomatique [Geomatics] department.

Maps containing information on the island's hydrography were digitized and georeferenced using the Geographic Information System (GIS). Georeferencing maps consists of positioning them in space by using the real geographical coordinates of places that are represented on them as reference points. This leads to a deformation of maps linked to the type of spatial projection chosen. The margin of error in georeferencing work depends on the quality and the reliability of the reference points used. After trial and error, the intersections of streets proved to be the most reliable reference points for georeferencing in this study.

Some of the maps consulted were not retained for this study because of their lack of accuracy and the impossibility of georeferencing them with precision. A list of the historical maps retained for this study is presented in the *Bibliography*.

2. Plotting the watercourses

Historical mentions of streams, rivers, bridges, locks, dams, shorelines, etc. were replotted using drafting software. The **plotting** of this information related to water on the maps consisted of digitally redrawing the watercourses as they were presented on maps in order to produce vectorial versions. This work implied reading the maps in detail, interpreting the legends and clearly identifying the various elements linked to the presence of water. Interpretation was also necessary when the elements were not clearly identified on the maps or in their legends. Next, all of the watercourses plotted from historical maps could be combined in the same file and compared. Georeferencing allowed us to superimpose and compare the information gathered on the various maps.

3. Establishment of altimetric data

The altimetric data represented was obtained from a 2009 orthophotograph of the Montreal Metropolitan Community (MMC).However, the high degree of precision of the method used to generate the contour lines from a digital ground model led some of them to be irregular and complex. While this level of detail was pertinent for the comprehension of the relief of the island and the plotting of thalwegs and crest lines, these contour lines were too detailed for the purposes of this publication. They have been simplified in order to facilitate the overall reading and comprehension of the altimetry of the following maps: *Cartographic survey of the island of Montreal's former watercourses showing thalwegs and crest lines*, index map(1:50 000) and detailed tiles (1:10 000) ; and *Map of the island of Montreal's thalwegs, crest lines, and road network* (1:20.000). These simplified contour lines provide information about the island's altimetry, while also facilitating the identification of other information illustrated on the maps. The altimetric information present on these maps is thus less precise than those used in the production of the data relative to thalwegs and crest lines. In order to offer a map presenting contour lines every metre, non simplified, we decided to make the *Map of the island of Montreal's thalwegs, crest lines, and topography* (1:20.000).

Methodology of the "interpretation: plotting of thalwegs and crests"

Using the digital altimetry of the island of Montreal as shown on the model with contour lines every metre and using the trajectories of former watercourses as they appeared in historical maps allowed us to plot the trajectories of the current thalwegs closest to the trajectories of former watercourses. These thalwegs would thus represent the current beds of watercourses if they had water flowing through them.

The research has also permitted us to identify crest lines, the boundaries dividing the island of Montreal's watersheds. Combined with the plotting of thalwegs, which indicate the location of watercourses towards which all rainwater converges in a watershed, the plotting of the boundaries of the watersheds allowed us to understand the trajectories of surface waters. An understanding of the relationship between a watershed and its primary watercourse and tributaries is useful for water management.

The plotting of crest lines are the result of an interpretation by the author using altimetric data from 2009, thalwegs, the trajectories of watercourses on historical maps, without taking into account periodic modifications to the ground linked to the presence of infrastructures such as canals, railways, landfills, quarries, highways, and certain major roads for which the author was aware of the embankments.

Incessantly going back and forth between the large wooden model and the digital data allowed us not only to situate where suspected thalwegs and crest lines would be, but also to determine their precise location using contour lines. Peat and marl zones (determined using a geological map[14]) and the thalwegs, calculated automatically by the digital program, also helped us refine our interpretation of the location of thalwegs and crests.

Variations in trajectories and estimation of error

When comparing the representations of watercourses on maps of the island of Montreal, one notices that their trajectories are not exactly the same from one map to the other. Several factors can explain these variations. However, it is important to note that, **although the maps have been identified by the year they were produced, the variations in the trajectories of watercourses do not evolve chronologically from one map to the other**. With the exception of very flat areas or after certain natural events (heavy rainfall, flash floods, earthquakes, changes in the Saint-Lawrence's water levels) or because of human activity, watercourses have only rarely changed trajectory over the course of the last five centuries. This variations in the trajectories of watercourses on historical maps are caused by several factors: differences in scale from one to the other and hence their relative (im)precision; the fact that most older maps were hand drawn; the imprecision of field tools and paper-tracing techniques of the time; and the margin of error caused by our georeferencing of the maps and our replotting. All of these sources of error can add up and contribute to the representation of slightly different trajectories for the same watercourse. We estimate the cumulated margin of error to be roughly equivalent to the width of the lines drawn.

The precision of the data produced in this study is relative to the scale of the historical maps used. A more precise positioning of watercourses can be determined with the help of smaller-scale graphic documents (surveying plans, certificates of location). Since we were covering a vast territory (500km^2), we were unable to conduct the research with that level of detail. The exact position of former watercourses must be determined through field or archaeological research.

Legend

The legend accompanying the maps is divided into three sections. The first section attributes a colour to each historical map. A second section in black and white shows the symbols for various elements that were drawn from historical maps. Although these symbols are in black and white on the legend, they are shown in colour on the maps corresponding to the colour of the historical map that the element came from. Hence, it is possible to identify both the type of element (shoreline, watercourse, bridge, etc.) and the historical source that it came from. A third section presents the legend of current data. It lists all of the symbols that came from present data (thalwegs, crests, contour lines, etc.) in one colour that does not vary. When the element was not drawn from our own research, its source has been specified in the legend.

In order to facilitate the reading of the information produced in this study, certain of the historical maps studied have been grouped within the same colour-code when that ensemble of maps was produced by the same source, within a period of a few years, and when the group of maps illustrate complementary territories (don't overlap). [15]

[14] Prest V.K., Hode-Keyser J., *Caractéristiques géologiques et géotechniques des dépôts meubles de l'île de Montréal et des environs, Québec*, 1982. The redrawn zone 9 contains peat and marl zones.

[15] For example, the maps from the *Department of militia and defence, geographical section*, which cover three distinct territories (31-H-12 Laval ; 31-H-05 Lachine ; 31-H-11 Beloeil) and for which the production of the maps was conducted in a period of a few years (1934, 1935 et 1936). These three maps constitute a homogenous group of data that is illustrated using the same colour.

Other elements shown

On top of the watercourses, shorelines, and boundaries of the maps used, we have shown the elements that have a direct or indirect link to water management. For example, we have drawn bridges as they have been shown on the maps. Buildings drawn along a watercourse may signify the presence of a mill or a tannery.

The reference grid and numbers appearing in the background of the map correspond to the divisions and nomenclature of the reference grid used for the cartography of the City of Montreal's digital database (also known as *"plans d'utilisation du sol"* [land use plan]) on the basis of the Québec plane coordinate system (QPCS or MTM - Quebec).

Names of watercourses and watersheds

In the document *Survey of the toponymy of the island of Montreal's watercourses*, the names of watercourses have been documented from the georeferenced maps and from research conducted throughout the study. Only names that were legible enough as to leave one possible interpretation were retained. Certain indecipherable inscriptions on the maps consulted were thus not included.

On the maps produced in this study, we chose to identify the watercourses by their most frequently used name. Even though there is still currently some debate on the nomenclature, we were guided by a reflection made by the Pointe-à-Callière museum on the name of the watercourse that flows alongside it: "*the name, in the procedures that lead to the conferring of a name to a particular place, should be established according to "usage", which is to say the way that people habitually designate a place."*[16] Hence, we selected the most frequently used name. However, the choice of certain names is motivated by a desire for clarification for the studies and projects to come. Indeed, there is confusion around the names of certain watercourses resulting from errors in the production of historical maps or errors in interpretation. Hence, in basing our analysis on watercourses, we have sometimes chosen a less-recurrent name. The textual documents consulted for toponymy are listed in the *Bibliography*.

Watersheds were given the name of their primary watercourse (the longest one) or that of the watercourse at their outlet. The watersheds and watercourses for which the names are unknown were not named during the study.

Funding agencies

Financing from the **Institut de Recherche en Histoire de l'Architecture** (IRHA) obtained with Michèle Dagenais (2012-2013) allowed us to make the wooden model, at a scale of 1:20.000, in which we took the altimetric data of the island and exaggerated its altitude sixty-fold compared to its horizontal dimensions. The data on the island's former watercourses and their watersheds was made possible through the financial support of the **Fonds de recherche du Québec - Société et culture** (FQRSC, 2013-2016). Funding from the Mobilisation des connaissances de l'**Université de Montréal - Conseil de recherche en sciences humaines** (UdeM-CRSH) allowed us to produce the maps available online (2015-2016).

Contributors

The following people participated in the collection and production of data and maps as research assistants or interns:

- **Bianca ARCIERO**, 2012, undergraduate student in architecture at the Université de Montréal
- **Angélique AUBERY**, 2015, master's student in architecture, École Nationale Supérieure d'Architecture de Toulouse, interned at the Université de Montréal for 2 months.
- **Didier BEAUDOIN**, 2012-2013, undergraduate student in architecture at the Université de Montréal
- **Pascale BUSSEAU**, 2016, master's student in architecture at the Université de Montréal

[16] Brossard J.G, Dufresne S., Hallé J., Provençal M.-H. (1993), *Question de potamonymes : les soubresauts d'une « petite rivière,* Mémoires Vives, **4** : 17-29.

- **Lora CASASOLA**, 2015-2016, undergraduate, then master's student in architecture at the Université de Montréal
- **Matthieu CADAERT**, 2013, master's student in architecture, École Nationale Supérieure d'Architecture de Versailles, in a Student Exchange Program at the Université de Montréal
- **Ariane CÔTÉ-BELISLE**, 2013-2014, undergraduate student in architecture at the Université de Montréal
- **Mark Ramsay ELSWORTHY**, 2012, undergraduate student in urbanism at the Université de Montréal
- **Aline GABRIEL-CHOUINARD**, 2013-2014, undergraduate, then master's student in architecture at the Université de Montréal
- **Samuel GENDRON-FORTIER**, 2015-2016, undergraduate student in architecture at the Université de Montréal
- **Anne GERMON**, 2016, master's student in engineering, École Centrale de Nantes, interned at the Université de Montréal for 6 months
- **Michael HAWRYSH**, 2012-2013, master's student in history at the Université de Montréal and in 2016, translator of the documents in the present study from French to English
- **Jean-Michel LAFORTUNE**, 2015, master's student in architecture at the Université de Montréal
- **Marie LAMBERT-BOULIANNE**, 2015-2016, master's student in urbanism at the Université de Montréal
- **Kevin LÉVESQUE**, 2015, master's student in architecture at the Université de Montréal
- **Clémence LHOYER**, 2012, master's student in architecture, École Nationale Supérieure d'Architecture de Paris-Malaquais, in a Student Exchange Program at the Université de Montréal
- **Sophie MICHEL**, 2012, master's student in architecture, Université libre de Bruxelles, in a Student Exchange Program at the Université de Montréal

Acknowledgment

We offer our sincerest thanks to Anne-Marie BALAC, Cécile BAIRD, Pierre BÉDARD, Alain CHARRON, Karim CHAREF, Laetitia CREMONA, Michèle DAGENAIS, Jean DÉCARIE, Claudine DESCHÊNES, Laetitia DEUDON, Christian GATES-SAINT-PIERRE, Marc GIRARD, Michaël HAWRYSH, Laurence JOHNSON, Anne-Marie LABRECQUE, Jacques LACHAPELLE, Annie LEBEL, Claude LEDUC, Anne MARCHAND, Line MORAND, Jean-François PALOMINO, Catherine PAULIN, Pierre J.H. RICHARD, Jean-Claude ROBERT, Mario ROBERT, Nicholas ROQUET, Nicole VALOIS, Les Amis de la Montagne, le Centre d'Histoire de Montréal, le Conseil Régional Environnement Montréal, Héritage Montréal, les Sœurs hospitalières de l'Hôtel-Dieu Saint-Joseph, Vinci Consultants for their interest in the research, their generosity, and their cherished assistance.