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HEALTH IMPACT ASSESSMENT OF THE TOD NEIGHBOURHOOD PROJECT IN SAINTE-CATHERINE. REPORT ON POTENTIAL IMPACTS AND RECOMMENDATIONS

REPORT | JUNE 2014

Centre de collaboration nationale sur les politiques publiques et la santé

National Collaborating Centre for Healthy Public Policy

Institut national de santé publique Québec

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SUGGESTED CITATION

Tremblay, É., Navert, P., Blackburn, M., Dufort, J., Drapeau, J.-B., Noisel, N…. Gagnon, F. (2014). *Health Impact Assessment of the TOD Neighbourhood Project in Sainte-*Catherine. *Report on potential impacts and recommendations*. Montréal, Québec: National Collaborating Centre for Healthy Public Policy.

PARTNERSHIP

Production of this report has been made possible through a financial contribution from Health Canada, through the Canadian Partnership Against Cancer (http://hcbd-clasp.com/). The views expressed in this report represent the views of Healthy Canada by Design and do not necessarily represent the views of the project funder.

Production of this document has also been made possible through a financial contribution from the Public Health Agency of Canada through funding for the National Collaborating Centre for Healthy Public Policy (NCCHPP). The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada.

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ABOUT THE NATIONAL COLLABORATING CENTRE FOR HEALTHY PUBLIC POLICY

The National Collaborating Centre for Healthy Public Policy (NCCHPP) seeks to increase the expertise of public health actors across Canada in healthy public policy through the development, sharing and use of knowledge. The NCCHPP is one of six Centres financed by the Public Health Agency of Canada. The six Centres form a network across Canada, each hosted by a different institution and each focusing on a specific topic linked to public health. In addition to the Centres' individual contributions, the network of Collaborating Centres provides focal points for the exchange and common production of knowledge relating to these topics.

ACKNOWLEDGMENTS

The NCCHPP would like to thank the DSP Montérégie for allowing us to participate in one of their health impact assessments (HIAs) and to adapt, translate and publish the report and the recommendations that emerged from that process. In particular, we wish to thank Émile Tremblay, who coordinated the work for the DSP.

FOREWORD

This document presents the analyses and recommendations produced within the context of a health impact assessment (HIA) of a residential development project, characterized as a Transit-Oriented Development (TOD). The HIA was conducted by the Direction de santé publique (DSP – public health unit) of Montérégie, Québec. The project, comprising nearly 950 residential units, commercial spaces, a bus station, a park-and-ride lot and new streets, represents a major development for its insertion environment, the town of Sainte-Catherine, a typical Montréal suburb of about 19,000 residents. The analyses and recommendations focus on various aspects of the project that are likely to affect a number of health determinants. These aspects include the configuration of public roadways and other project elements that can encourage or discourage more widespread use of active modes of travel, such as walking and cycling.

The National Collaborating Centre for Healthy Public Policy (NCCHPP) was represented on the scientific committee for the HIA and the Centre's publication of this report falls within the context of work on the second phase of the Healthy Canada by Design initiative, a Coalitions Linking Action and Science for Prevention (CLASP) project. The purpose of this CLASP initiative is to promote built environments that encourage safe active transportation. Thus, the HIA process established by the DSP Montérégie seems to represent a means of fostering healthy public policy, in particular, by promoting environments that encourage safe active transportation, that could be of interest to other public health authorities in Canada.

This document begins by describing the HIA process undertaken by the DSP Montérégie, in collaboration with the municipalities concerned. This background information is intended to give public health actors an overview of how the DSP Montérégie conducts its HIAs, of the structures it has established and of the political contexts in which these HIAs are carried out. Next, the body of the document presents the DSP Montérégie's analyses and recommendations concerning the proposed project in Sainte-Catherine. For more information on HIA in Montérégie and to access their published reports (in French), please visit the HIA page of the DSP Montérégie website (http://extranet.santemonteregie.qc.ca/sante-publique/promotion-prevention/eis.fr.html).

For public health actors interested in promoting environments that encourage safe active transportation, this document is doubly relevant. On the one hand, it demonstrates a means of promoting such environments: the collaborative HIA model adopted by the DSP Montérégie. And on the other hand, it contains a sample report that incorporates the DSP's analyses, along with its concrete and specific recommendations, many of which concern aspects of the environment that encourage or discourage active transportation. Because the residential project analyzed is meant to be integrated into a typical suburb, such as is found across Canada, we believe that the content of the analyses and recommendations will also be of interest to other Canadian regional health authorities.

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1 HEALTH IMPACT ASSESSMENT

Health impact assessment (HIA) is a process that draws on a set of methods for analyzing the potential impacts of a policy on the health and well-being of the population (World Health Organization [WHO] and the European Centre for Health Policy [ECHP], 1999). Carried out upstream of implementation, an HIA makes it possible to anticipate the probable effects, both positive and negative, of a public policy (law, regulation, project, action plan, development plan or other decision of a public administration) on the health and well-being of the population. The analyses produced are then used to make recommendations which, when implemented by policy makers, improve the potential health outcomes of the policy. As a guide to carrying out HIAs, the World Health Organization (WHO) suggests a process structured into five successive stages (WHO and ECHP, 1999). Figure 1 presents a summary of the HIA process, inspired by the WHO guidelines.

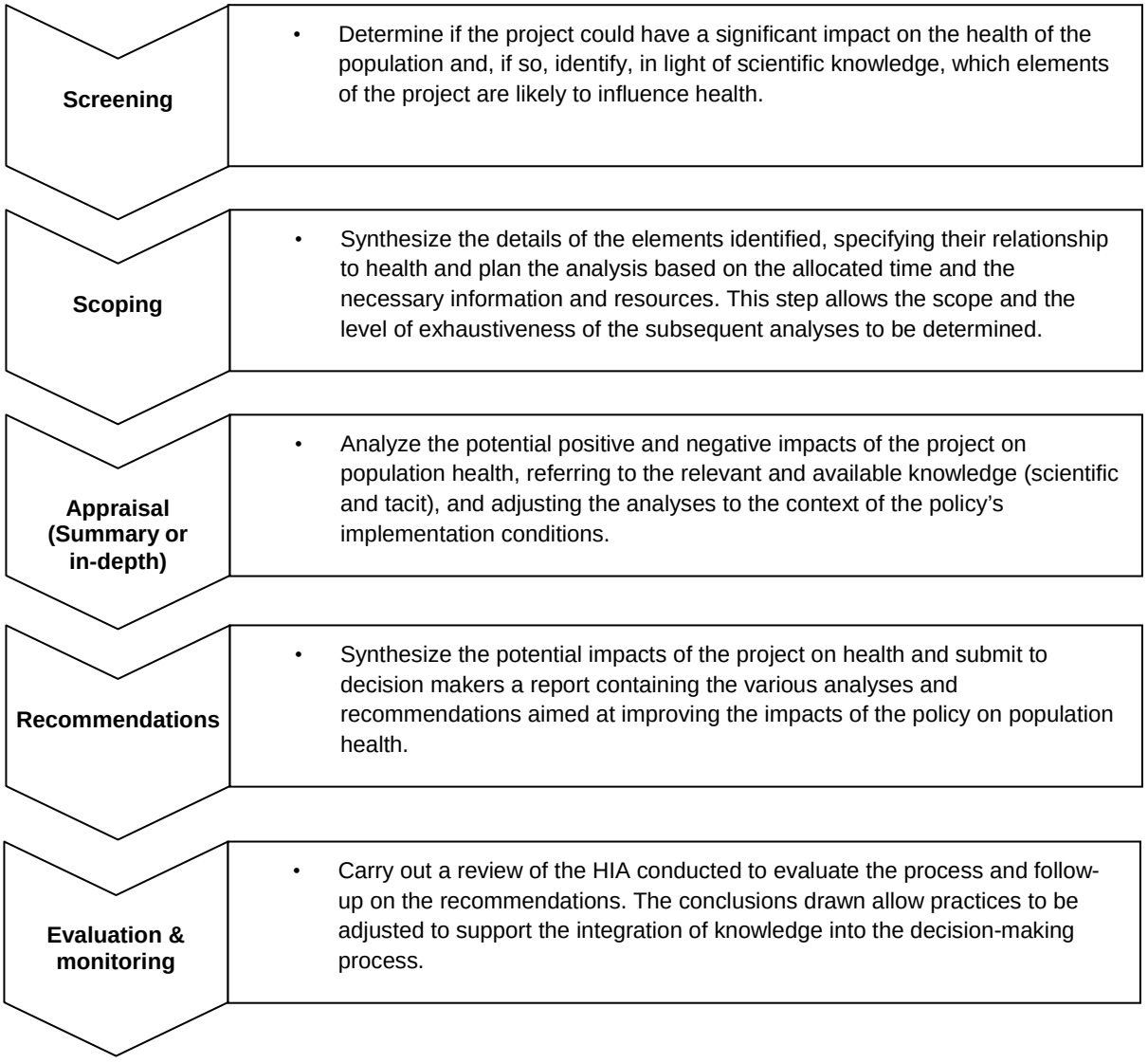


Figure 1 The HIA process

Source: DSP Montérégie.

Depending on the context of implementation and the objective pursued by the initiators of an HIA, this process can vary considerably. It can take the form of a mandatory process focused on measuring health risks, it can be a voluntary intervention aimed at informing decision making, or it can be initiated to support a professional or citizen-based position regarding a cause or issue (Harris-Roxas & Harris, 2011). Collaboration between policy makers and scientists is recognized as a way to encourage the integration of new knowledge into decision-making processes (Contandriopoulos, Lemire, Denis & Tremblay, 2010). Therefore, carrying out decision-support HIAs in partnership with those responsible for the policy being analyzed appears to be an effective way to influence public policies and ensure the integration of population health concerns.

2 THE PRATICE OF HIA IN MONTÉRÉGIE

In Montérégie, HIA is carried out to support the decision-making processes of municipal authorities. Overseen by the Direction de santé publique (DSP) and conducted in close collaboration with the health and social services centres within its territory, known as Centres de santé et de services sociaux (CSSS),[1] the HIA procedure provides municipal decision makers with the opportunity to gain further knowledge about the potential impacts of their decisions on the health and quality of life of their citizens, prior to the adoption and implementation of a policy.

The strategy developed in Montérégie to maximize the potential use of the analyses and recommendations generated by the HIA involves knowledge brokering. Regional and local partners, including municipal decision makers, are involved in this exchange of knowledge, which supports the production of scientific analyses and recommendations that take into account the local reality.

2.1 KNOWLEDGE-BROKERING STRATEGY APPLIED TO HIA

Evidence-informed decision making, supported, in Montérégie, by HIA, addresses the need to develop healthy public policies, which has been clearly expounded since the Ottawa Charter (WHO, 1986). However, even when policy makers try to base their decisions on evidence, they often encounter obstacles limiting the extent to which evidence can be taken into account. These obstacles, the most significant of which are limited access to evidence, the lack of time and resources available to decision makers and their isolation from the scientific community (Bowen, Erickson, Martens & Crockett, 2009; Innvær, Vist, Trommald & Oxman, 2002; Oliver, Innvær, Lorenc, Woodman & Thomas, 2014; Petticrew, Whitehead, Macintyre, Graham & Egan, 2004), can, however, be overcome through deliberate knowledge transfer and sharing processes (Armstrong et al., 2013; Contandriopoulos et al., 2010; Lavis et al., 2005; Mitton, Adair, Mckenzie, Patten & Perry, 2007; Ward, House & Hamer, 2009).

As such, the knowledge-brokering process can help improve access to evidence and strengthen collaboration among actors. Defined as a way to facilitate interaction between policy makers and scientists, knowledge brokering can breach the cultural and organizational barriers separating the political and scientific worlds and allow the definition of mutually beneficial goals that support the integration of evidence into the decision-making process (Canadian Health Services Research Foundation, 2003; Meyer, 2010).

As applied to HIA, knowledge brokering focuses municipal decision makers and scientists on a shared challenge and supports the integration of knowledge from each that is relevant to a policy and its context. In Montérégie, this process of knowledge brokering is part of a

[1] In Québec, the CSSSs are the local organizations responsible, notably, for coordinating the delivery of health services and facilitating intersectoral collaborations addressing the determinants of health. Such interventions fall within the population-based mandate of the health and social services organizations, according to which their actions should help maintain or improve the health status of the population.

strategy of collaboration and communication involving the DSP, the CSSSs and participating municipalities.

As shown in Figure 2, the knowledge-brokering strategy, as applied to HIA in Montérégie, is based on collaboration among several actors, all of whom have unique or shared roles and responsibilities. On the one hand, municipal partners are free to develop policies that reflect their priorities and to submit these to an HIA. CSSS participants, for their part, assist the HIA process by contributing their knowledge of local conditions and the issues associated with these. To these actors is added a knowledge broker, whose role is to coordinate the work and efforts of all partners involved in the HIA. A local HIA committee, able to bring together these three partners and host their discussions, helps clarify the context and issues tied to the policy, identify the elements that are likely to influence citizens' health and quality of life as well as review and validate the relevance of analyses and recommendations. Alongside the local committee, a multidisciplinary scientific committee is formed, consisting of the knowledge broker and DSP professionals whose expertise is tied to the concerns raised by the local committee. The mandate of the scientific committee is to analyze the potential health impacts of the policy and make recommendations for improvement. The close collaboration among the members of this multidisciplinary committee (that is, among the professionals themselves and with the knowledge broker) makes it possible to contextualize each of the analyses and recommendations produced, to tailor their scientific relevance to local priorities and to harmonize all the analyses and recommendations so as to produce a coherent report to be sent to the policy's proponents. The combined collaborative efforts of all the partners makes it possible to align the scientific and political relevance of the analyses and recommendations, to maximize their potential use and to contribute, ultimately, to the development of public policies that better support the health of the population.

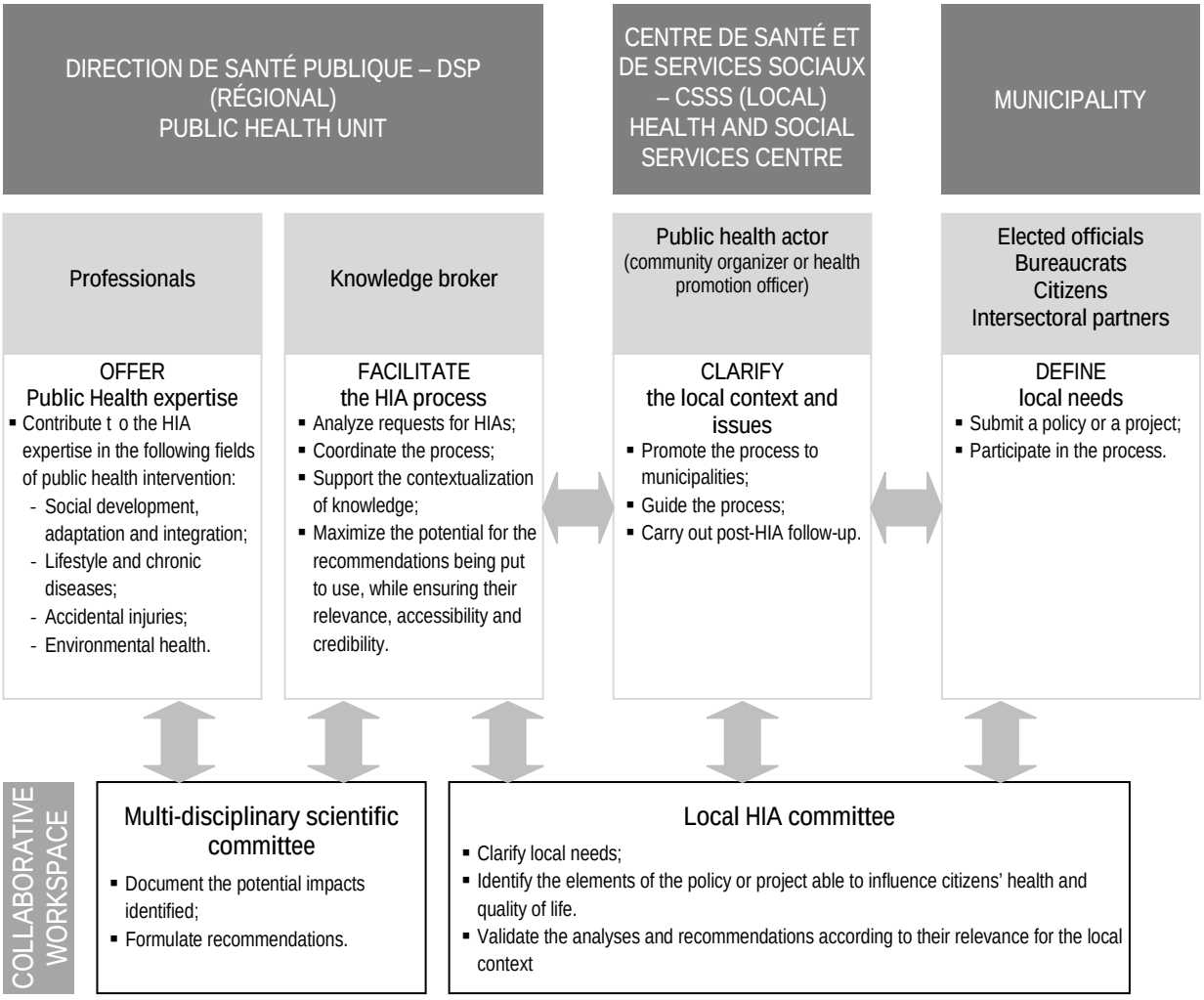


Figure 2 Knowledge-brokering strategy as applied to HIA in Montérégie

Source: adapted from Tremblay, 2012.

2.2 COLLABORATIVE HIA PROCESS

The knowledge-brokering strategy applied to HIA determines how the process is structured and how it is carried out. Since the HIA process is intersectoral and multidisciplinary, it involves collaboration on multiple levels. First, the voluntary participation of municipalities in the Montérégie region leads to a conciliatory approach, characterized by respect for the nature of the project and the intentions of the policy makers. The decision-support work is carried out in collaboration with municipal decision makers and therefore reflects their needs and respects the limitations of the local context.

In addition, the multidisciplinary nature of the work involved in producing the HIA analyses and recommendations necessitates a collaborative work structure. The collaboration between the professionals and the knowledge broker is intended to ensure that the needs identified at the municipal level are adequately met, and their work is informed by multiple back-and-forth consultations with local partners.

Figure 3 summarizes the entire process established in Montérégie to support the knowledge-brokering approach to conducting HIAs. This figure illustrates an adaptation of the HIA process proposed by the WHO (Figure 1) and describes the participation of the stakeholders involved in the knowledge-brokering strategy (Figure 2). The HIA process details the numerous interventions required to situate the HIA within a complex political and organizational reality. On the one hand, this process takes into account the multiplicity of stakeholders involved, all of whose responsibilities are as unique as they are complementary. On the other hand, the process recognizes that the nature and objectives of the policy under study and its implementation context are the starting point for the HIA and that these determine the implementation parameters of the policy and the type of support that is appropriate.

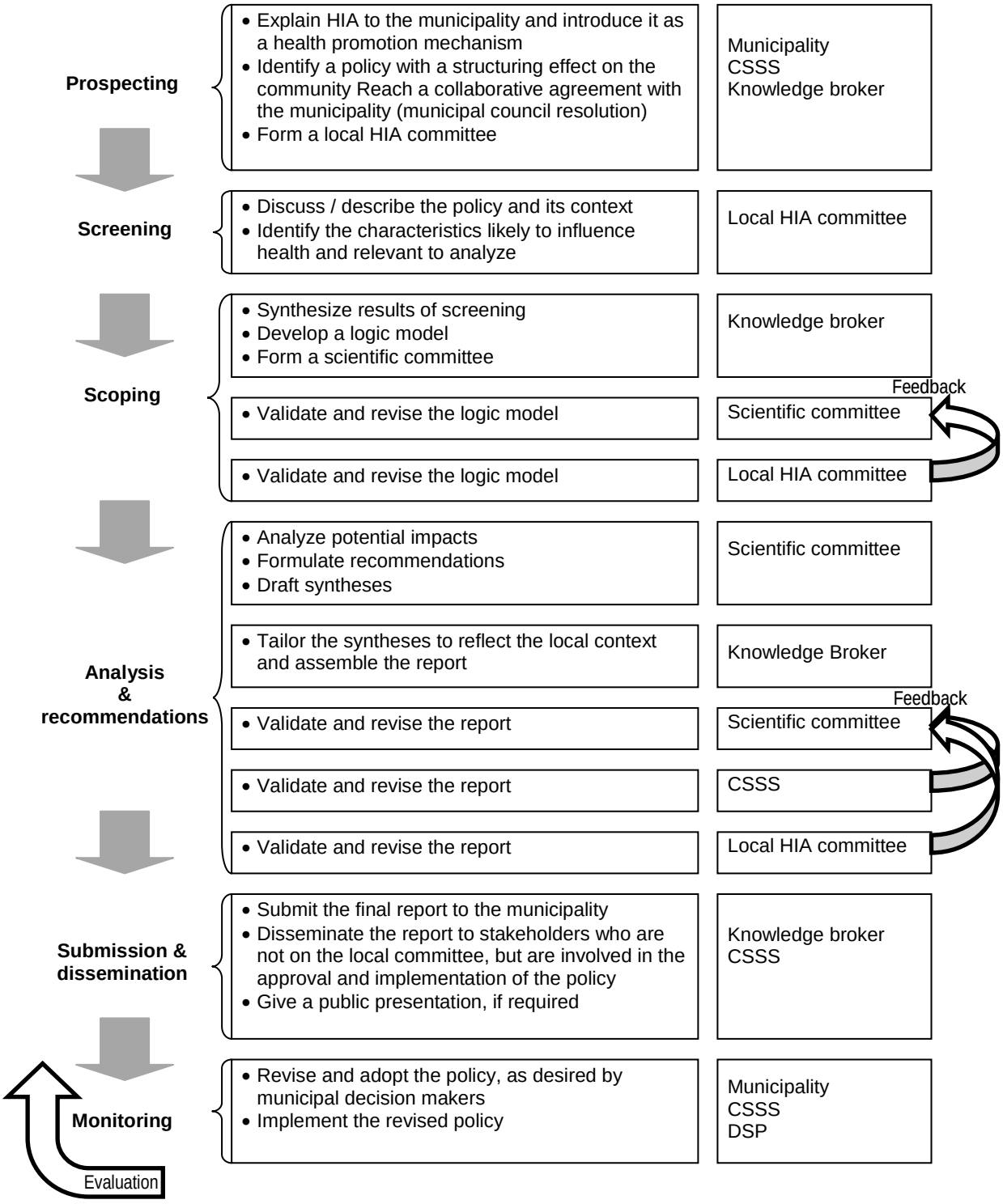


Figure 3 HIA process in Montérégie (HIA process consistent with a knowledge-brokering strategy)

Source: DSP Montérégie.

For this reason, screening is invariably preceded by a prospective stage. At this stage, the policy makers concerned meet with the knowledge broker and his or her collaborator in the CSSS, who explain the added value the HIA brings to citizens and to the policy, so the parties can arrive at an agreement to collaborate on a voluntary basis. Following this step and the selection of a policy with a strong potential impact on health, screening begins with the establishment of a local HIA committee. The local HIA committee then works as a group to carry out the screening step, which consists of outlining the characteristics of the policy selected and its implementation context, and identifying which of its components it seems most relevant to analyze.

Next, during the scoping stage, the previous discussions are synthesized and the scientific and local committees are called on to validate the scientific and political relevance of the elements selected to be the subjects of analyses and recommendations. The analysis of potential impacts then begins, to be followed by the drafting of a report containing analyses and recommendations tailored to the local context. Validation of these analyses and recommendations by the members of the local HIA committee paves the way for the final report to be filed and disseminated to the other municipal stakeholders, who are not part of this committee, but are involved in the approval and implementation of the policy.

The subsequent activities provide support to decision makers during the revision and implementation of their policy. Since policy implementation may extend over a period of several months and years, the health network (the CSSS and DSP) therefore focuses on long-term support, which does not cease with the completion of the HIA. Finally, four to six months after submission of the report containing the analyses and recommendations, a DSP evaluator external to the HIA process evaluates the response of local partners to the process and the benefits of the HIA at the municipal level. The observations made at this stage allow the entire process to be reviewed and point to elements that can be improved on in future HIAs.

3 DESCRIPTION OF THE PROJECT UNDER STUDY AND ITS CONTEXT

The Sainte-Catherine residential neighbourhood project falls within the context of the Metropolitan Land Use and Development Plan (Plan métropolitain d'aménagement et de développement or PMAD) for Greater Montréal. To clarify the conditions governing the development of this residential project and the analyses and recommendations that follow, the following section describes the raison d'être of the PMAD and its main orientations. A description of the project and its immediate environment follows, to contextualize the discussion of the aspects that were selected for study in this HIA.

3.1 METROPOLITAN LAND USE AND DEVELOPMENT PLAN

Greater Montréal is composed of 82 municipalities distributed among the agglomerations of Montréal and Longueuil, the City of Laval and the North and South Shores. This area, home to nearly 3.7 million people, is the demographic centre of Québec and generates nearly 50% of the province's GDP (Communauté métropolitaine de Montréal [CMM], 2012). To address the challenges associated with the urbanization of the greater metropolitan region and the expected demographic increase of 319,400 new households between 2011 and 2031, local elected officials collectively representing the Communauté métropolitaine de Montréal (CMM – Montréal metropolitan community) adopted, in December 2011, the Metropolitan Land Use and Development Plan for Greater Montréal. This shared vision inspired by the principles of sustainable development comprises many guidelines related to planning, transportation and the environment, and intended to foster the creation of sustainable living environments. Included among the many stated objectives is the main goal of directing at least 40% of household growth toward Transit-Oriented Development (TOD) neighbourhoods, built up around 155 mass-transit network access points (see Figure 4 for the locations of these). Achieving this goal of accommodating 128,000 new households within TOD neighbourhoods would lessen the expected increase in pressure on the already heavily used road network, strengthen protection of the environment and farmland and curb urban sprawl.

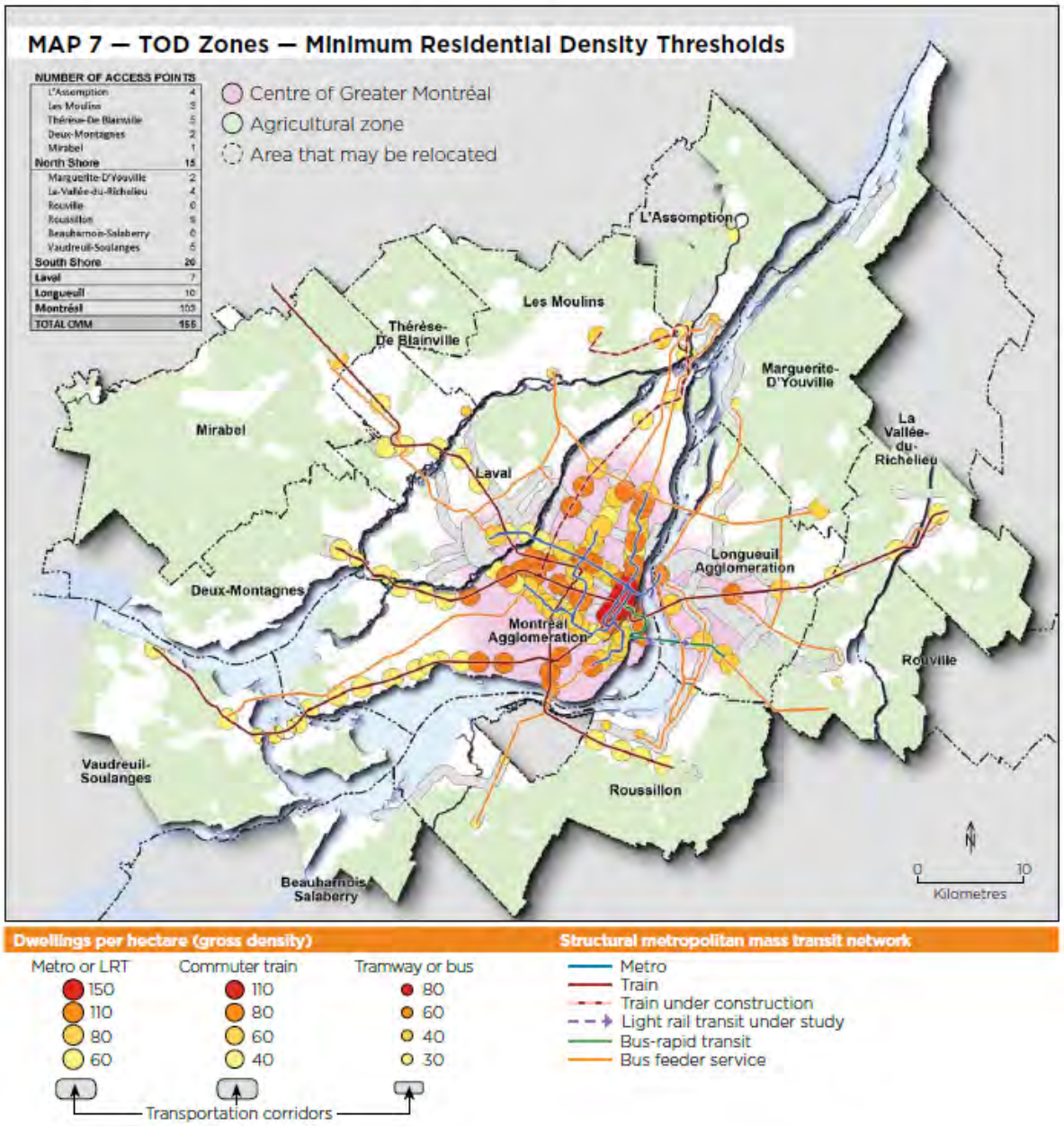


Figure 4 Location of TOD zones within the Greater Montréal region

Source: CMM, 2012, p. 87. It is forbidden to reproduct this map without the authorization of the CMM.

With the aim of creating sustainable and healthy living environments, the PMAD specifies that the TOD zones must be based on development and transportation plans which promote collective and active travel among sector residents. Thus, the TOD zones should reflect the following objectives:

- "Better integrate the station into its surrounding environment by promoting its visibility and accessibility (mass-transit access point interfaces).

- Adjust the territory's density so there is a gradation from the access point outwards and so lot development is maximized while respecting local

particularities like heritage, landscape, natural environment, facilities and services (density of uses adapted to the environment).

- Promote diversity and a better horizontal and vertical integration of uses (businesses, services, residences and institutions) to cultivate a dynamic community life (mixed use).

- Encourage the construction of a wide variety of dwellings (typologies and tenures) to better meet the needs of different household types and better integrate different socio-economic groups into community life (upholding social diversity).

- Facilitate access to the mass-transit infrastructure while prioritizing active transportation (road network and accessibility).

- Facilitate active transportation (walking, biking, etc.) through planning that will ensure security and comfort (road network and accessibility).

- Manage off-street parking that limits the number of available spots while encouraging other forms of parking — underground or aboveground — and prioritizing public and active transportation (manage parking).

- Encourage distinctive planning that emphasizes the location's identity (urban design, safety, quality of facilities and location identity).

- Implement a street-front built environment as well as diversified architecture to reduce the walking distance to mass-transit stops and create a friendly environment for pedestrians (building layout and diversified architecture).

- Promote sustainable facilities to improve the quality of life of these spaces, notably by constructing high-energy-efficiency buildings, adapting the landscaping to the environment, protecting natural environments and areas with a historic, heritage and cultural character, recycling and managing stormwater run-off (sustainable planning)".

(CMM, 2012, p. 90)

3.2 TOD NEIGHBOURHOOD PROJECT AND THE HIA PROCESS IN SAINTE-CATHERINE

With the City of Sainte-Catherine having been designated to accommodate new public-transit infrastructure and a TOD zone in the area along the length of rue Léo, local authorities undertook to plan the development of a residential neighbourhood based on the new planning guidelines in the PMAD. In accordance with these guidelines, the City of Sainte-Catherine has planned for the construction of a TOD neighbourhood combining residential and commercial functions and designed to support the active and collective mobility of its residents, with an area of 13.2 hectares to accommodate 606 residential units in Phase 1 (see Figure 5) and an area of 20.9 hectares to include 948 residential units by the end of Phase 2 (see Figure 6). Given that the city has a population of nearly 19,000 people, this project, whose implementation will likely result in the addition of more than 2,400 people and

an increase in the Sainte-Catherine population of about 13%,[2] represents a major undertaking for the municipality.

Figure 5 TOD neighbourhood project, Phase 1

Source: Ville de Sainte-Catherine & Plania, 2013.

[2] This estimate is based on an average of 2.6 persons per household and a population estimated at 19,000 citizens in 2012.

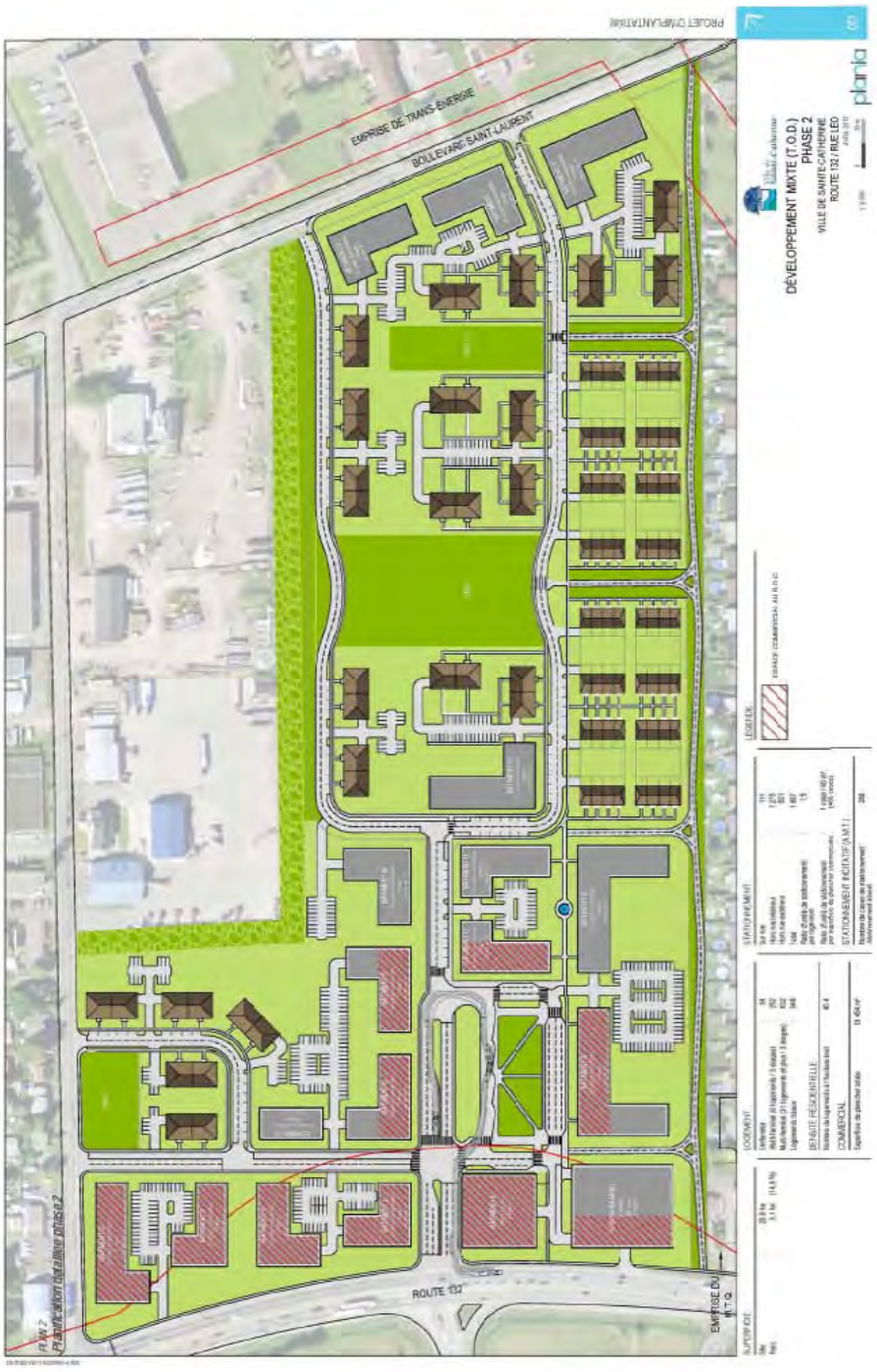


Figure 6 TOD Neighbourhood project, Phase 2

Source: Ville de Sainte-Catherine & Plania, 2013.

In order to anticipate the impacts of the development of the TOD neighbourhood and of its immediate environment on the health and quality of life of residents, the City of Sainte-Catherine decided to participate in an HIA. To this end, municipal authorities, the CSSS Jardins-Roussillon and the DSP Montérégie collaborated over a period of nearly sixteen

months. Four working meetings and several communicative exchanges marked the progress of the HIA, making it possible to delineate the project and its context, to reach a consensus on the relevant characteristics to be analyzed and, subsequently, to validate and adjust the analyses and recommendations submitted. Throughout the HIA, the DSP was able to rely on the special collaboration of two members of the National Collaborating Centre for Healthy Public Policy (NCCHPP), who formed part of its multidisciplinary scientific committee.

As shown in Figure 7, the characteristics whose potential impacts were selected for analysis were those of the urban design features of the future TOD neighbourhood and those of the current activities in the industrial park located nearby. Thus, the public transit infrastructure and services, the design of streets, walkways and bikeways and the design of urban parks and green spaces planned for the TOD neighbourhood were chosen to be the subjects of analyses and recommendations. Similarly, the storage and transportation of hazardous materials and industrial nuisances likely to threaten the safety and disturb the tranquility of future citizens were among the characteristics selected for analysis. These characteristics, of importance to the entire TOD neighbourhood, were selected because of their potential influence on physical activity, safety, social capital, urban heat islands, noise and exterior air quality and their possible impacts on the health and quality of life of both future citizens of this neighbourhood and citizens of adjacent neighbourhoods.

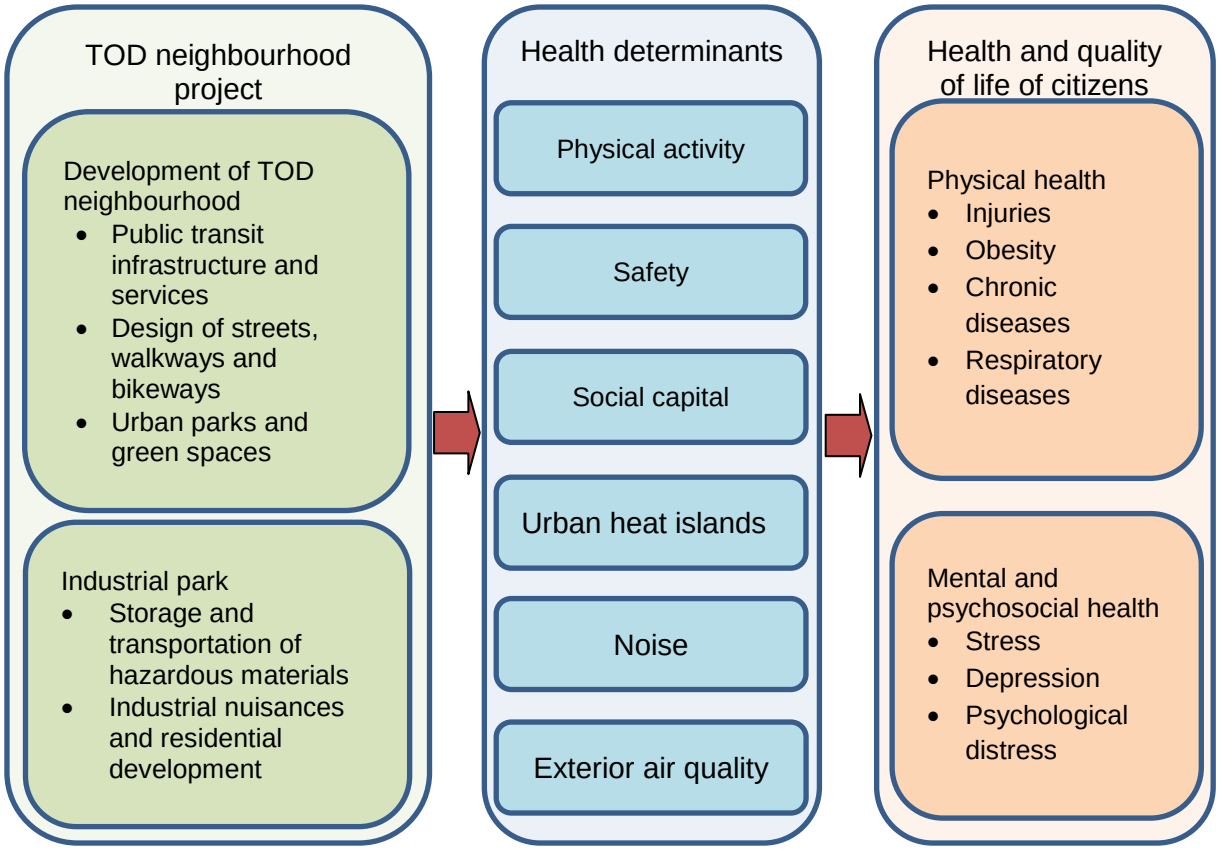


Figure 7 Representation of the potential impacts of the TOD neighbourhood project on citizens' health and quality of life

Source: DSP Montérégie.

The following section describes these six health determinants which could potentially be affected by the proposed TOD neighbourhood. Next, the analyses of the potential impacts of the urban design features of the TOD neighbourhood and of the current activities in the industrial park are presented in conjunction with their associated recommendations. All the recommendations contained in this report are presented in Appendix 1 in the form of a summary table.

Close-up of the City of Sainte-Catherine

Since being founded in 1937, Sainte-Catherine has grown significantly. The successive construction of the Mercier and Champlain bridges, in 1934 and 1962 respectively, linked the city more closely with Montréal and propelled its population growth to new heights. From 614 inhabitants in 1951, Sainte-Catherine grew to reach 4,000 inhabitants in 1973 and nearly 19,000 citizens in 2012 (Ville de Sainte-Catherine, 2012).

The population of Sainte-Catherine can be characterized as young, since it is predominantly composed of individuals aged 64 years old or less and the percentage of elderly people there is lower than in Québec as a whole (10% vs. 16% in 2011). The population of Sainte-Catherine aged 15 years and older is mainly composed of workers, with a 74% employment rate, as compared to 60% for all of Québec, and with a median income that is nearly 29% higher than that of the Québec population as a whole ($31,464 vs. $24,430 in 2005). This relative economic prosperity is illustrated, in particular, by a lower percentage of low-income households than that of the province (10.5% vs. 17.2% in 2005) and a rate of owner-occupied private dwellings that is higher than the provincial average (79% vs. 61% in 2006). In 2006, the proportion of Sainte-Catherine residents using public transportation to get to work was about 50% lower than that of workers across the province (6.5% vs. 12.8%).

This limited use of public transportation is partly explained by the high number of cars per household in Sainte-Catherine, which is nearly 40% higher than the average for Greater Montréal (Agence métropolitaine de transport [AMT], 2008). This predominance is observable today, in particular, because of an urban network that is rather spread out and whose development is primarily structured around the automobile.

Figure 8 Location of Sainte-Catherine within the Greater Montréal region

Source: DSP Montérégie.

4 HEALTH DETERMINANTS

This section provides an overview of the main health determinants that could be affected by the urban development of the TOD Neighbourhood and by the nearby industrial activities. These determinants include: physical activity, safety, social capital, urban heat islands, noise and exterior air quality.

4.1 PHYSICAL ACTIVITY

Physical activity carried out for utilitarian or leisure purposes is known to be beneficial to the health and quality of life of a population. The required 30 to 60 minutes of daily physical activity can be achieved through the practice of sports or through active modes of travel (Canadian Society for Exercise Physiology and ParticipACTION, 2011). Active travel includes any form of travel powered by human energy (e.g., walking or cycling).

Regular physical activity can help reduce mortality linked to various types of chronic diseases, and this is true for adults of all ages. Thus, the adoption of a physically active lifestyle is known to prevent obesity and overweight as well as to reduce the occurrence of chronic and cardiovascular diseases (Herbst, Kordonouri, Schwab, Schmidt & Holl, 2007; Kahn et al., 2002; Larouche & Trudeau, 2010). Physical activity is also known to reduce stress and depression (Motl, McAuley, Snook & Gliottoni, 2009; Suh, Weikert, Dlugonski, Sandroff & Motl, 2011). However, according to data from the *Canadian Community Health Survey 2009-2010*, about 60% of adults in the Montérégie region are not sufficiently active during their leisure time to gain health benefits. That is, they do not practice the equivalent of at least 30 minutes a day of moderate intensity physical activity (Boulais, 2012).

The design of the built environment is known to influence how physically active people are. The design of travel routes, such as streets, bike paths, sidewalks and crosswalks, influences the frequency and duration of active travel. Parks and other recreational facilities also help increase the time spent engaged in physical activity, among both adults and youth (Bergeron & Reyburn, 2010; Vida, 2011). With this in mind, it is recommended that the number of places where people can engage in physical activity be increased and that existing locations be made more accessible, by ensuring their attractiveness, cleanliness and safety (Community Preventive Services Task Force, 2001).

4.2 SAFETY

Safety and a sense of security are dependent on natural environments, built environments and the human activities carried out in them. Unsafe environments and behaviour increase the risk of injury and death, and the sense of fear or of confidence inspired in citizens by their environment stems from their perception of risk and from a sense of security, which can influence quality of life (e.g., change stress levels) or change behaviour (e.g., change level of physical activity).

4.2.1 Road safety

With 7,389 road accident victims in 2011 (Bisizi & Savoie, 2013), road safety is an important issue in Montérégie. Many studies demonstrate the relationship between the risk of collision and the configuration of roadways (Kavanagh, Doyle & Metcalfe, 2005; Miranda-Moreno, Morency & El-Geneidy, 2011; Morrison, Thomson & Petticrew, 2004; Scheiner & Holz-Rau, 2011; Thomson, Jepson, Hurley & Douglas, 2008). Thus, it is possible to prevent injuries and deaths related to collisions by configuring the road network and developing the environment according to criteria designed to ensure the safety of all users, that is, not only of drivers, but also of cyclists and pedestrians.

Indeed, the absence of sidewalks combined with high speeds and traffic volumes increases the risk of collisions between pedestrians and vehicles (McMahon et al., 2002). Similarly, the risk of injury to a cyclist following a collision with a motor vehicle is 3 to 12 times greater at intersections where the cyclist is using a two-way bike lane on the pavement, as opposed to cycling on a one-way lane (Fortier, 2009; Ljungberg, 1989; Wachtel & Lewiston, 1994). Taking action to make an environment safer, by adding a pedestrian traffic light with a countdown signal or by installing roundabouts, for example, helps to heighten citizens' sense of security and to encourage healthy behaviours (Kerr et al., 2006).

4.2.2 Industrial safety

Another important safety issue is the safety tied to industrial activities. Given the type of procedures used and the storage of hazardous materials, industrial activities inherently carry the risk of causing what is referred to as a technological accident, which takes the form of a fire, an explosion or the release of substances. A technological accident is an event that occurs when a technological hazard is not controlled and the potential danger of a situation becomes real. Accidents can happen on-site or during transportation. Some natural disasters (e.g., floods) can also be accompanied by technological disasters (Auger et al., 2003).

Certain populations sub-groups are at greater risk of experiencing health problems in the event of a technological accident, due to their individual characteristics (young children, pregnant women, the elderly, etc.) or their place of residence (near industrial sites, highways, flood zones, etc.). The health consequences of such events are varied, and can be psychological as well as physical (Auger et al, 2003).

During a chemical disaster, the risk of atmospheric release of toxic substances and of contamination of soil and of groundwater and surface water is significant. The population is generally exposed through the respiratory tract at the beginning of the event, and then, potentially, through the digestive tract and skin. Exposure through inhalation is usually brief and tapers off with the dissipation of the toxic cloud.

Distancing the population from at-risk sites remains the most effective means of preventing their exposure to toxic spills. Alternatively, when toxic products are released following an industrial accident, the competent authorities (civil security, public health) may order the confinement of the population or its evacuation, to limit exposure and reduce health risks. Resources must then be mobilized to support those affected by the event (accommodation,

basic personal items, food, psychosocial support, etc.). These operations need to have been carefully prepared. However, even the most careful preparation cannot guarantee the safety of residents located in the vicinity of at-risk industries.

4.3 SOCIAL CAPITAL

Social capital is defined as the range of social resources available to an individual which provides him or her with access to services or goods (Morgan & Swann, 2004). Like economic capital, social capital helps produce material and social realities, such as wealth and health (van Kemenade, 2003).

Indeed, several studies have shown that social capital helps lower mortality rates and increase longevity (Bouchard, 2008; Kawachi, Kennedy, Lochner & Prothrow-Stith, 1997; Lochner, Kawachi, Brennan & Buka, 2003), and also leads to economic growth (Dasgupta & Serageldin, 2000). The effects of this first association are partly attributable to the protection conferred by social support, which mitigates the effects of stress and its negative consequences for physical and mental health (Stansfeld, 2006). In addition, belonging to social networks is known to promote physical activity (Lindström, Moghaddassi & Merlo, 2003; Oliveira et al., 2011).

The economic aspect is explained, in turn, by the way a community rich in social capital supports the development of its territory. Social capital is recognized as a factor that contributes to the attraction and retention of a labour force, particularly in rural areas (Deller, Tsai, Marcouiller & English, 2001; Halstead & Deller, 1997), and it contributes overall to promoting economic development within a region (Helliwell & Putnam, 2000).

The development of convivial neighbourhoods helps create a sense of security among residents and increases their use. For example, adding vegetation, lighting and street furniture encourages pedestrian travel and increases contact with and trust among neighbours (Kaczynski & Sharratt, 2010; Leyden, 2003; Renalds, Smith & Hale, 2010; Rogers, Halstead, Gardner & Carlson, 2010), thus fostering a neighbourhood dynamic conducive to the creation of social capital (Baum & Palmer, 2002).

Transportation can also have an impact on social capital. For the most vulnerable populations, including low-income individuals, seniors and persons with a physical or mental disability, access to affordable public transit services helps to break social isolation and improves access to employment, education and basic services (Barton & Tsourou, 2004).

4.4 URBAN HEAT ISLANDS

An urban heat island (UHI) is an urban area characterized by summer temperatures of 5^{o}C to 10^{o}C higher than those of the immediate environment (Smargiassi et al., 2009). Urbanization and urban development practices help create UHIs, mainly due to three factors: the materials used store heat; the loss of vegetation reduces heat dissipation; and the height of buildings reduces air circulation and delays night cooling (Giguère, 2009). To this is added the increasing frequency and duration of heat waves caused by climate change (Tairou, Bélanger & Gosselin, 2013).

UHIs adversely affect the environment and health. They contribute to the formation of smog and to increased demand for energy and drinking water and can cause thermal stress within the population. Thermal stress can cause many health problems, including disturbances of consciousness and heat stroke, it can exacerbate pre-existing chronic diseases, such as respiratory dysfunction and cardiovascular and kidney diseases, and it can even cause death (Giguère, 2009; Kovats & Hajat, 2008).

The elderly are more vulnerable to heat stress (the risk of mortality associated with heat increases after the age of 50), as are infants and young children (Canadian Institute for Health Information, 2011). People living alone are also more vulnerable because of their greater risk of social isolation. Certain health problems also increase the risk of mortality due to exposure to extreme heat, including, in particular, chronic diseases, obesity and mental health problems (Price, Perron & King, 2013). Moreover, certain characteristics related to housing, such as poor insulation, upper-floor occupancy and the absence of an adequate ventilation system are also associated with a higher risk of morbidity and mortality during heat waves (Kovats & Hajat, 2008; Tairou et al., 2013). Low-income individuals may be particularly vulnerable due to inadequate housing conditions, to being unable to acquire an air conditioner or because they are proportionately more likely to suffer from certain health problems.

In Montérégie, in 2006, 1 in 5 adults reported being very bothered by the intense heat felt inside their homes during heat waves. This proportion is higher among renters (30%) than among owners (17%), as well as in urban areas (22%) as compared to rural areas (13%) (Tardif, Bellerose & Masson, 2006).

It is possible to limit the formation of UHIs by planting vegetation and trees and reducing the area of paved surfaces, such as parking lots covered with asphalt (Bureau de normalization du Québec, 2013). Other measures that apply to buildings may also be used: vegetation walls, reflective materials, green roofs, or light-coloured roofs (Giguère, 2009).

4.5 NOISE

Noise refers to an unpleasant or annoying auditory sensation; to unwanted sound that can be annoying or harmful to health. When it is produced in the open and affects an entire living community, it is considered to be communal noise. The main sources of environmental noise are associated with locality, with road, air and rail transport, and with industrial activities (Laroche, Vallet & Aubrée, 2003). The population of the Montérégie region reported, in 2006, that road noise was the main source of such noise: about 34% of adults were often exposed and 15% were inconvenienced by it (Tardif et al., 2006).

Depending on its intensity, duration and frequency, noise can result in varying degrees of annoyance. Loud and repeated noises can affect health and quality of life in different ways. In addition to having negative effects on the auditory system, loud noises can disrupt a number of everyday activities, such as communication, work and recreation. When it occurs during sleep hours, noise can be a stressor, cause sleep disorders (Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail, 2013) and have significant physiological and psychological consequences, including increased heart rate,

raised blood pressure and cardiovascular disease. The impact of sleep disorders can also be felt during waking periods the next day and cause increased fatigue, mood changes, anxiety, depression and reduced performance (Berglund, Lindvall & Schwela, 1999; Maynard et al., 2010; WHO, 2009). In children, sleep disorders can lead to cognitive impairment and learning difficulties (Laroche et al., 2003; WHO, 2011).

4.6 EXTERIOR AIR QUALITY

Air quality refers to atmospheric pollution, characterized by the presence of contaminants that are potentially harmful, a nuisance or an annoyance, and the corresponding quantity or concentration of such contaminants. The main source of air pollution is transportation. Indeed, in 2008, in Québec, transportation was responsible for 62% of emissions of major air pollutants (NOx, SOx, CO, VOCs and particulates) (Ministère du Développement durable de l'Environnement, de la Faune et des Parcs, 2011). Particulate pollutants emitted by industrial activities also contribute to air pollution.

The health effects of air pollution are multiple and can include acute respiratory symptoms (cough, irritation and bronchial inflammation) and chronic diseases affecting the cardiorespiratory system (Abelsohn & Stieb, 2011; Quénel, Dab, Bernard, Viau & Zmirou, 2003). Short-term exposure to air pollution mainly exacerbates pre-existing respiratory and cardiovascular diseases (asthma, ischemia, etc.) (Boyd & Genuis, 2008; Brook et al., 2004; Mustafic et al., 2012) and is associated with increased hospital admissions and emergency room visits (Abelsohn & Stieb, 2011; Cakmak, Dales & Judek, 2006). After long-term exposure, increased rates of mortality, lung cancer and pneumonia have been reported (Abelsohn & Stieb, 2011; Brook et al., 2004).

Thus, in 2004, it was estimated that 6,000 premature deaths due to air pollution occurred yearly in the 8 main cities across Canada, which represents 8% of deaths from all causes (Abelsohn & Stieb, 2011). Finally, it should be recalled that outdoor air pollution was recently recognized by the International Agency for Research on Cancer (IARC) as carcinogenic to humans, making it the leading environmental carcinogen, ahead of second-hand tobacco smoke (Loomis et al., 2013).

Air pollution affects the entire population and, more particularly, vulnerable individuals including young children (Krewski & Rainham, 2007), the elderly (Brook et al., 2004), persons with chronic diseases (Brook et al., 2004), persons with low socioeconomic status (Finkelstein et al., 2003) and persons with a low level of education (Cakmak et al., 2006), among others..

For over twenty years, a shift toward sustainable development and active mobility has been underway, and many communities have adopted an active transportation plan or a sustainable transportation plan. However, the automobile remains the predominant means of transportation. Montérégie is the Québec region with the largest number of registered passenger vehicles: between 2006 and 2011, the number of vehicles in the region increased

by 12%, as compared with a population increase of only 5% during the same period.[3] This trend toward motorization, which remains strong, is not without consequences for exterior air quality and population health; from a public health standpoint, initiatives aimed at combating this phenomenon should be encouraged.

[3] Société de l'assurance automobile du Québec, *Fichier des propriétaires de véhicules*, DSP, January, 2013; Institut de la statistique du Québec*, Estimation de la population*, DSP, November, 2013. This data excludes industrial and commercial vehicles, which also travel within the region.

5 ANALYSES AND RECOMMENDATIONS

5.1 TOD NEIGHBOURHOOD

The TOD Neighbourhood, with the development of infrastructure, the establishment of public transit services, and its layout of streets, walkways, bicycle paths and urban parks and green spaces, is likely to influence future residents' health and quality of life. The characteristics listed above and included in the plans for the TOD Neighbourhood are successively described below in terms of their respective impacts on the health determinants previously discussed. Thus, the aim of the following analyses is to anticipate the potential impacts of the main features of the TOD Neighbourhood and develop recommendations for enhancing their *health outcomes*.

5.1.1 Public transit infrastructure and services

The health impacts of public transit (PT) are numerous. Compared to individuals who commute by car, public transit users are more likely to be physically active (Besser & Dannenberg, 2005) and less likely to be involved in a motor vehicle crash resulting in injury or death (Beck, Dellinger & O'Neil, 2007), and they contribute less to pollution (Société de transport de Montréal, 2003). Therefore, the construction of bus platforms and park-and-ride lots in the TOD Neighbourhood could make a significant difference in the health and quality of life of potential PT users and residents in adjacent neighbourhoods. To ensure these potential impacts are taken into account, the following analyses detail the nature of the impacts associated with PT infrastructure and services, and outline measures aimed at maximizing their use and reducing any associated risks or nuisances.

5.1.1.1 Public transit services

The Roussillon intermunicipal transportation committee (Comité intermunicipal de transport (CIT) de Roussillon), which represents the local municipalities of Sainte-Catherine, Saint-Constant and Delson, offers a network of eight local routes and five regional routes, which primarily provide Monday to Friday rush-hour service. For its part, the Agence métropolitaine de transport (AMT) offers four commuter rail stations and one park-and-ride lot, along with an express bus service between Montréal and the South Shore, within the same territory. Despite the presence of these bus routes, train stations and a park-and-ride lot, PT use in all three municipalities remains quite limited. According to the AMT's 2008 origin-destination survey, only 4% of daily trips involve the use of PT, whereas cars and active modes of transportation account for 81% and 15% of trips, respectively (Table 1). Even though public transit use has jumped 10% during the morning rush hour, private vehicles still remain the dominant mode of travel (Table 2).

Moreover, despite the availability of bus routes that provide local service, the AMT study shows that PT use for trips within local municipalities is either nonexistent or limited, and that PT is used primarily to travel to and from Montréal and the South Shore. The same survey reveals that although local municipalities are the destination for the largest share of trips made, Montréal and the South Shore represent the second most popular destinations, accounting for 28% of daily trips and 42% of trips made during rush hour.

Table 1 Modes of transportation per day by final destination, individuals aged 5 years and older

Final destinations / Modes of transportation	Sainte-Catherine, Saint-Constant and Delson	Montréal and South Shore	Other	Total
Automobile	41%	24%	16%	81%
Public transit	0%	4%	0%	4%
Walking and cycling	15%	0%	0%	15%
Total	56%	28%	16%	100%

Note 1: One trip using multiple modes of transportation is factored in for each mode.
Note 2: Other modes of transportation have not been included (taxi, motorcycle, paratransit, etc.).
Source: AMT, 2008.

Table 2 Modes of transportation used during morning rush hour by final destination, individuals aged 5 years and older

Final destinations / Modes of transportation	Sainte-Catherine, Saint-Constant and Delson	Montréal and South Shore	Other	Total
Automobile	30%	32%	14%	76%
Public transit	0%	10%	0%	10%
Walking and cycling	14%	0%	0%	14%
Total	44%	42%	14%	100%

Note 1: One trip using multiple modes of transportation is factored in for each mode.
Note 2: Other modes of transportation have not been included (taxi, motorcycle, paratransit, etc.).
Source: AMT, 2008.

Considering the overall health benefits of PT, it would be highly beneficial to encourage future TOD Neighbourhood residents to make more frequent use of such services than do their fellow citizens in Sainte-Catherine, Saint-Constant and Delson. In addition to the establishment of a bus rapid transit system between Montréal and the South Shore, and the reduction of tariff barriers to encourage newcomers to adopt PT as their mode of transportation, it would be appropriate to introduce a range of complementary measures designed to enlarge the pool of prospective PT users. These measures, which would extend beyond the TOD Neighbourhood's boundaries, would encourage all residents from adjacent sectors to adopt a more physically active lifestyle focused around walking, biking and using PT as opposed to driving.

With this in mind, and to increase PT use among TOD residents, the number of residential parking spaces in the neighbourhood should be limited. In fact, given that the level of household car ownership is directly influenced by the number of parking spaces available,

and that the latter is a key determinant of PT use (Dieleman, Dijst & Burghouwt, 2002; Pinjari, Pendyala, Bhat & Waddell, 2007), it would be advisable to review the relevance of creating 1,140 residential parking spaces in Phase 1 and 1,887 spaces in Phase 2. The ratios of 1.9 and 2.0 spaces per household,[4] for Phases 1 and 2 respectively, could be revised downward to 1.5 spaces per household. This 25% reduction in parking spaces would better support the demand for public transportation as well as minimize the impacts of car use on road safety and noise. Moreover, given that the standard dimension of a parking space is 2.7 m by 5.5 m (14.85 m²), the 472 fewer spaces planned for in Phase 2 would allow 7,000 m² of paved land to be converted into parks and green areas.

A second measure to be considered is the development of pedestrian walkways and bike paths between the TOD Neighbourhood and the existing neighbourhood to the east. This initiative, in addition to increasing the potential for active travel in the sector and reducing the risks and nuisances associated with road traffic, would allow close to 850 households (dwellings) to easily access the bus platforms by foot and 8,000 households (dwellings) to access them by bicycle in 15 minutes or less. To illustrate, Figure a (Appendix 2) shows that the development of such passageways would significantly increase the number of households in Sainte-Catherine with easy access to bus platforms, i.e., within 15-minutes walking distance, without having to take Route 132 or any other detour that could potentially act as a deterrent. Figure b (Appendix 2) presents the 3-km territorial expanse centred around the bus platforms and the vast potential for active bike travel that the development of such passageways would generate.

Finally, the third measure relies on the fact that residential density is a factor which supports the use of public transit. Given that the capacity to offer and maintain frequent PT service is dependent on ridership demand, higher density neighbourhoods in the perimeter immediately adjacent to the future neighbourhood would increase the pool of potential PT users. However, the average residential density within the TOD zone of Sainte-Catherine,[5] where industrial, commercial and low-density residential areas make up 70% of the total land area (see Figure 9), could hinder the establishment of an efficient PT system. Despite the 45 dwellings per hectare (DPH) residential density planned for the TOD Neighbourhood, the 15 DPH average calculated for the entire TOD zone will fall below the threshold of 17 DPH, which is regarded as the minimum standard for developing and maintaining an appropriate level of PT service (minimum frequency of 30 minutes) (Institut national de santé publique du Québec, 2014; Congress for the New Urbanism, Natural Resources Defence Council, U.S. Green Building Council and Canada Green Building Council, 2009; Cervero et al., 2004). To increase the pool of potential PT users and support the service development process, focus should be placed on gradually increasing the residential density of existing neighbourhoods, until it reaches at least 17 DPH.

[4] A ratio of 1.9 parking spaces per residential unit in Phase 1 (1,140 parking spaces for 606 residential units) and 2.0 spaces per unit in Phase 2 (1,887 spaces for 948 residential units).

[5] The delineation of the TOD zone is based on the existing PT infrastructure's area of influence, which is defined as a 500-m radius area in the case of a bus rapid transit (BRT) system.

Figure 9 Boundary of the planned TOD zone in Sainte-Catherine

Source: Municipalité régionale de comté (MRC) de Roussillon, 2013. Sheet 14d, Zoning project 170, © MRC de Roussillon. All rights reserved.

5.1.1.2 Public transit infrastructure

Despite the mainly positive impacts that bus platforms and park-and-ride lots have on PT use, this infrastructure could also generate negative health impacts. In fact, it is conceivable that the 288 park-and-ride spaces and the bus platforms would increase traffic to such an extent as to generate significant noise levels and also increase the risk of collision for bystanders and residents in the surrounding communities.

For this reason, special attention should be paid to pedestrian walkways and bike paths that cross intersections frequently used by buses and vehicles entering the bus bays or park-and-ride lots. The intersections of concern are contained in the red boxes in Figure 10. Moreover, ensuring superior-quality soundproofing of nearby residential buildings would greatly aid in minimizing noise pollution from increased traffic volumes in the area of the bus platforms. This level of building quality would help limit residents' exposure to potentially excessive nuisance noise.

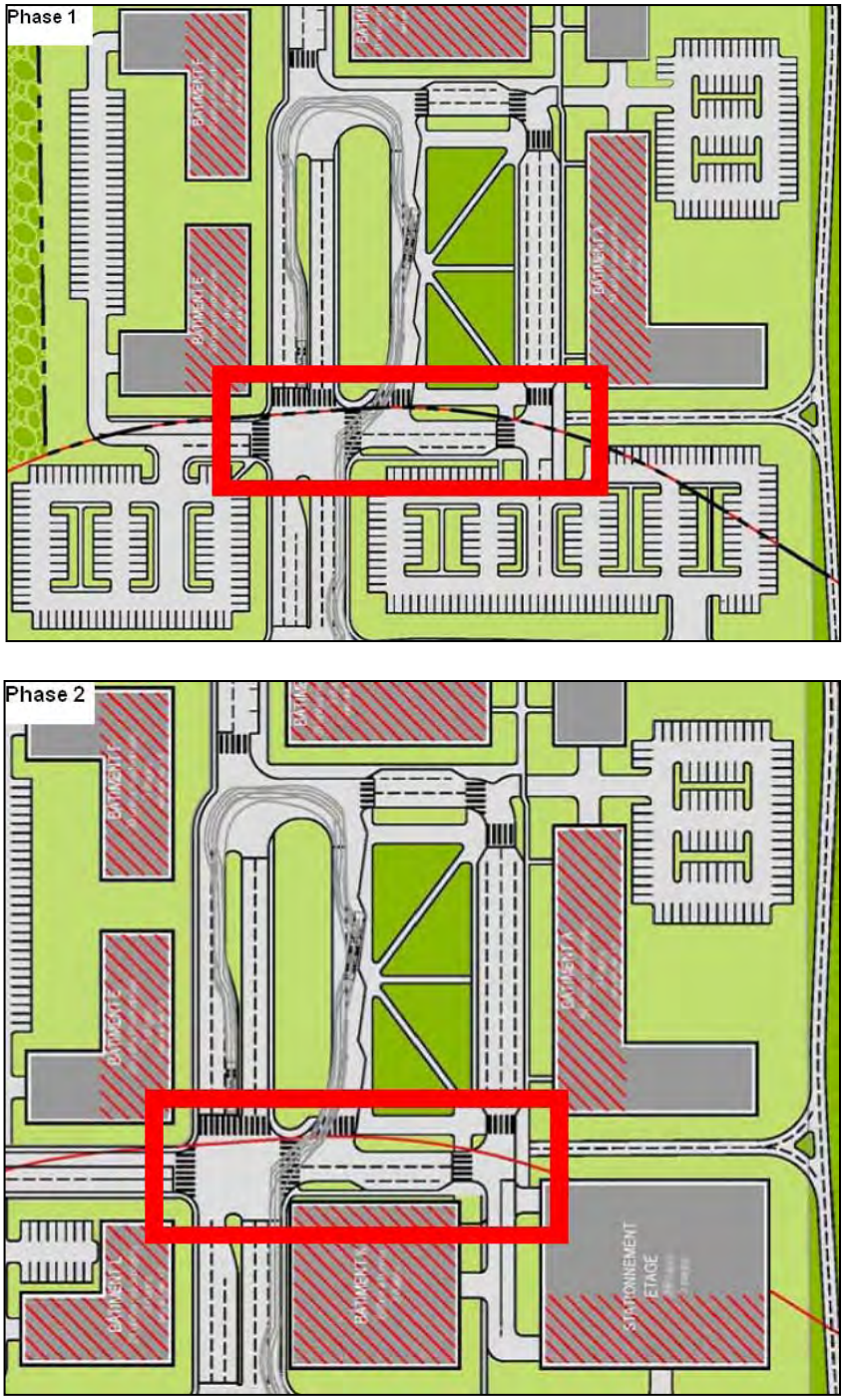


Figure 10 Proposed design for bus platforms and park-and-ride lots, Phases 1 and 2

Source: adapted from Ville de Sainte-Catherine & Plania, 2013.

In addition to affecting road safety and noise, the park-and-ride lots could also lead to the creation of urban heat islands, which would negatively impact residents of bordering streets. Like many examples of parking lots having successfully reduced their environmental footprint

(CMM, 2013), the Sainte-Catherine lot could be designed to incorporate green spaces and rainwater retention basins (in Phase 1), and the multi-level parking structure (in Phase 2) could be constructed of light-coloured materials and greened with vegetation or placed beneath ground.

Three measures could be advanced in order to maximize the number of park-and-ride users and increase the modal share of PT. Accordingly, it would be advantageous:

- to reserve at least 10% of parking spaces for carpool participants, as recommended by LEED-ND (Leadership in Energy and Environmental Design for Neighbourhood Development) (Congress for the New Urbanism et al., 2009) and as is already done in several Québec cities, including Boisbriand;[6]
- to reduce the size of parking spaces by 10% (from the standard dimensions of 2.7 m x 5.5 m to 2.7 m x 5.0 m), bringing them in line with the new standards for parking lot design issued by Québec's standards council, the Bureau de la normalisation du Québec (Bureau de normalisation du Québec, 2013). This (if it is not already planned) would help maximize the capacity of the park-and-ride lots. Hence, this measure would either reduce the overall size of the lot or increase the number of cars that park in the lot; and
- to integrate shelters that provide indoor parking facilities for bikes, similar to the Bikezone shelter at the Deux-Montagnes station.[7] These bike shelters, which could also be set up close to bus platforms, have the potential to increase the number of active transport trips (made by bike), over distances of 3 to 8 km, consequently reducing motor vehicle use to and from the site (Winters, Brauer, Setton & Teshke, 2010; Flamm & Rivasplata, 2014; Dalhousie University, Capital Health, IWK Health Centre & Saint Mary's University, 2012; City of Ottawa, 2013).

Other innovative forms of land use and planning, such as the installation of charging stations for electric cars, the use of photovoltaic panels to generate the energy required to operate buildings, the sharing of parking lots with other organizations, or the implementation of universal accessibility measures (ramps, traffic control devices, etc.), are becoming more widespread in the U.S., Europe, and Québec. In reference to this trend, a compendium of good practices for parking facility planning and design, entitled the *Recueil d'exemples de bonnes pratiques en aménagement de stationnement* and published in 2013 by the CMM, presents several concrete examples that are particularly encouraging (CMM, 2013).

Recommandations

1. Collaborate with the CIT Roussillon and the AMT to establish a public transit service as soon as construction of the TOD Neighbourhood commences and to review the plans based on the evolving needs of the new residents.
2. Limit the residential parking ratio to 1.5 lots per residential unit.
   - 2.1. Reduce the number of on-street and off-street parking spaces in order to limit the amount of paved surfaces and prevent the creation of urban heat islands in the TOD

[6] For more information, visit the following websites: http://www.rive-sud.covoiture.ca/index.asp?Action=Logiciel_Covoiturage; http://www.boisbriand.covoiturage.ca/ and http://www.covoiturage.ca

[7] The AMT installed a Bikezone at the Deux-Montagnes station: http://www.amt.qc.ca/velostation

Neighbourhood.

2.2. Implement measures for greening outdoor residential parking lots in order to prevent the creation of urban heat islands.

3. Create at least one pedestrian walkway and one bike path between the TOD Neighbourhood and the existing neighbourhood to the east (rue Barbeau).
4. Collaborate with the AMT to reserve 10% of all parking spaces (in the future park-and-ride lot) for carpoolers.
5. Set up a secure bike parking station, close to the park-and-ride lot, for cyclists who want to make use of public transit.
6. Increase density in residential sectors adjacent to the TOD Neighbourhood to increase the number of potential users of the bus service offered at the station.
7. Proceed with the greening or underground design of the multi-level park-and-ride structure in order to prevent the creation of urban heat islands.
8. Offer all buyers of a new residential unit in the newly developed TOD Neighbourhood a 12-month CIT Roussillon or AMT transit pass for free or at reduced rates—to encourage widespread use of public transit right from the start. For more information on this subject, consult the LEED for Neighbourhood Development (Congress for the New Urbanism et al., 2009).

5.1.2 Design of streets, walkways and bikeways

Street, pedestrian and cycling networks, along with the street furniture that accompanies them, are able to influence transportation safety, the practice of physical activity, citizens' sense of security and social contact among citizens, as well as help prevent the formation of urban heat islands and improve outdoor air quality. To create neighbourhoods that foster health and quality of life, transportation infrastructure (for vehicles as well as for pedestrians and cyclists) must meet the following development criteria.

1) Sidewalks:

A width of 1.8 m is recommended to ensure pedestrian comfort and allow two people to pass easily; a width of 1.5 m may, however, be considered if the sidewalk is clear of obstacles that could hinder the movement of pedestrians (American Planning Association, 2009; National Center for Environmental Health, 2009; Vélo Québec, 2010). A protective border of greenery of at least 0.5 m can be added between the road and the sidewalk to enhance the safety and comfort of pedestrians. During winter, the removal of snow and ice on sidewalks and pathways is essential to encouraging active modes of travel and preventing falls, especially for people with disabilities, seniors and persons pushing a stroller.

2) Bike lanes:

On streets, it is preferable to install unidirectional lanes with a minimum width of 1.5 m per lane and to provide an additional 0.5 m to allow the necessary clearance for opening doors when there is parking along the street (Ministère des Transports du Québec, 2011). Bidirectional lanes, which are considered less safe, are to be avoided because they lead cyclists to travel in the opposite direction to motorized traffic and can produce many conflicts among users as well as visibility problems. On streets with parking, ideally, bike lanes should be placed between motorized traffic lanes and parking spaces in order to increase the

visibility of cyclists, but they can also be placed between parking spaces and the sidewalk, provided there is a minimum parking-free area of 20 m before each intersection. A separate bicycle path, that is, one that allows cyclists to travel separately from vehicles (not on the roadway), should have a minimum width of 2.75 to 3 m and include safety features that ensure good visibility when roadways are crossed (Ministère des Transports du Québec, 2011). Finally, it should be noted that cycling facilities which are poorly designed, especially at intersections, are more dangerous than an absence of cycling facilities, especially when those facilities create confusion among cyclists and motorists, leading to unpredictable and potentially dangerous behaviour.

3) Multipurpose lanes:
Infrastructure intended for several types of active users (pedestrians, cyclists, rollerbladers and others) should take into account traffic volumes to avoid confusion and potential conflicts. Such lanes can be installed where the number of pedestrians and cyclists using them is low and cohabitation is possible. However, it is preferable to place footpaths parallel to bike paths or to widen pathways to 4 m (Vélo Québec, 2010) on high-volume paths, to reduce the risk of collision for pedestrians (Jordan & Leso, 2000; Reynolds, Harris, Teschke, Cripton & Winters, 2009).

4) Pedestrian traffic signals:
To maximize the safety of pedestrians crossing the street, vehicles should not be allowed to enter the intersection or to turn when pedestrians have the signal to cross. It is highly preferable to install pedestrian signals that offer complete protection throughout the signal cycle, or at least during the first phase of the cycle. Pedestrian signals should be long enough to allow persons with reduced mobility to cross the street at a speed of 0.9 m/s (Ministère des Transports du Québec, 2011). In addition, when pedestrians have the signal to advance, a right turn on red (RTOR) should be forbidden to vehicles, since this increases more than threefold the risk of collision for pedestrians (Conférence des régies régionales de la santé et des services sociaux du Québec, 2000). For reasons of safety, the RTOR should not be allowed at intersections with one or more of the following characteristics: the presence of a pedestrian signal; the presence of a school corridor, a school, a park, a CPE [daycare centre], a hospital or a retirement home; the presence of a bike lane.

5) Street furniture and greenery:
Street furniture, such as benches, tables and trash receptacles, and vegetation along the busiest pedestrian and bicycle routes help increase their use, encourage formal and informal social contact among citizens, increase their sense of security and promote safe, active travel (Dannenberg, Frumkin & Jackson, 2011; Burney, Farley, Sadik-Khan & Burden, 2010; Gehl, 2012; Vida, 2011). When placed so as to provide rest areas along popular routes, preferably every 400 m, street furniture encourages citizens, especially the elderly, to walk more frequently and for longer distances (Barton, Grant & Guise, 2010). Planting trees along streets, except at intersections, increases shade, enhancing the comfort of people using the sector, while helping to reduce the speed of motorists by reducing their field of vision (American Planning Association, 2009; Center for Applied Transect Studies, 2003; Congress for the New Urbanism et al.,2009; Smart Growth America, 2007). To increase safety and

feelings of security, it is also preferable to avoid the presence of obstacles that reduce the field of vision, particularly at intersections, and in dark places where an individual can hide.

6) Lighting:
Lighting increases the field of vision of pedestrians and cyclists, allowing them to identify potential obstacles and hazards on their route. On little used routes, a light intensity of 5 lux is sufficient, whereas an intensity of 20 lux is recommended on busy routes, making it possible to perceive a person's face at a distance of 20 m (Vélo Québec, 2010). To add to the comfort of users, it is preferable for streetlamps not to exceed 6 m in height, ensuring sidewalks are well-lit and glare is minimized.

5.1.2.1 TOD Neighbourhood network

The arrival of 948 households and the development of more than 2,000 parking spots, of commercial spaces and of bus platforms will likely result in a large volume of motorized, pedestrian and bicycle traffic throughout the TOD Neighbourhood. In addition, the extension of rue Léo to boulevard Saint-Laurent will certainly attract through traffic and increase motorized traffic in the neighbourhood.

The TOD Neighbourhood project calls for the development of long and winding streets lined with sidewalks and a bike path along the east side of the development. The project plan also includes devices for discouraging motorized through traffic and controlling speeds on the two north-south axes, including:

- Horizontal deflections (chicanes) beside the park to slow down traffic;
- A fork making the route through the neighbourhood less direct and less attractive to through traffic;
- Numerous curb extensions that can slow down traffic and make pedestrians more visible;
- Parking spaces along streets that narrow the width of the street and help to reduce speeds.

These traffic-calming devices could usefully be installed throughout the TOD Neighbourhood, drawing inspiration from the *Zone 30* concept. The core idea of this concept is to foster a friendly and safe environment for pedestrians and cyclists, by designing streets in a way that prioritizes local circulation and reduces nuisances associated with motorized traffic. When applied at the neighbourhood and district levels, the *Zone 30* concept improves the potential for active travel in those areas.

The integrated development approach of the *Zone 30* concept (an example of which is illustrated in Figure 11) involves creating facilities that promote the cohabitation of different types of road users. Because traffic signals alone do not suffice to lower traffic speeds, and police interventions are too isolated to bring this about, physical devices must be used to create a road environment consistent with the speeds desired. To this end, street widths should be reduced and physical constraints should be added, such as curves and road deflections (chicanes) so that drivers will reduce their speed.

Figure 11 Candiac sector designed to limit speed to 30 km/h

Photo credit: Gabrielle Manseau

As shown in Figure 12, the likelihood of a pedestrian dying due to collision with a car is significantly reduced when vehicle speed falls below 30 km/h, compared to when vehicle speed is 50 km/h (10% and 60% respectively) (de Gonneville & Martin, 2006; Sergerie et al., 2008). For this reason, a street whose speed is limited to 30 km/h through the creation of a *Zone-30* area is safer, and provides a calmer environment for residents and users of active transportation, since noise from motorized vehicles is also greatly reduced.

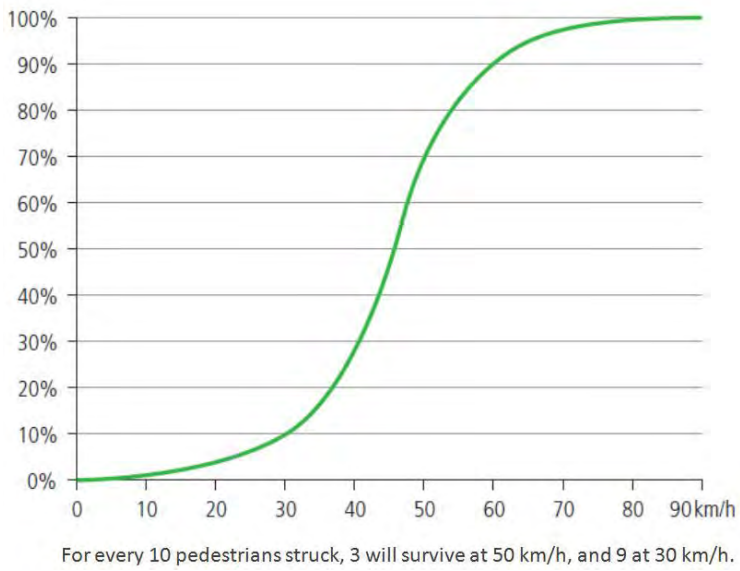


Figure 12 Probability that a pedestrian will die due to collision with a car in relation to speed at impact

Source: adapted from Bureau de prévention des accidents, 2011.

Active travel is also known to be influenced by the number of street intersections and crossings present in a neighbourhood. Given that high street connectivity reduces travel distances and times, it is preferable to design road networks that include a minimum of 54 intersections per km^2 (Congress for the New Urbanism et al., 2009). The TOD Neighbourhood project appears to have a sufficient number of intersections.[8] In fact, at the end of Phase 2, the neighbourhood will cover an area of 0.21 km^2 (21 hectares) and include more than 11 street intersections and crossings. However, these intersections being mainly located in the southern part of the neighbourhood, the northern section has a lower level of connectivity.

To overcome this lack of connectivity in the northern section of the TOD Neighbourhood and facilitate east-west travel for pedestrians and cyclists, it would be beneficial to transform outdoor residential parking areas into laneways laid out according to the principles of a *woonerf*. Reducing the number of outdoor residential parking spaces, as was discussed previously, would make it possible to integrate the remaining spaces into *woonerf* laneways (see Figure 13). *Woonerfs* represent an approach aimed at giving greater priority to pedestrians and cyclists, as compared with motor vehicles, by balancing the interests of users sharing public roads in residential areas. This approach, designed for laneways or parking areas where residents drive at low speeds (see Figure 14), prioritizes living environment over vehicle movement. It fosters community life and creates a safe play environment for children and rest areas with greenery, while keeping some parking spaces for vehicles.

[8] A result of 54 intersections per km^2 is equivalent to 11 intersections for a 0.21 km^2 sector.

Key:

Possibility of a *woonerf* laneway

Figure 13 Location of possible *woonerf* laneways in the TOD Neighbourhood

Source: adapted from Ville de Sainte-Catherine & Plania, 2013.

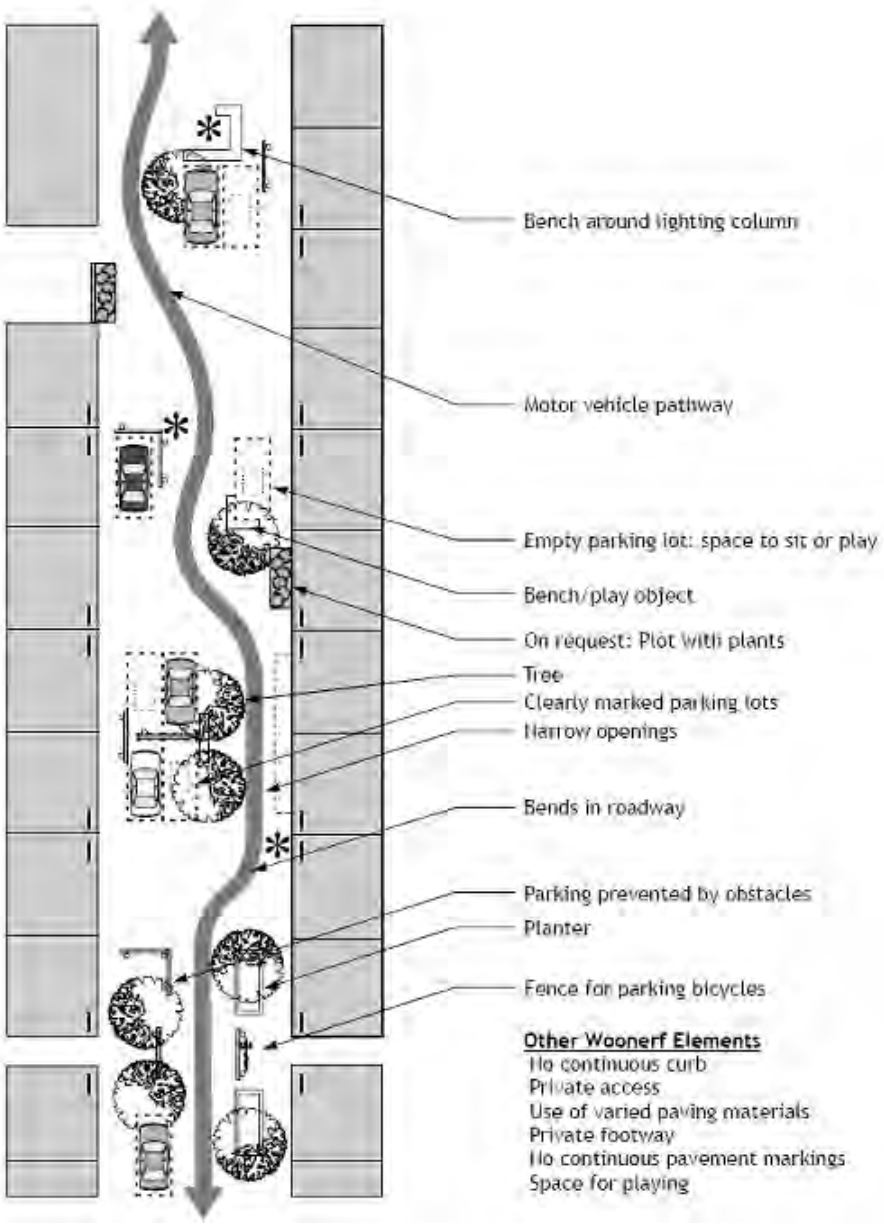


Figure 14 Schematic of a typical *woonerf*

Source: Federal Highway Administration, 2006.

Another factor likely to promote active modes of travel, including walking, is the high residential density of the TOD Neighbourhood and the close proximity of numerous shops, services and other infrastructure. It is therefore essential to ensure a safe environment for pedestrians and, in doing so, to achieve the goals of the *Zone 30* approach. The installation of 1.5- to 1.8-m wide sidewalks on both sides of all streets, of a protective strip of greenery between these and the street, and of textured and raised crosswalks at regular intervals on the streets and at intersections would make pedestrian travel safer.

In addition, active travel by bicycle will be facilitated by the bike path that crosses the residential area from north to south and provides access to the shops and public transit services. However, its integration into the neighbourhood does not seem optimal: it is not connected to the bike path in the adjacent neighbourhood, it seems discontinuous and it ends at pedestrian crossings and streets and even at Route 132. This configuration could place cyclists in danger if adequate facilities are not designed to fully integrate cyclists with motorized traffic, in particular, on the section of the path that ends at the commercial sector, near the bus platforms. A specific facility should be designed for this area to allow cyclists to merge onto the street, in the same direction as traffic. In the absence of a reserved bike lane, it is necessary to make sure that the pavement properly accommodates the various users and that the speed and flow of vehicles are limited, so that cyclists can travel there comfortably and safely.

The planned bike path seems to be located in a green strip and does not appear to cross either streets or parking entrances or exits. This configuration makes the risk of collision with a vehicle almost nonexistent. On the other hand, the ending of the bike path at Route 132, where the only facility “amenable” to cyclists and pedestrians is a narrow shoulder that could well disappear with the construction of express lanes for buses, is troubling from a safety standpoint. This concern is also justified by the absence of a passage into the adjacent neighbourhood southeast of the project.

Moreover, considering that this bike path will likely be used by pedestrians, it would be desirable to run a walking lane parallel to the bike lane or to widen the bike path to 4 m and identify it as a multiuse path. Also, because this track is recessed and will possibly be bordered by the fences of neighbouring homes, it is necessary to install lighting. This lighting would enhance the safety of users, who might be afraid to use the path at times when it is less frequented. However, to prevent the lighting from bothering neighbouring residents, it would be preferable to direct light beams toward the ground and to limit their intensity to 5 lux (Vélo Québec, 2010).

In addition to the cycling network, the presence of bike racks near the shops, near the bus station, in parks and also in residential parking areas is essential to encouraging active transportation (Congress for the New Urbanism et al., 2009). Ideally, bike racks would be placed in covered areas to protect them from the weather and would be positioned near main entrances. In the case of homes, facilities that protect against theft (lockers or indoor spaces) are also desirable.

5.1.2.2 Surrounding neighbourhoods

The surrounding neighbourhoods are also likely to be affected by the influx of households and the establishment of shops and bus platforms in the TOD Neighbourhood. One effect, in particular, will be an increase in travel. For this reason, it seems important to identify certain nearby intersections and street sections where the development of the TOD Neighbourhood could lead to an increase in traffic. Figure 15 shows the location of all motor vehicle collisions

involving pedestrians and cyclists for the period 2006 to 2011,[9] but the following three sectors are the main ones that should be considered:

- The section of boulevard Saint-Laurent between rue Barbeau and rue du Parc, particularly the intersection with rue Central, where the record shows 9 pedestrians or cyclists were injured. This stretch will certainly be used by residents wishing to walk or bike to the shopping centre and the grocery store located between rue Union and rue du Parc.
- The intersections crossed by the bike lane going along Hydro-Québec's right-of-way toward the Saint-Jean and de l'Odyssée schools, the Aimé-Guérin civic centre, the Equinox youth centre, and the Terry Fox and Fleur-de-Lys parks: rue Cherrier and rue Centrale. In this sector, 4 pedestrians or cyclists were reported injured.
- The Smart Centre parking lot, located south of Route 132, where 3 were reported injured, is an environment that is ill-suited for pedestrians and cyclists, despite the presence there of several utilitarian businesses, including 2 grocery stores, a pharmacy and banks.

[9] Note that this portrait underestimates the real situation, because many accidents which occurred in the area under study and which caused injury to pedestrians or cyclists could not be precisely located and accounted for in this portrait. Moreover, accidents involving pedestrians or cyclists who are not transported by ambulance are not included.

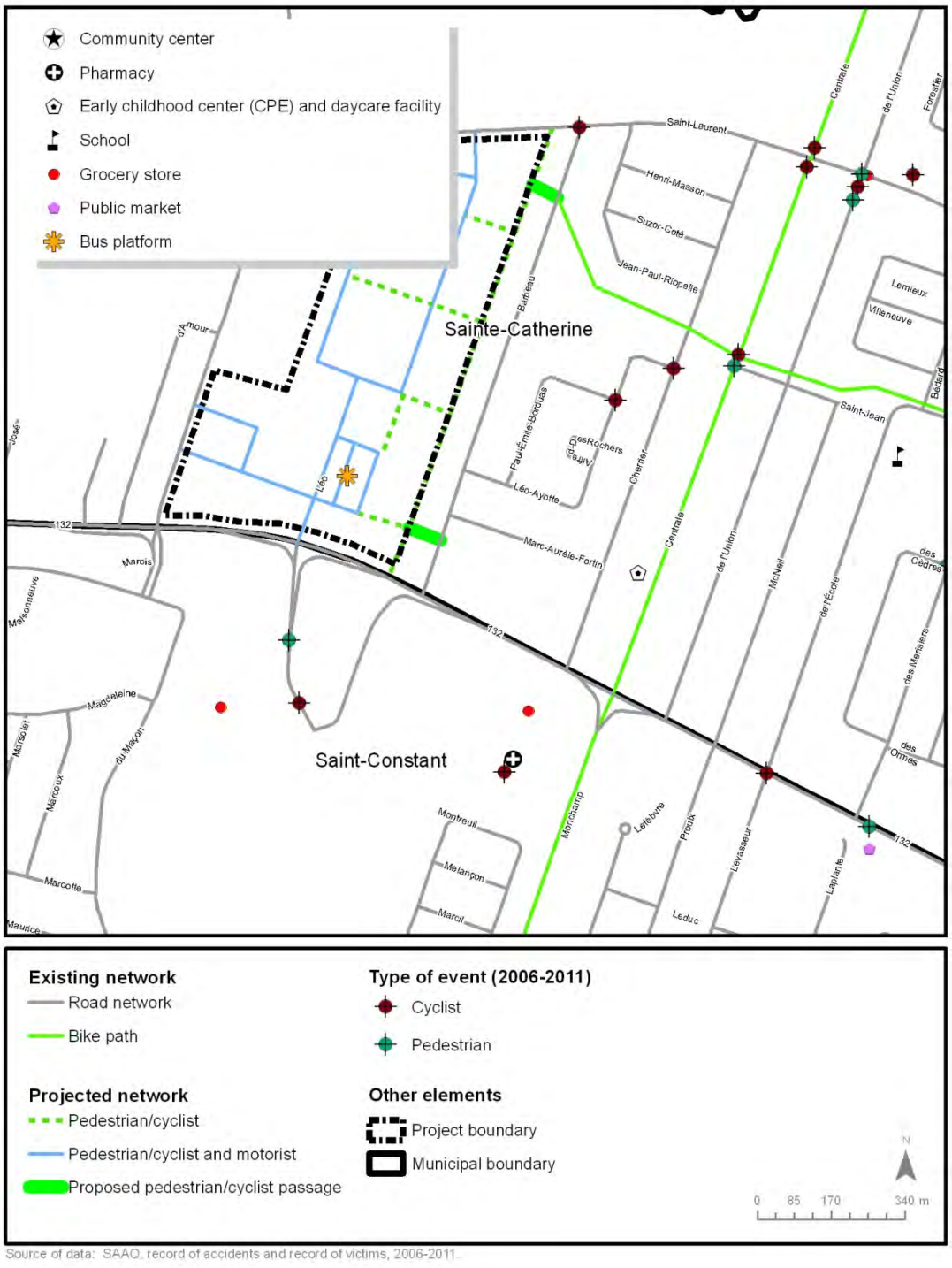


Figure 15 Sites of motor vehicle collisions involving pedestrians and cyclists

Source: DSP Montérégie

With the design of new road allowances and the arrival of new residents and visitors in the TOD Neighbourhood, it is likely that the number of incidents involving pedestrians and

cyclists will increase. Particular attention should therefore be paid to ensuring the safety of facilities so as to minimize the potential for conflict between road users. Doing so will encourage active travel throughout Sainte-Catherine which, in turn, will calm motorized traffic and reduce the risks associated with it.

Utilitarian trips can easily be made on foot for distances within 1.2 km and by bicycle for distances within 3 km (15 minutes for most people); therefore, the installation of crossings to the north and southeast, between the TOD neighbourhood and the existing neighbourhood, would increase the potential for active travel throughout the sector. As shown in Appendix 2, these passages would facilitate access to the main utilitarian destinations in the new neighbourhood, such as businesses and PT services, and would facilitate access to schools, the library, the community centre, parks, daycares and other services located nearby in the adjacent neighbourhood. Such facilities would certainly increase the popularity of active travel, since only 36% of trips of less than 1.2 km and 10% of trips of between 1.2 and 3.0 km are made on foot or by bicycle within the territory of Sainte-Catherine, Saint-Constant and Delson (AMT, 2008).

5.1.2.3 Route 132

In light of the health impacts associated with motorized and active travel, with safety, with noise and with air quality, it is necessary to briefly analyze the issues associated with the proximity of the planned TOD Neighbourhood to Route 132. Indeed, Route 132 is likely to influence the levels of noise and air pollution to which the bordering population is exposed and to pose safety concerns for those using the route.

Phase 1 of the project involves the construction of homes within 80 m of Route 132, which is a major artery. With the completion of Phase 2, the distance between the highway and homes will be reduced to about 10 m. This proximity, combined with an average daily traffic flow of 31,000 vehicles,[10] is likely to expose the bordering population to high levels of noise and air pollutants. This exposure could also be exacerbated by the presence of the industrial park and the port of Sainte-Catherine which, during the summer, entails the daily passage of 800 heavy trucks travelling to or from Route 132 along 1st Avenue, a road bordering the TOD Neighbourhood.

Although, currently, there are no data indicating the precise noise level at about 10 m from Route 132, this artery, characterized as a "zone de niveau sonore élevé" [high noise level zone] by the Roussillon Regional County Municipality (RCM) (see Appendix 3), is currently known to produce a sound intensity level greater than 55 dBA (Leq 24 h). Similarly, a lack of data prevents characterization of the air quality along Route 132, although there is reason to believe that it resembles the poor quality observed near equivalent major arteries. The deterioration of air quality caused by incomplete combustion of motor-vehicle fuel generally extends over a distance of 100 m to 300 m (Brauer, Hystad & Reynolds, 2012; Gilbert,

[10] This estimate is based on data from the Ministère des Transports du Québec, accessed in November, 2013. There being no data on the annual average daily traffic (AADT) along the stretch of Route 132 adjacent to the *TOD neighbourhood*, the average of the traffic volumes on the preceding and subsequent sections was calculated.

Goldberg, Beckerman, Brook & Jerrett, 2005, Canadian Institute for Health Information, 2011; Jerrett et al., 2007; Nuvolone et al., 2011).

With the construction of the TOD Neighbourhood, a high volume of traffic at the corner of Route 132 and rue Léo can be expected. During the morning rush period, the volume of traffic exiting the neighbourhood could easily reach between 1,100 and 1,500 cars if 80% of the cars in the TOD Neighbourhood are used by their owners.[11] Because the main route out of the neighbourhood is rue Léo, there is a risk of major traffic congestion at its junction with Route 132. In addition, the high volume of traffic expected is likely to be slowed by a high number of left turns and by pedestrian and cyclist crossings, both of which require protected phases within the traffic light cycle. Congestion at the traffic light will contribute to increased noise levels and pollutant emissions at this intersection, around which homes are slated to be built. Since idling motors emit more particulate pollutants than moving vehicles (U.S. Environmental Protection Agency, 2010; WHO, 2005), residents near the intersection will be exposed to an increase in air pollutants.

The best way to limit the exposure of residents to noise and air pollution is to distance them from this intersection. Although it is impossible to determine the distance required to reach acceptable levels of noise and air pollutants without carrying out sampling or using modeling techniques, it would be preferable to construct businesses and offices, rather than homes, along Route 132. An acoustic screen formed of buildings, added to the placement of homes about 80 m from the highway, will help reduce the levels of noise and pollutants to which residents will be exposed. This noise mitigation measure will help make it possible to reach the recommended levels, measured at exterior bedroom walls, of 45 dBA during the day and 40 dBA at night (WHO, 2009). The quality of residential construction (foundations, choice of materials, quality of windows, insulation) can also reduce noise nuisances inside homes.

In terms of safety, it is also important to point out that the increase in traffic volumes and the multiplication of left turns at the intersection of Route 132 will increase the risk of potential conflicts (see Figure 16). For this reason, it would be appropriate to install traffic lights with a protected crossing phase for the most vulnerable users, pedestrians and cyclists. A traffic light equipped with bus-detection technology would facilitate bus passage, allowing buses to avoid long waits at the light, and encouraging the use of this mode of transportation.

[11] Estimation based on the number of *residential* and *on-street* parking spaces recommended herein (1,415 spaces), and in the existing plan (1,887 spaces).

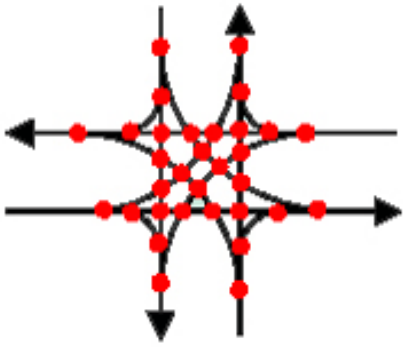


Figure 16 Zones of potential conflict at an intersection

Source: Ministère des Transports du Québec, n.d.

Furthermore, with the completion of the TOD Neighbourhood, it is to be expected that walking and bicycle travel will increase, since active residents will easily be able to access the businesses and services on both sides of Route 132. On the other hand, despite the presence of a crossing signal for pedestrians, this intersection is dangerous for pedestrians and cyclists, because they must cross many lanes that allow a right turn on a red light. In addition, the presence of deflector islands and the absence of a sidewalk along this road, whose authorized speed limit is 70 km/h, increase the risk of collision for active users (number of collisions and severity of injuries). The possible addition on the highway shoulder of a lane for buses (oversized vehicles) will make the intersection still more stressful and dangerous for users of active transportation. Without a complete redesign of this intersection, many people making short trips on foot or by bike could become discouraged and opt for motorized transportation instead.

Due to concerns related to noise, air quality, road safety and active travel, it seems important to adjust the capacity of the intersection and of Route 132 to accommodate the needs of all its users. When they next undergo reconstruction, it would be appropriate to consider various options for redesign, including that of converting existing lanes to bus lanes instead of installing these on the shoulder, that of adding sidewalks, cycle tracks and protective borders of greenery along the road and that of placing a roundabout at the corner of Route 132 and rue Léo, with protected crossings and lights for pedestrians.

Recommendations

9. Design streets in the TOD Neighbourhood based on the Zone 30 concept, to strike a balance between the needs of users of different modes of transportation and to facilitate active travel.
   - 9.1. Allow a maximum speed limit of 30 km/h on local streets.
   - 9.2. Provide traffic-calming devices, such as shorter bend radii, horizontal deflections, chicanes or raised crosswalks, to enforce this speed limit and discourage motorized through traffic.
   - 9.3. Maximize on-street parking for visitors to give drivers the impression that streets are narrower (which would allow some of the planned parking spaces behind backyards to be eliminated).
   - 9.4. Install sidewalks on each side of the street with a minimum width of 1.5 m, but preferably of 1.8 m, with curb cutouts at intersections and crosswalks, as well as a protective border between the street and the sidewalk.
   - 9.5. Plant trees at a minimum distance of every 9 to 12 m, between the sidewalk and the street.
   - 9.6. Provide for the installation of benches, picnic tables and trash receptacles along popular bike paths and walking routes.
   - 9.7. Provide for the installation of lighting along streets, the bike path and in public spaces and opt for human-scale lighting, ensuring visibility for a minimum distance of 20 m and providing 20 lux of illumination, while avoiding creating nuisances for bordering residents.
10. Design woonerfs between parking areas to increase connectivity in the northern sector and facilitate east to west travel for pedestrians and cyclists.
11. Design pedestrian and bicycle networks in a manner that ensures their safety, encourages active transportation and facilitates access to nearby local businesses.
    - 11.1. Install two crossings for pedestrians and cyclists connecting the east side of the TOD Neighbourhood to rue Barbeau, thus facilitating access to adjacent businesses and services.
    - 11.2. Install interconnected infrastructurethat allows pedestrians and cyclists to circulate for minimum distances of 1.2 km and 3 km respectively in the area surrounding the bus platforms.
    - 11.3. Link businesses to bus platforms and homes by way of sidewalks and bike lanes.
    - 11.4. Design the bike path in the eastern section of the neighbourhood according to multipurpose trail standards.
    - 11.5. Place the main entrances of residential and commercial buildings (buildings A to Q) facing the streets (not the parking lots) or, at least, construct secondary entrances on the street side to avoid forcing pedestrians to make a detour.
12. Provide for the installation of protected bicycle racks and storage spaces on the project site, in the garages of multi-dwelling buildings and close to businesses.
    - 12.1. For multi-unit residential buildings (over 24 dwellings), provide bicycle parking spaces for the equivalent of 30% of occupants (Congress for the New Urbanism et al., 2009), which calls for about 190 bicycle parking spaces.
    - 12.2. For commercial buildings, provide at least one parking space per 465 m2 of business surface area, or approximately 40 parking spaces by the end of Phase 2.
    - 12.3. Redesign the three zones identified as problematic for the safety of pedestrians and cyclists, namely, the length of boulevard Saint-Laurent, the length of the school corridor via the bike path following Hydro-Québec's right-of-way and the route for accessing the

shopping centre south of Route 132.

12.4. In collaboration with the City of Saint-Constant and the owner of the shopping centre, redesign the latter's parking lot so as to make it safer and more congenial for pedestrians and cyclists.

13. Redevelop the portion of Route 132 that borders the sector as well as the intersection with rue Léo, to reduce the exposure of future residents of the TOD neighbourhood to noise and air pollution and to improve road safety in the sector.

13.1. Redesign the intersection of Route 132 and rue Léo, in collaboration with the Ministère des Transports du Québec and the AMT, to strike a balance between traffic fluidity and the safety of drivers, cyclists and pedestrians.

13.2. Install devices for protecting pedestrians that take both physical form (e.g., pedestrian islands) and temporal form (e.g., traffic lights with pedestrian phase, ban on RTOR).

13.3. During the conversion of Route 132 into an urban boulevard and the development of bus lanes, install footpaths and bike paths to enhance the safety of pedestrians and cyclists (in collaboration with the MTQ and the AMT).

13.4. Do not increase the number of lanes on Route 132 to limit the increase in traffic volumes.

13.5. During Phase 2 of the project, avoid the construction of homes along Route 132 and place commercial buildings there so as to form an acoustic barrier that helps reduce noise and block the dispersion of air pollutants.

13.6. Program acceptable wait times for pedestrians and crossing times that are adequate for the width of lanes, especially for the young and the elderly (calculated at 0.9 m/s).

13.7. Install traffic lights with radar detection to prioritize bus passage through the intersection.

13.8. Study the feasibility of installing a roundabout to increase traffic fluidity and reduce speed variations.

5.1.3 Parks and urban green spaces

The presence of parks and other urban green spaces contributes in many ways to improving community health and quality of life. On the environmental front, parks and green spaces help improve air quality by replenishing oxygen, and by trapping pollutant particles, dust, heavy metals, and ozone. They also absorb carbon dioxide and lower ambient temperatures, which helps combat climate change and minimize urban heat islands (Vida, 2011).

From a health perspective, the presence of parks is associated with improved self-reported physical and mental health: for every 10% increase in green space there is a reduction in health complaints equivalent to a reduction in age of five years among adults and seniors (de Vries, Verheij, Groenewegen & Spreeuwenberg, 2003). A link has also been established between the presence of parks and lower levels of anxiety, depression and stress (Maas, van Dillen, Verheij & Groenewegen, 2009; White, Alcock, Wheeler & Depledge, 2013). In terms of social cohesion, parks and urban green spaces serve as informal gathering areas where people can forge relationships and develop social networks (Abraham, Sommerhalder & Abel, 2010; Kuo, Sullivan, Coley & Brunson, 1998; Kweon, Sullivan & Wiley, 1998). In fact, people who live closer to green spaces are generally less likely to feel lonely or lack social support (Maas, van Dillen, Verheij & Groenewegen, 2009).

The presence of landscaped areas is also associated with increased levels of walking and physical activity. In fact, a survey conducted in eight European cities found that people who live in areas with high levels of greenery are three times more likely to be active and 40% less likely to be overweight or obese (Ellaway, Macintyre & Bonnefoy, 2005). Similar associations have also been observed among children (Roemmich et al., 2006). To ensure an optimal use of parks, they must contain a variety of facilities and amenities, such as age-appropriate play structures, trails, benches, drinking fountains, picnic tables, and restrooms (Giles-Corti et al., 2005; Kaczynski, Potwarka & Saelens, 2008).

Certain attributes of the built environment surrounding parks, such as street connectivity and higher speed limits (over 50 km/h), can also influence park usage and park-based physical activity (Kaczynski, Koohsari, Wilhelm Stanis, Bergstrom & Sugiyama, 2014). The effects of parks and green spaces on leisure-time physical activity are dependent on a number of attributes, including accessibility and condition (maintenance, presence of facilities and amenities, etc.), as well as perceived and objective measures of park safety (McCormack, Rock, Toohey & Hignell, 2010).

For people to benefit from everything the parks have to offer, the number and size of parks must be consistent with the project's overall goal. In Phase 2, the municipality is planning to develop three parks in the TOD Neighbourhood with a total surface area of approximately 2.1 ha, while the new development will take up 20.9 ha of land and comprise 948 dwellings (households) (Ville de Sainte-Catherine & Plania, 2013). Assuming an average household size of 2.6 people,[12] the ratio of park land per 1,000 residents would be 0.85 ha. Given that this ratio is below the international standard of 2.5 ha per 1,000 residents (Fields in Trust, 2008)—a standard adopted by many Québec municipalities—it would appear that the TOD Neighbourhood is lacking in park space. However, this deficiency will be offset in part by the existing Terry-Fox, Chevaliers de Colomb and Fleur-de-Lys parks, all located within a range of 200 m to 900 m from the TOD Neighbourhood and covering a combined surface area of about 9 ha. These parks also feature several sports facilities, i.e., soccer and baseball fields, petanque courts, and a skating rink and oval. Given the high concentration of multi-unit dwellings planned in the TOD Neighbourhood and the scarcity of private green spaces, parks in the area should be designed as enjoyable, welcoming places where residents can gather for fun or simply to relax and unwind.

A number of measures could be implemented to increase the surface area of parks and green spaces in the TOD Neighbourhood. Among them is a 25% reduction in the number of parking spaces, as discussed previously in the section on public transit, which would increase green space by nearly 7,000 m² (0.7 ha). A second measure consists in reducing the size of parking spaces (from 2.7 m x 5.5 m to 2.7 m x 5.0 m), which would shrink the surface area occupied by the remaining 1,422 parking spaces by 10%, or approximately 2,000 m² (0.2 ha). In addition to reducing the amount of paved surfaces in the area, fewer and smaller parking spaces would also mean that future residents of the TOD Neighbourhood would have access to nearly 2.9 ha of parks and other green spaces (about 1.18 ha per 1,000 residents).

[12] Average size of households reported by the Roussillon RCM.

A third measure would be to green the proposed *woonerfs* in order to transform them into green laneways. This would serve to increase the overall amount of vegetation in the northern section of the TOD Neighbourhood. This greening strategy could also include developing community gardens where residents would grow their own fruits and vegetables at a fraction of market cost, while socializing with other growers. Community gardens would also serve to create shade and consequently reduce ambient temperatures.

Vegetation cover in the TOD Neighbourhood could be further enhanced by the addition of green roofs on top of buildings, including the park-and-ride structures, residential buildings, and commercial properties. The added greenery would help mitigate the urban heat island effect by bringing ambient temperatures down, and improve the energy efficiency of buildings by providing effective insulation (less heat loss in winter).

With regard to park development and recreational facilities, the data were insufficient to allow for any critical analysis. However, evidence suggests that facilities must be adapted to the needs of the various subpopulations (young children, teenagers, seniors), and that basic street furniture, such as benches, tables and street lamps, are required.

Lastly, as recommended in the special provisions applicable to zones H-404 and H-414 outlined in Sainte-Catherine's comprehensive development plan, the *Plan d'aménagement d'ensemble de la ville de Sainte-Catherine* (Ville de Sainte-Catherine, 2009), "the planting of… one tree per housing unit, on municipal right-of-ways along public streets, and on land reserved for parks and green spaces," [translation] will result in a total of 948 trees being planted in the TOD Neighbourhood and consequently help green the communal public spaces.

Recommendations

14. Increase the surface area of parks and green spaces in the TOD Neighbourhood by reducing the number (by 25%) and size (by 10%) of residential parking spaces.
15. Adopt a municipal bylaw (or master plan or policy) to protect parks and urban green spaces in the City of Sainte-Catherine and to strive for 2.5 ha of parkland per 1,000 residents.
16. Develop and green the proposed woonerfs, so they can be used as public spaces for leisure activities.
17. Set up community gardens close to multi-unit dwellings.
18. Ensure the presence of appropriate, safe facilities that are suited to residents' needs, and that encourage people of all ages to participate in physical and leisure activities (e.g., playgrounds for kids, benches, tables).
19. Adopt a municipal bylaw that requires the creation of green roofs, and encourages efforts to increase vegetation cover on larger buildings (or requires the use of white or light-coloured roof coverings that increase reflectance).
20. Plant at least 948 trees throughout the entire TOD Neighbourhood, as recommended in the special provisions applicable to zones H-404 and H-414 outlined in Sainte-Catherine's comprehensive development plan, the Plan d'aménagement d'ensemble de Sainte-Catherine.

5.2 INDUSTRIAL PARK

Cautionary note

The land targeted for the TOD Neighbourhood project is currently zoned for light industrial activities. In order to allow residential use in the sector, the Roussillon RCM must submit a proposal for an amendment to a land use plan to the Ministère des Affaires municipales, des Régions et de l'Occupation du territoire (MAMROT – the ministry of municipal affairs, the regions and the occupation of territory).

Before the TOD Neighbourhood project can move ahead, the MAMROT must determine whether the proposal for a land use plan amendment is consistent with government policy guidelines for land use planning and development. This process requires consultations to be held with relevant departments and agencies; therefore, the Montérégie public health unit (Momtérégie DSP) will be invited to issue an opinion on the matter.

It is important to mention that land use amendment proposals requesting permission to construct residential units in proximity to an industrial sector have in the past drawn negative reactions from the DSP, as well as from other departments and agencies, in particular due to concerns relating to public health, safety and well-being.

Despite this HIA being carried out, the proposal for the land use plan amendment submitted by the City of Sainte-Catherine could still be deemed non-compliant, which is why the two processes must be regarded as independent of one another.

The Sainte-Catherine TOD Neighbourhood project is situated in close proximity to a heavy industrial sector, which includes companies whose activities pose technological risks which have the potential to negatively affect the surrounding environment. This section aims to identify the potential impacts of the activities carried out in the Sainte-Catherine industrial park on the health and quality of life of future residents of, or those transiting through, the TOD Neighbourhood.

The factors described below—tied to the storage of hazardous materials, the transportation of dangerous goods, and industrial developments—were analyzed and formed the basis for recommendations, because their impact on certain determinants of health could be significant.

5.2.1 Transportation and storage of hazardous materials

Under the Environmental Emergency Regulations (E2 Regulations), businesses that handle or store large quantities of hazardous materials are required to notify Environment Canada. The E2 Regulations outline the reporting thresholds for each of the specified hazardous materials, which, due to their flammable or combustible properties and their potentially toxic nature, would constitute a danger to health in the event of an accident or a spill. The same businesses must also implement and test an environmental emergency plan for each site where controlled substances are stored (see Appendix 4).

The TOD Neighbourhood project is bordered to the west and northwest by a heavy industrial sector. This poses technological risks associated with both the nature of the activities carried out and the types of materials stored at the site. Moreover, in addition to the existing businesses, new ones that also handle hazardous materials may move in and set up shop. If

a leak, spill or explosion involving hazardous materials were to occur, the intervention perimeter (evacuation or confinement) could extend into part of the TOD Neighbourhood. That said, the conventional measures for limiting the effects of a potential disaster consist primarily in keeping vulnerable uses away from heavy industrial sectors.

In Sainte-Catherine, four companies have reported inventories equal to or above the established threshold quantities, requiring notification to be sent to Environment Canada in accordance with the E2 Regulations (see Table 3).

Table 3 Sainte-Catherine companies reporting the presence of hazardous materials (and corresponding thresholds) in accordance with E2 Regulations

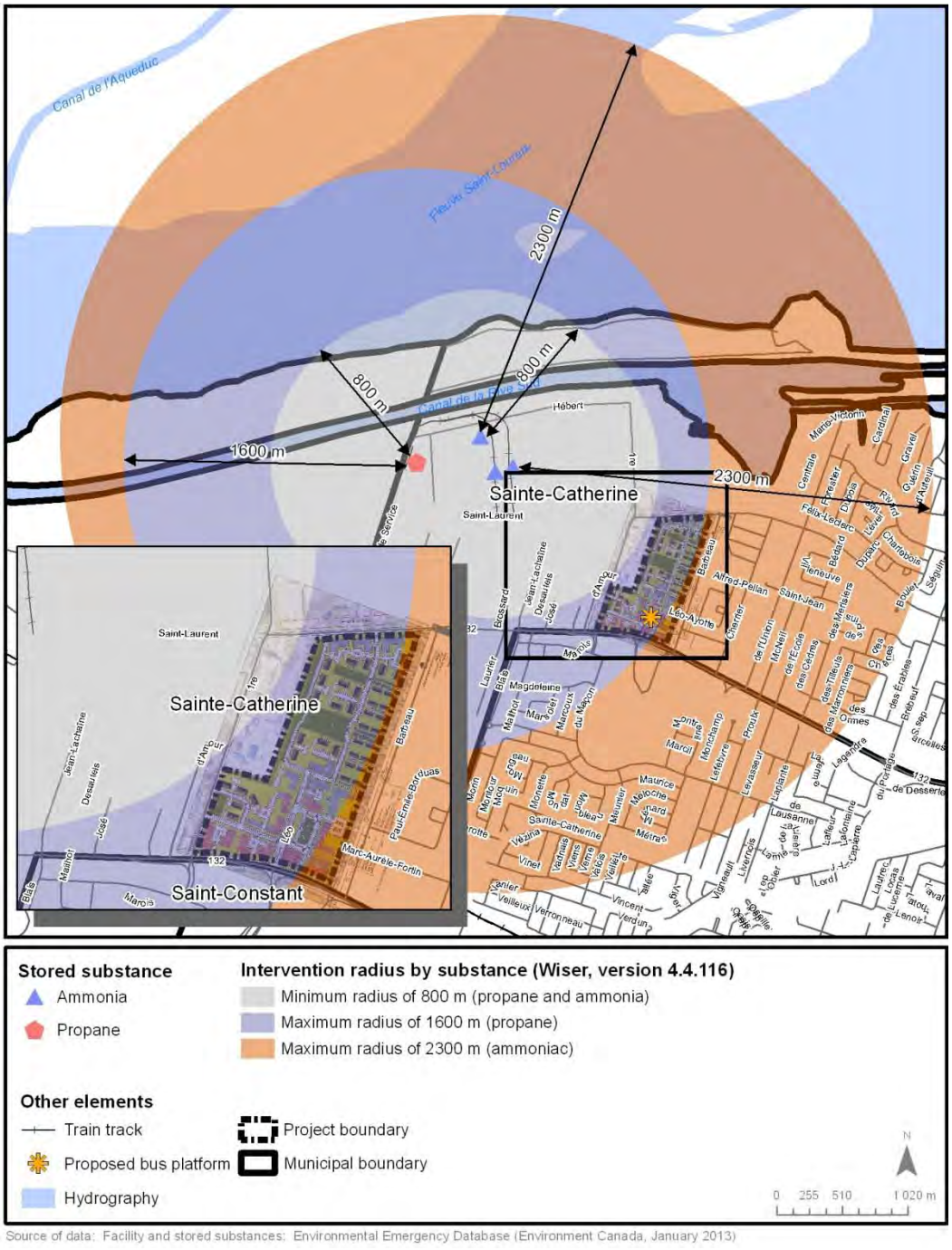
Businesses	CAS registry number / Substance	Maximum quantity (tonnes)	Maximum quantity per container (tonnes)
Centre de distribution de Sainte-Catherine 6605, boulevard Hébert	7664-41-7 Ammonia (anhydrous)	490	70
	7664-41-7 Ammonia (solution)	307	102
Produits Chimiques Anco 6905, boulevard Hébert	7664-41-7 Ammonia (anhydrous)	171	82
	7664-41-7 Ammonia (solution)	132	98
Servichem inc. 6805, boulevard Hébert	7664-41-7 Ammonia (anhydrous)	80	80
Superior Propane a division of Superior Plus LP 600, rue Garnier	74-98-6 Propane	230.3	115.1

Source: Environment Canada, 2011.

In the event of a technological accident, exposure to high levels of ammonia in the air can irritate skin, eyes, throat, and lungs, and cause coughing and burns. Lung damage and death may also occur after exposure to very high concentrations of ammonia.[13] The main hazards associated with propane include fire and explosion. In the case of technological accidents involving propane, the main health risks are exposure to toxic and irritating gases.

As Figure 17 illustrates, in the event of a spill or leak involving ammonia, the recommended intervention perimeter (evacuation or confinement) ranges from 800 m to 2,300 m, depending on the circumstances surrounding the accident (prevailing winds, time of day, etc.). In the case of propane, the recommended intervention perimeter ranges from 800 m to 1,600 m, depending on the nature of the accident (leak or fire) (U.S. National Library of Medicine).

[13] It should be noted that the *Centre de distribution de Sainte-Catherine* ranks second in the Montérégie region in terms of maximum quantity of anhydrous ammonia and ammonia solution stored on site.



Source of data: Facility and stored substances: Environmental Emergency Database (Environment Canada, January 2013)

Figure 17 Map of recommended intervention perimeters (evacuation or confinement) according to specified hazardous substances

Source: DSP Montérégie.

The information collected is insufficient to determine the exact location of the containers of hazardous materials or the boundaries of the property on which they are located. Therefore, the distances between the facilities of concern and the TOD Neighbourhood cannot be established with certainty. However, estimates indicate that the TOD Neighbourhood falls

just inside the outermost edge of the intervention perimeter for both propane (1,600 m) and ammonia (2,300 m).

Moreover, there may be other companies in the sector that store hazardous materials, although in quantities that are below the thresholds set out in the Environmental Emergency Regulations, but which nonetheless pose a technological risk. These companies are not required to be registered; hence, the lack of data makes it difficult to quantify and measure the added technological risk.

For this reason, it would be appropriate, for the development of the TOD Neighbourhood, to have the current zoning designation changed from "heavy industrial" (I2-64.1) to one that presents less risk to the population (light industrial, commercial or multi-functional), at least for the zones in close proximity to the TOD Neighbourhood. This change would provide the means of preventing other companies that handle hazardous materials from establishing their operations too close to the residential area.

The transportation of dangerous goods is another activity that poses a risk, particularly during the loading and unloading stages, and in the event of an accident during transportation. That said, large quantities of hazardous materials are shipped over Canadian roads on a daily basis: In 2008, in terms of tonnage, 70% of dangerous goods were transported by road, compared to 23% by rail and 6% by waterway (de Marcellis-Warin, Trépanier & Peignier, 2013). Due to the nature of its activities, the industrial park attracts and generates substantial volumes of traffic. In fact, it is estimated that 800 trucks enter and exit the site every day during the summer season via 1st Avenue (Ville de Sainte-Catherine & Plania, 2013), and all indications are that many of those trucks carry hazardous materials.

When transporting dangerous goods, shippers are not required to identify the specific materials being transported, provided all laws and regulations relating to the transportation of hazardous and restricted goods have been followed (the federal Transportation of Dangerous Goods Act, 1992 and its Regulations, and the provincial Transportation of Dangerous Substances Regulation (chapter C-24.2, r. 43)). However, given that municipalities are responsible for monitoring hazardous activities within their jurisdictions and, as such, are indirectly responsible for activities associated with hazardous materials, they can adopt bylaws under the Municipal Code of Québec and the Cities and Towns Act in order to propose alternative routes for shipping hazardous material (de Marcellis-Warin et al., 2013). Signage is used to mark the proposed routes to guide drivers through high-risk areas (e.g., a town).

As part of the TOD Neighbourhood project, it would be appropriate to map out alternative routes to guide the large number of trucks carrying hazardous materials away from 1st Avenue, which would reduce the risk to area residents. Two possible options are to direct such traffic onto the service road along the railway track toward boulevard Hébert, or to join up rue Garnier Street, allowing the TOD Neighbourhood to be bypassed completely.

Moreover, given that the Sainte-Catherine industrial park appears to be "isolated and not easily served by municipal water and wastewater services" [translation] (MRC de Roussillon, 2013, Table 2-13), it would be essential to ensure that the basic infrastructure (e.g., a

functional water supply system in the event of fire) is in good working order to protect the population in an emergency.

The effectiveness of the response to a technological accident depends largely on the level of preparedness of the various actors concerned (municipality, fire department, companies, citizens, etc.). A variety of tools, such as environmental emergency plans, risk coverage plans, the creation of a joint municipal industrial committee (comité mixte municipal-industriel or CMMI), along with municipal sirens, would help improve emergency preparedness (see Appendix 5).

Recommendations

Due to the proximity between future residents and certain heavy industries that use and store large quantities of hazardous materials, the recommendations below will not eliminate all risks—instead they outline ways to mitigate and better manage those risks. Thus, the effectiveness of the following recommendations at eliminating the potential risks identified is somewhat limited:

21. Create an accurate mapping of the companies to which the Environmental Emergency Regulations apply and of the other companies that use and store hazardous materials, taking care to include the locations of the hazardous material containers in order to determine their distance from the TOD Neighbourhood.
22. Implement actions and strategies to prevent other companies that use and store hazardous materials from establishing their operations too close to nearby residences. For example, these strategies could include:
    - 22.1. Collaborating with the RCM to clarify the activities permitted in the heavy and light industrial zones, in proximity to the TOD Neighbourhood.
    - 22.2. Taking steps to change the "heavy industrial" zoning designation (I2-64.1), at least for the areas adjacent to the TOD Neighbourhood.
    - 22.3. Adopting a municipal zoning bylaw that outlines which activities are excluded from specific zones.
    - 22.4. Avoiding controversial uses, such as daycares and nursing homes, within the intervention perimeter to ensure the most vulnerable populations are kept distant in the event of a technological accident.
23. Implement action plans and strategies to reduce the nuisances generated by existing industries situated in proximity to the TOD Neighbourhood. For example, these strategies could include:
    - 23.1. Establishing a buffer zone in the southwest corner (on 1st Avenue, at the corner of Route 132), giving preference to the construction of strictly commercial buildings.
    - 23.2. Expanding (initially by 15 m) the buffer zone included in the plan for Phase 2 of the project, and located along the western edge, in particular by protecting the forested area in the northwest corner, by reclaiming previously forested areas that have been cleared (approximately 2/3 of the surface area), and by preventing all construction on the west side of the sector.
24. Propose an alternative route—via the service road along the railway track or by joining up rue Garnier —for trucks transporting hazardous materials.
25. Develop tools for managing the risk of technological accidents and ensure all actors concerned (municipality, citizens, companies, etc.) are well prepared.
    - 25.1. Ensure that all companies identified as having hazardous materials on site have

adopted and updated their emergency plans, as required.

25.2. Establish mechanisms for sharing information and for managing environmental emergency plans, i.e., through the creation of a joint municipal industrial committee (comité mixte municipal-industriel or CMMI).

25.3. Maintain risk coverage plans, ensuring they are kept up to date.

25.4. Ensure that the industrial park's basic infrastructure (municipal water and wastewater network) can effectively protect the population in the event of an emergency.

5.2.2 Industrial nuisances and residential developments

Heavy industrial sectors pose increased health, safety, and quality-of-life concerns for people who live nearby. The industries in these sectors are generally characterized by very large-scale asphalt or concrete infrastructure that can contribute to the creation of urban heat islands. Moreover, the types of activities conducted in these zones traditionally include the transportation of goods, the use of loading and unloading docks, and the circulation of heavy vehicles. These activities constitute significant sources of noise and ambient air contamination.

As Figure 18 illustrates, the TOD Neighbourhood project is located in proximity to large pockets of heat islands. In fact, the entire industrial park constitutes one such heat island (northwest, west, south and southwest of the land earmarked for the project). The heat island's location is problematic from a community health perspective, since a radiant heat effect is created around its perimeter, inside the area identified for residential construction. Moreover, the construction of new buildings in the TOD Neighbourhood and the presence of above-ground parking structures and paved streets are all factors that could increase the total area affected by heat islands.

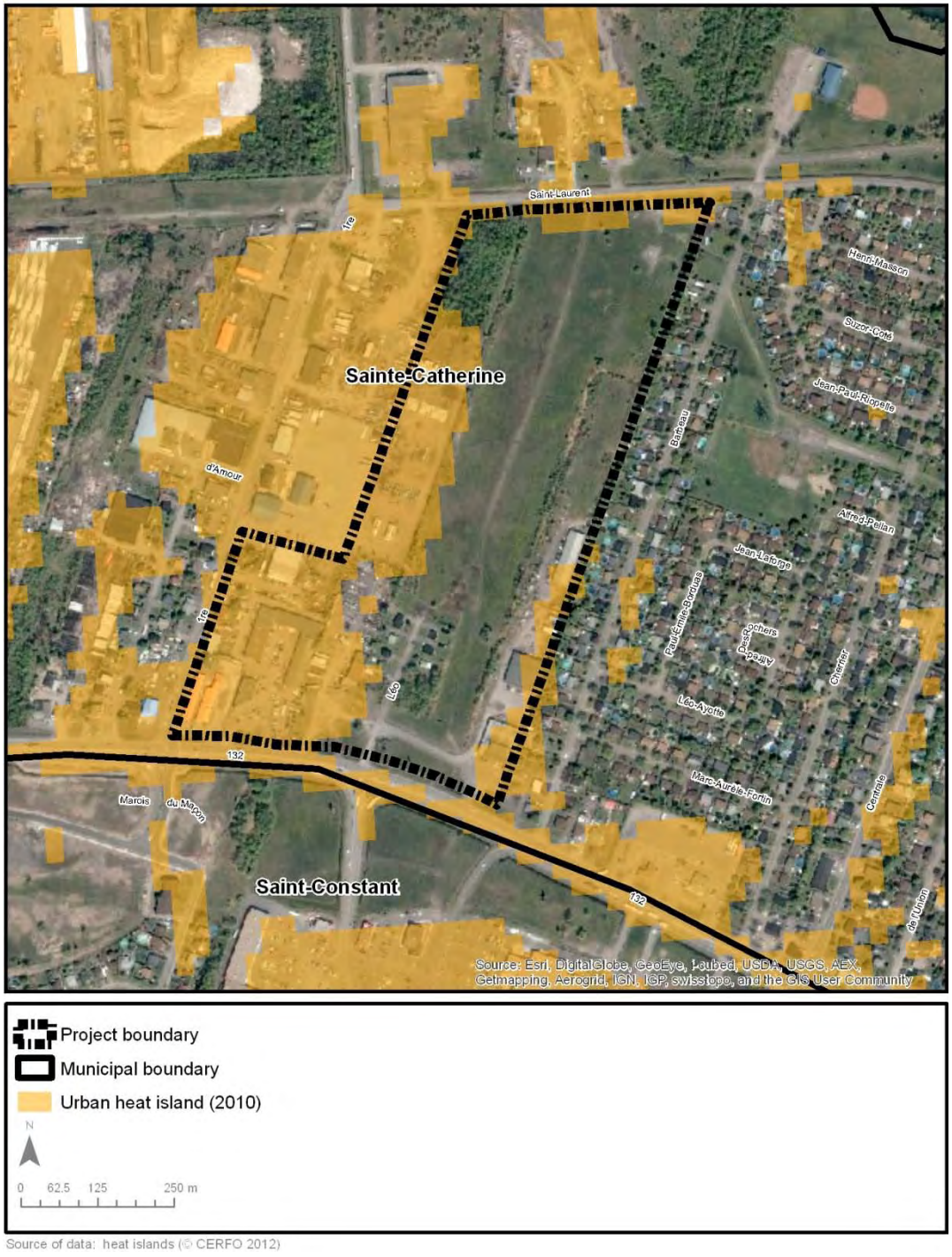


Figure 18 Mapping of the heat islands over the TOD Neighbourhood

Source: DSP Montérégie.

Note also that the industrial park located close to the TOD Neighbourhood project will likely generate noise nuisances due to the heavy truck traffic in and out of the area, the movement of heavy machinery between various sites, as well as the industrial operations themselves. In addition, the railroad tracks providing access to the industrial park, the transhipment of

goods, the frequent locomotive stops and starts, and the coupling and uncoupling of freight cars all represent significant sources of noise. And even more worrisome is the possibility that these industries may continue their noisy operations throughout the night. These same activities would also certainly lower air quality.

The TOD Neighbourhood project plans call for a 15-m buffer zone to be maintained between the industrial park and the TOD Neighbourhood; however, this zone is considered insufficient to effectively reduce noise levels from the industrial park. Note that the project also calls for the installation of a 3-m noise barrier atop a 2.7-m-high embankment along the western perimeter of the TOD Neighbourhood; however, its effectiveness cannot be guaranteed. If it is effective, the planned noise barrier would mitigate noise effects only for residents on the lower floors of buildings located close to the industrial park. It is uncertain whether residents on the upper floors would experience any reduction in noise. In other words, top-floor residents could be adversely affected by high noise levels.

The best way to limit nuisances related to noise is to ensure that areas used for purposes that raise concern (residences, schools, daycares, etc.) are far from the noise-emitting source. However, although the land targeted by the housing development plan separates the industrial park from the existing residential properties, the housing project itself will benefit from a very limited buffer zone, if any.

Given these circumstances, it is imperative that noise mitigation measures be implemented. In instruction memo 98-01, issued by the Ministère du Développement durable de l'Environnement, de la Faune et des Parcs (ministry of sustainable environmental development, wildlife and parks), the noise level limits not to be exceeded over the course of an hour (LAr,1 h) have been set at 45 dBA (nighttime) and 50 dBA (daytime). These limits are specific to "land intended for multi-unit dwellings, mobile home parks, institutions, or camping grounds" [translation]. In the case of "land intended for semi-detached or single-family dwellings, schools, hospitals, or other educational, health or convalescence establishments" [translation], the noise level limits not to be exceeded over the course of an hour (LAr, 1 h) are 40 dBA (nighttime) and 45 dBA (daytime). Noise mitigation measures should help ensure compliance with these threshold limits.

Recommendations

26. Reduce noise exposure to a minimum for residents along the western edge of the TOD Neighbourhood.
    - 26.1. Expand the buffer zone between the industrial park and residential buildings, and protect and increase vegetation cover in the forest area located to the northwest of the neighbourhood.
    - 26.2. Ensure superior-quality soundproofing of residential buildings.
    - 26.3. Locate bedrooms on the opposite side from the industrial park (on the east side of buildings).
    - 26.4. After installation of the noise barrier, carry out tests to evaluate its effectiveness. If the noise detected exceeds 45 dBA during the day and 40 dBA at night, take the necessary corrective measures.
    - 26.5. Establish an alternate route for heavy trucks accessing the industrial park, to keep them away from residential properties.
27. Implement measures for reducing urban heat islands.
    - 27.1. Maximize the number of trees planted inside the TOD Neighbourhood.
    - 27.2. Incorporate rainwater drainage systems designed to promote plant growth.
    - 27.3. Select materials that absorb less heat, both for buildings and for parking lots (e.g., green roofs or light-coloured roofs, green walls, light-coloured paving materials).

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APPENDIX 1

SUMMARY TABLE OF RECOMMENDATIONS

5.1.1. Public transit infrastructure and services

1. Collaborate with the CIT Roussillon and the AMT to establish a public transit service as soon as construction of the TOD Neighbourhood commences and to review the plans based on the evolving needs of the new residents.
2. Limit the residential parking ratio to 1.5 lots per residential unit.
   - 2.1. Reduce the number of on-street and off-street parking spaces in order to limit the amount of paved surfaces and prevent the creation of urban heat islands in the TOD Neighbourhood.
   - 2.2. Implement measures for greening outdoor residential parking lots in order to prevent the creation of urban heat islands.
3. Create at least one pedestrian walkway and one bike path between the TOD Neighbourhood and the existing neighbourhood to the east (rue Barbeau).
4. Collaborate with the AMT to reserve 10% of all parking spaces (in the future park-and-ride lot) for carpoolers.
5. Set up a secure bike parking station, close to the park-and-ride lot, for cyclists who want to make use of public transit.
6. Increase density in residential sectors adjacent to the TOD Neighbourhood to increase the number of potential users of the bus service offered at the station.
7. Proceed with the greening or underground design of the multi-level park-and-ride structure in order to prevent the creation of urban heat islands.
8. Offer all buyers of a new residential unit in the newly developed TOD Neighbourhood a 12-month CIT Roussillon or AMT transit pass for free or at reduced rates—to encourage widespread use of public transit right from the start. For more information on this subject, consult the LEED for Neighbourhood Development (Congress for the New Urbanism et al., 2009).

5.1.2. Design of streets, walkways and bikeways

9. Design streets in the TOD Neighbourhood based on the Zone 30 concept, to strike a balance between the needs of users of different modes of transportation and to facilitate active travel.
   - 9.1. Allow a maximum speed limit of 30 km/h on local streets.
   - 9.2. Provide traffic-calming devices, such as shorter bend radii, horizontal deflections, chicanes or raised crosswalks, to enforce this speed limit and discourage motorized through traffic.
   - 9.3. Maximize on-street parking for visitors to give drivers the impression that streets are narrower (which would allow some of the planned parking spaces behind backyards to be eliminated).
   - 9.4. Install sidewalks on each side of the street with a minimum width of 1.5 m, but preferably of 1.8 m, with curb cutouts at intersections and crosswalks, as well as a protective border between the street and the sidewalk.
   - 9.5. Plant trees at a minimum distance of every 9 to 12 m, between the sidewalk and the street.
   - 9.6. Provide for the installation of benches, picnic tables and trash receptacles along popular bike paths and walking routes.

9.7. Provide for the installation of lighting along streets, the bike path and in public spaces and opt for human-scale lighting, ensuring visibility for a minimum distance of 20 m and providing 20 lux of illumination, while avoiding creating nuisances for bordering residents.

10. Design woonerfs between parking areas to increase connectivity in the northern sector and facilitate east to west travel for pedestrians and cyclists.
11. Design pedestrian and bicycle networks in a manner that ensures their safety, encourages active transportation and facilitates access to nearby local businesses.
    11.1. Install two crossings for pedestrians and cyclists connecting the east side of the TOD Neighbourhood to rue Barbeau, thus facilitating access to adjacent businesses and services.
    11.2. Install interconnected infrastructurethat allows pedestrians and cyclists to circulate for minimum distances of 1.2 km and 3 km respectively in the area surrounding the bus platforms.
    11.3. Link businesses to bus platforms and homes by way of sidewalks and bike lanes.
    11.4. Design the bike path in the eastern section of the neighbourhood according to multipurpose trail standards.
    11.5. Place the main entrances of residential and commercial buildings (buildings A to Q) facing the streets (not the parking lots) or, at least, construct secondary entrances on the street side to avoid forcing pedestrians to make a detour.
12. Provide for the installation of protected bicycle racks and storage spaces on the project site, in the garages of multi-dwelling buildings and close to businesses.
    12.1. For multi-unit residential buildings (over 24 dwellings), provide bicycle parking spaces for the equivalent of 30% of occupants (Congress for the New Urbanism et al., 2009), which calls for about 190 bicycle parking spaces.
    12.2. For commercial buildings, provide at least one parking space per 465 m2 of business surface area, or approximately 40 parking spaces by the end of Phase 2.
    12.3. Redesign the three zones identified as problematic for the safety of pedestrians and cyclists, namely, the length of boulevard Saint-Laurent, the length of the school corridor via the bike path following Hydro-Québec's right-of-way and the route for accessing the shopping centre south of Route 132.
    12.4. In collaboration with the City of Saint-Constant and the owner of the shopping centre, redesign the latter's parking lot so as to make it safer and more congenial for pedestrians and cyclists.
13. Redevelop the portion of Route 132 that borders the sector as well as the intersection with rue Léo, to reduce the exposure of future residents of the TOD neighbourhood to noise and air pollution and to improve road safety in the sector.
    13.1. Redesign the intersection of Route 132 and rue Léo, in collaboration with the Ministère des Transports du Québec and the AMT, to strike a balance between traffic fluidity and the safety of drivers, cyclists and pedestrians.
    13.2. Install devices for protecting pedestrians that take both physical form (e.g., pedestrian islands) and temporal form (e.g., traffic lights with pedestrian phase, ban on RTOR).

13.3. During the conversion of Route 132 into an urban boulevard and the development of bus lanes, install footpaths and bike paths to enhance the safety of pedestrians and cyclists (in collaboration with the MTQ and the AMT).
13.4. Do not increase the number of lanes on Route 132 to limit the increase in traffic volumes.
13.5. During Phase 2 of the project, avoid the construction of homes along Route 132 and place commercial buildings there so as to form an acoustic barrier that helps reduce noise and block the dispersion of air pollutants.
13.6. Program acceptable wait times for pedestrians and crossing times that are adequate for the width of lanes, especially for the young and the elderly (calculated at 0.9 m/s).
13.7. Install traffic lights with radar detection to prioritize bus passage through the intersection.
13.8. Study the feasibility of installing a roundabout to increase traffic fluidity and reduce speed variations.

5.1.3 Parks and urban green spaces

14. Increase the surface area of parks and green spaces in the TOD Neighbourhood by reducing the number (by 25%) and size (by 10%) of residential parking spaces.
15. Adopt a municipal bylaw (or master plan or policy) to protect parks and urban green spaces in the City of Sainte-Catherine and to strive for 2.5 ha of parkland per 1,000 residents.
16. Develop and green the proposed woonerfs, so they can be used as public spaces for leisure activities.
17. Set up community gardens close to multi-unit dwellings.
18. Ensure the presence of appropriate, safe facilities that are suited to residents' needs, and that encourage people of all ages to participate in physical and leisure activities (e.g., playgrounds for kids, benches, tables).
19. Adopt a municipal bylaw that requires the creation of green roofs, and encourages efforts to increase vegetation cover on larger buildings (or requires the use of white or light-coloured roof coverings that increase reflectance).
20. Plant at least 948 trees throughout the entire TOD Neighbourhood, as recommended in the special provisions applicable to zones H-404 and H-414 outlined in Sainte-Catherine's comprehensive development plan, the Plan d'aménagement d'ensemble de Sainte-Catherine.

5.2.1 Transportation and storage of hazardous materials

21. Create an accurate mapping of the companies to which the Environmental Emergency Regulations apply and of the other companies that use and store hazardous materials, taking care to include the locations of the hazardous material containers in order to determine their distance from the TOD Neighbourhood.
22. Implement actions and strategies to prevent other companies that use and store hazardous materials from establishing their operations too close to nearby residences. For example, these strategies could include:

22.1. Collaborating with the RCM to clarify the activities permitted in the heavy and light industrial zones, in proximity to the TOD Neighbourhood.
22.2. Taking steps to change the "heavy industrial" zoning designation (I2-64.1), at least for the areas adjacent to the TOD Neighbourhood.
22.3. Adopting a municipal zoning bylaw that outlines which activities are excluded from specific zones.
22.4. Avoiding controversial uses, such as daycares and nursing homes, within the intervention perimeter to ensure the most vulnerable populations are kept distant in the event of a technological accident.

23. Implement action plans and strategies to reduce the nuisances generated by existing industries situated in proximity to the TOD Neighbourhood. For example, these strategies could include:
23.1. Establishing a buffer zone in the southwest corner (on 1st Avenue, at the corner of Route 132), giving preference to the construction of strictly commercial buildings.
23.2. Expanding (initially by 15 m) the buffer zone included in the plan for Phase 2 of the project, and located along the western edge, in particular by protecting the forested area in the northwest corner, by reclaiming previously forested areas that have been cleared (approximately 2/3 of the surface area), and by preventing all construction on the west side of the sector.
24. Propose an alternative route—via the service road along the railway track or by joining up rue Garnier —for trucks transporting hazardous materials.
25. Develop tools for managing the risk of technological accidents and ensure all actors concerned (municipality, citizens, companies, etc.) are well prepared.
25.1. Ensure that all companies identified as having hazardous materials on site have adopted and updated their emergency plans, as required.
25.2. Establish mechanisms for sharing information and for managing environmental emergency plans, i.e., through the creation of a joint municipal industrial committee (comité mixte municipal-industriel or CMMI).
25.3. Maintain risk coverage plans, ensuring they are kept up to date.
25.4. Ensure that the industrial park's basic infrastructure (municipal water and wastewater network) can effectively protect the population in the event of an emergency.

5.2.2 Industrial nuisances and residential developments

26. Reduce noise exposure to a minimum for residents along the western edge of the TOD Neighbourhood.
26.1. Expand the buffer zone between the industrial park and residential buildings, and protect and increase vegetation cover in the forest area located to the northwest of the neighbourhood.
26.2. Ensure superior-quality soundproofing of residential buildings.
26.3. Locate bedrooms on the opposite side from the industrial park (on the east side of buildings).
26.4. After installation of the noise barrier, carry out tests to evaluate its effectiveness. If the noise detected exceeds 45 dBA during the day and 40 dBA at night, take the necessary corrective measures.

26.5. Establish an alternate route for heavy trucks accessing the industrial park, to keep them away from residential properties.

27. Implement measures for reducing urban heat islands.
    27.1. Maximize the number of trees planted inside the TOD Neighbourhood.
    27.2. Incorporate rainwater drainage systems designed to promote plant growth.
    27.3. Select materials that absorb less heat, both for buildings and for parking lots (e.g., green roofs or light-coloured roofs, green walls, light-coloured paving materials).

APPENDIX 2

MAPS OF ZONES OF INFLUENCE FOR BUS PLATFORMS AFTER THE INSTALLATION OF PEDESTRIAN AND BICYCLE CROSSINGS

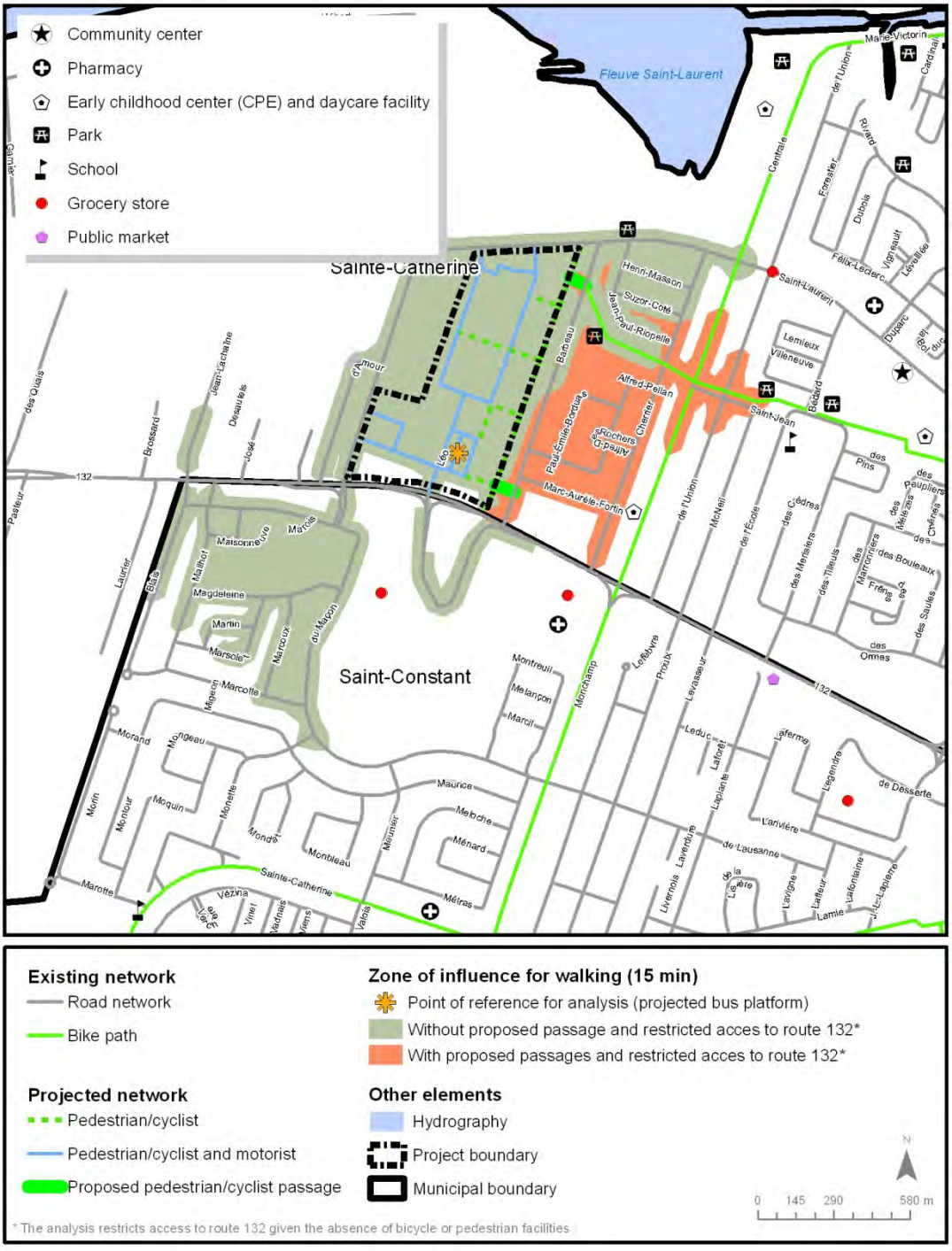

Figure a Representation of zones of influence for walking, with or without the proposed crossings

Source: DSP Montérégie.

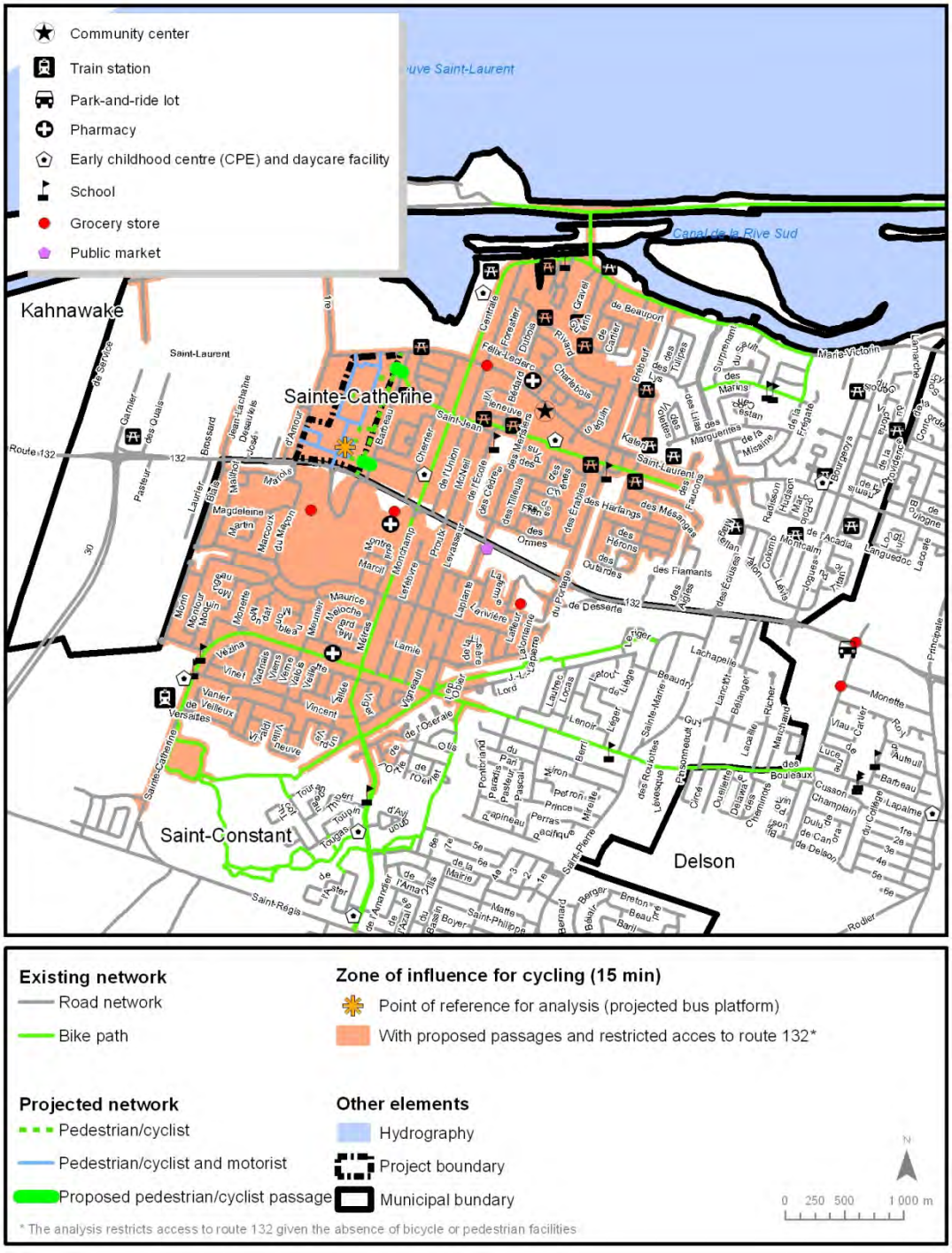

Figure b Representation of zones of influence for cycling, with or without the proposed crossings

Source: DSP Montérégie.

APPENDIX 3

ZONES WITH HUMAN-CAUSED (ANTHROPIC) CONSTRAINTS

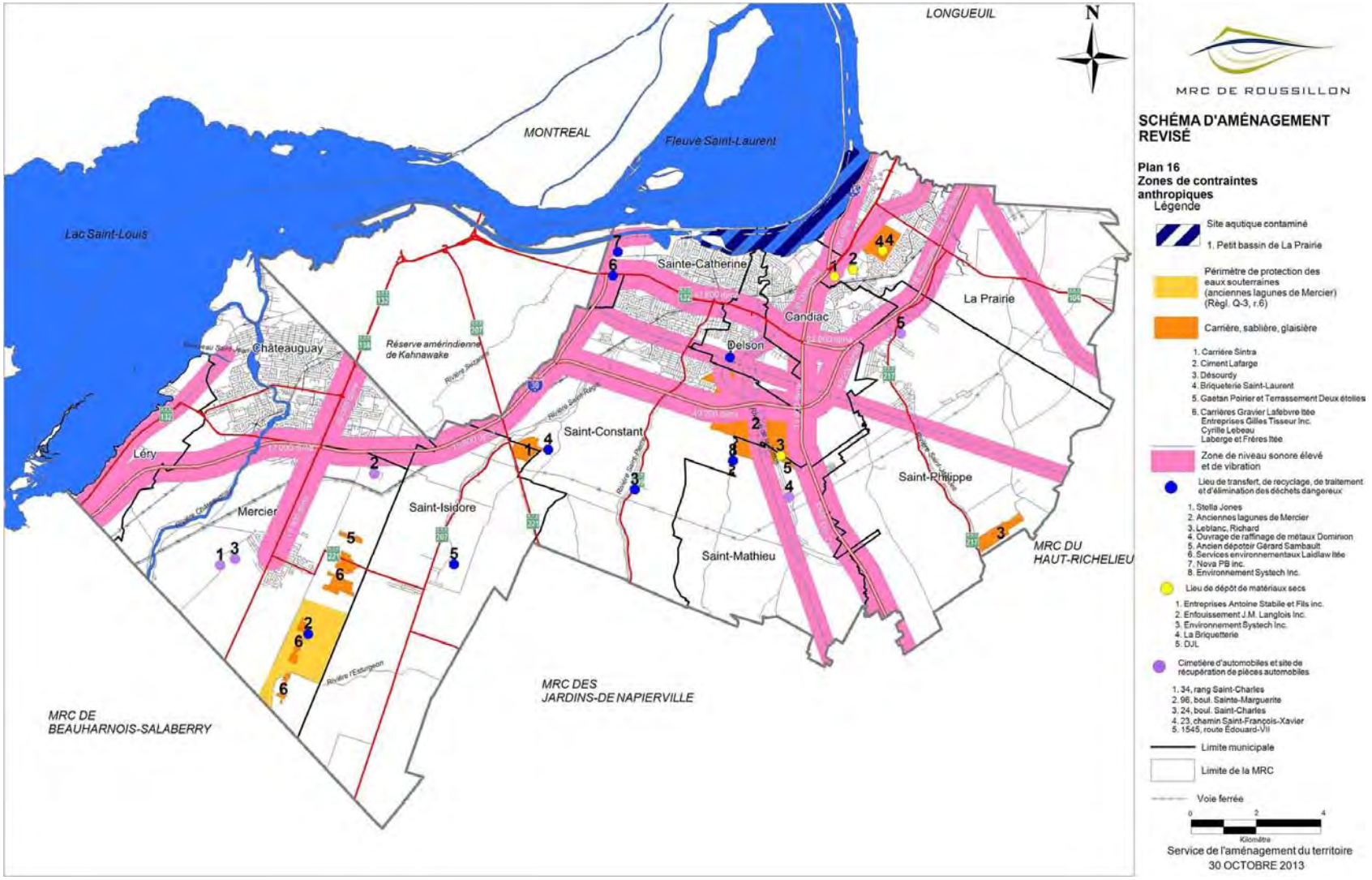

Figure c Zones with human-caused (anthropic) constraints

The pink area on the map indicates a zone of elevated noise levels and vibration

Source: MRC de Roussillon, 2013. Carte 16, Projet de règlement 170 (map 16, zoning project 170), © 2013 MRC de Roussillon. All rights reserved.

APPENDIX 4

ENVIRONMENTAL EMERGENCY REGULATIONS

Canada's Environmental Emergency Regulations were passed in 2003, and a copy is available online at: http://publications.gc.ca/gazette/archives/p2/2003/2003-09-10/pdf/g2-13719.pdf#page=2. The following are excerpts from this document.

Section 3 states that:

"Any person who owns or has the charge, management or control of a substance set out in column 1 of Schedule 1 that is located at a place in Canada, must submit to the Minister a notice containing the information requested in Schedule 2 for each such place in either of the following circumstances:

a. the substance is in a quantity that at any time is equal to or exceeds the quantity set out in column 3 of Schedule 1 for that substance; or
b. the substance is stored in a container that has a maximum capacity equal to or exceeding the quantity set out in column 3 of Schedule 1 for that substance" (pp. 2394-2395).

In addition, Section 4 states that:

"a person required to submit a notice to the Minister under subsection 3(1) must prepare an environmental emergency plan with respect to the substance referred to in that subsection" (p. 2396), and "must consider the following factors:

a. the properties and characteristics of the substance and the maximum expected quantity of the substance at the place at any time during a calendar year;
b. the commercial, manufacturing, processing or other activity in relation to which the plan is to be prepared;
c. the characteristics of the place where the substance is located and of the surrounding area that may increase the risk of harm to the environment or of danger to human life or health; and
d. the potential consequences from an environmental emergency on the environment and on human life or health.

(3) The environmental emergency plan must include:

a. a description of the factors considered under subsection (2);
b. the identification of any environmental emergency that can reasonably be expected to occur at the place and that would likely cause harm to the environment or constitute a danger to human life or health, and identification of the harm or danger;
c. a description of the measures to be used to prevent, prepare for, respond to and recover from any environmental emergency identified under paragraph (b);
d. a list of the individuals who are to carry into effect the plan in the event of an environmental emergency and a description of their roles and responsibilities;
e. the identification of the training required for each of the individuals listed under paragraph (d);
f. a list of the emergency response equipment included as part of the environmental emergency plan, and the equipment's location; and

g. the measures to be taken to notify members of the public who may be adversely affected by an environmental emergency" (pp. 2396-2397).

"Information to be submitted in the report regarding the preparation of an environmental emergency plan

1. Place where one or more substances are located:

   a. the facility name (or description) and civic address; and
   b. the name of each substance.

2. Use of prior plans:

   a. indicate whether the environmental emergency plan was based on a plan prepared on a voluntary basis;
   b. indicate whether the environmental emergency plan was based on a plan prepared for another government and provide particulars, if applicable; and
   c. indicate whether the environmental emergency plan was based on a plan prepared under another Act of Parliament and provide particulars, if applicable.

3. Local-level involvement:

   a. give the name of the local authorities, community or interest groups that have been involved in the plan's development, if any; and
   b. identify whether the plan or its relevant parts were made available to the appropriate local authorities (such as police and fire departments) that may be involved in an emergency response.

4. Information for each substance covered by an environmental emergency plan:

   a. the name, CAS registry number and UN number (if applicable) of the substance; and
   b. the nature of activities at the place where the substance is located.

5. The date on which the preparation of the environmental emergency plan was completed.

6. The location of the environmental emergency plan if it is different from the place where one or more substances are located" (p. 2046).

The list of substances subject to reporting requirements under the Environmental Emergency Regulations is included in the regulations; it can also be consulted online on the Environment Canada website at: https://cepae2-lcpeue.ec.gc.ca/cepae2.cfm?Language=en&screen=Substances/SubstanceList.

From the same website, it is possible to run a search on a specific location. To do so, simply click on the tab to the left marked "Who is Registered?" (https://cepae2-lcpeue.ec.gc.ca/cepae2.cfm?screen=Search/Search) and enter the name of a location.

In the case of the City of Sainte-Catherine, four companies are listed. See: https://cepae2-lcpeue.ec.gc.ca/cepae2.cfm?screen=Search/Search&ReportID=4&Search.City=catherine&Search.Province=9&Language=en.

Table a Location of businesses registered under E2 regulations

Facility Name	Latitude	Longitude
Centre de distribution de Sainte-Catherine 6605, boulevard Hébert Ville Sainte-Catherine (Québec) J5C 1B5	45.4012°	-73.5950°
Produits Chimiques Anco 6905, rue Hebert Ville Ste-Catherine (Québec) J0L 1E0	45.4048°	-73.6013°
Servichem inc. 6805, boulevard Hébert Sainte-Catherine (Québec) J0L1E0	45.4050°	-73.6007°
Superior Propane – Sainte-Catherine 600, rue Garnier Sainte-Catherine (Québec) J5C 1B4	45.4045°	-73.6018°

However, this information comprises the following limitations:

- The spelling of city names is not standardized (e.g., Ville Sainte-Catherine, Ville Ste-Catherine, Sainte-Catherine); also, the latitude and longitude are sometimes reversed.
- Businesses are listed by address, but there is no indication of whether this is the location of the company's head office or the location of the containers that must be reported.
- Registration of statements is mandatory. However, to date, little information is available regarding validation procedures (frequency of inspections, verification of the information reported, etc.).

This registry only identifies businesses having reported hazardous materials subject to regulation when the quantities held exceed thresholds. It does indicate what substance is held by a business, or the quantity held. For more detailed information about the facilities located in a community and the notices they have been required to submit under the Environmental Emergency Regulations, it is possible to contact Environment Canada's regional office (see below).

Environment Canada Regional Office – Québec Region
Compliance Promotion – Environmental Emergencies Program
Québec Region
Environment Canada
351 St-Joseph Blvd
Gatineau (Québec) K1A 0H3
Phone: 1 800 668-6767
Fax: 819 997-5029
Email: cepae2-lcpeue-qc@ec.gc.ca

APPENDIX 5

JOINT MUNICIPAL-INDUSTRIAL COMMITTEE
(COMITÉ MIXTE MUNICIPAL-INDUSTRIEL [CMMI])

Definition and role

Given that municipalities have jurisdiction over their territories, in the event of a major industrial accident, municipalities are responsible for managing intervention operations. For their part, companies that handle and store hazardous materials are required, under certain federal and provincial laws, to submit a current inventory of hazardous materials to the municipality. These companies must also develop appropriate environmental emergency plans to reduce the impacts of an industrial accident on communities and the environment.

To better understand the risks related to the presence of hazardous materials on their territories and to facilitate discussion between the partners involved in managing these risks, several Québec municipalities have established joint municipal industrial committees, known by the French acronym CMMI (comités mixtes municipalités-industries). The CMMI is a committee composed of municipal, industrial, and government representatives (Ministère de la Sécurité publique and Ministère et de la Santé et des Services sociaux [the ministries of public security and health and social services]) and citizens, whose goal is to identify major industrial risks, to establish and align the environmental emergency plans of the various partners, and to inform the public about the risks and the necessary protection measures in the event of an industrial accident.

A CMMI generally comprises three sub-committees: risk assessment; preparation and intervention; and communications. Members serve on the committee on a voluntary basis, which means that participating companies, regardless of whether they are subject to E2 Regulations, are under no obligation to be part of a CMMI. However, participation is in the interest of all companies, since the CMMI helps ensure better alignment among emergency plans and enables companies to meet their obligation to communicate potential risks to the public.

Examples of active CMMIs (2014) in Montérégie:

Beauharnois (http://ville.beauharnois.qc.ca/mairie/structure-administrative/securite-incendie-et-securite-publique/)

Salaberry-de-Valleyfield (http://www.affairesvalleyfield.com/cmmi)

Varennes (http://www.ville.varennes.qc.ca/citoyens-securite/securitepublique)

Contact person at the Ministère de la Sécurité publique

Hugues Daveluy, Councillor
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Ministère de la Sécurité publique
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Saint-Jean-sur-Richelieu (Québec) J3B 6S9
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hugues.daveluy@msp.gouv.qc.ca
www.securitepublique.gouv.qc.ca

www.ncchpp.ca