

Thriving on
the New Décarie Expressway:

*Reconciling Trenched Urban
Expressways with the City*

by
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presented to the University of Waterloo
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thesis requirement for the degree of
Master of Architecture

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

During the 1960s large trenched expressways were introduced into our urban centres to accommodate the booming vehicular traffic. These expressways were built on an enormous scale, often traversing entire cities. Unfortunately, some neighbourhoods have been divided and now share a noxious physical boundary. The Vine Street Expressway in Philadelphia, the Cross Bronx Expressway in New York and the Décarie Expressway in Montreal are examples of such thoroughfares. They are noisy, polluted and uninspiring spaces. The auto-centric mindset with which these expressways were designed with is being challenged. A desire to make cities more sustainable, healthy and accessible for their citizens is emerging. Given the decreased mobility issues that would arise if these structures were to be completely eliminated, it is necessary to explore architectural solutions to remedy the destructive effects these massive artefacts have on the urban fabric. Through surgical interventions along the Décarie Expressway in Montreal, I will investigate realistic if slightly optimistic solutions in which we can foster a symbiotic relationship between these massive trenched urban vehicular infrastructures and the surrounding urban space. The large scale of interventions allows for the exploration of the inherent possibilities for expressive structural bridging solutions over the expressway, new configurations of urban public space by utilizing the captured space over the infrastructural thoroughfare and a productive urban fabric which begins to address the potential of a hybrid urbanism of the twenty first century.

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To my mother, sister and Meghan, thank you for your patience and encouragement. Without your support, I could not have achieved this.

DEDICATION

To my friends, family and Meghan.

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“The multiplication of private car use leads to congestion and reduced efficacy. The usual response to traffic congestion, road accidents, pollution and energy costs is to build more road capacity for automobiles, at enormous cost and with further perverse effects on public transportation and other forms of transit. Such approaches, borrowed from the lexicon of urban planning in developed countries and from the priorities of transportation engineers, are bound to exacerbate environmental degradation and social inequity, while also impairing economic growth in poorer countries.”

United Nations. (2011). In *Population Distribution, Urbanization, Internal Migration and Development: An International Perspective* (p. 22). United Nations.



INTRODUCTION



INTRODUCTION

“Stuck in traffic in Washington, DC in 1959, President Eisenhower was shocked to learn that the delay was being caused by Interstate Highway construction. Surely the Interstates were being built between cities, not in them. The President demanded to know who was responsible for this state of affairs, only to be told that he was; it was the result of legislation he had signed three years earlier. Aghast, Eisenhower attempted to get the federal government out of the urban freeway business. But it was too late: the program had built up momentum that not even he could halt.”¹

The famous U.S. Federal-Aid Expressway Act signed by the President led to the explosion of vehicular infrastructure development in North America during the 1950's and 60's.

Massive infrastructures began inserting themselves into city centers and the fine textured urban fabric was sacrificed, neighbourhoods were divided, noise and air pollution became a serious concern and adjacent property values decreased.

The evolution of expressways began with parkways. They were intended to facilitate the access to parks and increase property values in outlying regions. They were considered to be opportunities to enhance the landscape and offer pleasurable experiential sensations. Landscape designers and architects were chiefly commissioned to design these roads and sought to achieve context sensitive projects.

Unfortunately, due to the lack of municipal funding, these designers had to cede their creative control over to federal expressway departments, who were primarily responsible for rural roads. Their engineers focused mainly on high-speed farm to market and intercity access, with an emphasis on traffic flows. Context, land-use and multi-modalism were largely absent from their plans. This rural centered mindset gradually became etched in stone and dominated expressway planning for decades all across the globe.¹ In his book, *Freeways*, landscape architect Lawrence Halprin asserts,

“Views have been obliterated, important landmarks have been isolated, great waterfronts have been cut off, all by freeways within the cities whom they supposedly serve”²

In the 1970's, largely due to public dissent and the lack of funding, expressway building slowed to a halt. The rapid wide-spread expressway construction was met with an equally as rapid demise.

This thesis will contribute to the overall discussion on urban expressways but it will focus its attention on trenched urban expressways

specifically. The Décarie Expressway in Montreal represents a typical example of such infrastructure and will be the site of the subsequent design proposal.

The Décarie Expressway, like most trenched urban expressways, is an unloved and unpleasant space. It fails to achieve any sort of peace with the bordering neighbourhoods it bisects and the city it serves.

Otherwise known as “the Décarie”, it is located in Montreal and was once a multi-modal boulevard. In 1967, it was converted into a trenched six lane urban expressway. It was built to accommodate the influx of people who flooded the city during the 1967 International and Universal Exposition (Expo '67). Serving as the main North/South artery in and out of Montreal, it connects the city's only East/West highways, namely the Trans-Canada Highway (A-40) and The Remembrance Highway (A-20). Situated between Villa-Maria and De la Savanne metro station, it is the physical barrier between two neighbourhoods, Côte-des-Neiges (CDN) to the east and Notre-Dame-de-Grâce (NDG) to the west.

The Décarie is a noisy, smelly, pollution filled, heat trapping, flood prone, ugly concrete canyon. It is considered by many one of the worst urban planning projects ever built on the island of Montreal. Dr. Pierre Gauthier, associate professor in the Department of Geography, Planning and Environment of Concordia University, has called The Décarie “a scar in the Island of Montreal”.³ The designers of the expressway believed that if they carved out the expressway 7-8m below grade, it would shield the bordering communities from the noise and the visual unpleasantness. They were wrong.

The grim reality is that the expressway's trenched concrete walls actually reverberate the sound and reflect it upward, directly into the bordering communities. It also fails to shield the communities from its dull and cold appearance simply because of the fact that it is a 30m wide trench that can be seen by anyone within the vicinity. The Décarie Expressway has become one of the most used highways in Montreal and it now supports, according to the Ministry of Transport Quebec, 178,000 cars per day, which is almost twice as much as the 90,000 cars projected during its conception.³ Unfortunately for the two neighbouring communities, it is now producing almost twice as much noise, pollution and visual unpleasantness.

The socioeconomic well-being of the residents and merchants bordering the expressway are being negatively affected.

Something must be done! The Décarie, like most trenched urban expressways, is much more than a functional transportation infrastructure. It has a direct impact on the socio-economic well-

being of the adjacent area and is frequented daily by hundreds of thousands of people. There is so much potential for these types of gateways to be more productive and indicative of the city's values by expressing themselves architecturally.

They deserve to be treated as important public spaces and given special design attention, for they are an important reflection of the city's image.

I will emphasize Canadian expressway development and use Canadian environmental and census data specifically to link the Décarie Expressway to its context. I will begin with an elaboration on the background and problems of trenched urban expressways. Then will follow with a precedent analysis of several unique and pertinent projects, which will focus its attention on retrofitting trenched urban expressways given the decreased city-wide mobility issues that would arise if the Décarie were to be completely removed; then, finally, I will discuss certain overarching design principles that have been distilled from the previous two parts and apply the knowledge to a final design proposal.

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 - 2 Halprin, L. (1966). In *Freeways* (p. 27). New York: Reinhold Publishing Corp.
 - 3 Gauthier, P. (2002). In *Southern Décarie Design Brief* (p.7). Montreal: Concordia University.

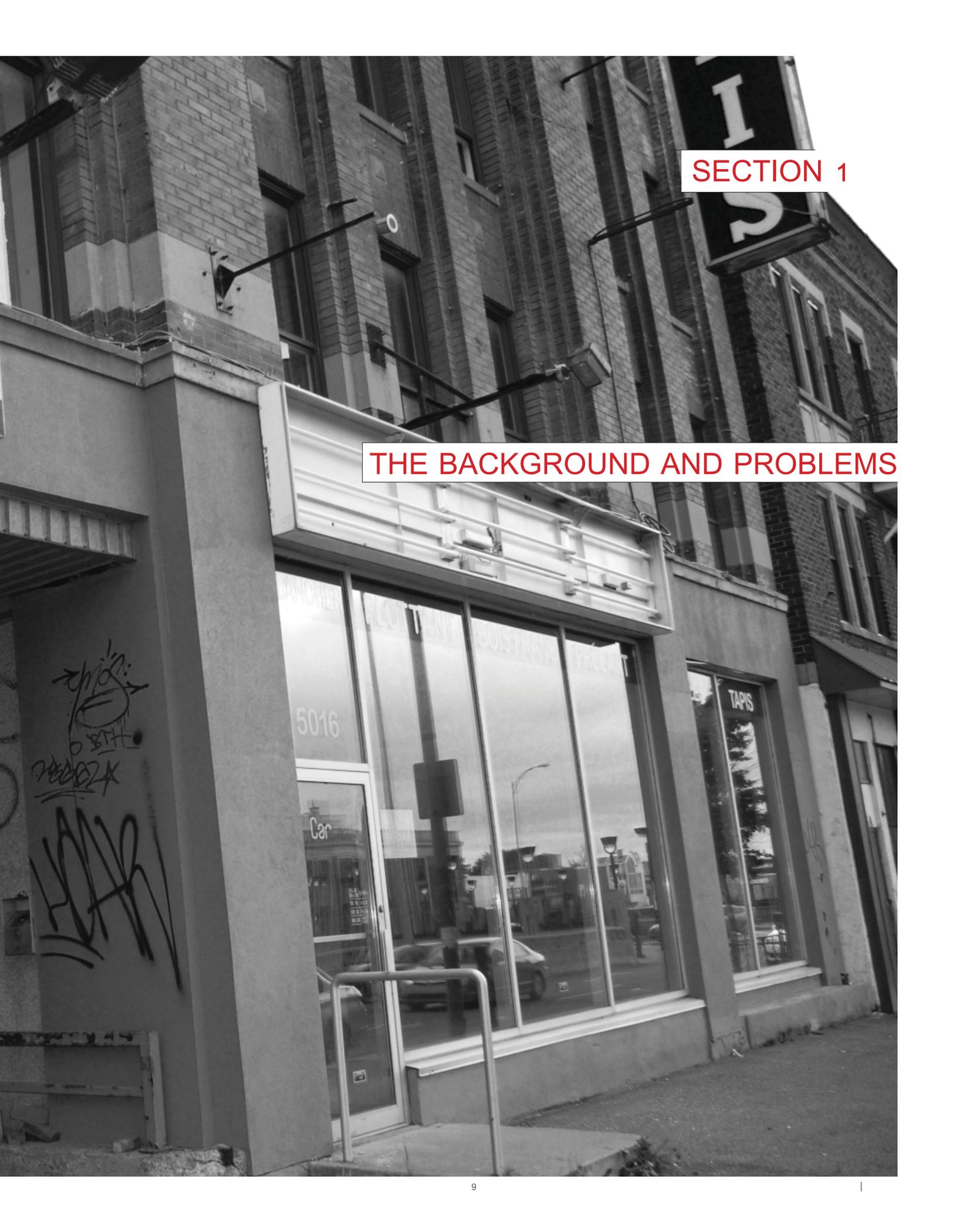
time

- 1898 John Moodie of Hamilton brought the first motor vehicle, a one-cylinder Winton "horseless carriage" from the USA.
- 1900 First tramway was built in NDG, the Montreal Park & Island Tramway.
- 1907 There were 2131 cars registered in Canada.
- 1908 The first production Model T was produced on August 12, 1908 and the Décarie Blvd. Tramway line was created.
- 1913 Model "T" price dropped to \$550 (\$12,798.83 in 2012 US dollars).
- 1914 There were 50 000 cars registered in Canada.
- 1921 Montreal Melon, grown on the Décarie Farm, was considered a luxury fruit.
- 1930 Urban expansion swallowed up the Montreal Melon farmers.
- 1935 Décarie Blvd. was an active commercial strip.
- 1946 38 982 km of public roads in Canada.
- 1956 USA's Federal Aid Highway Act.
- 1959 Montreal's decommissioned streetcar system.
- 1964 Demolition for the Décarie Expressway began.
- 1967 Décarie Expressway opened / Montreal Expo '67.
- 1976 Montreal Summer Olympics.
- 1981 17% population drop in the bordering neighbourhoods (NDG + CDN) since the completion of the Décarie Expressway.
- 1987 Flash flood - up to 3.6m of water in the Décarie trench.
- 1995 901 903 km of public roads in Canada.
- 2004 The Quartier International is completed.
- 2005 Décarie Expressway flooded + Plans proposed for residential development in the Namur - Jean Talon area.
- 2009 Bankruptcy of the Montréal Hippodrome.
- 2010 Approval of the construction of the MUHC Superhospital
- 2011 The number of census families on Montréal island dropped 0.3% from 2006. This compares to a growth rate for Canada of 5.5% over the same period.

*1606 The first graded road was built by Samuel de Champlain.

1650s Europeans began settling in what is now known as the Côte-des-Neiges-Notre-Dame-de-Grâce borough (CDN-NDG).





SECTION 1

THE BACKGROUND AND PROBLEMS

SECTION 1 - THE BACKGROUND AND PROBLEM(S)

1.1 THE BACKGROUND

Expressways came into existence because of the explosion of personalized motor vehicle ownership during the 1950s. Cars were affordable and the boom in population after World War II resulted in the proliferation of this new transportation mode.

The car gave people the ability to travel long distances over a short amount of time. This spawned a mass urban exodus towards the undeveloped lands close to the city, where large detached homes on big plots of land could be built cheaply. This gave rise to the suburbs and one of the consequences of suburbia was that large amounts of people had to travel twice daily and over large distances to go to work, which for most of them was in the city. This meant that to accommodate the rush of traffic during peak hours, high speed multi lane limited access roadways, called expressways, were built.

In order for them to connect to the city center, they were built through existing neighbourhoods either by elevating themselves over local roads or running underneath inside a trench.

In the beginning, expressways were hailed as the only solution to the transportation problems North American metropolitan cities were facing in the mid 20th century. But as soon as people saw the destruction of their neighbourhood and the noxious environments they created, massive opposition was mounted to block the construction of any more.

Jane Jacobs was an important figure in the fight against the way urban expressways were constructed and she is responsible for the cancelling of several projects. For example, the Lower Manhattan expressway was cancelled because of her efforts. The parishioner of her church was concerned with the plans to demolish his church in order to make room for the expressway and thought that his church's demise was inevitable. It was Jane Jacobs that grouped together several organizations in order to stop its construction.²

Often expressway plans were approved by city officials but strongly opposed by local citizens who unfortunately did not have the power to stop their construction unless they banded together. The altruistic nature of these massive road infrastructures often trumped the desires of the existing neighbourhood they were about to destroy.



Figure 1.1.1 - Henry Ford's Model T. The first affordable car.

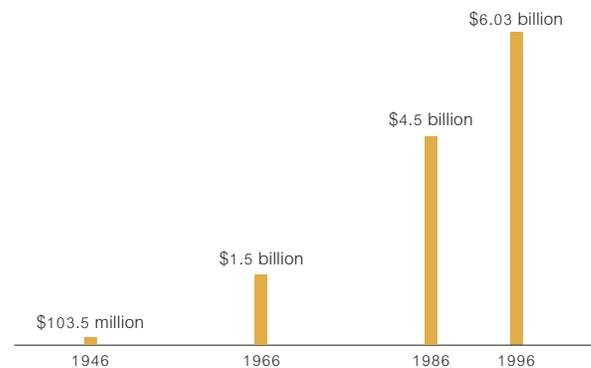


Figure 1.1.2 - Canada's expenditures on roads and highways post WWII.¹

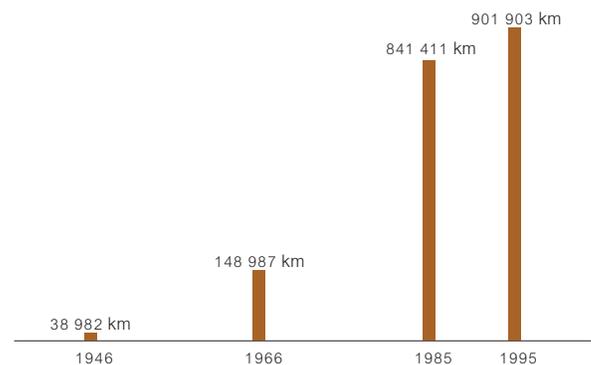


Figure 1.1.3 - Amount of Public Roadways in Canada - post WWII.¹



Figure 1.1.4 - Typical Décarie Expressway traffic.

An account of the general effect expressways had on their surrounding areas is described in this news article printed in the New York Post in February 1960:

“The slaying in Cohen’s butcher shop at 164 E. 174th St. Monday night was no isolated incident, but the culmination of a series of burglaries and holdups along the street...Ever since the work started on the Cross-Bronx Expressway across the street some two years ago, a grocer said, trouble has plagued the area...Stores which once stayed open to 9 or 10 o’clock are shutting down at 7pm. Few shoppers dare venture out after dark, so storekeepers feel the little business they lose hardly justifies the risk in remaining open late...the slaying had the greatest impact on the owner of a nearby drug store, which remains open to 10pm. “We’re scared to death,” he commented. “We’re the only store that stays open that late.”³

The negative effects of urban expressways are becoming more and more important to the overall health and economy of the city and touch more than just the local quality of life.

In the following chapter, I will discuss the negative effects urban expressways have on their local neighbourhood and also on their city overall with a focus placed on trenched urban expressways and the Décarie condition.



Figure 1.1.5 - The proposed LOMEX (The Lower Manhattan Expressway) was cancelled due to the protests spearheaded by Jane Jacobs..



Figure 1.1.6 - Jane Jacobs rallying with protesters.

- 1 Gilchrist, C. (2012). *Roads and Highways*. Retrieved 01 04, 2012, from The Canadian Encyclopedia : <http://www.thecanadianencyclopedia.com/articles/roads-and-highways>
- 2 Khawaja, A. G. (2010, 12). *Lower Manhattan Expressway*. Retrieved 01 04, 2013, from www.gsd.harvard.edu: http://www.gsd.harvard.edu/research/research_centers/zofnass/pdf/Lower%20Manhattan%20Expressway.pdf
- 3 Jacobs, J. (1961). In *The Life and Death of American Cities* (p. 260). New York: Random House.

1.2 THE PROBLEM(S)

The overarching problem plaguing most trenched urban expressways is the fact that they run through dense urban fabric. They follow very specific engineering design principles but fail to integrate themselves into the surrounding urban context in a productive way – they lack architectural integrity. These types of spaces are characterless, inefficient, toxic and non-contextual entities that look and feel foreign. Their alienation towards the character and needs of the neighbourhoods they cut through results all too often in the socio-economic decline of the area.

Such problems as air pollution, noise pollution, light pollution, flooding, traffic congestion (saturation of motor vehicles within the city's transportation system), decreased property values, discontinuous urban fabric and pedestrian safety issues are associated with most trenched urban expressways and the Décarie Expressway is no exception. The above mentioned problems will now be categorically elaborated upon to provide an in depth analysis into the health, economic and social costs these trenched urban expressways incur on society.



Figure 1.2.1 - The Décarie Expressway cuts through dense urban fabric.

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- 4 Environment Canada. (2012, 02 15). 2010 *Air Pollutant Emissions for Quebec*. Retrieved 01 04, 2013, from [www.ec.gc.ca: http://ec.gc.ca/pdb/websol/emissions/ap/ap_result_e.cfm?year=2010&substance=all&location=QC+++++++§or=&submit=Search](http://ec.gc.ca/pdb/websol/emissions/ap/ap_result_e.cfm?year=2010&substance=all&location=QC+++++++§or=&submit=Search)
 - 5 Statistics Canada. (2010, 05 13). *Greenhouse Gas Emissions from Private Vehicles in Canada, 1990 to 2007*. Retrieved 01 04, 2013, from www.statcan.gc.ca: http://www.statcan.gc.ca/pub/16-001-m/2010012/part-partie1-eng.htm
 - 6 Pope CA, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD. (2002). "Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution". *JAMA*. 287(9):1132-1141.
 - 7 Guo J, Kauppinen T, Kyyronen P, Heikkila P, Lindbohm ML, Pukkala E. (2004). "Risk of esophageal, ovarian, testicular, kidney and bladder cancers and leukemia among Finnish workers exposed to diesel or gasoline engine exhaust". *International Journal of Cancer*. 111(2):286-92
 - 8 Ritz B, Yu F, Fruin F, Chapa G, Shaw G, Harris J. (2002). "Ambient air pollution and risk of birth defects in Southern California". *Am J Epidemiology*. 155:17-25
 - 9 Wilhelm M, Ritz B. (2005). "Local Variations in CO and Particulate Air Pollution and Adverse Birth Outcomes in Los Angeles County, California, USA". *Environ Health Perspect*. 113(9):1212-21.
 - 10 Krämer, U. 2., Koch, T., Ranft, U., Ring, J., & Behrendt, H. (2000). *Traffic-Related Air Pollution Is Associated with Atopy in Children Living in Urban Areas*. *Epidemiology*, Volume 11(1), pp 64-70.
 - 11 Health Canada. (2006, 05 16). Health Effects of Air Pollution. Retrieved 01 04, 2013, from www.hc-sc.gc.ca: http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/health_effects-effets_sante-eng.php
 - 12 Environment Canada. (2010, 06 02). *Damage to Infrastructure and Canadian Industries*. Retrieved 01 04, 2013, from www.ec.gc.ca: http://www.ec.gc.ca/air/default.asp?lang=En&n=7DBE4D9F-1
 - 13 Statistics Canada. (2008, 11 21). *Population and Road Motor Vehicle Registration, Canada, 1956 to 2006*. Retrieved 01 04, 2013, from www.statcan.gc.ca: http://www.statcan.gc.ca/pub/16-002-x/2007001/charts/5008059-eng.htm

PROBLEM #1 - AIR POLLUTION

Thousands of cars drive through the Décarie Expressway every day and they generate an important amount of air pollution, which negatively affects the health and economy of the city. The extent to which air pollution is caused by on-road vehicles (cars and trucks) and how it damages our society is described below.

On-road vehicles account for 27% of all air pollutants in Quebec (see figure 1.2.6). This amount does not include the air pollutants caused by the production/processing of fuel (gasoline/diesel), pipeline construction; the mining/processing/manufacturing of the paint, glass, metal, plastic and textile used in car parts and the air pollution caused by paving and maintaining the roads.⁴

Air pollutants are the chemicals that make greenhouse gases (GHG). The effects of GHG emissions are well documented and should be taken seriously. Not only is motor vehicle use directly linked with deadly greenhouse gas emissions, but it is directly linked to another killer - smog.

Smog, a chemical reaction between airborne pollutants that are largely emitted from passenger vehicles (Cars, pick-up trucks, minivans and sport utility vehicles (SUVs)) has devastating effects on human health and consequently cost Canadians billions of dollars. Smog has been linked to ⁵:

- Lung cancer ⁶
- Ovarian cancer ⁷
- Reproductive defects ^{8,9}
- Allergies ¹⁰
- Cardiovascular and respiratory problems ¹¹

Poor air quality also corrodes and deteriorates the materials that make up our buildings and infrastructures. Dirt particles make buildings dirty and property owners must spend money on clean-up. Repairing this damage costs money and resources that could be used productively elsewhere.¹²

The Canadian tourism and the commercial fishing industry is also affected by air pollution. In 1996, Canadians spent over \$11 billion on nature-related activities. If we keep polluting the air, our natural resources will suffer and consequently our economy.¹²

The future of personal mobility is uncertain but motor vehicle ownership is increasing in Canada and consequently, so will the air pollution levels.¹³

Alternative fuel sources may help reduce air pollution but



Figure 1.2.2 - On-road vehicles are the leading cause of all air pollutants in Quebec.⁴



Figure 1.2.3 - Smog.

if car ownership keeps increasing, the amount of energy it takes to produce the motor vehicles and pave the roads will not offset the fuel savings. Also, many other questions arise when critically discussing their environmental impact.

For example, what if all on-road vehicles were electric? Will the manufacturing/recycling of their batteries be better for the environment than burning fossil fuels? Is supporting electric cars for all Canadians feasible with our current electricity generating capabilities? If not, what would it take to supply Canada's national average of 1.5 cars per Canadian? ¹⁴ Can heavy and medium trucks (the on-road vehicles that have the highest fuel consumption rate)¹⁴ ever convert to electric motors? Maybe, maybe not, but one thing is for certain, the health, economy and environment is profoundly affected by air pollution largely caused by on-road vehicles.⁴

Thus, curbing air pollution from places with a high concentration of these vehicles such as, trenched urban expressways, is crucial in saving millions of lives and billions of dollars.

14 Natural Resources Canada. (2012, 01 11). *2009 Canadian Vehicle Survey Summary Report*. Retrieved 01 04, 2013, from [www.nrcan.gc.ca: http://oee.mcan.gc.ca/publications/statistics/cvs09/chapter2.cfm?attr=0](http://oee.mcan.gc.ca/publications/statistics/cvs09/chapter2.cfm?attr=0)

15 Environment Canada. (2012, 02 15). *2010 Air Pollutant Emissions for Quebec*. Retrieved 01 04, 2013, from [www.ec.gc.ca: http://ec.gc.ca/pdb/websol/emissions/ap/ap_result_e.cfm?year=2010&substance=all&location=QC+++++++§or=&submit=Search](http://ec.gc.ca/pdb/websol/emissions/ap/ap_result_e.cfm?year=2010&substance=all&location=QC+++++++§or=&submit=Search)

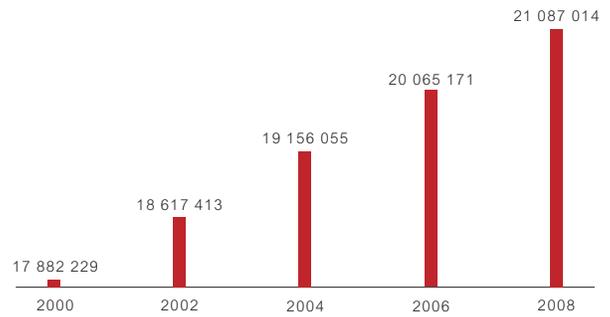


Figure 1.2.4 - Number of road motor vehicle registrations in Canada 2000-2008.¹⁴



Figure 1.2.5 - An electric car's fuelling port. Electric cars eliminate emissions but do not eliminate the air pollution caused by the production of the cars themselves nor the roads that support them.

THE DISTRIBUTION OF MAJOR AIR POLLUTANTS IN QUEBEC PER SECTOR ¹⁵

CARBON MONOXIDEⁱ

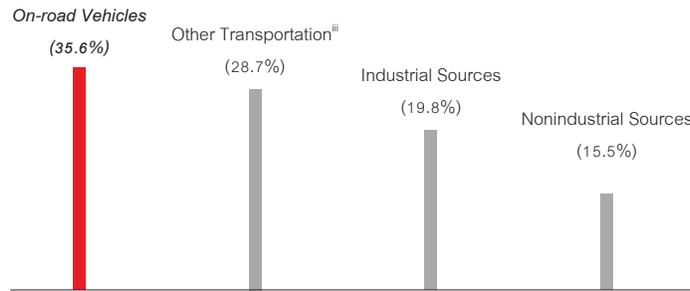


Figure 1.2.6 - Distribution of Carbon Monoxide (CO) production per sector.ⁱ

NITROGEN OXIDESⁱ

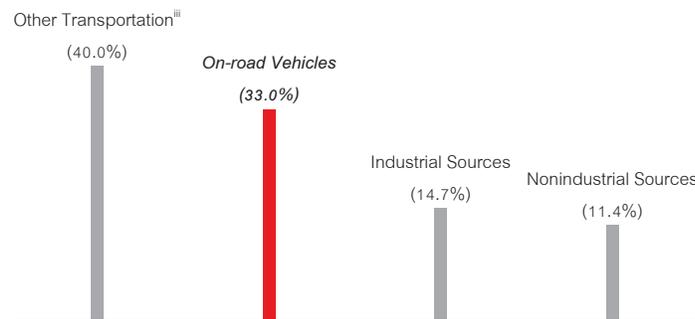


Figure 1.2.7 - Distribution of Nitrogen Oxides (NO_x) production per sector.ⁱ

VOLATILE ORGANIC COMPOUNDSⁱ

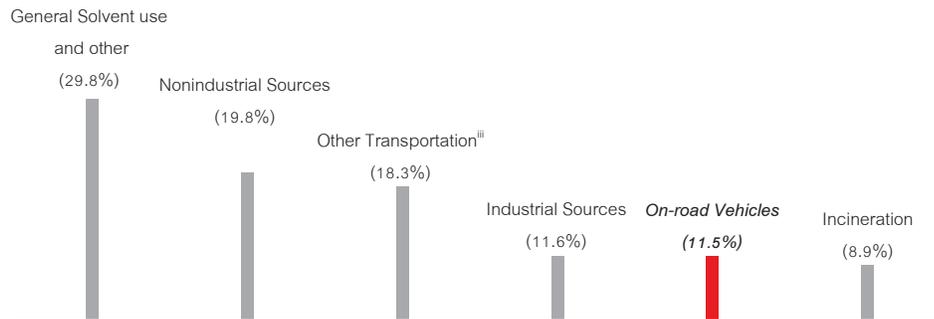


Figure 1.2.8 - Distribution of Nitrogen Oxides (NO_x) production per sector.ⁱ

ALL AIR POLLUTANT EMISSIONSⁱⁱ

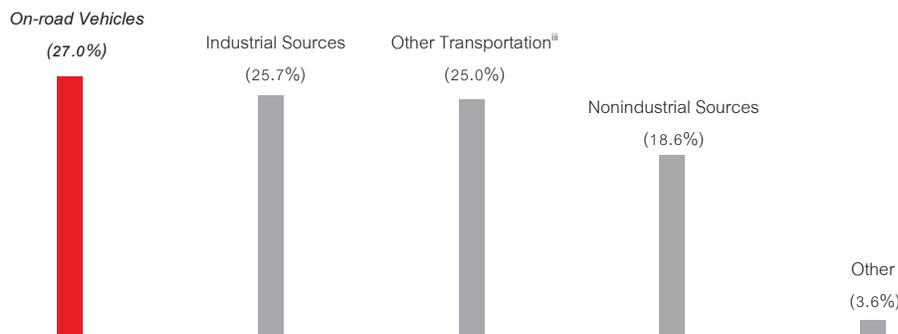


Figure 1.2.9 - Distribution of all Air Pollutant Emissions per sector.ⁱⁱ

i. Quebec 2010 data only, not including natural resources.

ii. Quebec 2010 data only, not including open sources or natural resources.

iii. Air, Marine, Rail (rail is the lowest emitter of air pollutants) and off-road gasoline and diesel use.

PROBLEM #2 - NOISE POLLUTION

Noise pollution is a major problem near trenched urban expressways and the noise levels are especially worrisome near the Décarie Expressway. The city of Montreal has documented that noise levels exceed 65dBA 24hours a day and can sometimes reach up to 77dBA.¹⁷ According to Transport Quebec, urban zones that exceed sound levels of 65dBA should be sheltered from noise pollution. Unfortunately, there are no noise barriers along the Décarie.

The World Health Organization states that noise pollution can be more than simply an annoyance, it can have a profound impact on human health and a city's economy.¹⁸ The following has been associated with noise pollution:

Interference With Speech Communication

Noise interferes with speech communication and can result in a large number of personal disabilities, handicaps, behavioural changes and conversational distractions, which are the biggest cause of lost productivity in open workplaces.^{18,19}

Children, in the process of acquiring language, are particularly affected as well as people who are not familiar with the spoken language. Given the number of schools and immigrants in the area around the Décarie, it represents a significant amount of the local population.

When listening to complicated messages such as those at school or during telephone conversations, it is recommended that the difference between the messages being heard and the undesired noise be less than 15dBA. This means that at a speech level of 50dBA, which corresponds to a casual speech level of both women and men, the interfering noise should not exceed 35dBA. Therefore, when listening to complicated messages, speech is unintelligible over the length of the Décarie Expressway +/-150m on either side.

Cardiovascular Effects

Studies have found that when noise levels exceed 65-70dB there is evidence to suggest an increase in ischaemic heart disease, which is the leading cause of death in the entire world.²⁰ When the orientation of the bedroom window opening habits and years of exposure are taken into account, the risk of heart disease is slightly higher.¹⁸

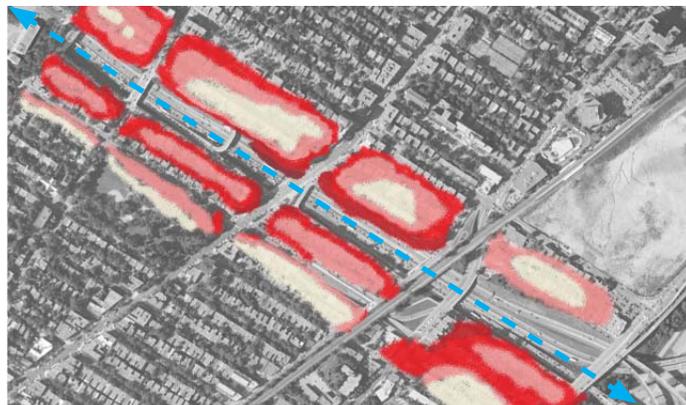


Figure 1.2.10 - Noise study by Transport Quebec.¹⁷

- 16 Health Canada. (2007, 12 21). *Table 1. Types of noises that bothered Canadians by the extent to which they were bothered by noise in general*. Retrieved 01 04, 2013, from www.hc-sc.gc.ca/ewh-semt/pubs/noise-bruit/insider7/noise-types-bruit-eng.php
- 17 Gamache L., D. L. (2006). *Étude de Pollution Sonore - Autoroute Décarie - Arrondissement Côte-des-Neiges/Notre-Dame-de-Grâce*. Montréal: Ville de Montréal.
- 18 The World Health Organization. (n.d.). *Adverse health effects of noise*. Retrieved 01 04, 2013, from www.who.int/docstore/peh/noise/Comnoise3.htm
- 19 David M. Sykes. (2009). *Productivity: How Acoustics Affect Workers' Performance In Offices & Open Areas*. Texas: Speech Privacy Systems.
- 20 The World Health Organization. (2011, 06). *The top 10 causes of death*. Retrieved 01 04, 2013, from www.who.int/mediacentre/factsheets/fs310/en/index.html

Sleep Disturbance

Studies have shown that sleep loss, which is characterized as less than seven hours per night, may have wide-ranging effects on the cardiovascular, endocrine, immune, and nervous systems, including the following:

- Obesity in adults and children ²¹
- Diabetes and impaired glucose tolerance ²¹
- Cardiovascular disease and hypertension ²¹
- Anxiety symptoms ²¹
- Depressed mood ²¹
- Alcohol use ²¹
- Decreased performance ¹⁸
- Increased use of sedatives or sleeping pills ¹⁸

A study by the World Health Organization has showed that people living next to road traffic in excess of 30dB during the night time are disturbed when sleeping.¹⁸ If negative effects on sleep are to be avoided, the equivalent continuous noise level should not exceed 30dBA.¹⁸ Therefore, people living within over 150m of the Décarie Expressway must have high-performance windows to insulate against the traffic noise and unfortunately they cannot sleep with the window open because they will suffer the consequences of sleep deprivation.

Mental Health Effects

Environmental noise such as noise caused by cars and trucks, accelerates and intensifies the development of latent mental disorders. Studies have associated environmental noise with: ¹⁸

- | | |
|------------------|--------------------|
| Psychosis | Anxiety |
| Emotional stress | Nervous complaints |
| Nausea | Headaches |
| Instability | Argumentativeness |
| Sexual impotency | Hysteria |
| Drug use | |



Figure 1.2.11 - A sleep deprived man.

21 Harvey R. Colten and Bruce M. Altevogt. (2006). Consequences of Chronic Sleep Loss and Sleep Disorders. In *Sleep Disorders and Sleep Deprivation* (p. 59). Washington: The National Academies Press.

PROBLEM #3 - LIGHT POLLUTION

The Décarie Expressway, like many other expressways, uses a considerable amount of artificial lighting to illuminate the road surface. Tall light posts allow light to escape vertically and the excessive light generated by the thousands of cars that drive through nightly create excessive artificial night time illumination. Overall, the lighting strategy along the Décarie causes unnecessary expenses to the city and seriously affects the health of humans, animals and plants.

Research indicates that excess artificial light projected into the sky affects specific chemical reactions that break down smog.²² Smog's devastating health effects have been described previously.

Light pollution has also been linked to an increased incidence rate of breast cancer among women who live with large amounts of night time illumination.²³

Being exposed constantly to artificial light can disrupt the body's circadian cycle. The 24-hour day/night cycle, known as the circadian clock, affects physiological processes in almost all organisms. These processes include brain wave patterns, hormone production, cell regulation, and other biological functions. Paolo Sassone-Corsi, chairman of the Pharmacology Department at the



Figure 1.2.12 - Light trespass.



Figure 1.2.13 - Light trespass, sky glow and over-illumination along the Décarie Expressway.

22 Environmental Health Perspectives. (2009). Missing the Dark - Health Effects of Light Pollution. *Environmental Health Perspectives*, 117(1), A22-A24.

23 Blask, D. E., Brainard, G. C., Dauchy, R. T., & et al. (2005). Melatonin-Depleted Blood from Premenopausal Women Exposed to Light at Night Stimulates Growth of Human Breast Cancer Xenografts in Nude Rats. *American Association for Cancer Research*, 11174.

University of California, Irvine, has done extensive research on the circadian clock and he says that “ [...] studies show that the circadian cycle controls from ten to fifteen percent of our genes” and that “ [...] the disruption of the circadian cycle can cause a lot of health problems.”²²

Disruption of the circadian clock is linked to several medical disorders in humans, including depression, insomnia, cardiovascular disease, and cancer.²²

Additionally, prolonged exposure to artificial light prevents many trees from adjusting to seasonal variations and therefore has an impact on the fauna that depend on them for their natural habitat.²²

Bright electric light also confuses and disrupts the behaviour of the 200 species of birds that fly their migration patterns at night in North America.²²



Figure 1.2.14 - NASA's "Earth at Night" image of Montreal.

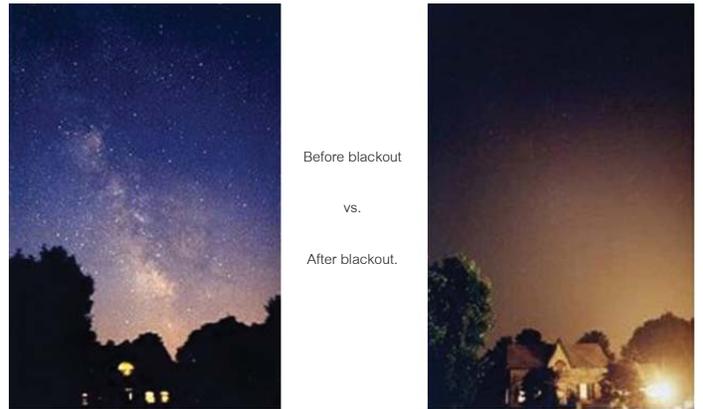


Figure 1.2.15 - Photos taken in Ontario before and after a blackout.

PROBLEM #4 - THE CITY OF MONTREAL IS BECOMING LESS ATTRACTIVE TO LIVE IN

The statistics paint a picture of an alarming exodus out of Montreal. The city's annual growth rate is in the middle of the pack with respect to the other regions in Quebec, but when one studies the statistics more closely one realizes that all of the regions that have a lower annual growth rate than Montreal are far flung regions with small populations; and the regions with the highest growth rate are directly adjacent to the Montreal region.²⁵

Traffic congestion and urban expressways are among the many reasons why people leave the city. The Décarie Expressway is an example of this as the borough that it bisects experienced a steady drop in population soon after its completion (see figure on right).

For the past 10 years Montreal has lost thousands of people to inter-regional migration, much to the delight of the bordering regions.²⁵

Montreal has been losing families as well since 2006 when other major cities are seeing an increase (see figure 1.2.24). Families are choosing to leave the island because they feel it is unsafe and an unattractive place to raise their children.

Consequently, parents must travel further for work, which exasperates traffic congestion in the city.

Therefore, if Montreal is not able to provide attractive urban dwellings that emphasize family living, then the traffic congestion will worsen and it will harm the health and economy of the entire region.

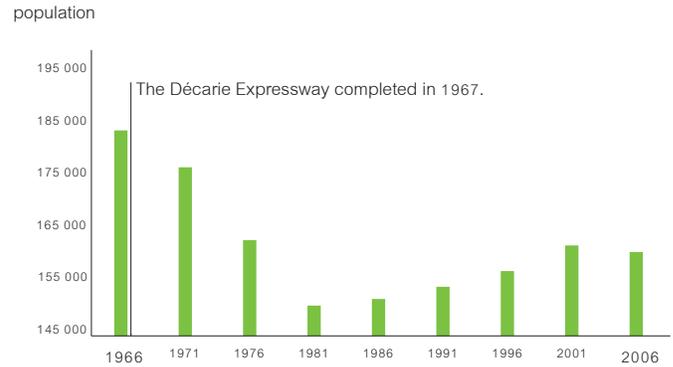


Figure 1.2.16 - Population drop in the neighbouring towns after the construction of the Décarie Expressway.²⁶

25 Institut de la Statistique du Québec. (2012). Le bilan démographique du Québec. Québec: Gouvernement du Québec.

26 Montréal en Statistiques. (2009). Profil sociodémographique - Côte-des-Neiges-Notre-Dame-de-Grâce. Montreal: Ville de Montréal.

27 Statistics Canada. (2013, 01 18). Focus on Geography Series, 2011 Census. Retrieved 02 13, 2012, from [www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-csd-eng.cfm?LANG=Eng&GK=CSD&GC=2466023](http://www.statcan.gc.ca: http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-csd-eng.cfm?LANG=Eng&GK=CSD&GC=2466023)

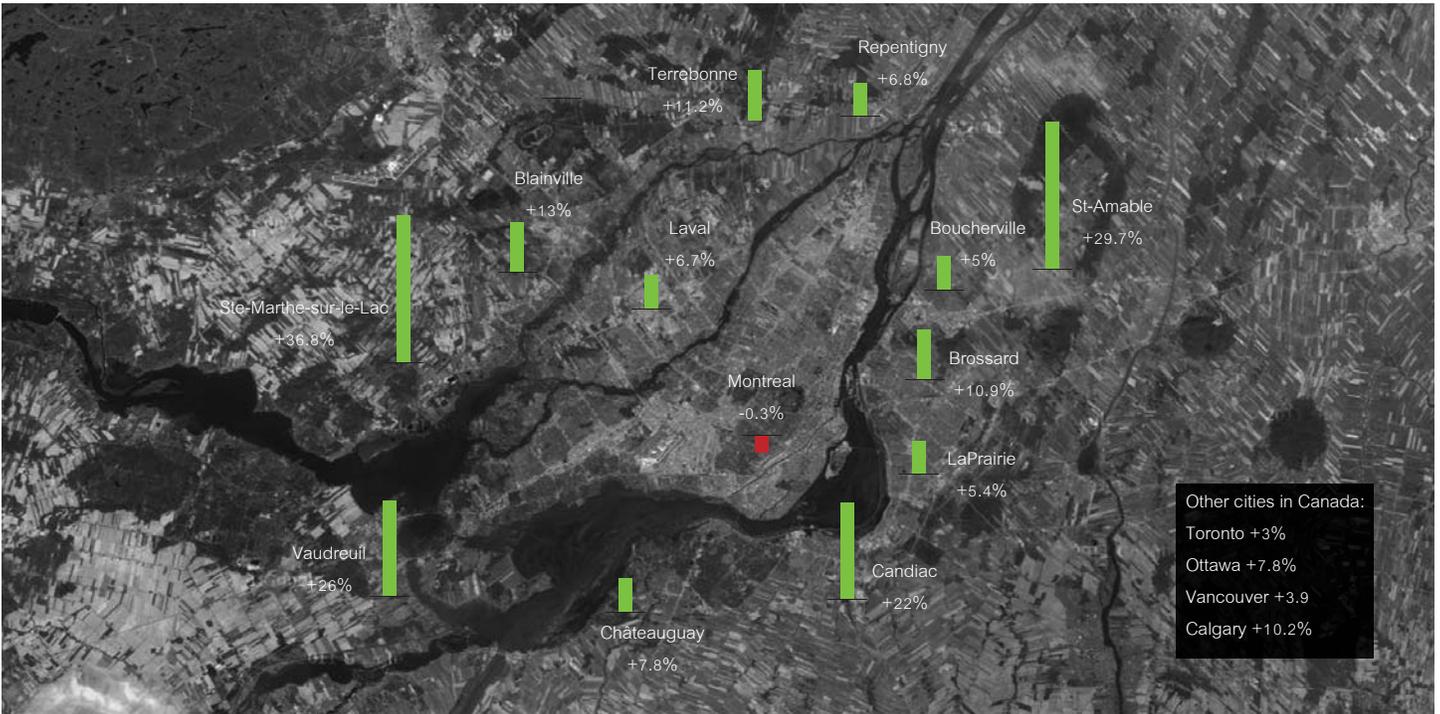


Figure 1.2.17 - Number of families in the city of Montreal. Rate of change is based on census data between 2006 and 2011. ²⁷

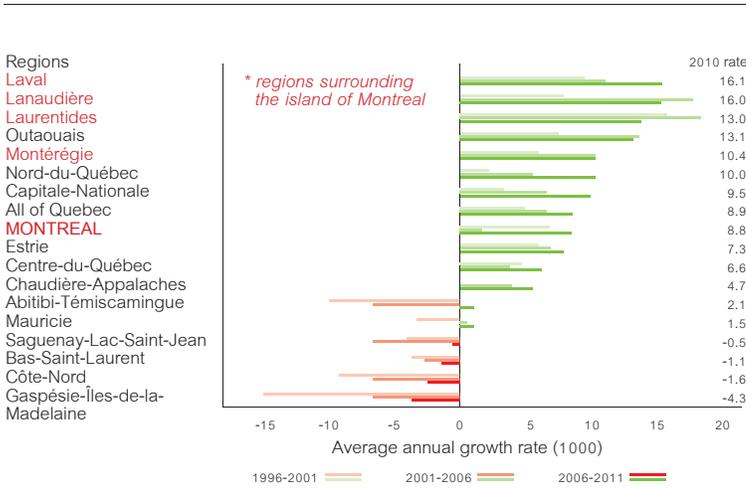


Figure 1.2.18 - Montreal's annual growth rate in comparison to the other regions in Québec. ²⁵

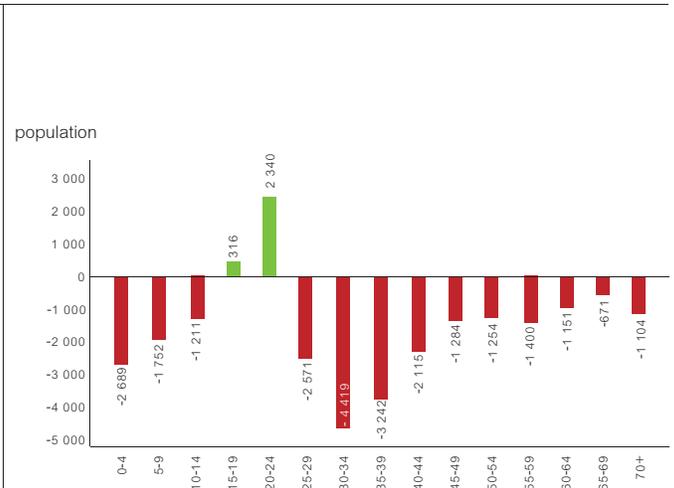


Figure 1.2.20 - Montreal's net interregional migration separated into age groups. ²⁵

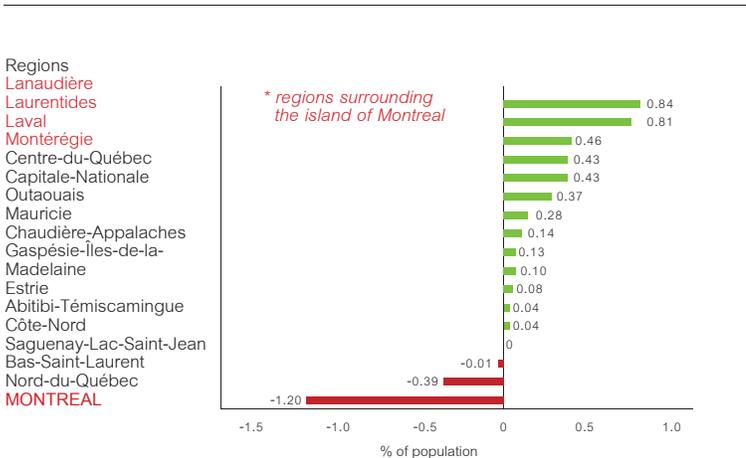


Figure 1.2.19 - Montreal's net interregional migration in comparison to the other regions in Québec. ²⁵

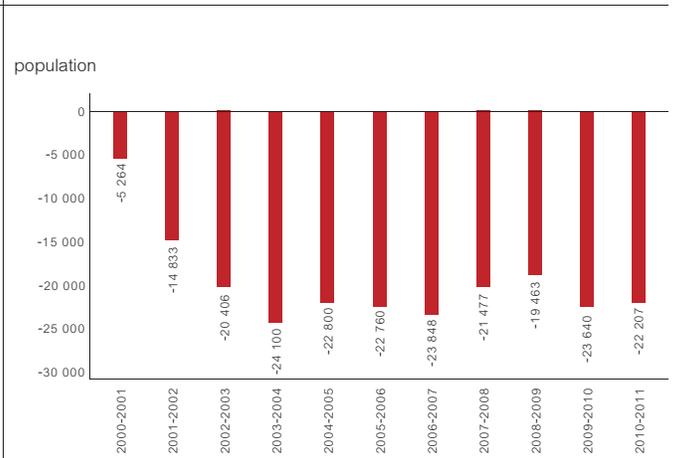


Figure 1.2.21 - Montreal's net interregional migration. Montreal has lost thousands of people per year to other regions in Québec. ²⁵

PROBLEM #5 - DISCONTINUOUS URBAN FABRIC

One of the main advantages of living in an urban area is the density and proximity to the services and goods people need and want. When there is a large rift in the continuity of the urban fabric, the social and economic welfare of the area suffers because of the diminutive effects the physical separation has on personal mobility. Due to the limited multi-modal crossings and one way service roads, pedestrians, cyclists and vehicles have longer paths to travel to reach their destination.

The average distance for a pedestrian to walk from one point on the Décarie to the exact opposite point on the other side is approximately 460m compared to 57m if there were no physical barrier. A 52 second walk (calculated with Google maps) becomes 4min one and that is not including the wait at the two traffic lights along the way, which can potentially be a couple of minutes each. That would bring the total walk time up to 8min, that is more than 9 times longer than being able to walk directly across. We have all heard of the economic principle of “location, location, location” and if businesses are hard or cumbersome to reach, their profits suffer.

Additionally, separating two communities with an expressway reduces the amount of social contacts and consequently reduces the transfer of ideas, another benefit of living in an urban context.

Children especially are affected since it is unsafe for them to cross the Décarie because of the large volume of fast moving cars. Therefore, children are more likely to stay on their side of the expressway, which limits their social circle and hinders their development.



Figure 1.2.22 - The Décarie Expressway physically separates two neighbourhoods.



Figure 1.2.23 - Pedestrians must walk further because of the Décarie's morphology.

PROBLEM #6 - PEDESTRIAN SAFETY ISSUES

Narrow sidewalks line the Décarie Expressway's surface level service roads and its overpasses, which create an unsafe environment for pedestrians. Vehicles coming off of the expressway at 100km/hr (the speed limit on the expressway is 70km/hr but based on personal experience, most people drive much faster than that) do not have any speed calming measures to encourage drivers to reduce their speed.

There are few physical barriers between the road traffic and pedestrians along the Décarie, further reducing their safety. According to the World Health Organization, road accidents are the tenth leading cause of death in the world.²⁸ The Décarie's proximity to several schools means that children especially are at risk of injury and potentially death.



Figure 1.2.24 - Narrow sidewalks along the Décarie Expressway.

28 The World Health Organization. (2011, 06). The top 10 causes of death. Retrieved 01 04, 2013, from www.who.int: <http://www.who.int/mediacentre/factsheets/fs310/en/index.html>

PROBLEM #7 - FLOODING

On July 14th 1987, 100mm of rain fell on Montreal during a very short period of time and overwhelmed the storm water drainage system. The Décarie Expressway was completely flooded and turned into a canal as water rose up to 3.6m. Extensive property damage and a couple deaths were associated with the flood.²⁹

Again in 2005, rain inundated the Décarie Expressway and also more recently in 2012.³⁰ According to experts, Quebec is on the verge of catastrophic climate change and the evidence shows that Montreal will experience warmer and warmer temperatures, thus increasing the risk of even more thunderstorms and consequently more floods.³¹

The Décarie Expressway is particularly susceptible to flooding due to its subterranean morphology and its location at the bottom of Mont-Royal.

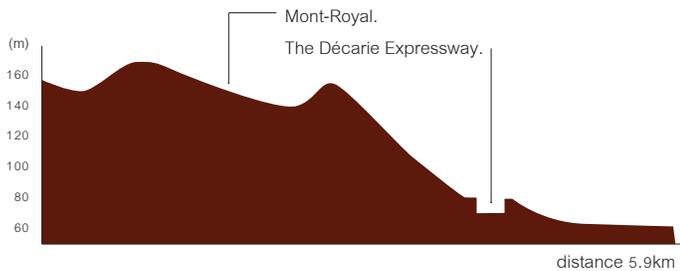


Figure 1.2.25 - Graphic Cross-section of the Décarie Expressway, data from www.geocontext.org



Figure 1.2.27 - Décarie Expressway flooding in 1987.



Figure 1.2.26 - Décarie Expressway flooding in 2005.

- 29 Environment Canada. (2010, 12 02). Flooding events in Canada - Quebec. Retrieved 01 04, 2013, from [www.ec.gc.ca: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=C0122DA3-1#Section2](http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=C0122DA3-1#Section2)
- 30 Duddin, J. M. (2005, 07 07). 30 millimètres d'eau en deux minutes sur l'autoroute Décarie. Retrieved 01 04, 2013, from [fr.canoe.ca: http://fr.canoe.ca/infos/quebeccanada/archives/2005/07/20050707-085407.html](http://fr.canoe.ca/infos/quebeccanada/archives/2005/07/20050707-085407.html)
- 31 Marsden, W. (2011, 12 30). Quebec on the verge of catastrophic climate change, expert say. Retrieved 01 04, 2013, from [www.montrealgazette.com: http://www.montrealgazette.com/technology/Quebec+verge+climate+shift/5925303/story.html](http://www.montrealgazette.com/technology/Quebec+verge+climate+shift/5925303/story.html)

PROBLEM #8 - POOR ECOLOGICAL HABITAT

"Conventional planning often under-represents, and at times even misrepresents, situations because it is overly biased towards physically tangible and humanly perceivable entities and events, while systematically undervaluing the less tangible, but formatively more significant, processes and functions that underwrite ecological realities. While we can only act in the world by manipulating the structural and morphological elements that mark its shapes, we cannot afford to ignore the often insensate processes and functions that constitute our world."³²

The Décarie and most other trenched expressways are huge pieces of infrastructure that together cover thousands of kilometres with tar infused asphalt and concrete, which creates an extremely poor habitat for human beings, let alone flora and fauna. The sheer scale of these structures effectively separates large areas of land impeding the natural movement of animals and the reproductive mechanisms of plants.

32 Vasishth, A. (2006). *Getting Humans Back Into Nature: A Scale-Hierarchic Ecosystem*. Los Angeles: University of Southern California.



Figure 1.2.28 - An image created by Erik Johannson.



Figure 1.2.29 - Evidence of the shrinking of ecological habitat for fauna.

PROBLEM #9 - MOTOR VEHICLES SATURATION OF THE TRANSPORT NETWORK

"For the current American way of life is founded not just on motor transportation but on the religion of the motorcar, and the sacrifices that people are prepared to make for this religion stand outside the realm of rational criticism [...] The result is that we have actually crippled the motorcar, by placing on this single means of transportation the burden for every kind of travel."³³

The saturation of the transport network by one single mode of transit (the motor vehicle) has drastic effects on economic growth and the quality of life of Montrealers. According to Transport Quebec, the use of automobiles in the Montreal region is increasing. If nothing is done by 2016 the number of kilometres of congested routes will quadruple, peak periods will be longer and traffic will be heavier.³⁴

The estimated cost of congestion for the Montreal region in 1998 was \$778 700 000.³⁵ Two-thirds of the goods traded between Quebec and the United States (worth \$50 billion) in 1998 were transported by truck.³⁶ The Décarie Expressway is the main link to the US border. If congestion increases then so will the costs associated with longer travel times, reducing Montreal's and Quebec's global competitiveness.

Below are a few examples of other financial and social costs of motor vehicle transport.

"\$62.7 billion each year collisions cost Canada. This estimate represents about 4.9 per cent of Canada's 2004 Gross Domestic Product (GDP)."³⁷

"10% of all criminal code violations in Quebec are due to traffic related crimes."³⁸

"The estimate of the social cost of motor vehicle collisions includes direct and indirect costs:

Direct costs relate to property damage, emergency response, hospital care, other medical care and insurance administration, out-of-pocket expenses by victims of motor vehicle collisions and traffic delays (lost time, extra fuel use, environmental pollution).

Indirect costs relate to human consequences of collisions, such as partial and total disability of victims, activity and workdays lost – as well as the pain and suffering of victims and their families."³⁷

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- 33 Mumford, L. (1970). In *The Highway and the City* (p. 234). Orlando: Harcourt Brace & Company.
- 34 Transport Québec. (2012). *Greater Montréal Area Transportation Management Plan*. Retrieved 01 04, 2013, from www.mtq.gouv.qc.ca/portal/page/portal/ministere_en/ministere/plans_transport/montreal_plan_gestion_deplacements
- 35 Gourvil, L., & Joubert, F. (2004). *Évaluation de la Congestion Routière dans la Région de Montréal*. Québec: Ministère des Transports du Québec.
- 36 Ministère de Transports. (2000). *Transportation Management Plan - Greater Montréal Area*. Québec: Ministère des Transports.
- 37 Transport Canada. (2012, 02 21). *Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario (2007 Report)*. Retrieved 01 04, 2013, from www.tc.gc.ca: http://www.tc.gc.ca/eng/roadsafety/tp-tp14800-menu-159.htm
- 38 Statistics Canada. (2012, 07 24). *Crimes, by type of violation, and by province and territory*. Retrieved 01 04, 2013, from www.statcan.gc.ca: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/legal50d-eng.htm

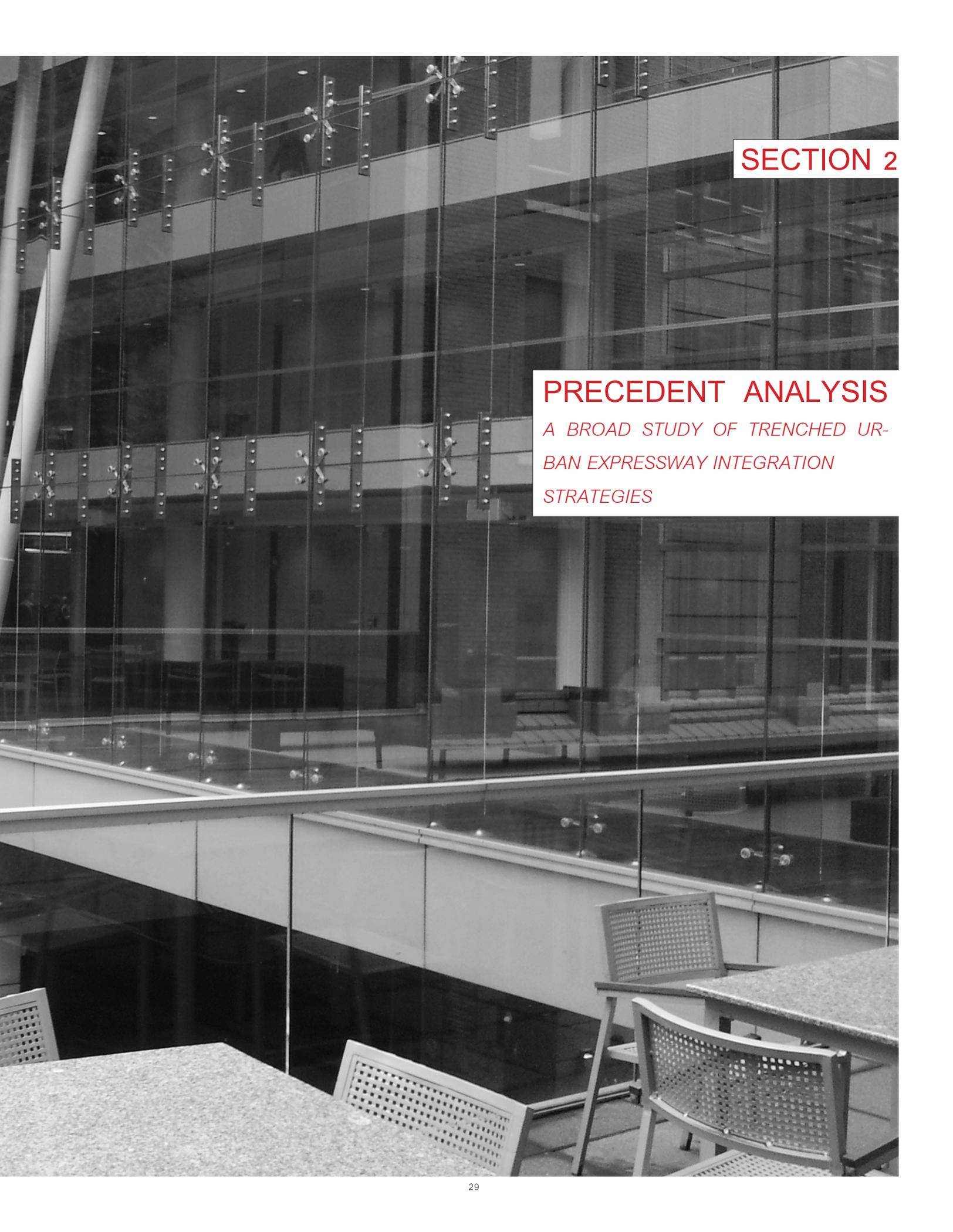
THE BACKGROUND AND PROBLEM(S) - CONCLUSION

"The future of the most of humanity now lies, for the first time in history, fundamentally in urbanizing areas. The qualities of urban living in the twentieth-first century will define the qualities of civilization itself."³⁹

Trenched urban expressways are monumental and key infrastructures for metropolitan cities and if they are not designed properly, the economy and the health of the city will suffer. Air, noise and light pollution, flooding, inefficient personal mobility and the lack of ecology are all issues belonging to most trenched urban expressways. In the following chapter, I will investigate specific projects that try to integrate trenched urban expressways into their context in a productive way. A critical analysis of their salient characteristics will form a bank of knowledge that will be drawn from in the final design proposal of the Décarie Expressway.

39 Harvey, D. (1996). In *Justice, Nature, & the Geography of Difference; Possible Urban Worlds* (p. 403). Malden: Blackwell Publishers Inc.





SECTION 2

PRECEDENT ANALYSIS

*A BROAD STUDY OF TRENCHED UR-
BAN EXPRESSWAY INTEGRATION
STRATEGIES*

SECTION 2 - PRECEDENT ANALYSIS - A BROAD STUDY OF TRENCHED URBAN EXPRESSWAY INTEGRATION STRATEGIES

Trenched urban expressways are present in most metropolitan cities around the world. They are frequented by hundreds and thousands of people every day. Unfortunately, their form is dictated more often than not as a function of motor vehicular capacity and flow rate rather than that of architectural integrity. They are often treated as a piece of infrastructural engineering without any consideration to how it will affect the surrounding urban fabric.

As architects, we must recognize the massive impact these structures have on our cities and claim responsibility for their design because they affect not only than the daily commute but also the surrounding urban fabric and the reputation of the entire city.

I intend to use this precedent analysis as a counterpoint to the theory that I will implement in the subsequent design proposal of the Décarie Expressway. The study analyzes four individual projects that have attempted to reconcile trenched urban expressways with their surrounding urban fabric. I have chosen the following projects for their morphological commonalities with the Décarie Expressway and their unique architectural qualities. The four projects are as follows:

- 2.1 The Gran Via de les Corts Catalanes, Barcelona, Spain.
- 2.2 The Boulevard Intercommunal du Parisis, Paris, France.
- 2.3 The Big Dig, Boston, USA.
- 2.4 The Quartier International de Montreal, Montreal, Canada.

The first two projects avoid covering the expressway and try to integrate themselves into their surrounding residential neighbourhoods by using noise barriers, landscaping and architectural techniques. The last two projects bury the expressway and try to stitch back together the once discontinuous urban fabric. Both approaches represent possible solutions for the Décarie Expressway. The lessons learned from each project will help inform the eventual design proposal.

The study will include a brief historical description and overview of each project along with a critique of their salient characteristics. To broaden the depth of the analysis, an emphasis will be placed on specific study areas within each project.

OVERVIEW OF A FEW EXPRESSWAY RENEWAL PROJECTS AROUND THE WORLD

EXPRESSWAY	CITY	TYPE (ORIGINAL/NEW)	DATE (ORIGINAL/NEW)
Removal			
Bonaventure Expressway	Montreal, QC	Elevated / Boulevard	1967 / proposed
Sheridan Expressway	Bronx, NY	Elevated / Boulevard	1962 / proposed
Cheonggyecheon Expressway	River Seoul, ROK	Elevated / River	1976 / 2005
Central Freeway	Octavia Boulevard San Francisco, CA	Elevated / Boulevard	1959 / 2005
Park East Freeway	McKinley Avenue Milwaukee, WI	Elevated / Boulevard	1971 / 2003
Embarcadero Freeway	Roadway San Francisco, CA	Elevated / Boulevard	1958 / 1991
Riverfront Parkway	Chattanooga, TN	At-grade / Boulevard	1960 / 1990
Retrofit			
Alaskan Way Viaduct	Seattle, WA	Elevated / Tunnel	1959 / proposed
Central Artery Tunnel 'Big Dig'	Boston, MA	Elevated / Tunnel	1959 / 2007
I-90 / I-35W	Minneapolis	Trench / Tunnel	1982 / proposed
I-405	Portland, OR	Trench / Tunnel	1969 / proposed
Hollywood Freeway	Park 101 Los Angeles, CA	Trench / Tunnel	1968 / proposed
Ville-Marie Expressway	Montreal, QC	Trench / Tunnel	1972 / 2002
I-5 / Freeway Park	Seattle, WA	Trench / Tunnel	1957 / 1976
Fort Washington Way	Cincinnati, OH	Trench / Tunnel	1959 / proposed
I-5	San Diego, CA	Trench / Tunnel	1957 / proposed



Figure 2.0.1 - Bonaventure Expressway



Figure 2.0.2 - Central Freeway



Figure 2.0.3 - Central Artery Tunnel 'The Big Dig'



Figure 2.0.4 - I-5 / Freeway Park



Figure 2.0.5 - Cheonggyecheon Expressway



Figure 2.0.6 - Alaskan Way Viaduct

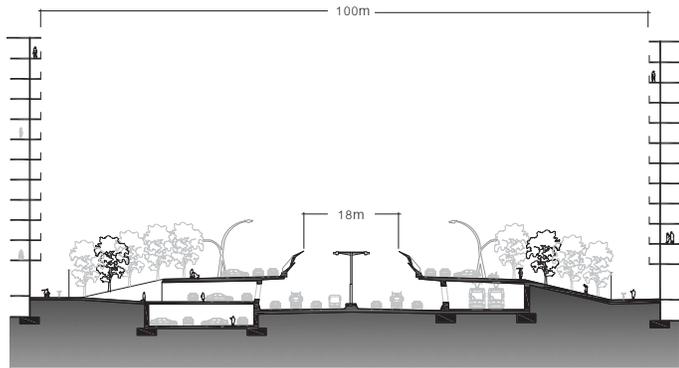


Figure 2.0.7 - Ville-Marie Expressway

SCALE COMPARISON OF SELECTED PROJECTS

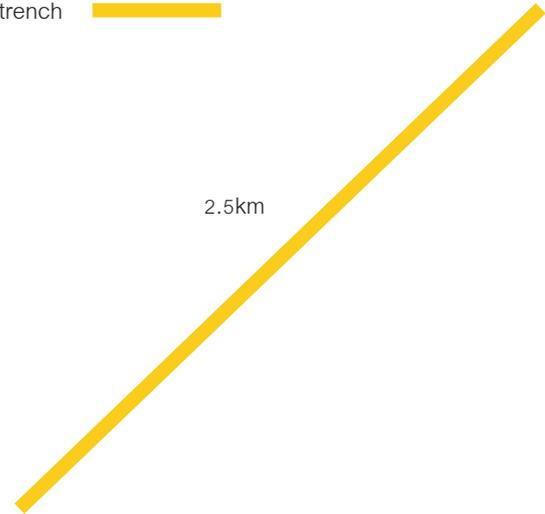
2.1 GRAN VIA DE LES CORTS CATALANES

Barcelona, Spain



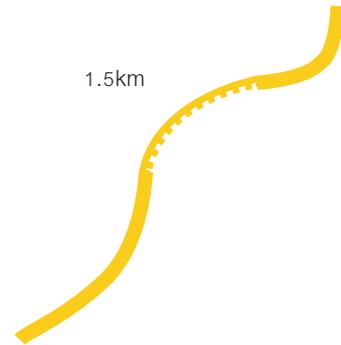
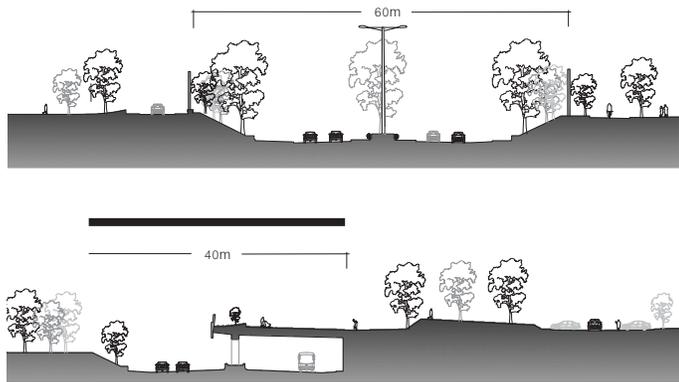
LEGEND

- Covered
- Open trench



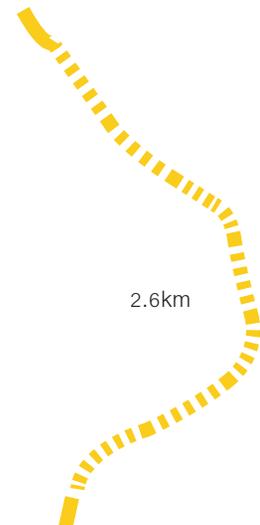
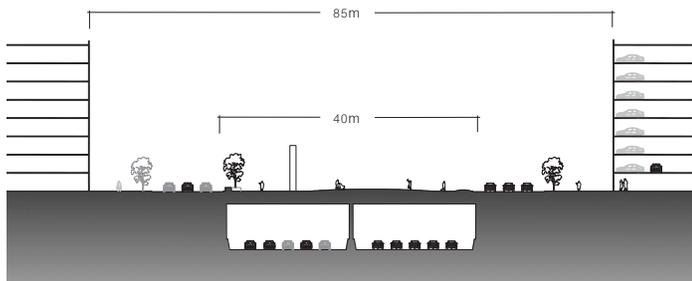
2.2 THE BOULEVARD INTERCOMMUNAL DU PARISIS (BIP)

Paris, France



2.3 THE CENTRAL ARTERY/TUNNEL PROJECT (THE BIG DIG)

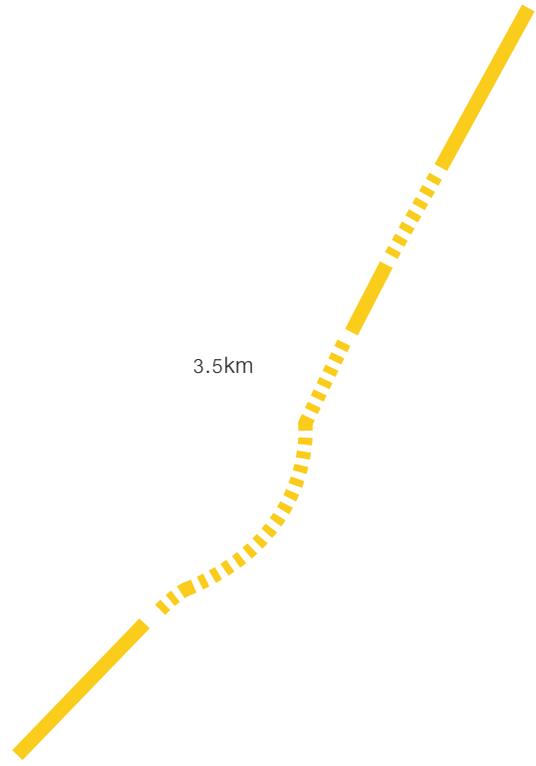
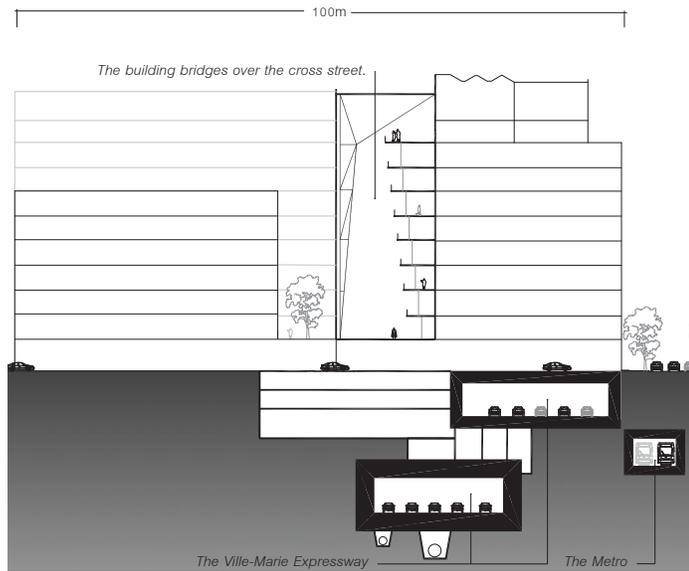
Boston, USA



Images by author. Length approximated using Google Earth measure tool (retrieved December 2012).

2.4 THE QUARTIER INTERNATIONAL DE MONTREAL (QIM)

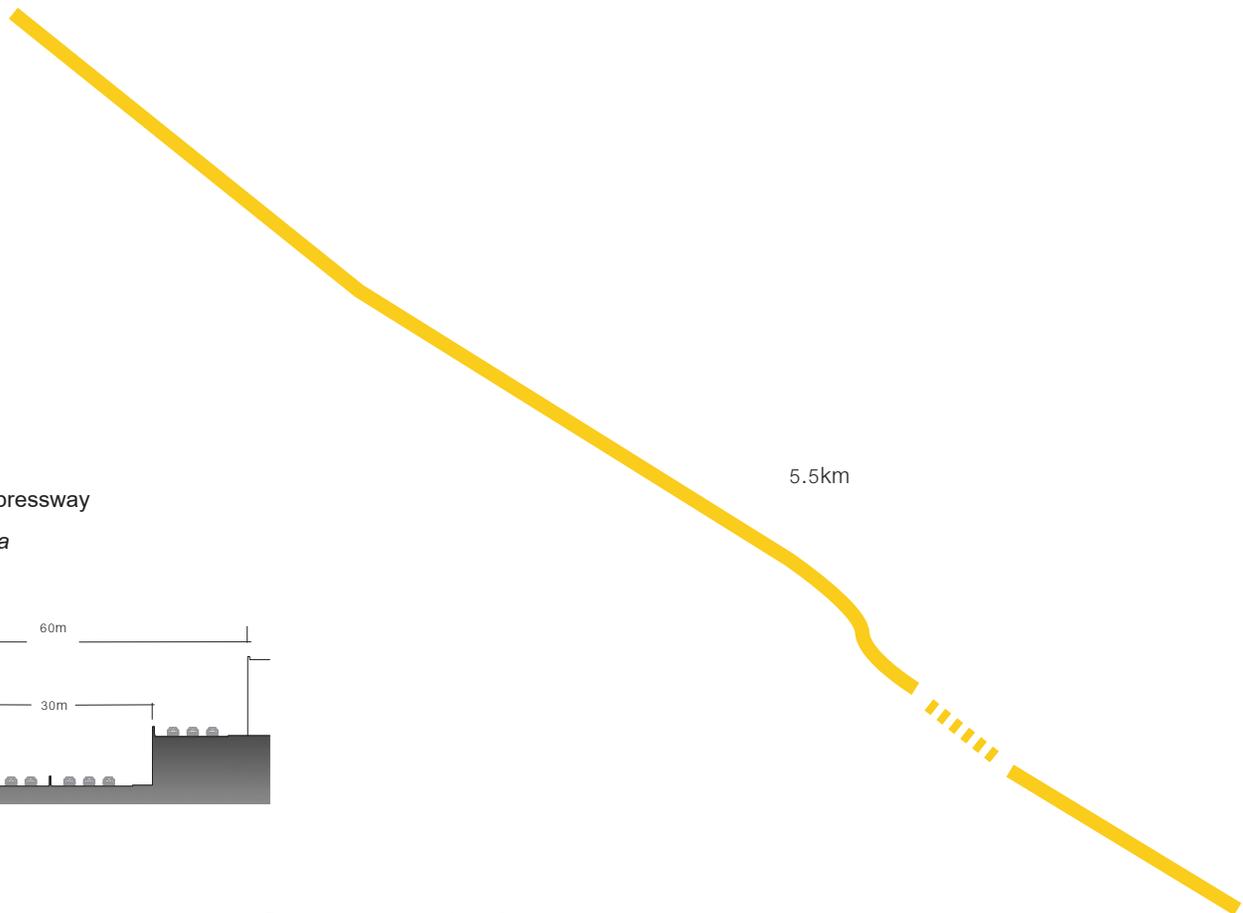
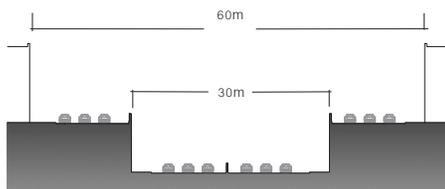
Montreal, Canada



3.5km

THE Décarie Expressway

Montreal, Canada



5.5km

Images by author. Length approximated using Google Earth measure tool (retrieved December 2012).



LAYERED INFRASTRUCTURE

2.1 GRAN VIA DE LES CORTS CATALANES

Location : Barcelona, Spain

Architects : Arriola & Fiol arquitectes

Project completion: 2007

Project dimensions: 250,000 m² (2.5km x 100m)

Budget: 16,500,000 euros

HISTORY

Gran via de les Cortes Catalanes is the main east-west thoroughfare situated in Barcelona, Spain. It runs parallel to the Mediterranean coast. It was part of the 1876 extension plan for Barcelona designed by Ildefons Cerdà. He was the urban planner responsible for the iconic morphology of present day Barcelona; a typical gridiron plan with cut corners and inner courtyards.

Most of the artery's 13km remains a beautifully landscaped urban boulevard but a section east of Plaça de les Glòries (once envisioned by Cerdà as the new center of Barcelona), was turned into a highway in the 1980's to relieve traffic congestion. As time passed, the city grew and this section of the thoroughfare became increasingly populated. Mounting community pressure forced the government to amend the negative effects of the expressway.¹

OVERVIEW

Arriola & Fiol arquitectes were asked by the city to retrofit the problematic portion of the highway and in 2007 they completed their vision. A layered infrastructure with an emphasis on pedestrianism



Figure 2.1.1 - Bird's eye view of the project.

and public space, the project reconnects the communities bordering the expressway to each other and also to the waterfront.

A central six-lane expressway (including one reserved bus lane heading towards the city center) is depressed with noise barriers cantilevered 3.5m on either side shielding the adjacent residential complexes from the noise and channelling the air pollution up and away. Elevated lateral roads flank both sides of the expressway, which include intermittent surface parking strips, on and off ramps as well entrances into two 400m long two storey underground parking lots. From there, triangular berms slope downwards on either side towards a continuous bike path that doubles as a service/emergency access road. The bike paths then transition into generous sidewalks that serve the apartment complexes that line the sides.

1 Kelly Shannon, M. S. (2010). In *The Landscape of Contemporary Infrastructure* (pp. 100-101). Rotterdam: NAI Publishers.

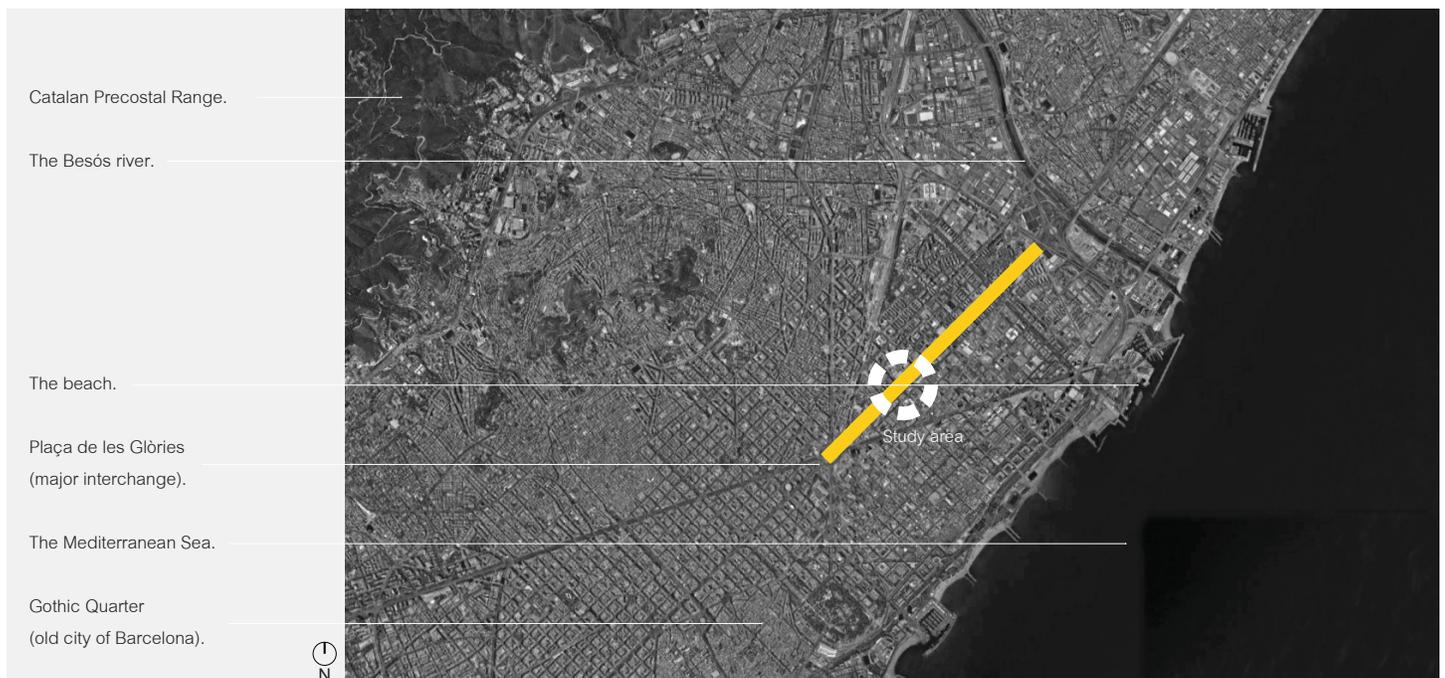


Figure 2.1.2 - Aerial image of Barcelona - site Context.

LAYERED INFRASTRUCTURE

Layering varying modes of transportation along a major city axis allows the transportation network in the area not only to be more flexible when things go wrong, but it gives the passenger a choice based on his or her preference; a luxury that increases the desirability of the surrounding properties. This layering also allows for multi-modal transfers to occur more frequently thus increasing the efficacy of the city's overall transportation network.

Arriola & Fiol have maximized the artery's potential as a multi-modal thoroughfare by efficiently using the space underneath and adjacent to the expressway.

The depressed six lane expressway and the tramway line buried underneath the two-lane service road on the south side are unimpeded from any surface crossings or intersecting transportation corridors, thus allowing them to flow continuously. On the surface, local vehicular traffic yields to pedestrian and bike crossings which gives local residents a sense of security and comfort.

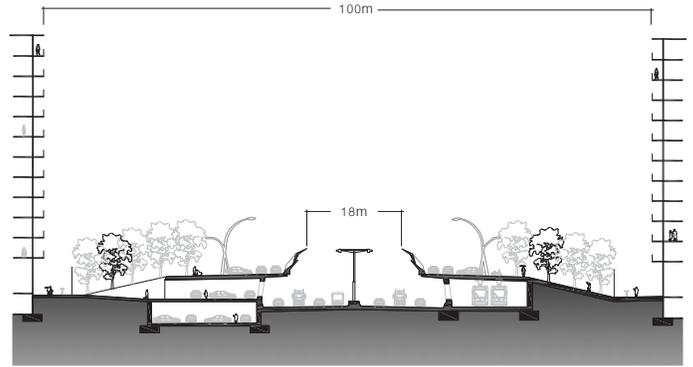


Figure 2.1.3 - Typical section.



Figure 2.1.4 - View of one the continuous bike paths. This image shows how the pedestrian, bicycle and local vehicle infrastructure are weaved together.

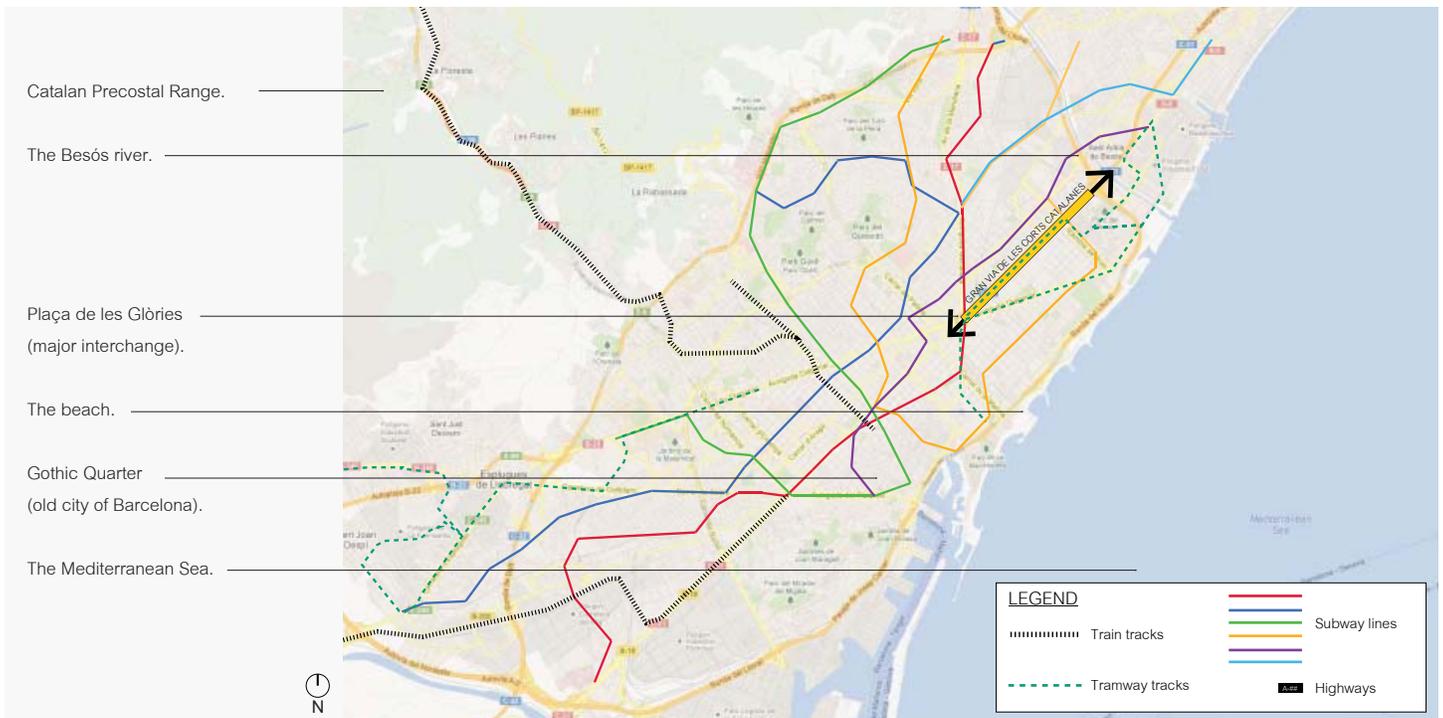


Figure 2.1.5 - Barcelona's transportation network. The image above shows how important this artery is to Barcelona. It penetrates the outer ring expressway right into the heart of the city.

GEOMETRIC COHERENCE

Throughout the length of the project, triangular berms are used to negotiate the changes in topography. When two inclined berms intersect, the interstitial space between them forms plazas that are level with the residential complexes. These spaces create varying opportunities for public space and for specific programs related to the artery's functionality to materialize while maintaining an overall geometric coherence. For example, figure 1.6 shows a typical entrance of one of the two underground parking lots. Remark how the geometry frames the entry portal and provides a barrier free entrance into the parking lot. Other types of programs are inserted into these cut outs such as: temporary parking facilities, public squares, playgrounds, basketball courts and fountains.

The design of the custom double pronged light posts, the street furniture and the pedestrian bridge treatment is repeated along the project creating a cohesive whole that identifies the neighbourhood but renders local spaces relatively indistinguishable from one another.



Figure 2.1.6 - Typical landscaped berm and underground parking lot entrance.



Figure 2.1.7 - View of a water feature. A good way to drown out the nearby vehicle noise , while animating the space and creating a cooling station for the passersby.

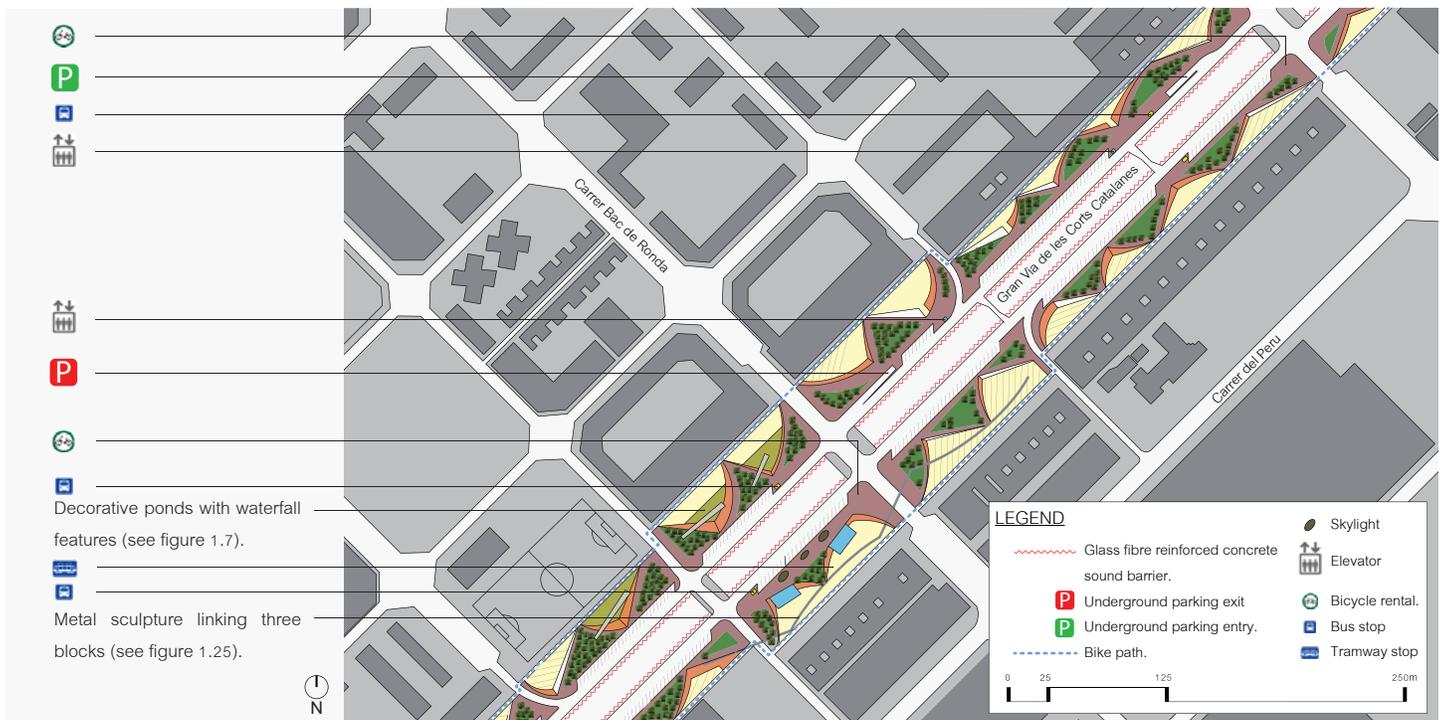


Figure 2.1.8 - Analysis summary of study area.

LEGEND

- ↔ Pedestrian crossing
- ↔ Multimodal crossing
- P Underground parking exit
- P Underground parking entry
- Bus stop
- On/off ramp
- Tramway stop

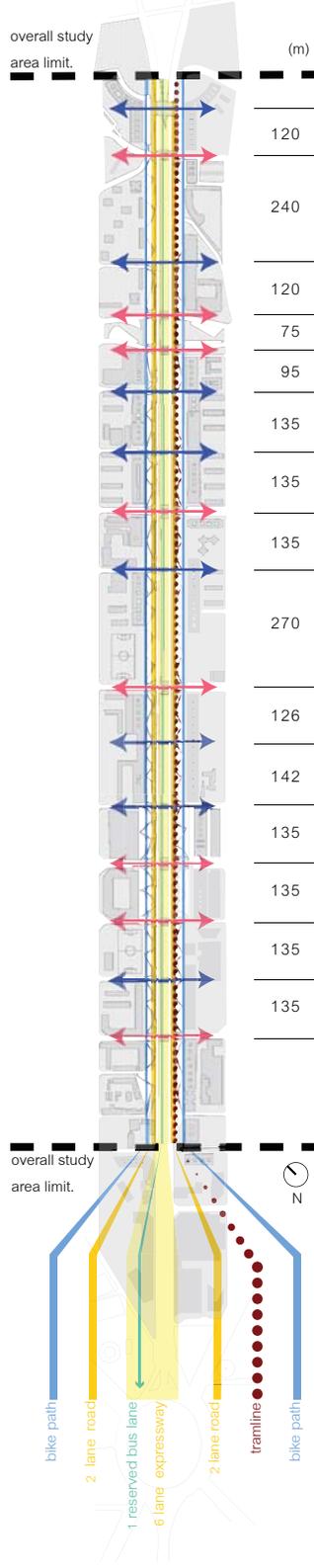


Figure 2.1.9 - Modes of transport and expressway cross-

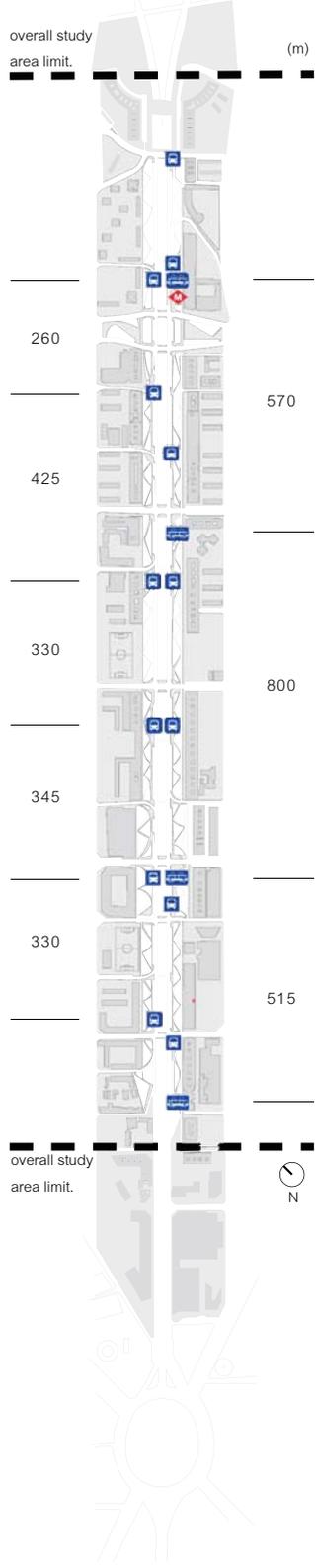


Figure 2.1.10 - Public transportation stops.

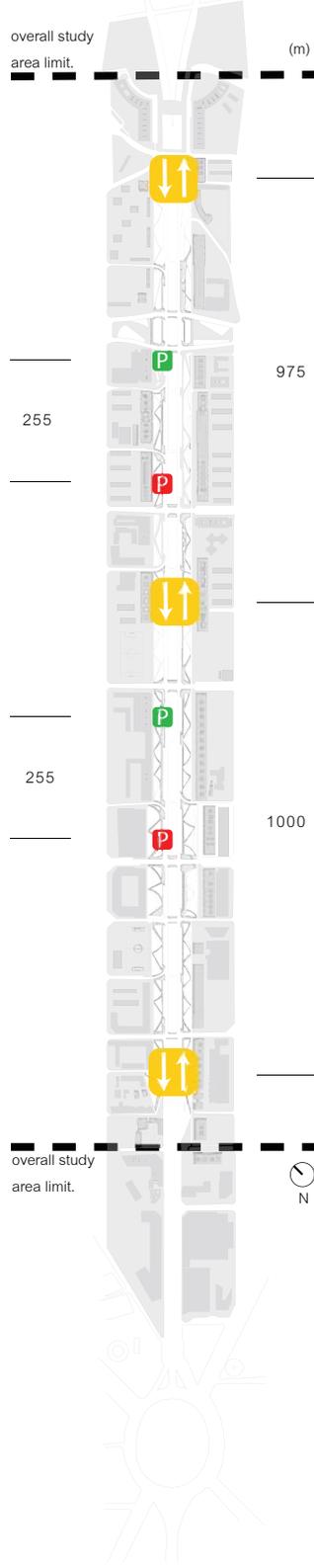


Figure 2.1.11 - On/off ramps and underground parking access.



Figure 2.1.12 - Typical view inside the depressed expressway and of a typical pedestrian crossing.



Figure 2.1.13 - Typical view of a glazed elevator used to enter the underground parking garages.



Figure 2.1.14 - Typical pedestrian crossing. A traffic light stops traffic and allows the pedestrian to cross safely.



Figure 2.1.15 - A view of a soccer field adjacent to the expressway. Remark that the pedestrians are sheltered from vehicular traffic by the landscaped berm.

ACCESSIBILITY

Arriola & Fiol have increased the permeability of the urban fabric along the expressway and have improved local circulation. The architects have considered the speed at which each mode of transportation travels and have spread their access points proportionally along the expressway (see page 07).

The six lane depressed expressway supports the fastest mode of transportation and consequently, it has the fewest access points, three on/off ramps located roughly 1km apart. The bidirectional tramway inserted underneath the two lane lateral road on the south side is the next slowest mode of transportation and it has four stations, located 630m apart on average. Its four stations are all level with the entrances to the residential complexes. The buses are slower (more frequent stops) and consequently have six bus stops in each direction, separated on average by 340m.

Local vehicle circulation travels practically as efficiently as if there were no expressway at all because the architects have added two additional multi-modal crossings. Now all the perpendicular streets are connected. Therefore, the only loss in efficiency is the 20m required to cross the expressway. The entrances and exits into and from the underground parking lots located on the north side can be accessed by the two lane lateral road, each served by two glass elevators.

Arriola & Fiol most significant improvement in terms of accessibility was quadrupling the amount of pedestrian crossings. A total of sixteen crossings now exist. Pedestrians now must only travel 160m on average to reach the opposite side. This is a tremendous improvement from the average 420m that pedestrians were originally forced to walk.

Increasing the pedestrian crossings provides an invaluable amenity to the local residents by allowing them to cross more freely, increasing the exchange of economies and social contacts, increasing the use of various programs (soccer fields, restaurants etc.) located on either side of the expressway and allowing each person to feel as though their neighbourhood belongs to them and not to through traffic.

It also allows the public transportation network to function better by allowing the pedestrian to access various transportation nodes. For example, bus stops are located in front of the parking lot entrances which stop in front of the tramway stops that connect to the commuter rail stations thus completing an effective city wide mobility network.



Figure 2.1.16 - Typical entrance into the underground parking lots.



Figure 2.1.17 - Typical angled surface parking spaces. Remark how all the cars face forward due to the nature of entering the parking space. This configuration allows cars to merge with traffic easily.

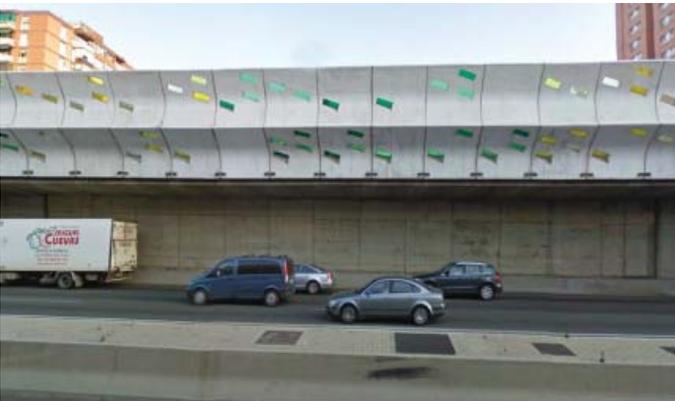


Figure 2.1.18 - Typical view of the noise barriers inside the depressed expressway. Plexi glass inserts filter light and create a rainbow like pattern on the road.

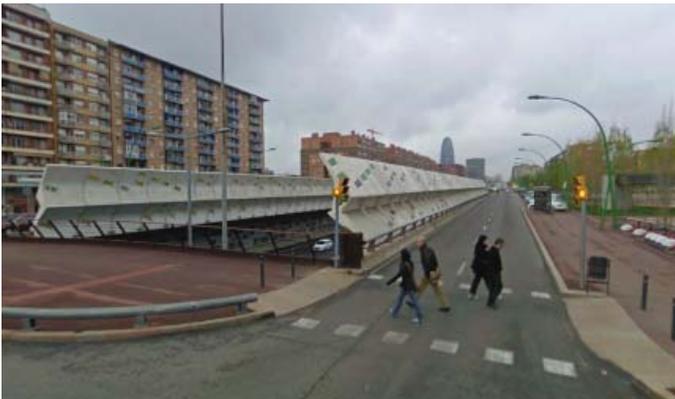


Figure 2.1.19 - Typical noise barriers. Remark their scale in relation to the pedestrians. They are effective at reducing the noise but create a visual barrier between both sides.

PARKING SPACE

There are two 400m long double decked underground parking lots that are accessible on the north side of the expressway. The entrances and exits are integrated with the local circulation and are clearly demarcated with signs and blue painted side walls.

Parking spots intermittently line the lateral roads. They are not oriented perpendicular or parallel like most parking spots in Montreal but they are angled in the direction of traffic. Angled parking lots require less time and space to park and they require less time to exit due to the fact that drivers are encouraged to park facing forward. This specific design feature would be important to implement in northern climates where snow accumulation often buries vehicles. Facing forward would allow the vehicle a better chance to overcome this obstacle.

SOUND BARRIERS

Glass fibre reinforced concrete (GFRC) panels with coloured plexi glass inserts line the edge of the trenched section of the expressway and dampen the noise from the traffic below. GFRC was chosen because it is lightweight, highly reproducible, able to form complex shapes without additional reinforcement, highly resistant to corrosion, highly resistant to chemicals, including urban pollutants and salt solutions, resistant to plastic and drying shrinkage cracking therefore resistant to freeze thaw cycles, absorbs sound, impact resistant and highly durable. The coloured plexi glass animates the trenched expressway and both lateral roads as the sunlight filters through.

Even though GFRC panels seem to be the ideal material to make sound barriers for high impact prone, pollution filled environments, these particular barriers extend approximately 4.5m above the surface level and block any visual connection across the expressway. In this project, acoustic comfort has outweighed visual connectivity.

Furthermore, the white finish becomes dirty quickly and reduces the aesthetic qualities of the space.



Figure 2.1.20 - Typical noise barrier connection detail.



Figure 2.1.21 - Typical view of skylights above the tramway platforms.



Figure 2.1.22 - Typical view of skylights above ground.



Figure 2.1.23 - Typical double pronged light post.

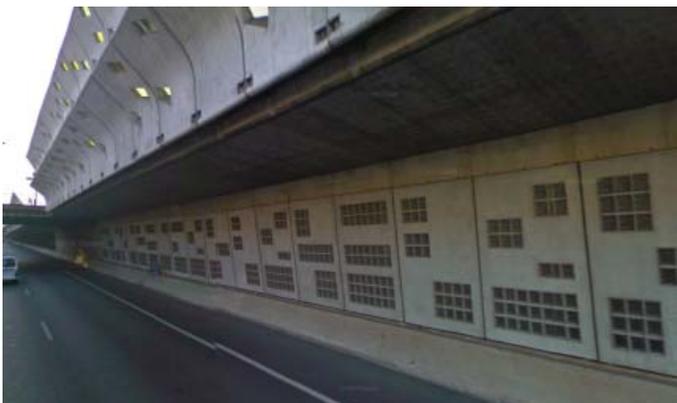


Figure 2.1.24 - Typical glass block windows along tramway tunnel and parking garage walls.

LIGHTING

Every section inhabited along this section of the expressway has access to natural light. The trenched expressway is exposed to the sky. Elliptical skylights are located above each tramway station's platform. Certain sections of the tramway line are open to the air while others are enclosed with an asymmetrical pattern of glass block windows. The underground parking garages receive light through the same glass block window treatment that the tramway tunnel benefits from. Even the access elevators are glazed and can catch the sun's rays.

Artificial lighting for the trenched expressways are located along the central median and they do not shine above the sound barriers reducing unwanted light pollution. The landscaped berms and lateral roads are lit by custom designed double pronged light posts. One prong is higher and it shines on the lateral roads increasing driver visibility at night while the other prong is shorter and it illuminates towards the residential complexes reducing the amount of light pollution entering the apartments.



Figure 2.1.25 - Metal sculpture, typical tramway station entrance and surface lighting.



Figure 2.1.26 - Typical trench lighting.

LESSONS LEARNED

Layered infrastructure

- 1) Existing large vehicular infrastructure provides a great opportunity to layer varying modes of transportation, creating a multi-modal transportation hub and an amenity to local residents and businesses.
- 2) Pedestrian safety and mobility enhances local unity and encourages the businesses and amenities on both sides to be used more frequently thus creating a more dynamic neighbourhood.
- 3) Adding copious amounts of vegetation where possible cleans the air, provides some sound protection, reduces the pressure on the storm water system, provides a habitat for urban fauna, reduces the heat island effect and beautifies the community.
- 4) The visual discontinuity across the expressway must have been outweighed by the cost of sinking the expressway lower. Ways in achieving visual connectivity and noise control must be seriously considered because they are as equally important.
- 5) Use interstitial space to provide amenities for local residents.
- 6) Sensitivity to local resident's light pollution tolerance is a laudable feature to incorporate into urban infrastructure.
- 7) Varying the architectural character along the expressway is important to enhance local qualities and as a wayfinding strategy.
- 8) Glass reinforced concrete is an ideal material to be used as noise barriers because of its high durability, lightness, ease of construction and acoustic absorption properties.
- 9) White finishes dirty quickly when exposed to vehicle pollution.
- 10) Angled parking spaces along lateral roads allow drivers to enter and exit the spaces more quickly. A two point turn is needed to enter the space unlike the three point turn required to parallel park. Also, by naturally guiding the driver to enter backwards the vehicle's trunk faces the sidewalk allowing the driver to unload his cargo safely. Finally, this configuration would help drivers in cold climates drive out when trapped in snow.
- 11) Water features drown the vehicle noise, animate the space and they provide cooling stations for local residents.

SENSITIVE RESIDENTIAL INTEGRATION



2.2 THE BOULEVARD INTERCOMMUNAL DU PARISIS (BIP)

Location: Paris, France

Architect: Patrick Duguet Architecture Urbanisme

Project completion: 2004

Project dimensions: 262 500 m² (3.5km x 75m)

HISTORY

The Boulevard Intercommunal du Parisis (BIP) project has been under development since 1939. Located in the suburbs northwest of Paris, it was conceived to improve the regional road network by linking two of its major highways, the A1 and the A15. Its secondary function was to serve the local urban fabric, consisting mostly of medium density residential neighbourhoods. Most of the residents commute into the city for work and the BIP is envisioned to facilitate their access to transportation nodes (the Ermont-Eaubonne train station) and employment sectors (Paris, Charles-de-Gaule and the Bourget airport). Community involvement and the early collaboration between specialists was a key ingredient in the realization of this project.²

OVERVIEW

The BIP is divided into three parts: West, Center and East. This analysis will focus on the completed West portion while the east remains partially finished and the center is still under investigation. The West portion itself was divided in two phases. The first section started in 1999 and it consists of a 2.1km high speed urban boulevard (speed

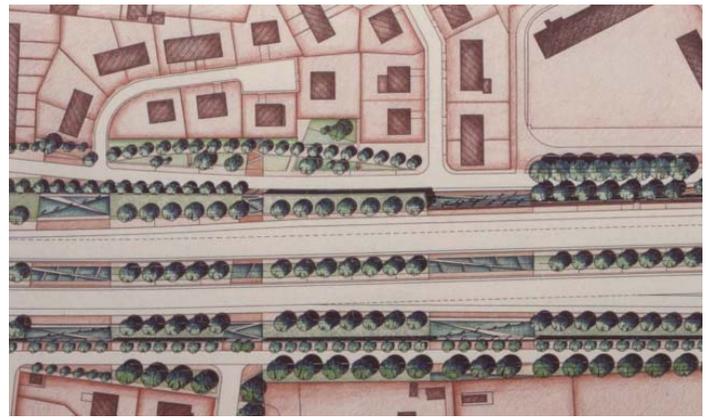


Figure 2.2.1 - Architectural concept.

= 70-90km/hr). It is bermed, landscaped and acoustically sheltered. Tall brick acoustic barriers shelter the adjacent neighbourhoods from the traffic noise. Intermittently along the brick wall, large glazed noise barriers visually connect the bisected neighbourhoods (see figure 2.14). Landscaping is a noticeable feature in this section of the BIP, specifically along the visual corridors created by the glazed noise barriers.

The second section, 1.3km long, has been in construction since 2003. It is similar to the first but it is semi-covered along a third of its length (see figure 2.17). The semi-covering of high speed vehicle thoroughfares is a typical strategy found in Paris. The coverings are strategically placed to shelter residential neighbourhoods from the noise and air pollution while allowing natural light into the space below.

² Marie Lessard, M. H., M.P., M.G. (2006). *Requalification d'autoroutes et réhabilitation paysagère et urbaine - quelques expériences nord-américaines et européennes*. Québec: La Direction de Québec.

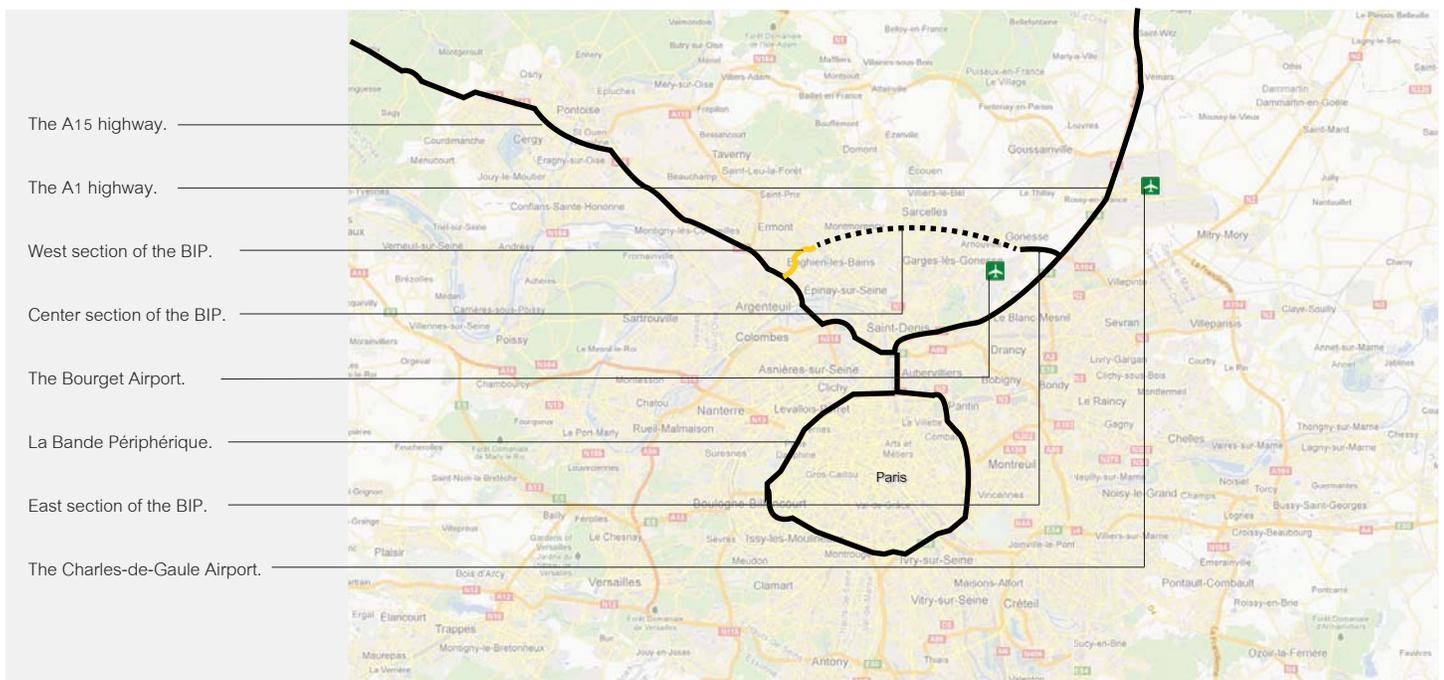


Figure 2.2.2 - The three sections of the BIP and the overall site context.

IN BETWEEN EXPRESSWAY AND BOULEVARD

According to the architect Patrick Duguet, it was imperative that the project not look like a highway and not like a thoroughfare hidden behind two walls but an integral piece of the city. The materials, land-project be an integral piece of the city and not look like a highway hidden behind two walls.³ The materials, landscaping and details have all been chosen and executed with great care. The lateral roads, limited to 30km/hr, accommodate vehicles, bikes and pedestrians. Every inch of unused space is covered with vegetation carefully placed to enhance the architectural concept. Noise barriers reduce the sound of the vehicle traffic without completely visually disconnecting adjacent neighbourhoods. Varying measures to make the driver aware of his/her speed are incorporated into the design, increasing the overall safety along the artery and reducing the noise pollution.

COMMUNITY INVOLVEMENT

Community participation in the design process was welcomed and before the design process was started, the authorities held a meeting where the residents were able to voice their opinions. An information center was created, the "Maison BIP", to provide residents with information on the project and as a place for the residents to communicate their concerns and ideas. Often the local residents are the ones that suffer in these types of large scale projects because of their altruistic nature but the architect placed a large emphasis on securing their comfort and safety. More importantly, he gave them a voice.



Figure 2.2.3 - Typical view down the BIP. Remark the amount of vegetation incorporated into the project.



Figure 2.2.4 - Typical view along the lateral roads. Brick and rounded corners gives a welcoming feeling to the space.

3 Duguet, P. (2005, January 15). *Boulevard intercommunal paris 2*. Retrieved Sept. 06, 2012, from Patrick Duguet Architecture Urbanisme: <http://duguet.fr/?p=183>

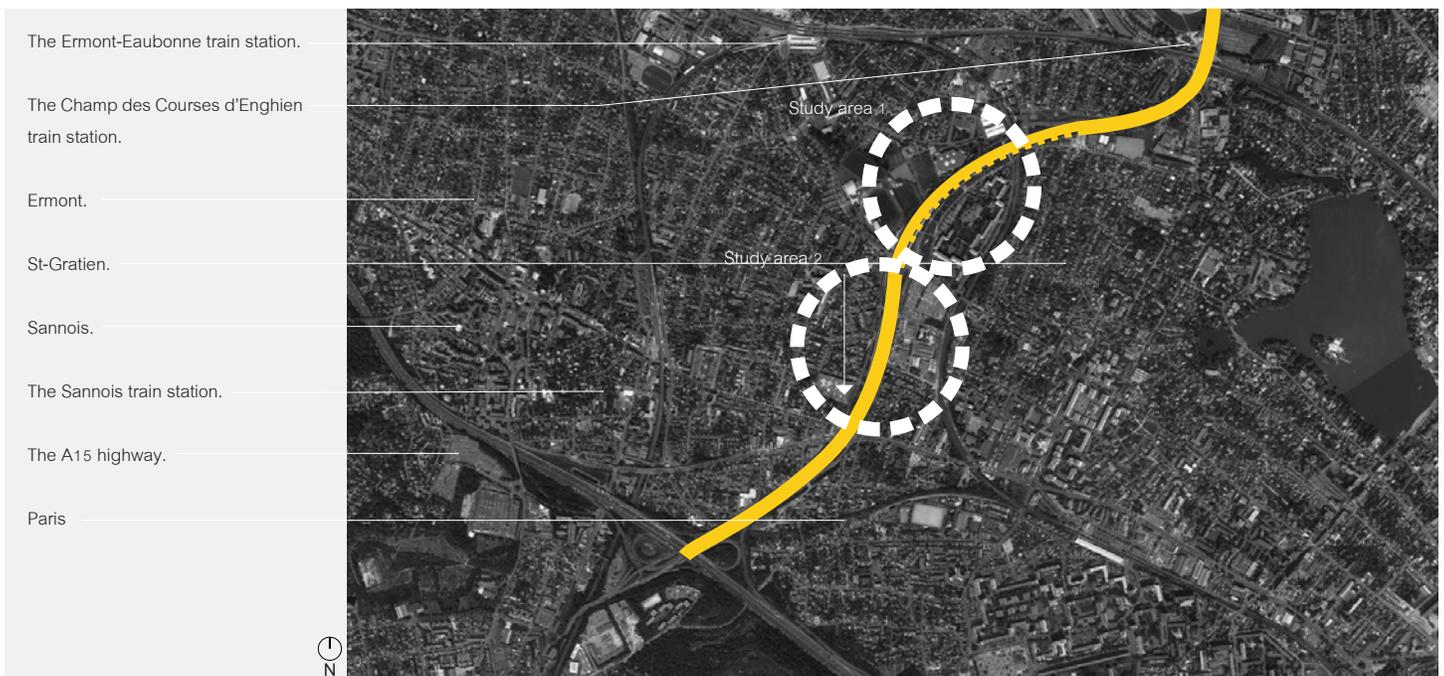


Figure 2.2.5 - Aerial image of the site - Site Context.

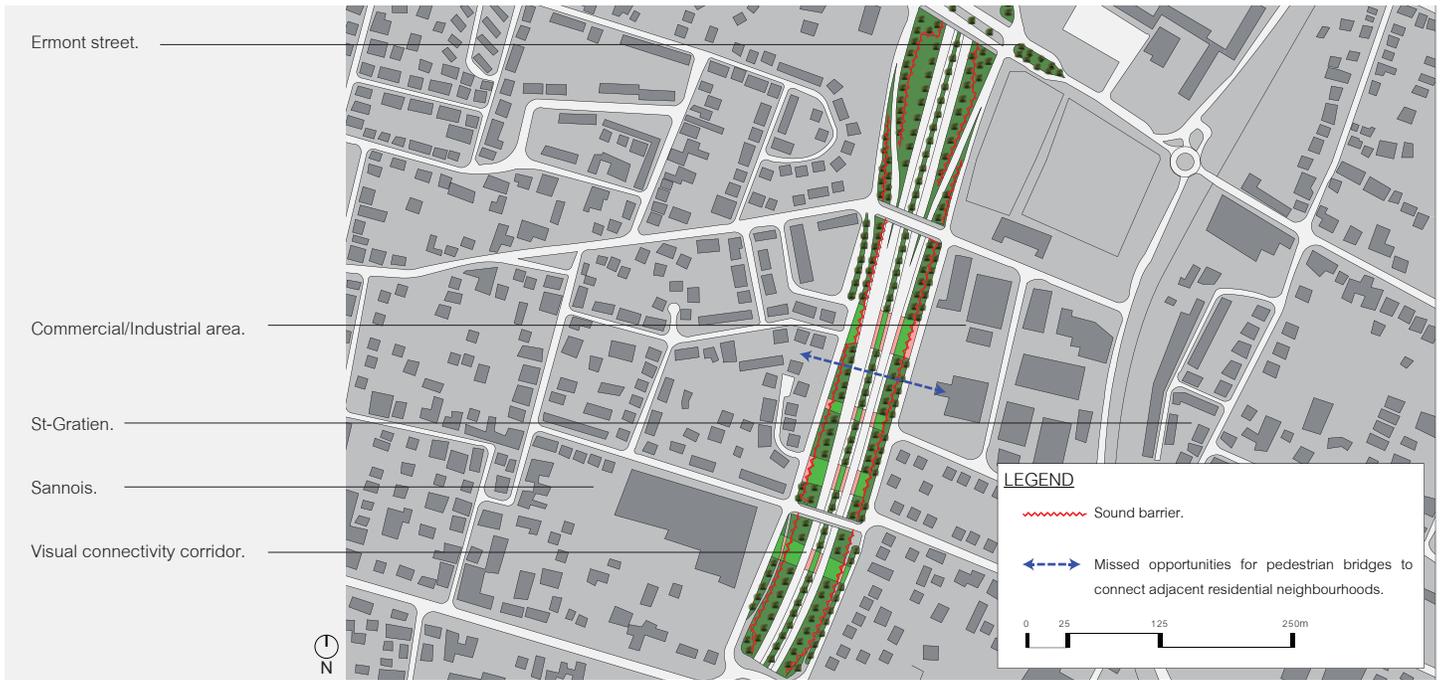


Figure 2.2.6 - Study area 1.

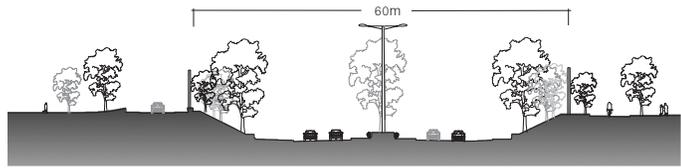


Figure 2.2.7 - Section of study area 1.

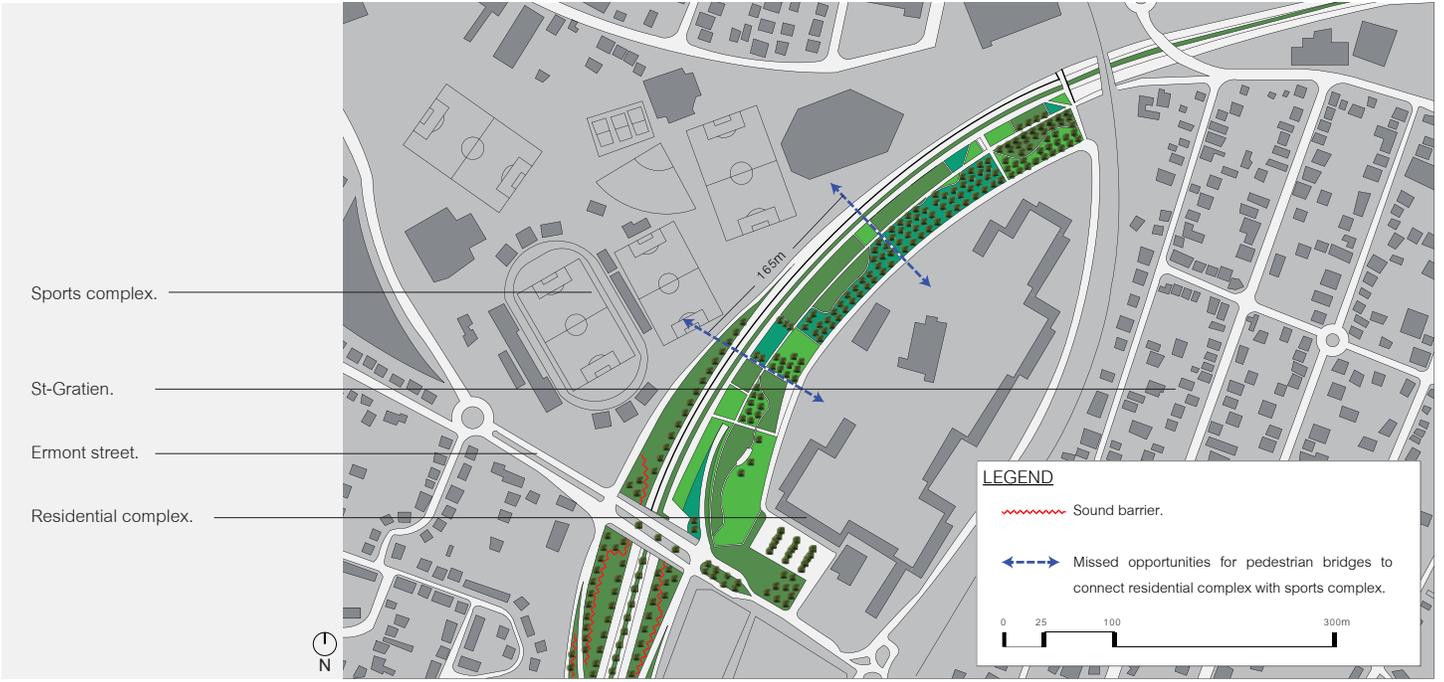


Figure 2.2.8 - Study area 2.

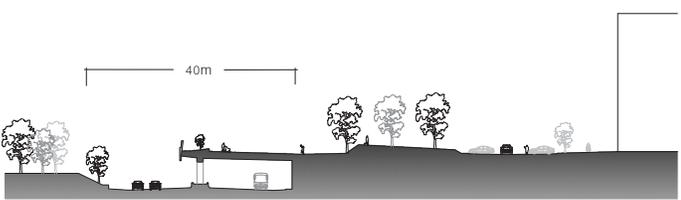


Figure 2.2.9 - Section of study area 2.



Figure 2.2.10 - Typical view on top of the covered section of the BIP.



Figure 2.2.11 - Landscaping in its early stages of growth.



Figure 2.2.12 - Accentuating the visual connectivity corridor with a distinct landscaping strategy.



Figure 2.2.13 - A view of the condition along the lateral roads of the BIP.

LANDSCAPING

Vegetation is omnipresent in this project and it plays an integral role in the architectural concept. The project is lined with a regular rhythm of deciduous trees, which is interrupted only when intersected with the visual connectivity corridors interspersed along the expressway.

The rhythmical lines of trees establish a tempo for the drivers and it makes them more aware of their speed as the sound pressure varies by each passing tree. Each tree is trained to grow straight with wood logs, a sustainable approach to staking trees.

The interruption of the tree cadence allows a greater visual connectivity along the above mentioned visual corridors, which is an important aspect within the project. Along each corridor axis the landscaping changes in texture and colour further accentuating the tectonics of the space.

Interestingly, Patrick Duguet has used the central median as an opportunity to introduce even more vegetation. A space usually reserved for light posts and chain-link fences the architect has lined the median with deciduous trees and has planted ground-cover vegetation in between. Moreover, dense shrubs are planted alongside the concrete median, practically hiding it altogether (see figure 2.3).

The landscaping over the semi-covered portion of the BIP is a noble attempt to naturalize the site and to provide amenity space for the residents but it could have done much more. The newly formed landscaped area is considerable and it could have been used as an opportunity to introduce a variety of programs that would enhance the surrounding community such as: a nature reserve or a pond doubling as a water runoff filtration system. The bulk of the dense vegetation is located close to the residential complexes and then it transitions into low lying vegetation until it reaches the edge of the covered portion. This configuration makes the open space near the edge unsafe because there is a chance of something going overboard and causing an accident and it reduces the open space near the residential complexes. It would make more sense to push the dense vegetation to the far edge of the cover and to create an open, safe recreation space close to the apartment complex.



Figure 2.2.14 - Typical view of the visual connectivity corridor.



Figure 2.2.15 - Missed opportunity to connect the sports complex beyond with the residential complex behind.



Figure 2.2.16 - The linearity and safety of the lateral roads allow for races to take place.



Figure 2.2.17 - A view of underneath the semi-covered section of the BIP. Remark the lustre of the finishes and the colourful treatment of the support columns.

VISUAL CONNECTIVITY

Patrick Duguet has paid special attention to ensuring that his tall noise barriers do not completely disconnect the adjacent communities visually from each other. Interspersed along the BIP, large glazed noise barriers allow the people to see across to the other side.

INTENTIONAL VISUAL OBSTRUCTION

The first section of the BIP is trenched 5m below grade and it cannot be seen by the residents. The second section is semi covered on the side of the residential complexes shielding the resident's view of the BIP's vehicular traffic.

ACCESSIBILITY

The BIP in general provides enough access points for pedestrians but there are few points along the thoroughfare that could benefit from a pedestrian crossing; most notably along the semi-covered portion where the residents of the apartment complex have limited access to the adjacent sports fields. Some of the residents must walk 1km to reach it comparatively to 300m it would take if pedestrian bridges were built.

MATERIALITY

As with the landscaping treatment, the materials chosen in the project accentuates the architectural concept. The visual connectivity corridor is emphasized by paving the buffer zones with a material of a different colour and of a tiled texture.

The noise barriers are built with brick. The rich colour and the texture of the brick not only animates the space but it makes the driver more aware of his speed than a smooth grey concrete wall (typical of trenched expressways) and gives more of a warm feeling to the space reflecting the residential character of the neighbouring communities.

The polished concrete under belly of the overpasses and the semi-covered section hide the structural beams giving it more of a refined look and its lustre attempts to capture as much natural light as possible. The columns are made of cream coloured polished concrete with salmon coloured granite inserts.

LESSONS LEARNED

Sensitive residential integration

Sensitive residential integration allows the trenched expressway to be happily accepted in the neighbourhood. Copious amounts of vegetation, community consultation, and warm textured materials are all sensitive measures that try to achieve a cohesive urban fabric.

1) **Visual connectivity between the bisected communities allows residents to feel connected to one another.**

2) A cohesive landscaping strategy is crucial to tie the project together.

3) Community involvement is essential to tailor the project to the specific needs and desires of the local community. It also increases the chance the project will be accepted within the community. Creating an information center allows the residents to have a voice and allows them to feel more in control of their surroundings by allowing them to voice their opinions and ask questions.

4) Polished concrete panels along the underbelly of the overpasses reflect natural light deeper into the space.

5) Utilize the unused spaces within typical expressway configurations to introduce vegetation.

6) Texturing the thoroughfare brings awareness to the driver of his/her speed.

7) Semi-covering is an interesting strategy to reduce the noise and pollution for the residents while still providing natural light for drivers below.

8) Using wood posts is a sustainable way to stake trees.

9) Use materials and colours to define and accentuate the tectonics of the varying spaces.

10) Brick provides sound protection, it is durable, it gives texture and colour to the space and it has a homely feeling to it, which is important when trying to fit within a residential neighbourhood.



2.3 THE CENTRAL ARTERY/TUNNEL PROJECT (THE BIG DIG)

Location: Boston, USA

Design and Construction: Bechtel/Parsons Brinckerhoff (renowned international engineering firms)

Project completion: 2007

Project Scope: Eliminate the existing 6-lane elevated highway and replace it with a widened underground highway, build a new wider bridge across the Charles River and extend the interstate 90 highway to Logan International Airport via underwater tunnel.

Budget: 24 300 000 000\$⁴

HISTORY

From 1959 to 1991 the city of Boston was bifurcated by a heavily congested elevated 6-lane central artery effectively separating the downtown core with the inner Harbour. The project was unpopular with local residents from the minute it was built. As traffic increased, the artery became unbearably congested. Designed to carry adequately 75,000 cars a day, during its final days it was far exceeding those numbers, carrying upwards of 200,000 daily vehicles. A solution was needed and in the 1970's the Big Dig project was conceived. It was intended to reduce traffic congestion, increase the efficiency of the city's highway network and to reconnect the city with the waterfront. Completed in 2007, it is the largest, most complex and most expensive urban infrastructure project ever undertaken in the United States of America (USA). It took 30 years of planning and 16 years of construction to complete. Escalating costs, scheduling overruns, charges of poor execution and use of substandard

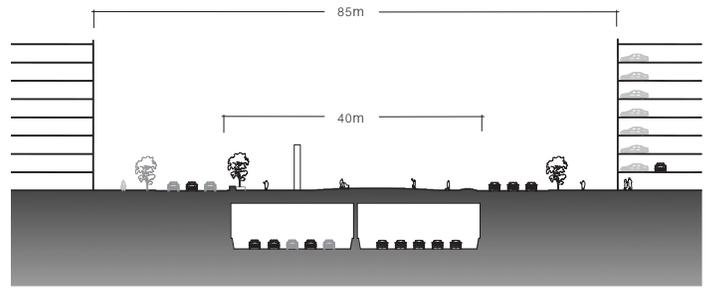


Figure 2.3.1 - Typical Section.

materials, criminal arrests, and even the deaths of four construction workers have plagued the project all along the way and continues to today as I write this paper.⁵

OVERVIEW

The Big Dig project consists of several interventions. This study will focus on a 5.6km long section running through downtown Boston (see figure 3.2) as it reflects most closely the Décarie situation. This portion of the highway is made up of a 8-10 lane trenched expressway and two surface roads with 3 lanes each.

4 Salsberg, B. (2012, July 10). *Big Dig costs pegged at \$24.3B, lawmakers told*. Retrieved Sept. 06, 2012, from www.boston.com: <http://www.boston.com/business/news/2012/07/10/big-dig-costs-pegged-lawmakers-told/iuHOVq2ENQtakQ8ZdlBHzN/story.html>

5 The Boston Globe. (2012). *Road to Tragedy - A history of Big Dig problems*. Retrieved Sept. 06, 2012, from www.boston.com: http://www.boston.com/news/specials/big_dig_problems/

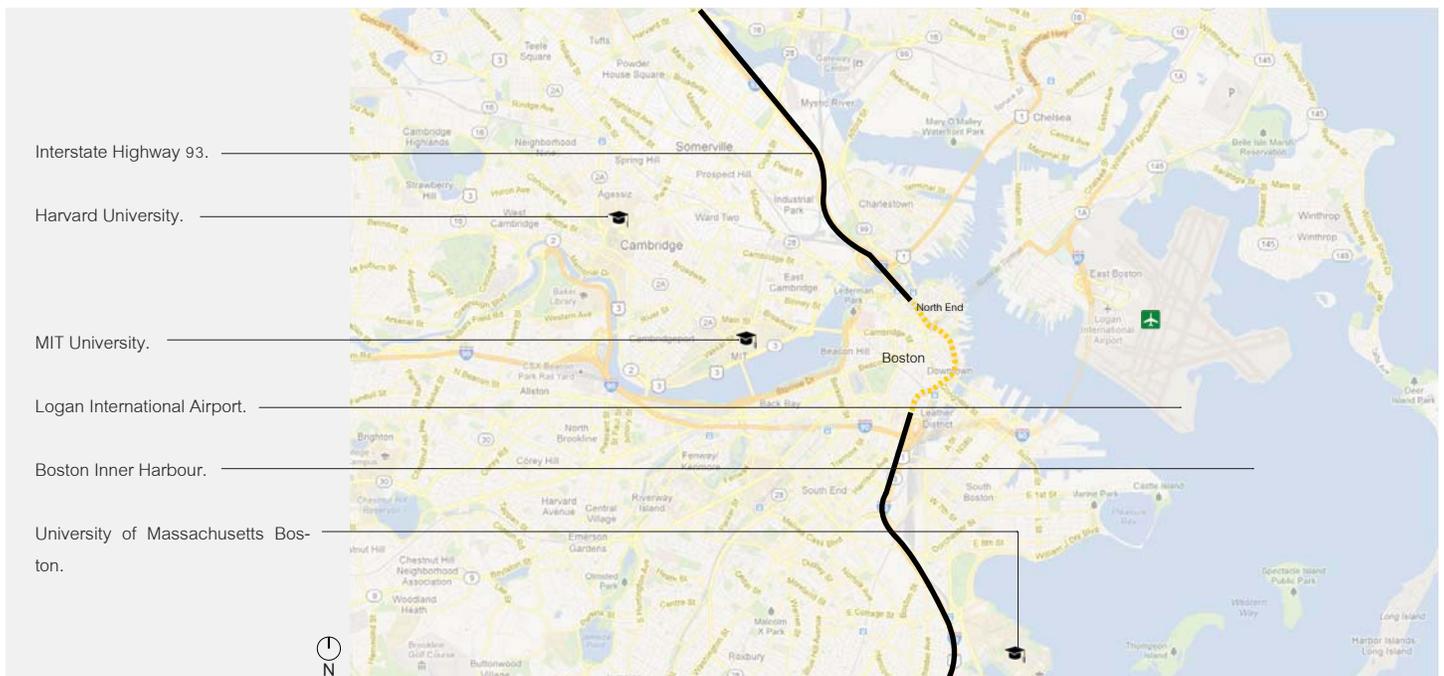


Figure 2.3.2 - Site Context.

The trenched portion of the project incorporates a major highway interchange between the Interstate Highway 93 (I93) running North-South and the Interstate Highway 90 (I90) running East-West terminating at Logan International Airport. The concrete panel clad tunnel is artificially lit and mechanically ventilated. At grade, the surface roads are separated from each other by 27 acres of landscaped parks and plazas, dubbed the Rose Fitzgerald Kennedy Greenway, and are lined with tall buildings and wide sidewalks.

UNDERDEVELOPED PARCELS OF LAND

The 27 acres of land that has been liberated by burying the expressway underground is “overwhelmingly underwhelming”.⁶ The space is made up of 22 distinct parcels of land separated by cross streets and cut up by on/off ramps and ventilation buildings. They trace the highway below and function mostly as pedestrian circulation space, accommodating through traffic rather than being destinations in and of themselves. The most frequented parcels of land are the ones where a merry-go-round and a fountain animate the space.

The master plan for the area allows only 25% of the Greenway to be built upon while the remaining area must be left as “open space”.⁷ By limiting its development, the policy hinders the Greenway’s future success and, in this way, it simply becomes a green tracing of the highway below.

In 2011, a parcel of land was used by the Occupy Boston movement as a camp site and during the subsequent trial proceedings (regarding their right to camp) a superior court judge offered this quote describing the quality of the space:

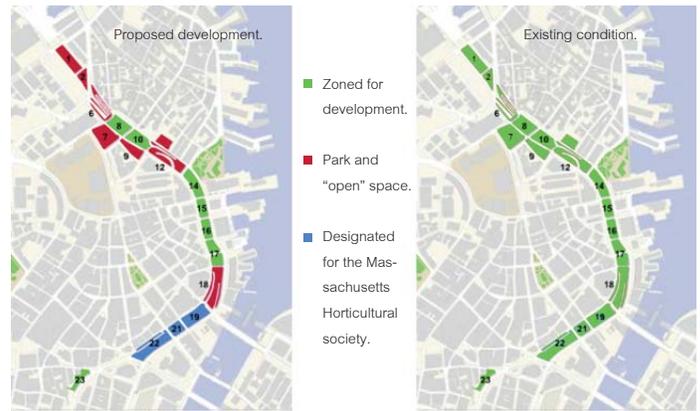


Figure 2.3.3 - Proposed development vs. existing condition diagram.

“Developed as parkland, the locus in quo is a hundred-foot wide median strip, which covers an interstate highway tunnel and is bounded by an exit ramp and heavily trafficked streets.”⁸

The Master plan has targeted certain parcels to be built upon and proposals have been put forward to develop the land but most have been shelved due to the lack of funding; also due to the high costs associated with building on top of the highway’s tunnel and access

- 6 Yoon, J. M. & Miller, M. (2008). *Public works:unsolicited small projects for the Big Dig* (pp.10, 71, 113). Hong Kong: MAP Book Publishers.
- 7 Massachusetts Department of Transportation - Highway Division. (2012). *The Big Dig - Project Background*. Retrieved Sept. 06, 2012, from The Official Website of The Massachusetts Department of Transportation - Highway Division: <http://www.massdot.state.ma.us/highway/TheBigDig/ProjectBackground.aspx>
- 8 Massachusetts, C. W. (2012). *Memorandum of decision on Occupy Boston restraining order*. Retrieved Sept. 09, 2012, from www.boston.com/news/local/massachusetts/specials/occupy_boston_decision/

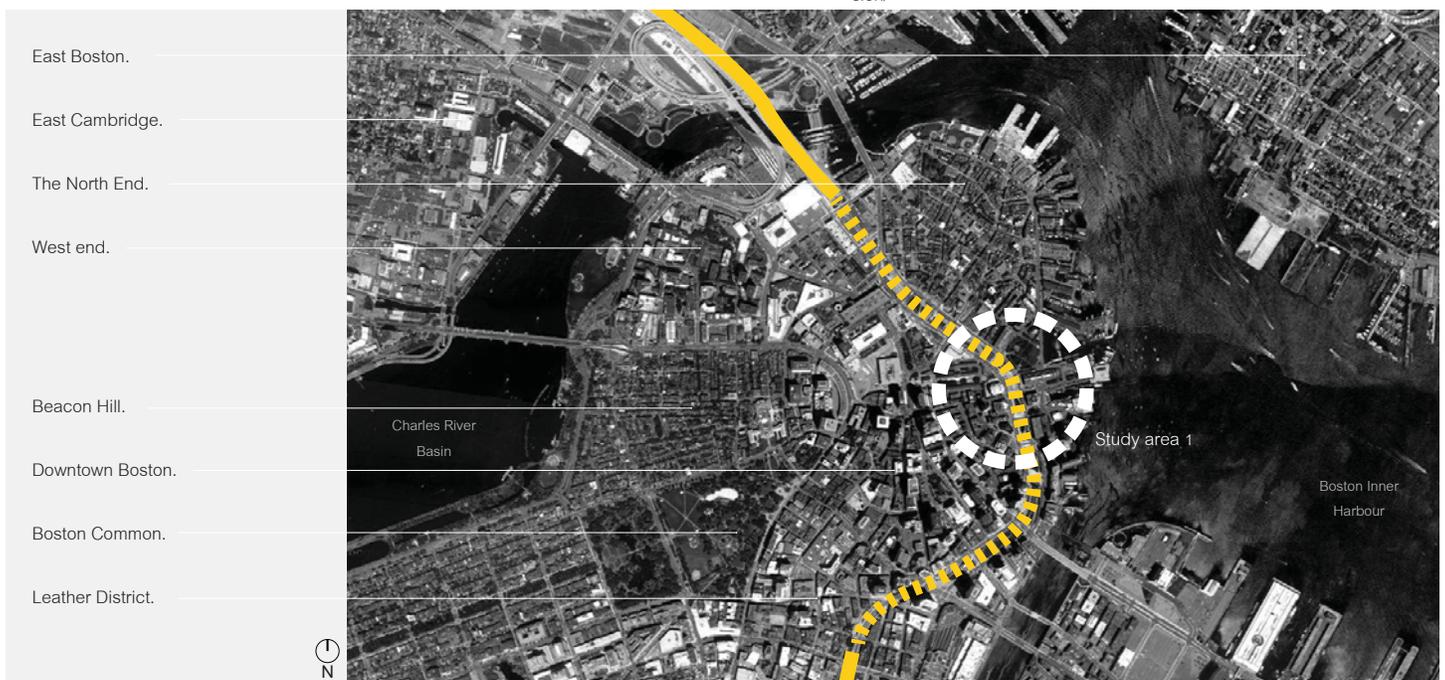


Figure 2.3.4 - Site Context.

ramps.⁹ Considering the 550 million dollar annual debt to be paid until 2038 that Boston now has incurred as a result of the Big Dig, the Greenway will remain underdeveloped for many years to come; functioning simply as a series of disconnected landscaped promenades.⁴

DRIVER EXPERIENCE

The Big Dig ultimately was created to reduce vehicle congestion and commuting times. But in an article, published by Sean P. Murphy of the Boston Globe, he talks about how, despite the new highway, commuters from the suburbs ultimately spend more time in traffic during peak hours, not less. In the article, he interviews several reputable people involved in the project about what they thought of the state funded transit study results. Here are some of their comments:

1) Jeff Larson, general manager of SmartRoutes Systems Inc., who has tracked traffic patterns in Boston for 18 years, says “if you build it, they will come” a phenomenon he describes as the cause for the longer commute times.¹⁰

2) Frederick P. Salvucci, the former state transportation secretary credited with first envisioning the concept of the Big Dig project and generating the project’s initial financial and political support, says that he and others anticipated that there would be bigger delays outside of the city, unless transit options expanded significantly. He is quoted as saying: ““You cannot expand highways enough to end congestion.”¹⁰

3) Carrie Russell, staff attorney for the Conservation Law Foundation, said:

“We can’t pave our way out of congestion. Adding more traffic lanes only attracts more people to highways and the roads leading to those highways. Suddenly, it’s attractive to drive through the downtown tunnels, because they are relatively clear of traffic, and that’s causing a pile up of traffic on the thresholds to the tunnel.”¹⁰

Boston has spent 24.3 billion dollars to increase overall commuting times and increase motor vehicle traffic while relocating hundreds of



Figure 2.3.5 - Leaking tunnel support walls.



Figure 2.3.6 - Defective ceiling panels kills a woman in 2006.

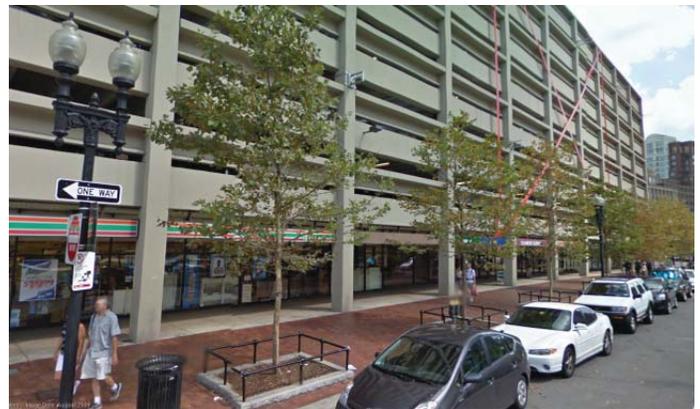


Figure 2.3.7 - Typical multilevel parking garage with commercial establishments on the ground floor.



Figure 2.3.8 - Typical multilevel parking garage with commercial establishments on the ground floor.

9 Fox, J. C. (2012, April 26). *Developers make pitches for parcel near Rose Fitzgerald Kennedy Greenway*. Retrieved Sept. 09, 2012, from www.boston.com: http://www.boston.com/yourtown/news/downtown/2012/04/proposed_developers_for_greenw.html

10 Murphy, S. P. (2008, November 16). *Big Dig pushes bottlenecks outward*. Retrieved Sept. 09, 2012, from www.boston.com: http://www.boston.com/news/local/articles/2008/11/16/big_dig_pushes_bottlenecks_outward/?page=full

thousands of drivers per day underground without any natural light.

Not only is the driver's experience deprived of natural light, the tunnel is prone to flooding and leaking and in 2006 a woman was killed by falling ceiling panels, which resulted in a number of road closures, criminal investigations and convictions.¹¹

PARKING

Surface parking is limited, mostly located in front of the Boston Harbour Hotel. To compensate, multilevel parking garages are incorporated into mixed use developments. Limiting surface parking and building multilevel parking garages has several advantages, some of which are highly pertinent for cold climates. The list of advantages are as follows:

- 1) Increases the flow of traffic by reducing the amount of drivers spending time and blocking lanes while parking.
- 2) Reduces the air pollution and noise around the area because fewer people are breaking and accelerating while trying to park.
- 3) The safety of drivers is increased because fewer people are trying to merge with oncoming traffic.
- 4) Street snow removal is easier since there are no cars blocking the way.
- 5) Aesthetically, the space feels more open since the sidewalks are not enclosed with a line of cars.
- 6) Sidewalks potentially can be widened since one lane of traffic is not reserved for surface parking.
- 7) Parking garages shelter cars from the elements and consequently during the winter months drivers do not need to defrost their car or shovel themselves out of snow banks. This advantage has many cascading benefits such as: saving people time getting to and from work (increasing productivity), reduces the pollution from people idling their cars trying to defrost their cars and reduces accidents and injuries from shovelling themselves out of snow banks (which is a real problem in Montreal).



Figure 2.3.9 - Typical Montreal street after a snow storm.



Figure 2.3.10 - Tree planters shielding pedestrians from motor vehicles.



Figure 2.3.11 - Large expanses of lawn are costly and hard to maintain.



Figure 2.3.12 - Landscaping and modern lighting.

¹¹ Saltzman, J. (2009, May 08). *Big Dig contractor Modern Continental pleads guilty*. Retrieved Sept. 09, 2012, from www.boston.com/news/local/breaking_news/2009/05/modern_continen_2.html

The key is to space and locate the parking garages in convenient locations. Along, the Big Dig they are located near major attractions and near major public transportation hubs. Surface level commercial establishments encourage continuous pedestrian activity, a key for a successful streetscape.

The garages, however, are dull and characterless. The potential to create inspiring spaces from these inherently purely functional buildings has been overlooked in this project.

LANDSCAPING

Planters along the edges of the plazas and parks shield the pedestrian from car traffic. Low planters are bounded by black painted metal guardrails. This ensures that the delicate plantings are not trampled on by pedestrians.

70% of all the vegetation is deciduous, which does nothing to shield people during the winter months from high winds prevalent in the area due to the linear nature of Greenway and to its proximity to the water.¹²

Large areas of grass fill the gaps in between the stone paved pedestrian pathways. Such large expanses of grass require a lot of maintenance and are hard to keep green especially when they are exposed to a lot of sun, which is the case in this project. Since these parks and plazas are mostly used by pedestrians moving through the space, manicured grass lawns are not the most cost-effective, sustainable or the best use of the space.

Lack of funding is threatening the Greenway and according to Nancy Brennan, the executive director of the The Rose Fitzgerald Kennedy Greenway Conservancy (the organization in charge of the Greenway's upkeep) if it does not find a new source of funding by



Figure 2.3.13 - Ventilation building.



Figure 2.3.14 - Ventilation building.

2013 the Greenway could face "significant deterioration".¹³

12 Yoon, J. M. & Miller, M. (2008). *Public works:unsolicited small projects for the Big Dig* (pp.10, 71, 113). Hong Kong: MAP Book Publishers.

13 The Boston Globe. (2010, April 19). *Boston park system facing cash shortage*. Retrieved Sept. 09, 2012, from www.boston.com: http://www.boston.com/news/local/massachusetts/articles/2010/04/19/boston_park_system_facing_cash_shortage/

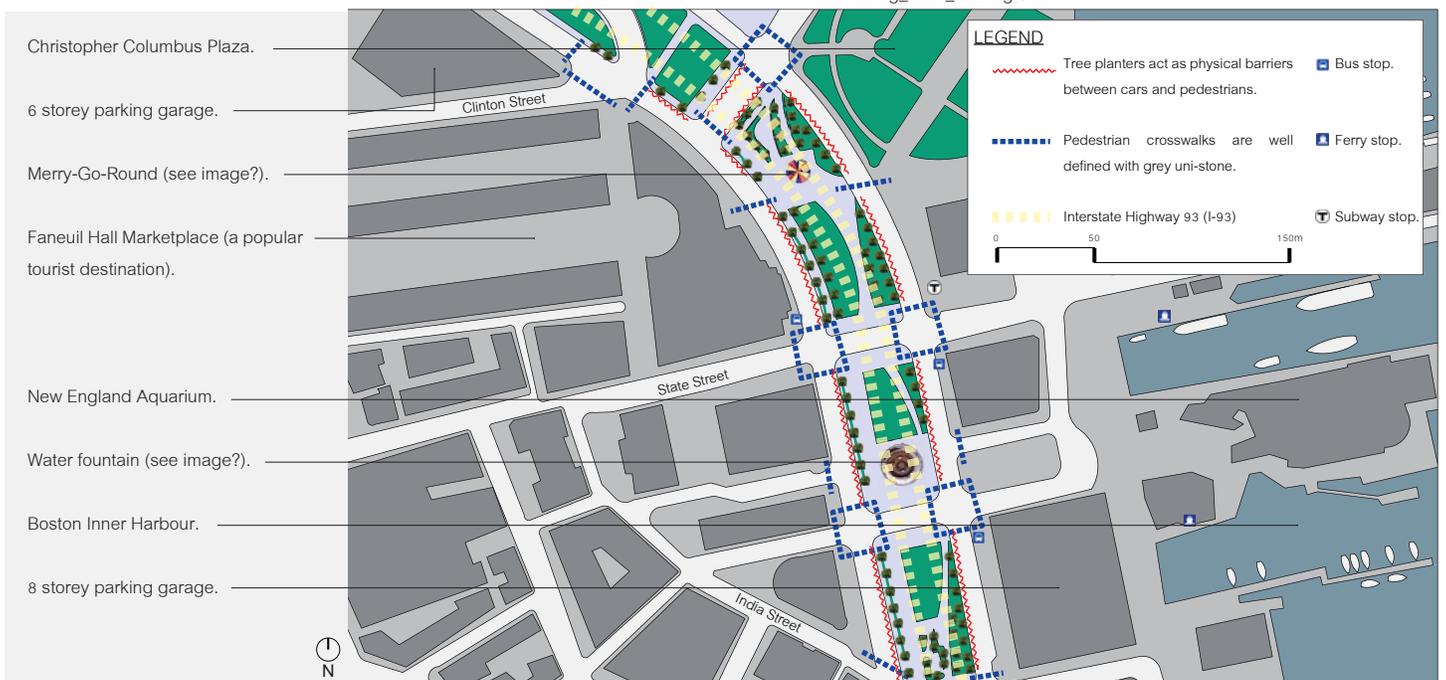


Figure 2.3.15 - Study Area 1.

VENTILATION AND FIRE SAFETY

The tunnel requires a massive amount of ventilation. An article by the National Fire Protection Agency describes the scope and scale of the ventilation system:

“The project’s ventilation is a two-way full transverse system in which fresh air is blown through ducts under the road or in a tunnel wall and circulated through the tunnels by fans in the vent buildings. Simultaneously, vehicle exhaust is extracted through openings in the ceiling to rooftop exhaust stacks in the vent buildings and then dispersed into the atmosphere. The highway tunnels’ three fan/shaft ventilation systems use about 14 miles (22.5 kilometres) of duct work, 139 double-width centrifugal fans that are 10 feet (3 meters) in diameter, 35 jet fans, and 8 axial fans. Eleven of the project’s ramp tunnels will use a jet-fan-based longitudinal/semi-transverse ventilation system.”¹⁴

The maintenance and operating costs required for such a system is astronomical. The ventilation buildings are 4-5 storeys tall, sometimes located in the middle of the parcels deemed as parkland (see Figure 2.3.13). According to Yoon and Miller, the vent structures are simply “residual artefacts” and “are not features of the Greenway but rather trans-sectional contaminations of the pastoral fantasy.”¹⁵

Fire protection operations are complex due to the tunnel’s limited access. In contrast, exposing the expressway to the air eliminates all ventilation and increases fire safety by allowing the smoke to escape. It also gives emergency crews several options and access points to extinguish the fire.

ACCESSIBILITY

Pedestrianism is encouraged around and on the Greenway. Clearly demarcated crosswalks are located at every intersection. Wide sidewalks line the corridor, which gives a sense of security and comfort. Benches are provided all along the expressway.



Figure 2.3.17 - Clearly demarcated pedestrian crosswalks.



Figure 2.3.18 - Merry-go-round.

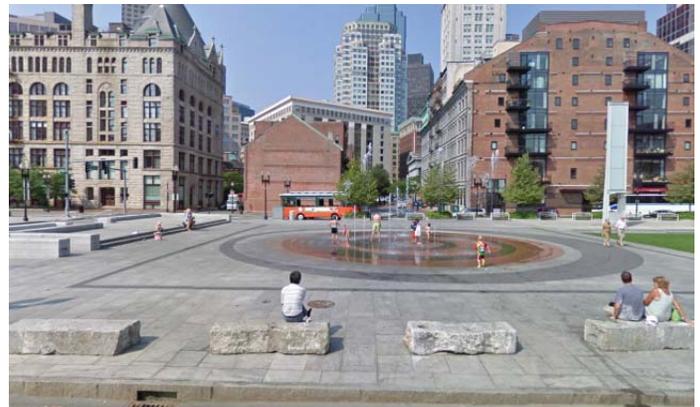


Figure 2.3.19 - Water fountain.



Figure 2.3.16 - The Massachusetts Horticultural Society’s proposal for a glass enclosed garden to be built on top of one of the parcels of land along the Greenway.



Figure 2.3.20 - A view of 20 storey vent shafts and the Intercontinental Hotel that houses them.

NO BIKE LANES

Bike lanes were not designed into the project reducing Bostonians mobility options. It encourages more car traffic, noise and pollution since people who normally would have taken their bikes do not feel safe on the roads. Moreover, bicyclists, rollerbladers and skateboarders are not permitted on the Greenway again, limiting the parks use.

LIGHTING

The street lighting along the sidewalks are of classic design. They are short but they create light pollution because they have no defectors causing light to escape upwards (see figure 3.20).

Similarly, the lighting treatment along the Greenway's parks allow light to escape upwards but they are of a modern design (see figure 3.12) reducing the cohesiveness of the Greenway and the urban fabric by contrasting with the classic lighting design that is present along the edges.

The tunnel is completely artificially lit. It was originally lit with fluorescent lights. Poor design or manufacturing defects have caused them to fall onto the highway. Since then, engineers have fortified lights with plastic ties. A \$54 million complete retrofit is scheduled to start in 2013 pending the approval of the state transportation board and federal officials. They will be switching to LED lights purportedly saving \$2.5 million dollars a year in electricity.¹⁶ Total lighting costs were unavailable but it is assumed to be much more than \$2.5million a year. If naturally lit, operating costs and maintenance would be considerably less.

14 Flynn, E. C. (2003). *The Big Dig - NFPA 502 drives safety of the world's biggest tunnel system*. NFPA Journal.

15 Yoon, J. M. & Miller, M. (2008). *Public works:unsolicited small projects for the Big Dig* (pp.10, 71, 113). Hong Kong: MAP Book Publishers.

16 Murphy, S. P. (2012, April 05). *Big Dig needs \$54m light fix*. Retrieved Sept. 09, 2012, from www.boston.com: http://articles.boston.com/2012-04-05/news/31295327_1_new-fixtures-entire-fixture-light-replacement-project

LESSONS LEARNED

Put a lid on it

1) Burying highways has several disadvantages, namely:

- a) It is astronomically expensive.
- b) High operating and maintenance costs and exorbitant amounts of energy are associated with ventilating and lighting the tunnel.
- c) Large ventilation buildings are required to be built on the surface reducing the amount of property taxes the city can recover and lowering the architectural quality of the space surrounding them.
- d) Safety of drivers is reduced during tunnel fires due the limited access and because of the potential for smoke to accumulate and cause harm to trapped drivers.
- e) They are prone to flooding.
- f) If not naturally lit, they are inherently drab spaces.

2) Increasing highway lanes does not improve traffic congestion, it simply aggravates it.

3) Decking over expressways is only a successful endeavour if it is programmed appropriately. Creating a series of disconnected parks and plazas is not an efficient use of space.

4) Limiting surface parking and compensating with multilevel and multiuse parking garages has several benefits (see page?)

5) Wide sidewalks and clearly demarcated crosswalks give a sense of security and comfort to pedestrians.

6) Incorporate coniferous trees to protect pedestrians from harsh winter winds.

7) Street lighting should deflect light downwards to reduce light pollution.

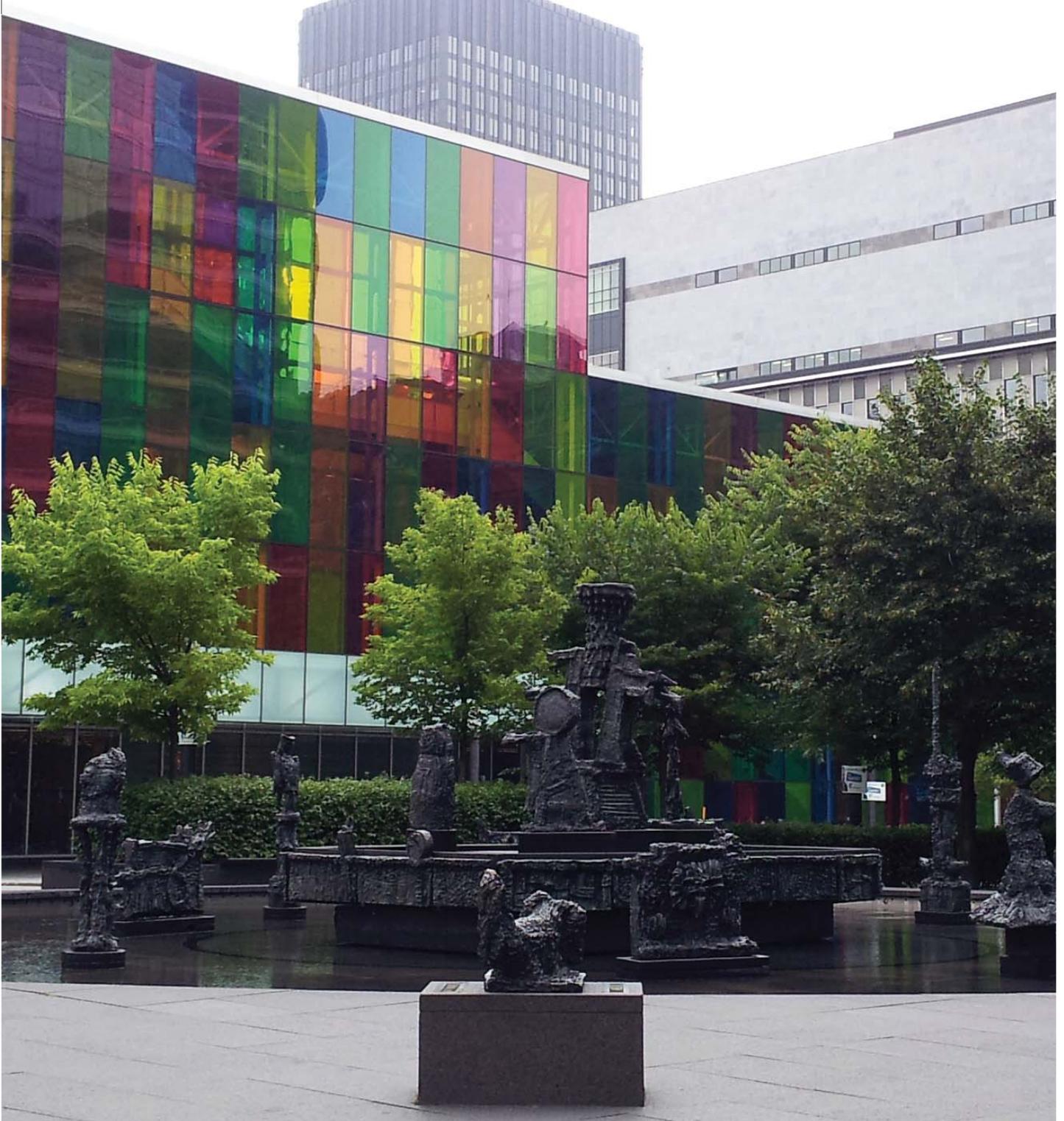
8) Use tree planters to protect pedestrians from motor vehicles.

9) Metal guardrails help protect the landscaping from being trampled on (see image?).

10) Plant robust vegetation that requires little water or maintenance to reduce costs while maintaining a well-kept landscape.

11) Water fountains attract young families because their children can cool off without the fear of them drowning. They also soften the noises of the city.

PHASED CAPPING WITH INTENSIFIED TRANSIT NODES



2.4 THE QUARTIER INTERNATIONAL DE MONTREAL (QIM)

Location: Montreal, Canada

Architects: Daoust Lestage Inc. + Provencher, Roy et associés

Project completion: 2004

Budget: 90 000 000\$

HISTORY

Completed in 1972, the Ville-Marie Expressway is an East-West thoroughfare running through downtown Montreal between the Mont-Royal Mountain and the Saint-Lawrence River. It was originally planned to run through the Old Port as an elevated 6-lane expressway, effectively destroying 40% of the old city. Thanks to public protests, the expressway was diverted around it and it was decided to tunnel through downtown. The tunnel ultimately did not run all the way through and the city was left with large portions of the expressway trenched and open to the air. This created noise, pollution and a discontinuity between the busiest parts of the city.¹⁷

The Palais de Congrès (a convention center), completed in 1983, was built above the expressway attempting to link the Old Port with downtown but it did not do enough to combat the negative effects of the expressway. In 2000, the city commissioned an urban renewal project that would reconnect the separated parts of the city with each other, mitigate the negative effects of the expressway and create a hub for international business and culture. In 2004 the Quartier International de Montreal was completed.



Figure 2.4.1 - A view of Square Victoria.

OVERVIEW

The Quartier International de Montreal (QIM) is located between downtown Montreal and the Old port, two of the most important areas of the city. It spans over the Ville-Marie Expressway, a major east-west artery.

The QIM is home to the Montreal World Trade center, the Stock Exchange Tower, several banks, luxury hotels and restaurants, the Palais de Congrès of Montreal and the Center CDP Capital.

In this study, there will be an emphasis on the Palais de Congrès of Montreal and the Center CDP Capital. They are built on top of the expressway and their design strategies can be used to better inform the eventual design proposal for the Décarie Expressway.

17 Eastern Roads. (n.d.). *Ville-Marie Autoroute - Historic Overview*. Retrieved Sept. 09, 2012, from www.montrealroads.com/roads/A-720/

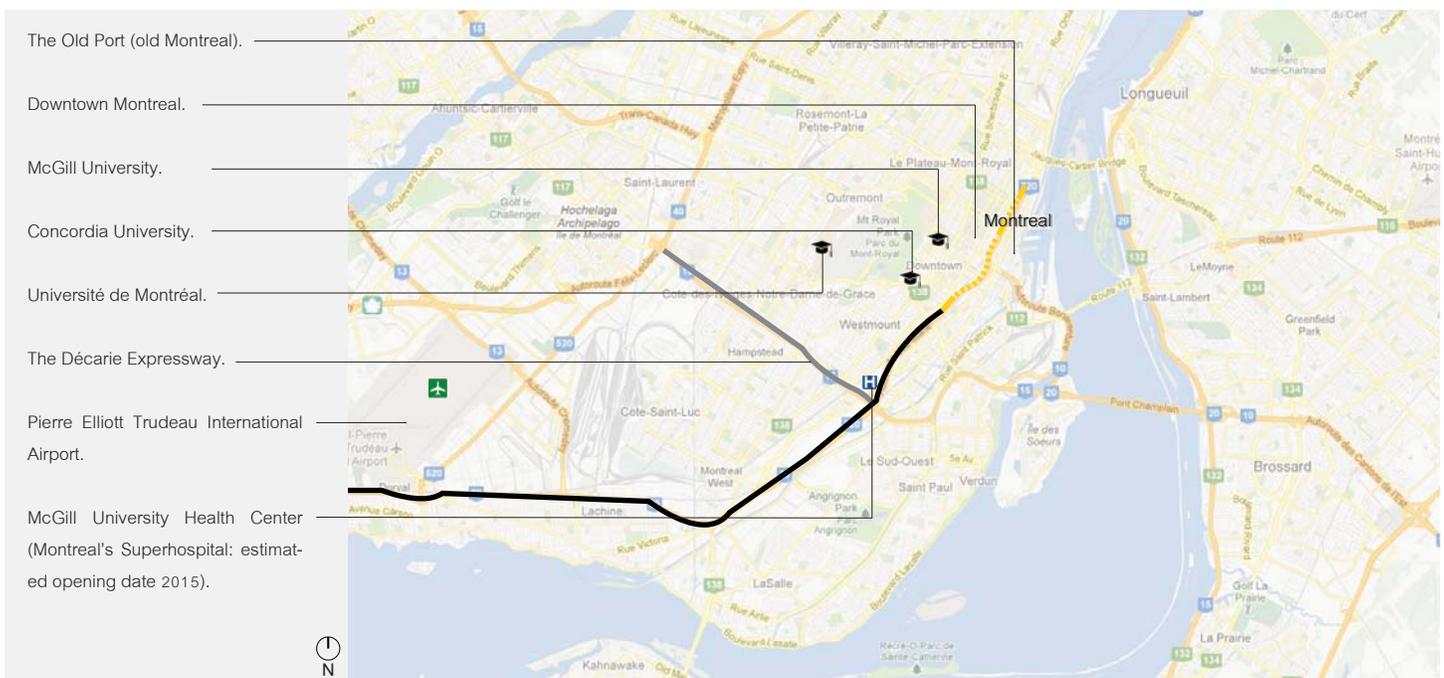


Figure 2.4.2 - Site context.

REINFORCING PUBLIC TRANSIT NODES

Since this area is at the heart of Montreal, it is imperative that the city provides efficient transportation in and out of the area. For the most part, the project has done so. The area is well served by metro and bus lines, roads and clearly demarcated bike paths. But the main public transit nodes are not reinforced architecturally. For example, the Square Victoria metro station is an important transit node serving mostly the west side of the Old Port. Its platforms are not located directly underneath the actual square. Users must enter the underground pedestrian network and walk down many long blank artificially lit corridors to reach them. Even though clearly demarcated and architecturally expressed entrances allow access into the network there is a missed opportunity to introduce natural light and programs along the way to better serve the daily commuters.

Moreover, the Place d'Armes metro station, the other main public transportation hub that serves the Old Port, is not sensitive to the daily commuters most travelled path. The station is located within the Palais de Congrès and most commuters enter the building using the entrance located on St-Antoine Street. Unfortunately, this entrance is not appropriately articulated architecturally; it is too small and too similar to the entrances of the nearby commercial establishments.

ACCESSIBILITY

Access from downtown to the Old Port has significantly improved. Sidewalk surface area has increased by 40%.¹⁸ The Palais de Congrès extension, the Center CDP Capital and Jean-Paul Riopelle place help restore the urban fabric continuity between downtown Montreal and the Old Port. However, the Palais de Congrès could

have done more to reconnect the two neighbourhoods as the entrances into the building are small and poorly articulated architectur-

18 Ellis, L. (2006, January). *PMI Project of the Year - Urban Inspiration*. Retrieved Sept. 09, 2012, from www.pmi.org/About-Us/Our-Professional-Awards/~media/PDF/Awards/PMN0106_QuartierMontreal.ashx



Figure 2.4.3 - A view down the long blank underground corridors leading the Square Victoria metro.



Figure 2.4.4 - A view of the Saint-Antoine metro entrance. Remark the lack of architectural articulation.

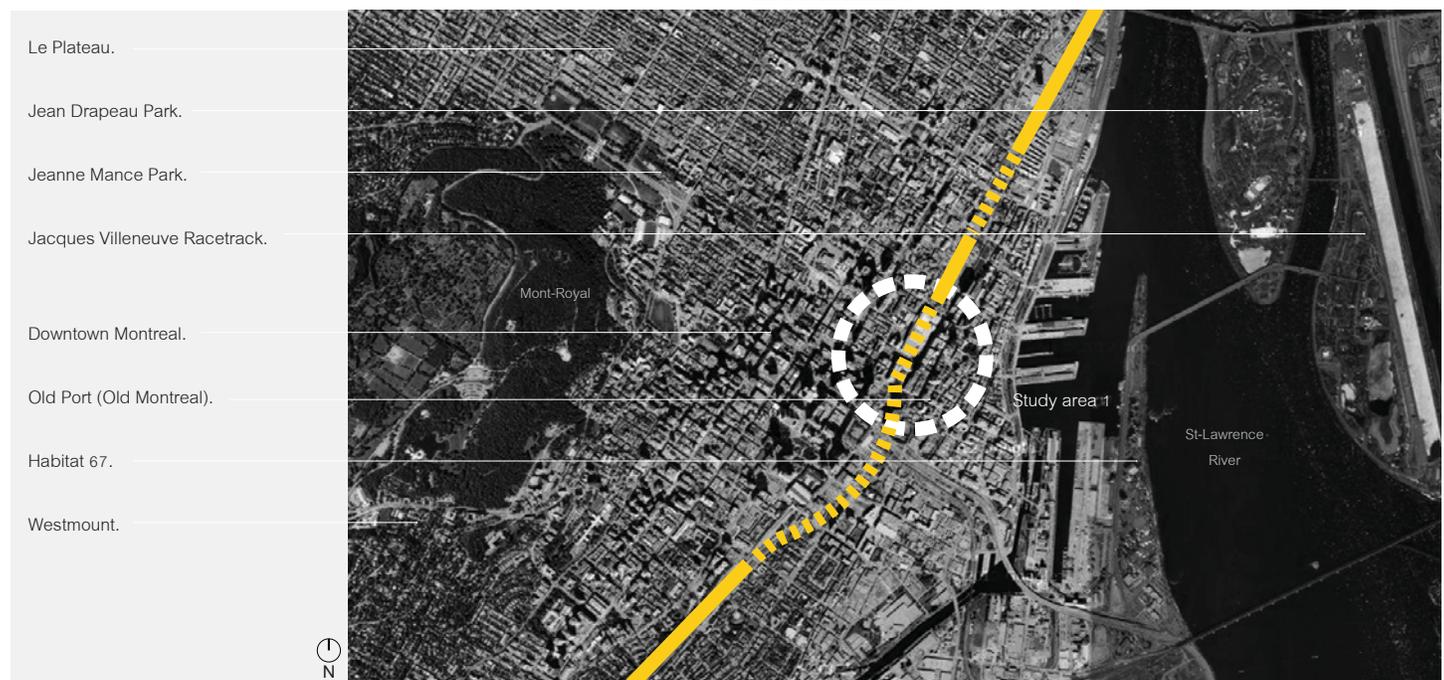


Figure 2.4.5 - Site context.

ally, which leaves the user confused about their function. The Center CDP Capital is a beautiful building that graciously bridges over Saint-Alexandre Street, a north south road that connects to downtown. It also allows access longitudinally along its east-west axis. Jean-Paul Riopelle Place, a landscaped square, bridges over the expressway and allows pedestrians and vehicles to flow around and through it.

The project also expands the existing underground pedestrian network allowing the public travel across the site in a sheltered environment. It links the two main metro stations in the area: the Square Victoria and the Place d'Armes metro stations. The network incorporates restaurants, offices and miscellaneous commercial establishments. Several access points exist along the site but few are fully accessible to people with disabilities.

SUSTAINABLE BUILDING

The Center CDP Capital has been awarded LEED Gold certification, a testament to its desire to be a leader in eco-efficiency. It incorporates double skin wall technology to optimise energy use. Raised floors allow for better circulation of ambient air and 40% of the large south facing atrium is clad in sintered glass (a type of glass fused with ceramic) to reduce excessive heat gains. High-efficiency lighting, an HVAC system with energy recovery ventilation and low emission boilers minimize energy use. The building has won several awards and is a good example of a beautiful, comfortable and energy efficient building that spans over an expressway. It stitches the once discontinuous surrounding urban fabric back together again while invigorating the entire area around it.¹⁹

CREATING LANDMARKS

Creating landmarks within the city facilitates user mobility by making places unforgettable so that it is easier to orient themselves when they return. The Palais de Congrès is one of those places. It is a des-

19 Canadian Mortgage and Housing Association. (1996-2012). *Green Building in Canada*. Retrieved Sept. 09, 2012, from www.cmhc-schl.gc.ca/en/hoficlincl/cmhcicmhcicm_009.cfm

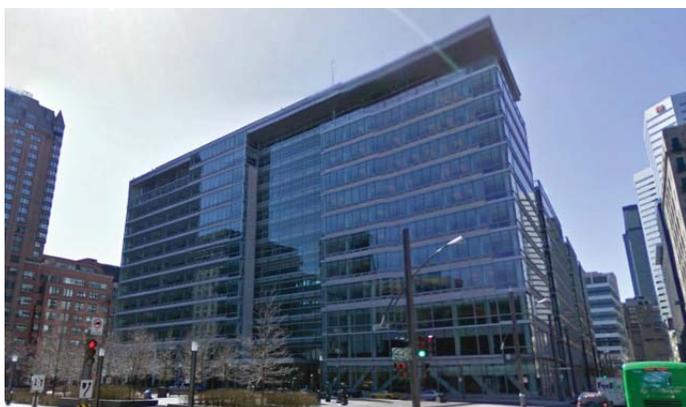


Figure 2.4.6 - A view of the CDP.

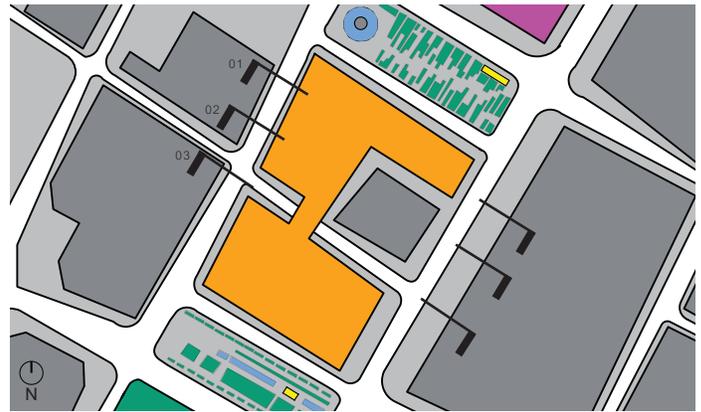


Figure 2.4.7 - Site plan of the CDP.

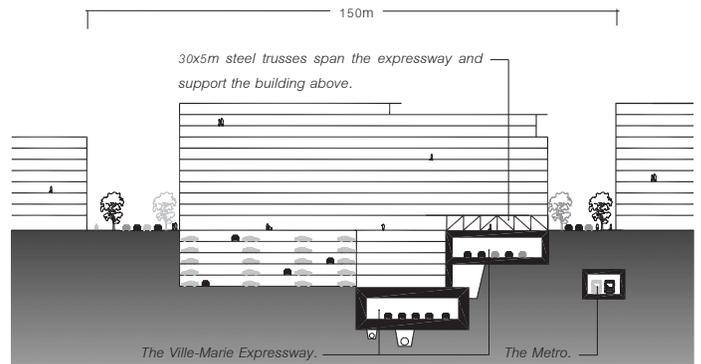


Figure 2.4.8 - Section 01 through the CDP.

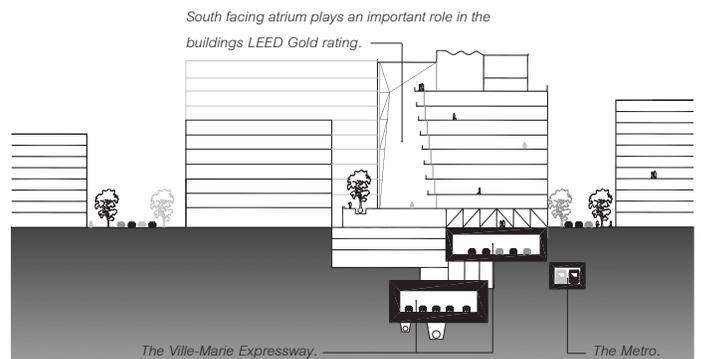


Figure 2.4.9 - Section 02 through the CDP.

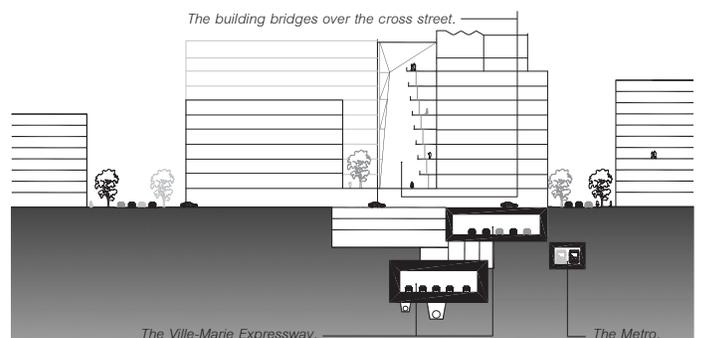


Figure 2.4.10 - Section 03 through the CDP.



Figure 2.4.11 - A view of the CDP on the corner of Square Victoria.



Figure 2.4.15 - A view of the Palais de Congrès multi-coloured facade.

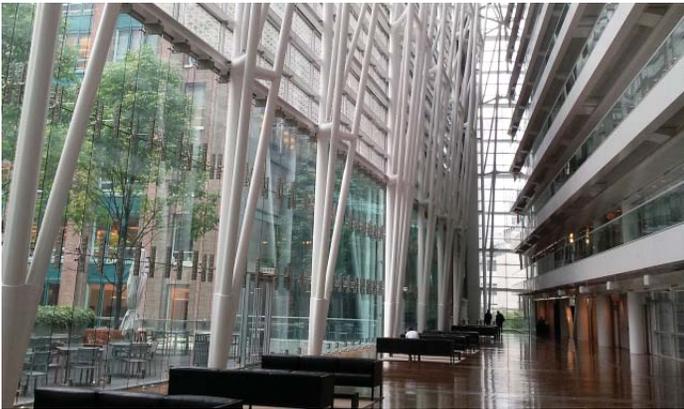


Figure 2.4.12 - A view of the CDP's atrium.



Figure 2.4.16 - A view of the Palais de Congrès poorly articulated building entrances and blank facades.



Figure 2.4.13 - A view of the outdoor terrace adjacent to the CDP's atrium.



Figure 2.4.17 - A view of Claude Cormier's sculpture from the outside. Remark the poor building permeability.



Figure 2.4.14 - A view of the CDP bridging over a street.

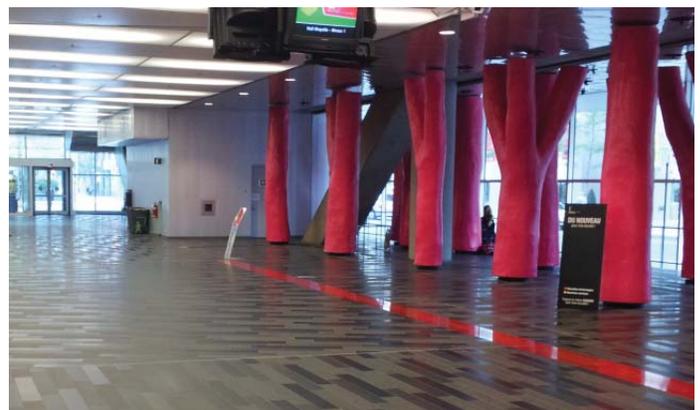


Figure 2.4.18 - A view of Claude Cormier's sculpture from the inside. Remark the poor building permeability.

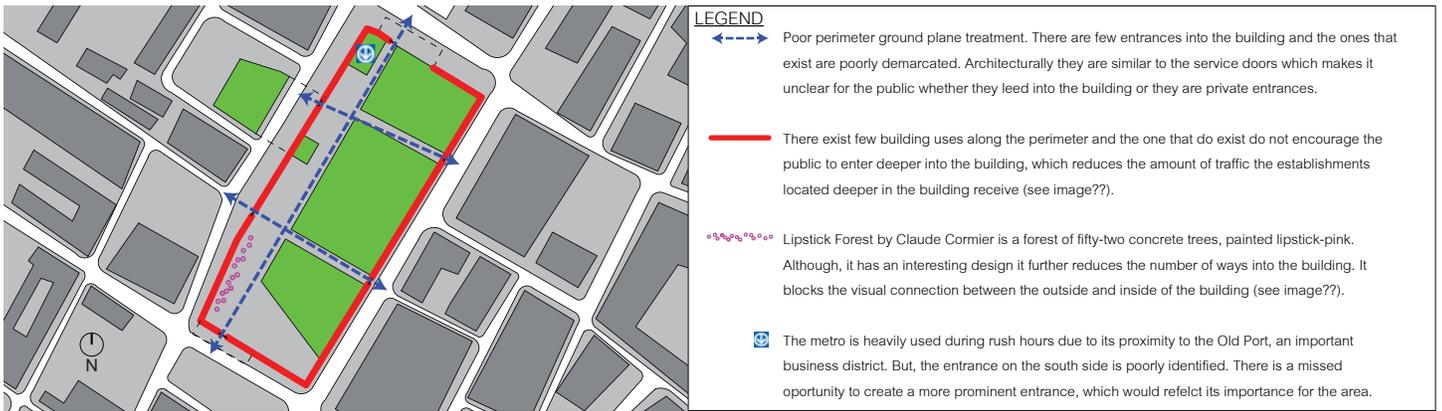


Figure 2.4.19 - Diagram of ground floor plan - Palais de Congrès.

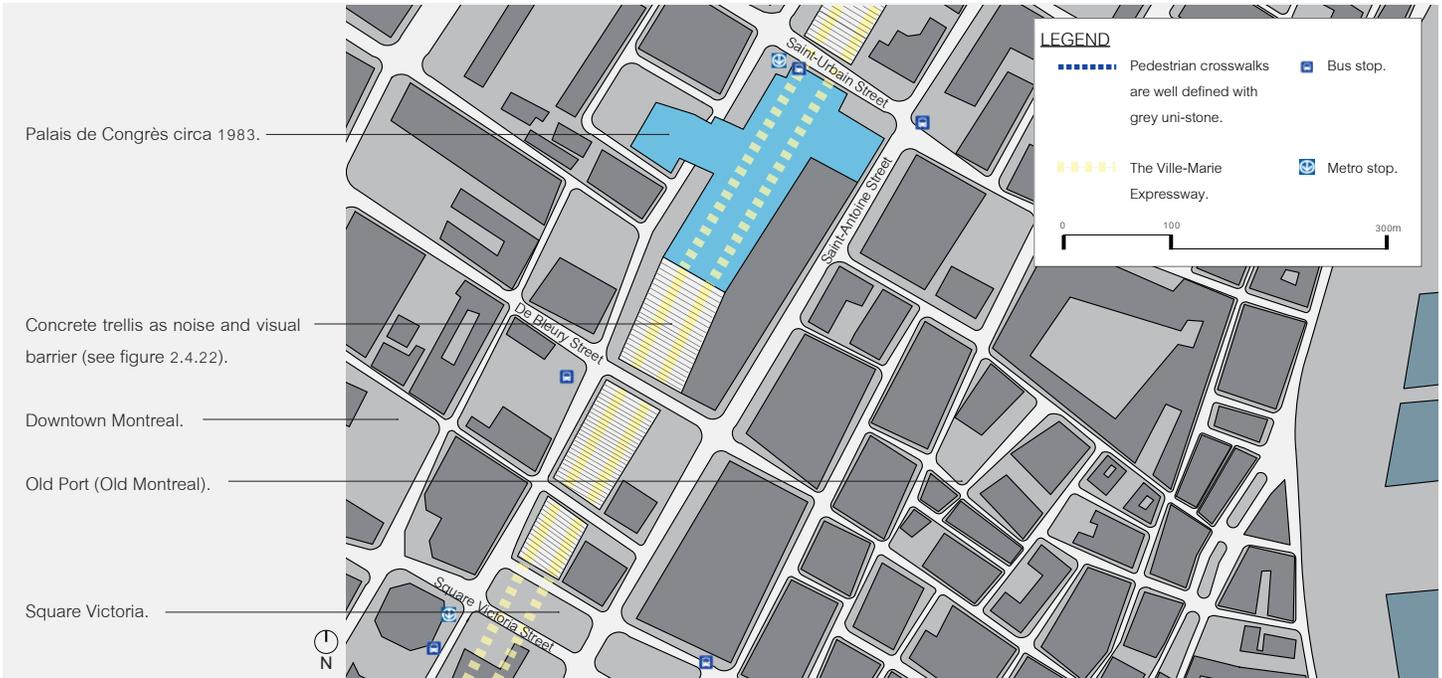


Figure 2.4.20 - Study Area 1 circa 1983.

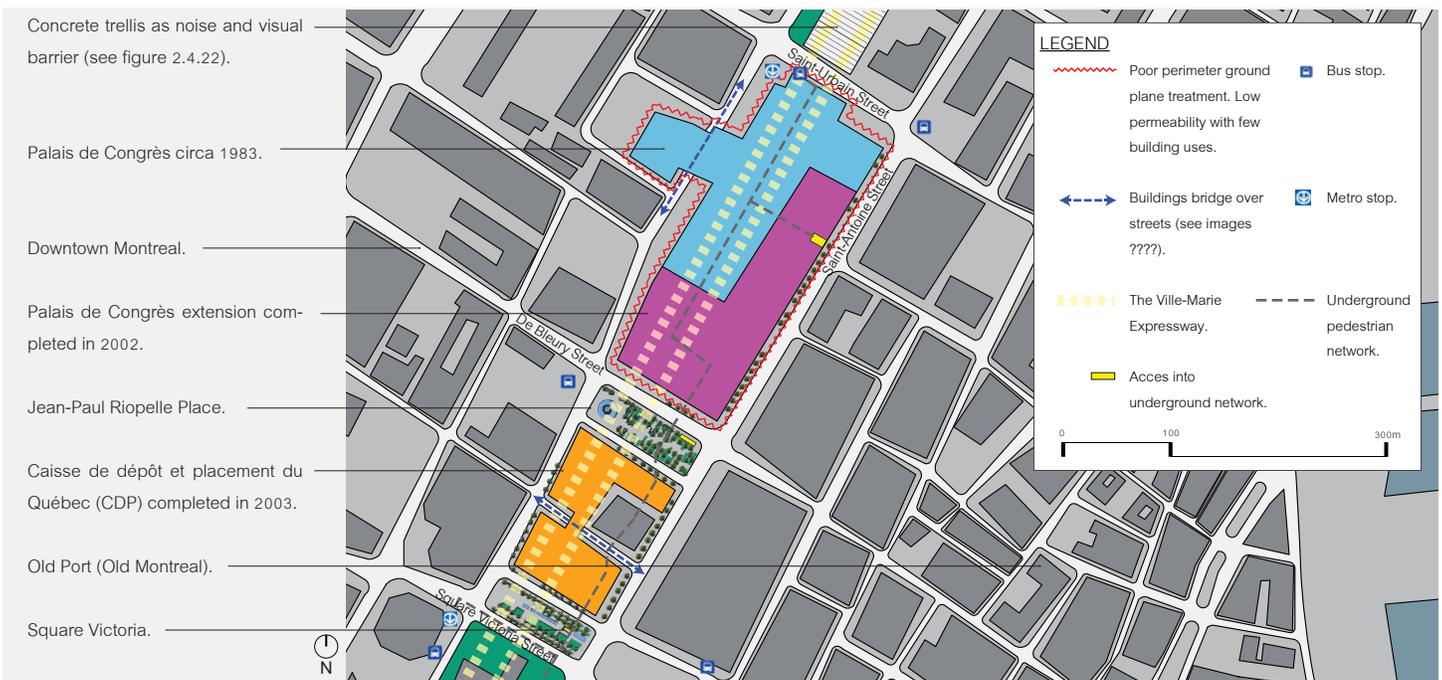


Figure 2.4.21 - Study Area 1 circa 2012.

ign icon in Montreal, often used as a point of reference by Montrealers. Its multi-coloured façade attracts thousands of people a year.

Square Victoria is another example of a landmark within the city. The historically significant square built in 1813 restored to its full glory with its Art Nouveau metro entrance, its sculptures and water fountains create distinctive spaces that give the public unique experiences that they will remember, fortifying their mental map of the city.

PHASING OF THE EXPRESSWAY CAPPING

The Quartier International de Montreal is part of an overall desire to fully cover the Ville-Marie Expressway portion running through Downtown Montreal. Other proposals to cap other sections of the expressway are underway (see figure 4.23).

The portions that already have been built over focus on important areas such as transport hubs and economic centers. The remaining portions are left open. They are left open because the city has not found a constructive way to deal with them yet but as time passes surely the city will grow and the land above the expressway will become more and more valuable; eventually leading to a proposal interesting enough to be realized. This phased approach to expressway capping allows the city to tailor each intervention to the specific site's needs and reduces the funding pressure exerted on the city and investors. It also allows the city to grow and adapt to its new environment gradually avoiding what happened with the Big Dig in Boston.

UNDERGROUND PEDESTRIAN NETWORK

The underground pedestrian network is extensive and spans the length of the QIM. It connects both metro stations and continues further toward downtown, sheltering the public from the elements. Since thousands of commuters use the space daily, the portions running under the Square Victoria could benefit from more programs inserted along its long corridors and from some natural light.

CAREFUL PLANNING OF PUBLIC SQUARES

Square Victoria and Jean-Paul Riopelle Place are public squares surrounded by dense office and residential buildings. Their size and location provide an amenity to the thousands of people who frequent the area daily. They give a sense of openness to the area and because of their size they can be heavily landscaped, which improves the air quality and consequently the productivity of the workers.

LIGHTING AND STREET FURNITURE

There is a clear and apparent lighting and street furniture strategy. Garbage bins, benches and notification signs are incorporated into the light posts reducing visual clutter (see figure 4.24). The street furniture and lighting are all of modern design further reflecting the cutting edge character of the area.



Figure 2.4.22 - A before and after aerial view of the site of the CDP and the Palais de Congrès extension.



Figure 2.4.23 - A proposal to cap another portion of the Ville-Marie Expressway. The CHUM hospital.

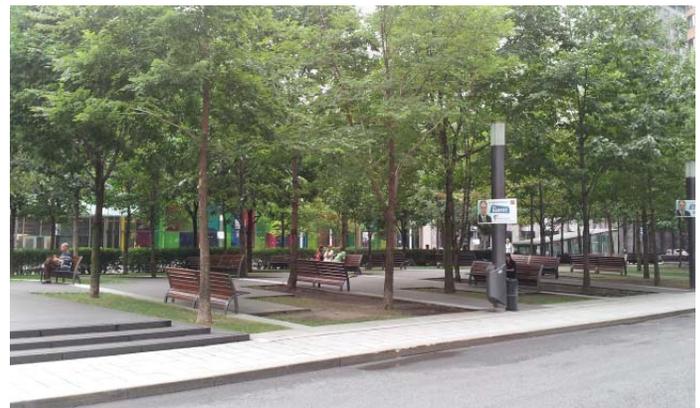


Figure 2.4.24 - A view of Jean-Paul Riopelle Place.

LESSONS LEARNED

Phased capping with intensified transit nodes

- 1) Phase capping interventions along the expressway to minimise capital investment and to focus the efforts in the areas that are more likely to be successful such as locations near transit hubs or other important areas.
- 2) Integrate lighting and street furniture into each other when possible to reduce visual clutter.
- 3) Pay close attention to important paths of travel and clearly articulate access points.
- 4) Create landmarks to aid in wayfinding.
- 5) Provide access to underground facilities for disabled people.
- 6) It is possible to construct a LEED Gold certified building over an expressway.
- 7) In dense and frequented areas, public squares give a sense of openness to pedestrians and increases their mobility around the area.
- 8) Allow the ground plane to be as permeable as possible to facilitate pedestrian movement.
- 9) Bridging buildings over roads allows them to be continuous while allowing vehicular traffic to flow through, increasing the building's functionality and the public's mobility.

COMARISON CHART - Studied Trenched Urban Expressways vs. The Décarie Expressway

	Key Concept	% Covered not including overpasses	Average Distance Between Crossings	Average Width of Sidewalk
<p>1 - GRAN VIA DE LES CORTS CATALANES <i>Barcelona, Spain</i> <i>Length = 2.5km</i></p>	<p><i>Layered infrastructure</i> Existing large vehicular infrastructure provides a great opportunity to layer varying modes of transportation, creating a multi-modal transportation hub and an amenity to local residents and businesses.</p>	0%	160m	6m
<p>2 - THE BOULEVARD INTERCOMMUNAL DU PARISIS (BIP) <i>Paris, France</i> <i>Length = 1.5km</i></p>	<p><i>Sensitive residential integration</i> Sensitive residential integration allows the trenched expressway to be happily accepted in the neighbourhood. Copious amounts of vegetation, community consultation, and warm/textured materials are all sensitive measures that try to achieve a cohesive urban fabric.</p>	25%	293m	3m
<p>3 - THE CENTRAL ARTERY/TUNNEL PROJECT (THE BIG DIG) <i>Boston, USA</i> <i>Length = 2.6km</i></p>	<p><i>Put a lid on it</i> Burying expressways has several disadvantages, namely: It is astronomically expensive, large ventilation buildings take up valuable space at grade, the safety of drivers is reduced, they are prone to flooding and if not naturally lit, they are inherently drab spaces.</p>	100%	134m	7m
<p>4 - THE QUARTIER INTERNATIONAL DE MONTREAL (QIM) <i>Montreal, Canada</i> <i>Length = 3.5km</i></p>	<p><i>Phased capping with intensified transit nodes</i> Phase capping interventions along the expressway to minimize capital investment and to focus the efforts in the areas that are more likely to be successful such as locations near transit hubs or other important areas.</p>	50%	164m	5m
<p>THE DÉCARIE EXPRESSWAY <i>Montreal, Canada</i> <i>Length = 5.5km</i></p>	existing condition	5%	290m	4m

Number of service road lanes + their width	Number of expressway lanes + their width	Integrated modes of transportation	Material Palette
<p>4 traffic lanes 2 parking lanes 3m wide</p>	<p>6 traffic lanes 1 reserved bus lane 3m wide</p>	<p>1) Motor Vehicles 2) Bus 3) Street tramway 4) Bicycles 5) Walking</p>	<p>Noise Barrier </p> <p>Street Tramway Entrance </p> <p>Vegetation </p> <p>Pavement </p>
<p>2 traffic lanes 3m wide</p>	<p>4 traffic lanes 3.5m wide</p>	<p>1) Motor Vehicles 2) Bicycles 3) Walking</p>	<p>Noise Barrier - Glass </p> <p>Noise Barrier - Brick </p> <p>Vegetation </p> <p>Pavement </p>
<p>3 traffic lanes 3.5m wide</p>	<p>8-10 traffic lanes 3.75m wide</p>	<p>1) Motor Vehicles 2) Bus 3) Walking</p>	<p>Street Furniture </p> <p>Tunnel </p> <p>Vegetation </p> <p>Pavement </p>
<p>4 traffic lanes 4 parking lanes 3.5m wide</p>	<p>6 traffic lanes 3.75m wide</p>	<p>1) Motor Vehicles 2) Bus 3) Metro 4) Bicycles 5) Walking (includes underground walking path)</p>	<p>Street Furniture </p> <p>Tunnel </p> <p>Vegetation </p> <p>Building Facade </p>
<p>4 traffic lanes 2 parking lane 3.5m wide</p>	<p>6 traffic lanes 3.5m wide</p>	<p>1) Motor Vehicles 2) Bus 3) Walking</p>	<p>Building Facade </p> <p>Noise Barrier </p> <p>Vegetation </p> <p>Pavement </p>

PRECEDENT ANALYSIS CONCLUSION

This study has focused on four different projects in four different countries each with their own unique characteristics and design challenges. They were chosen specifically because they share a similar morphology with the Décarie Expressway and because they each use unique approaches in dealing with trenched urban expressways. All four projects demonstrated differing visions of trenched urban expressways.

The Big Dig project revealed that covering such a large portion of an expressway requires a great deal of money and that creating a series of parcelled grass covered parks may not be the best use of such prime real estate.

The Quartier International de Montreal was a good example of how phasing the covering of a trenched urban vehicular expressway reduces the initial capital investment and allows the city to grow gradually by letting the city's needs dictate the nature of each subsequent intervention. It also demonstrated the positive effects architectural design considerations can have on the surrounding area. The architectural qualities of the spaces are landmarks within the city and attract thousands of people daily. For the most part the project has also managed to increase access and mobility within and around the site.

The Gran Via de les Corts Catalanes architects, Arriola & Fiol, have optimized the typical morphology of trenched expressways by incorporating within the typical framework: tramway lines, parking lots, bike paths and a reserved bus lane. The architects ensured that all spaces had access to plenty of natural light and air. Noise pollution was abated thanks to large noise barriers installed along the edges of the expressway's trench walls. Unfortunately, they are too large and obstruct the views across.

Architect Patrick Duguet solved that problem in the Boulevard Intercommunal du Parisis project by glazing certain sections of the noise barrier wall, consequently visually connecting the adjacent communities. Furthermore, a connection with nature was clearly an important part of the project. An extensive and articulate landscaping strategy tries to mitigate the noxious environment created by the cars while integrating itself with the surrounding residential neighbourhood and the architectural concept..

Even though each project has inherently context specific design challenges, many of lessons have been learned and they will be further reflected upon during the subsequent design proposal for the Décarie Expressway.





SECTION 3

URBAN DESIGN PRINCIPLES

ENHANCING THE ROLE OF TRENCHED URBAN EXPRESSWAYS WITHIN THE URBAN FABRIC

“The current tendency to design for technology instead of with it – for instance, to design roads for cars instead of for people using cars – is to create built-in obsolescence, building only for today. Urban design based on the sense of community and on its functions is essential to city building for tomorrow.”¹

Blanche Lemco van Ginkel - The architect that saved Montreal's Old Port from destruction by diverting the Ville-Marie Expressway.

1 Scott, M. (2012, 09 22). Retrieved 01 09, 2013, from [www.montrealgazette.com](http://www.montrealgazette.com/entertainment/Urban+planners+were+saviours+city/7284962/story.html#ixzz2AKFdgs8A): <http://www.montrealgazette.com/entertainment/Urban+planners+were+saviours+city/7284962/story.html#ixzz2AKFdgs8A>

SECTION 3 - ENHANCING THE ROLE OF TRENCHED URBAN EXPRESSWAYS WITHIN THE URBAN FABRIC

Most problems and design decisions involving trenched urban expressways have ripple effects that are often hard to grasp due to their subtle, long term and sometimes almost imperceptible characteristics such as air quality and neighbourhood walkability but they are nonetheless equally important if not more than certain more obvious ones such as traffic congestion. The ideas presented in the following paragraphs try to generalise these types of effects for the sake of comprehension all the while maintaining a focus on tangible and factual evidence. The following section outlines specific design principles that have been developed through critical analysis of empirical research, architectural precedents, personal experience and news articles. Enhancing public transportation, intensifying existing transit nodes and sensitive residential integration are the three major principles that will be elaborated upon. They allow trenched urban expressways to integrate themselves productively and efficiently into the urban fabric.

3.1 ENHANCE PUBLIC TRANSPORTATION

“If there are three times as many cars in twenty years as there are today on the planet, of course, it won’t matter very much if they are highly efficient ultralight cars made from advanced carbon fibers and get a hundred miles to a gallon, or are even nutrivehicles. The planet will be crawling with cars, and we will need other options. A more far ranging assignment? “Design transportation.”²

Trenched urban expressways are large expanses of open linear space within a dense urban form. When motor vehicles saturate that open space, their ability to travel quickly over long distances is hindered by the fact that there is simply not enough room for all of them to go through the same place at the same time. The result is that they spend more time in the space and release more of air, noise and light pollution into the bordering neighbourhoods.

There exists, however, an opportunity to optimise the linear space reserved for trenched urban expressways and integrate within it other modes of transportation, effectively enhancing public transportation. In doing so, they become more versatile and productive. For example, if sidewalks are made too narrow and people feel unsafe to walk along them they are more inclined to drive to their destination, however close it is, which increases the chance of exacerbating motor vehicle congestion and consequently all the negative effects that are inherently linked to that as outlined in the previous sections.

The health benefits associated with public transportation are numerous such as: “reduced traffic crashes and pollution emissions, increased physical fitness, improved mental health, improved basic access to medical care and healthy food and increased affordability which reduces financial stress to lower-income households.”³

Encouraging public transportation not only has a significant impact on people’s health but also on the city’s economy. According to a report made by the Board of Trade of Metropolitan Montreal (BTMM) public transportation “plays a predominant role in the economic development and competitiveness of metropolitan areas.” The following are some pertinent excerpts:⁴

“Public transit generates four to 20 times fewer harmful effects than private transport by car.”

“The activities of public transit authorities in the Montreal area supported 12,845 jobs in 2003 and helped increase incomes in the Montreal economy by almost \$1 billion.”

"While stimulating real estate development and increasing property values (city revenues are primarily generated by property taxes and will total some \$3 billion in 2012 or two thirds of total revenues for Montreal in 2012), public transit enabled Montreal transit users to save almost \$570 M in 2003. These savings resulted in increased household purchasing power and double the economic benefits for the Montreal area."

"The impact of public transit on the Montreal economy is double that of equivalent expenditures for user-operated transportation, since the import rate is much lower."

"In the Montreal area, a public transit trip costs an average of \$0.17 per kilometer, whereas a trip by car costs an average of \$0.41 per kilometer."

The revenue generated from increased ridership resulting from encouraging public transportation use can be put into maintaining a high standard of comfort and efficiency; further increasing its attractiveness as a daily mode of travel.

Enhancing public transportation has many positives and when combined with housing developments around public transportation nodes it can reduce considerably the amount of traffic congestion along urban expressways by giving people the opportunity to forgo their cars. The following pages will elaborate on the benefits of building around transit nodes.

2 McDonough, W. (2002). In *Cradle to Cradle* (pp. 178-181). New York: North Point Press.

3 Litman, T. (2010). *Evaluating Public Transportation Health Benefits*. Victoria Transport Policy Institute.

4 Board of Trade of Metropolitan Montreal. (2004). *Public transit: a powerful economic development engine for the metropolitan Montreal region*. Montreal: Board of Trade of Metropolitan Montreal.



Autocentric urban expansion vs. multi-modal urban expansion.

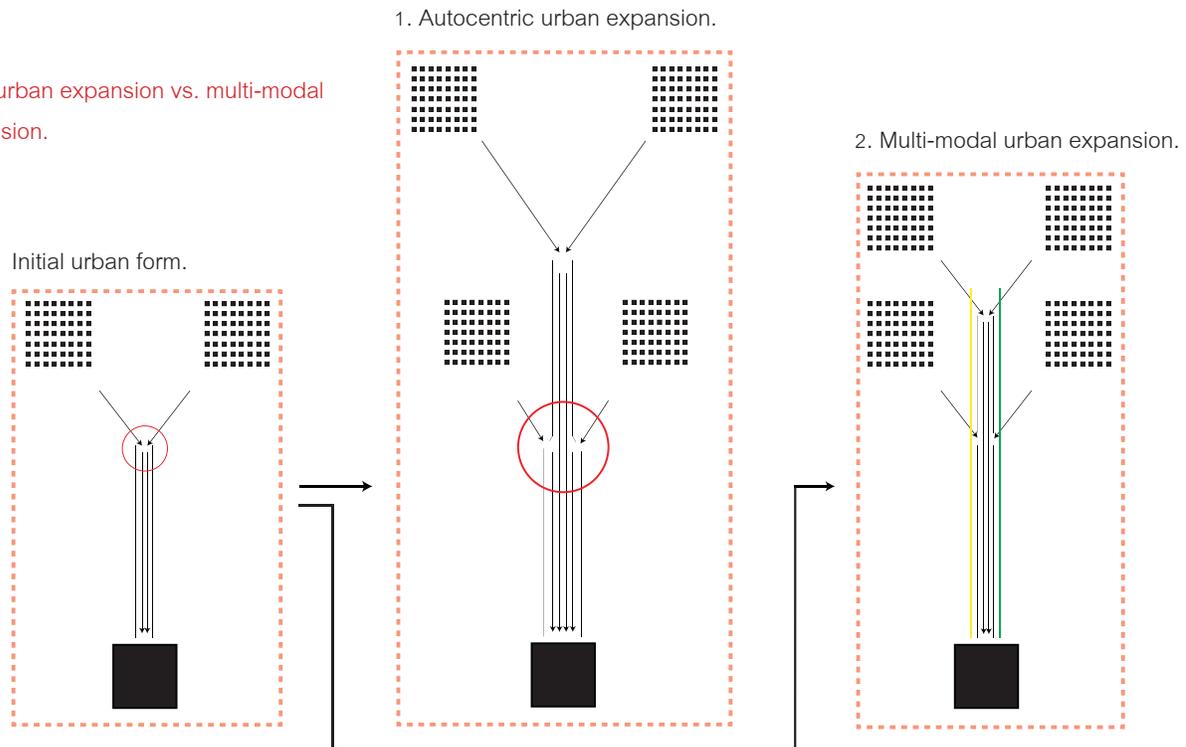


Figure 3.1.1 - This figure demonstrates autocentric vs. multi-modal urban expansion. Enhancing the public transportation system reduces traffic congestion and save billions of dollars in infrastructure and services costs by reducing the city's footprint.

3.2 INTENSIFY TRANSIT NODES

"[...] With a world population of 6.7 billion, growing by close to 80 million a year, demographic concentration in densely-populated urban areas actually favours the protection of rural ecosystems. Moreover, cities are the major source of critical technological innovations that can benefit the environment. Nevertheless, present patterns marked by the disordered spatial expansion of cities – an expansion that uses up more land than necessary, that encroaches upon valuable agricultural or ecological riches, that generates biologically sterile expanses of built-up land and that squanders biomass – also fail to maximise the potential benefits of concentration. The amount of land area that is increasingly being appropriated for urban land use is not negligible, nor is the environmental loss it causes (UNFPA, 2007, chapter 4)."⁵

City density has been a much talked about subject over the past century. In the mid 20th century, density was associated with slums and in some countries this is still the case. But in a developed country like Canada, we are privileged enough to have access to state of the art construction materials and methods, which ensures that people can live a healthy life in a dense urban environment.

Over the years we have nurtured the opposite of dense living and a sprawling urban form characterizes most Canadian cities. The auto-centric mobility framework built to sustain the existing low density urban morphology is becoming less and less efficient.

To solve this problem, strategic and well-conceived building density should be built around existing transit nodes. This can improve the city in several different ways.

Firstly, the city's infrastructural networks such as: sewers, lighting, fire protection, water, electricity, gas, police protection, emergency services and ambulances would all benefit economically and functionally from a dense urban form since the distances that they need to travel are shorter, This translates in increased efficiency and lower costs. For example, policemen/policewomen can patrol a larger population because people are physically closer together, which means he/she can see more things and receive back up quicker than if they patrolled in a low density neighbourhood.

Secondly, motor vehicle congestion would decrease because if dwellings are concentrated near transit nodes more people would live in the city where it is easier to use public transportation instead of their cars.

Thirdly, since public transportation would be encouraged most people would get the recommended amount of daily exercise required to stay fit and healthy.⁶

Lastly, increasing the overall amount of dwellings in the city reduces the need for further development on the outskirts, thus reducing the city's ecological impact and increasing its property tax revenue.

The benefits of intensifying transit nodes within our cities are far reaching but the challenge for the future will be how to achieve a more dense urban form without denying ourselves the comforts of privacy, nature and a healthy environment. The following section will discuss specific issues to consider when trying to maintain those comforts when designing building developments around trenched urban expressways.

5 United Nations. (2011). In *Population Distribution, Urbanization, Internal Migration and Development: An International Perspective* (p.23). United Nations.

6 Litman, T. (2010). *Evaluating Public Transportation Health Benefits*. Victoria Transport Policy Institute.

Low density city vs. dense city.

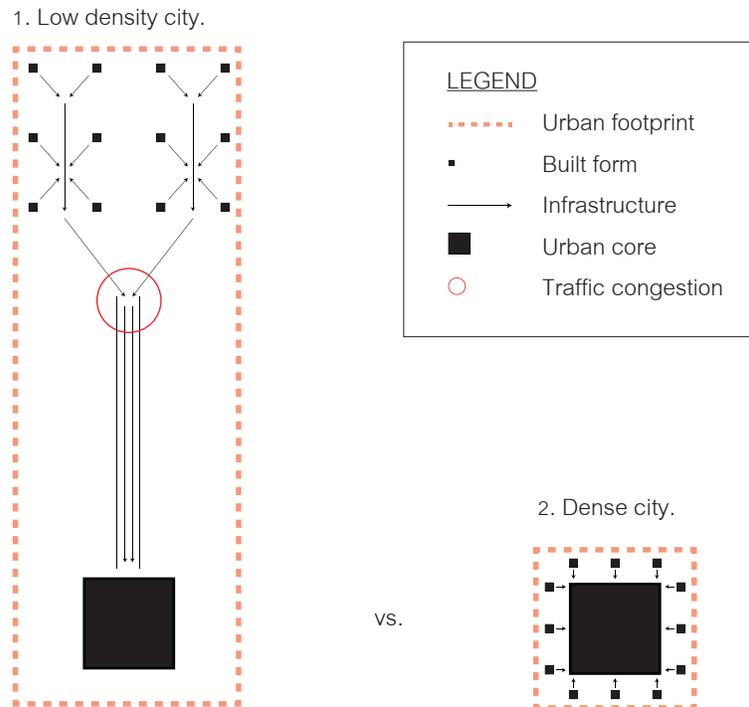


Figure 3.2.1 - This figure demonstrates the large urban footprint a low density city has. A dense city allows people to live closer to the urban core, which is where most people work; thus effectively reducing traffic during rush hour and reducing the amount of infrastructure and services costs that are required to support the city's citizens. Additionally, more land near the urban core is freed for agriculture, ecological tourism and recreation.

3.3 SENSITIVE RESIDENTIAL INTEGRATION

Massive trenched urban expressways often run through residential neighbourhoods and if they are designed in such a way as to enhance the amenities and the well-being of the surrounding residents they can become a productive and attractive infrastructural element within a city. In order to successfully integrate themselves into residential neighbourhoods they must consider the following.

Safety

The personal safety of the residents and passerbyers is tantamount for a residential neighbourhood to flourish. Inserting a 6-lane high-speed expressway into a residential neighbourhood is not the best way to ensure the safety of its residents. According to the UK department of transportation the odds of a pedestrian being fatally injured when struck by a motor vehicle is 85% at 64km/hr, which is a very common speed along the surface level service roads bordering the Décarie. At 32km/hr, the fatality rate drops to 5%.⁷ Speed mitigation methods, large sidewalks and sturdy well defined physical barriers (between motor vehicles and other forms of transportation) can mitigate a lot of the risk.

Along most trenched urban expressways the socioeconomic decline of the surrounding area also contributes to their dangerous environment; where crime, graffiti and filth are present. By reducing the negative effects trenched urban expressways have on the surrounding neighbourhood the socioeconomic decline will decrease and, consequently, so will the danger currently associated with the area.



Figure 3.3.1 - Street bollards.



Figure 3.3.2 - Street furniture.

7 UK Dept. of Transportation. (n.d.). Killing Speed and Saving Lives. London, England: UK Dept. of Transportation.

Noise

The noise pollution caused by trenched urban expressways has been discussed in section 1 and the extent to which it has a negative effect on the health and economy of the area is tremendous. Therefore, reducing the noise from the cars is essential to improve the overall surrounding quality of life.

Absorptive noise barriers are effective at reducing noise pollution but they must be strategically placed. According to Susan Tighe, professor of civil engineering at the University of Waterloo, the most significant source of noise from cars at speeds over 60km/hr (the Décarie Expressway has a speed limit of 70km/hr) is generated from the contact between the motor vehicle's tires and the pavement.⁸ Therefore, environmentally friendly absorptive noise barriers should be placed as close as possible to the wheels of the passing motorists.

Vegetation and water features muffle sounds while also providing many other benefits. Varying the heights of the vegetation along the road will ensure a continuous wall of foliage enhancing its noise absorptive properties.

Also, coupling water features with water storage and remediation systems allows the noise muffling properties of the running water to be more productive.



Figure 3.3.3 - Noise barrier.



Figure 3.3.4 - Foliage wall.

⁸ Ahammed, M. A., & Tighe, S. L. (2009). Understanding Pavement Noise: A Pavement Designer's Primer. Downsview: Ministry of Transportation Ontario.

Environmental Health

“Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, and genetics.”⁹

Fundamentally, environmental health pertains to the abundance and proportional quantities of clean water and air, natural light and fertile soil (to grow vegetation). In order for trenched urban expressways to create a “health-supportive” environment, aggressive strategies must be implemented to counteract the massive amount of environmental pollution it generates. The following are examples of strategies based on the four elements described above, that can help create a healthy environment.

Air remediation techniques:

There exists several ways to filter the air. There are mechanical systems that exist but they are expensive, require regular maintenance and large amounts of energy to function. Luckily, there are two natural ways that clean the air that are both highly effective, attractive and inexpensive to maintain.

1) Vegetation

a) Properly planted and selected vegetation reduces ambient air temperature and consequently reduces air pollution due to the fact that the emission of many air pollutants and/or ozone-forming chemicals are temperature dependent.

The shelter given from shrubs and trees planted strategically next to buildings reduces their heating/cooling load required and thus reduces the emissions released into the air from power generation and consumption. The Urban Forestry department from the University of Michigan found that a tree planted near houses or office buildings can reduce air conditioning demand by 30%.¹⁰

b) Vegetation removes gaseous air pollutants (e.g. O₃ and NO₂) through uptake via their leaf stomata and from their canopy’s interception of airborne particles (dust, ash, dirt, pollen and smoke) that are either: absorbed by the plant, washed away from the rain or re-suspended in the air.¹¹ A healthy medium size tree can capture 7000 suspended particles per litre of air and at the same time it can fulfil 4 people with their daily oxygen intake.¹⁰

It is estimated that trees and shrubs remove 1 430 metric tonnes of air pollution (CO, NO₂, O₃, PM₁₀, SO₂) per year with an

associated value of \$16.1 million in the city of Toronto with shrubs accounting for 25%. The remaining 75% of air pollution is removed by trees and their size affects the amount of it they can absorb. A large tree with a diameter of 75cm can intercept up to ten times more air pollution than a small tree with a diameter of 15cm. One sugar maple (one foot in diameter) along a roadway removes in one growing season 60 mg cadmium, 140 mg chromium, 820 mg nickel and 5200mg lead from the environment.¹² That’s why encouraging trees to reach maturity is very important.¹³



Figure 3.3.4 - A beautiful tree.



Figure 3.3.5 - Freeway Park by Lawrence Halprin.

- 9 The World Health Organization. (2013). *Environmental health*. Retrieved 01 09, 2013, from www.who.int: http://www.who.int/topics/environmental_health/en/
- 10 Ville de Montréal. (2005). *Politique de l'arbre de Montréal*. Montréal: Ville de Montréal.
- 11 Nowak, D. J. (2002). *The Effects of Urban Trees on Air Quality*. Syracuse: USDA Forest Service.
- 12 Davis, A. P., Shokouhian, M., Sharma, H., & Minami, C. (2001). *Laboratory Study of Biological Retention for Urban Stormwater Management*. *Water Environment Research*, 73(1), 5-14.
- 13 Parks, Forestry & Recreation - Urban Forestry. (n.d.). *Every Tree Counts - A Portrait of Toronto's Urban Forest*. Toronto: The City of Toronto.

2) Water bodies and water features reduce air pollution by capturing suspended air particles. The positive effect water has on air pollution was documented during the Beijing Olympics in 2008 (which were inundated with controversies over their air quality). Drastic measures were taken by the government to reduce air pollution such as curtailing traffic, implementing strict restrictions on automobile and truck use, closing factories, halting construction projects, spraying roads with water to reduce dust, and going as far as seeding clouds to induce rain fall. On August 11, 2008 the city's air pollution levels were reduced by half because of the downpour from the previous day.¹⁴

Water remediation techniques:

The low permeability of typical urban environments has made stormwater management into a multibillion dollar industry. Cities have extensive piping networks and large filtration centres to handle stormwater runoff. Most of the pollutants and contaminants that wash off of buildings and roads during and after a rainfall are treated in this system but unfortunately some manage to enter our streams, rivers and lakes. Pollutants and contaminants such as:

- Sediment
- Oil, grease, and toxic chemicals from motor vehicles.
- Pesticides and nutrients from lawns and gardens.
- Viruses, bacteria, and nutrients from pet waste and failing septic systems.
- Road salts
- Heavy metals from roof shingles, motor vehicles, and other sources.

These pollutants and contaminants can harm fish and wildlife populations, make recreational areas unsafe and unpleasant, kill native vegetation and foul drinking water supplies.¹⁵

In order to reduce the load on the city's stormwater management system and reduce the amount of pollutants that enter our waterways, natural systems have been developed to slow stormwater runoff, filter and improve overall water quality. These systems, namely bioswales and bioretention ponds, are high effective landscape elements that combine various types of vegetation to absorb and intercept water and air pollutants.

Bioswales are made up of rocks, grass, and other types of vegetation. They must be sloped in order to move water through it efficiently.

Bioretention ponds are depressed vegetated areas that capture and store stormwater runoff. They can work in combination with bioswales. Several studies have found that bioretention ponds are extremely effective at absorbing heavy metals, oil, greases and

lead (>90%) and are highly effective at reducing phosphorous and ammonium.¹²

Increasing the permeability of the pavement also allows for more contaminants and pollutants to be absorbed by the soil and plant roots.



Figure 3.3.6 - Bioswale.



Figure 3.3.7 - Bioretention pond.

14 Tran, T. (2008, 11 08). *Rain, rain: Beijing air pollution washes away*. Retrieved 01 04, 2013, from [www.usatoday.com](http://usatoday.com): [http://usatoday30.usatoday.com/weather/news/2008-08-11-beijing-air-quality_N.htm?csp=34&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+usatoday-WeatherTopStories+\(Weather++Top+Stories\)](http://usatoday30.usatoday.com/weather/news/2008-08-11-beijing-air-quality_N.htm?csp=34&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+usatoday-WeatherTopStories+(Weather++Top+Stories))

15 United States Environmental Protection Agency. (2012, 12 04). *Managing Urban Runoff*. Retrieved 01 09, 2013, from [water.epa.gov](http://water.epa.gov/polwaste/nps/urban.cfm): <http://water.epa.gov/polwaste/nps/urban.cfm>

Fertile Land

Increasing the amount of fertile land increases the amount of vegetation and consequently increases the positive benefits vegetation has on our health and economy. Trees are a significant part of the urban forest and for them to reach maturity their roots need to have room to spread out. Due to engineering requirements, heavy soil compaction is required in urban centres to support things like roads and buildings but there are ways to layer structural pavement with un-compacted soil so that they both can coexist. For example, Silva Cell is a modular suspended pavement system that uses soil volumes to support large tree growth and provide powerful on-site stormwater management through absorption, evapotranspiration, and interception. Silva Cell basically provides a deck for compacted soil to rest onto with and any sort of pavement to be overlaid on top and allows for un-compacted soil to be untouched underneath. This facilitates tree roots to spread naturally thus creating a healthier tree. Ensuring that trees have enough room to spread their roots increases their chances of being able to grow to maturity, which drastically increases the amount of pollution they can absorb.

Urban agriculture is also an important activity in Montreal and an increase in small patches of fertile land would benefit the thousands of urban farmers and would reduce the pollution generated from the production, processing and distribution of food.

Strategic Illumination

Eliminating unnecessary artificial light requires that all lamp posts illuminate where absolutely necessary and nowhere else. Covers and caps must not let light deflect vertically and ideally they should not shine too far horizontally.

Ease of Mobility.

Being able to move around easily through one's neighbourhood is essential for its success. Living close to transportation arteries and nodes increases property values.

Walkable neighbourhoods is also important. In fact the most valuable real estate in the USA lies in walkable urban locations.¹⁶



Figure 3.3.9 - Lufa Farms Montreal. A commercial rooftop greenhouse.

16 Leinberger, C. B. (2012, 05 25). *Now Coveted: A Walkable, Convenient Place*. Retrieved 01 04, 2013, from www.nytimes.com/2012/05/27/opinion/sunday/how-coveted-a-walkable-convenient-place.html?_r=1&

Design Standards

Design matters. The design of benches, lamp posts, buildings, traffic lights all must adhere to high design standards. No element is too small to be ignored. Investing in design may cost slightly more initially but that little extra is nothing compared to the overall construction costs of most projects and the benefits good design can provide are numerous. Complex architectural projects require several iterations in order to balance form with function, and good design can eliminate useless space, reduce operating costs, accommodate and anticipate change increasing the project's long term value, increase the comfort and wellbeing of its occupants and due to its distinctive aesthetic quality can become a cherished commodity within a city.

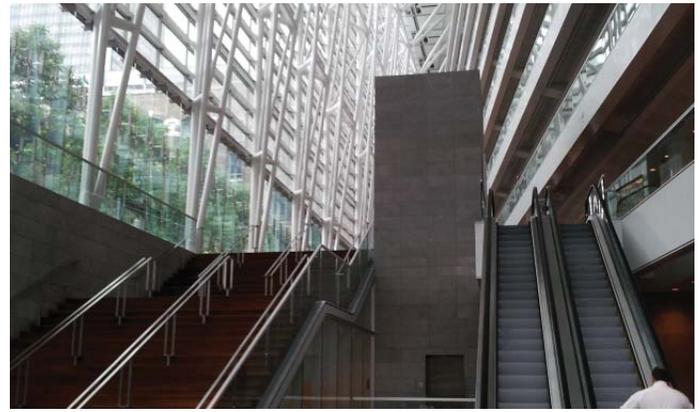


Figure 3.3.10 - Centre CDP Capital lobby.

Local Services and Materials

New urban projects involving trenched urban expressways should use local materials, architects, designers, and contractors etc. as much as possible. This will ensure that the neighbourhood and the city will be well represented since the people and materials involved would be intimately associated with the area.

The neighbourhood's/city's character and charm would be enhanced since the design and construction would generate different forms from city to city, reducing the monotonous nature of most trenched urban expressways.

The local economy would also benefit from giving local materials and services priority over foreign sources.



Figure 3.3.11 - Square Victoria street furniture.

Diversity of Program and Building Type

Building diversity allows neighbourhoods to be more walkable since more of people's needs and desires are located nearby. Mixed-use is a key ingredient to achieve a healthy and thriving neighbourhood. Jane Jacobs was a fervent advocate of building diversity. She has famously said that building use, if properly chosen, "keeps eyes on the street", which she argued reduced crime. She believed that building diversity allows neighbourhoods to be frequented at all hours of the day, increasing the safety, encouraging chance encounters and economic success.¹⁷ In new large urban projects it is paramount to architecturally plan for building diversity initially, and create spaces that favour certain building types in order to elongate the hours the area is frequented; ultimately to increase the area's safety, building occupancy, walkability and the personal and economic health of its residents.



Figure 3.3.12 - Old Port Montreal.

17 Jacobs, J. (1961). In *The Life and Death of American Cities*. New York: Random House.

ENHANCING THE ROLE OF TRENCHED URBAN EXPRESSWAYS WITHIN THE URBAN FABRIC - CONCLUSION

Many trenched urban expressways have been created in several major metropolises in North America but few have managed to maximize the potential of the massive amount of land they take up. Engineering principles have been the primary design tools used and unfortunately they do not take into account, to any significant degree, the impact they have on the health, comfort and economic vitality of the neighbourhoods they bisect.

Optimizing the land occupied by these massive infrastructures by using the three design principles outlined in the preceding subsections namely: enhancing public transportation, intensifying transit nodes and sensitive residential integration; trenched urban expressways can become a productive and efficient architectural element within the city.

“However, it does not follow that all institutions or other facilities that cleave cities with borders and tend to ring themselves with vacuums are to be considered enemies of city life. On the contrary, many of them are obviously desirable and most important to cities. A big city needs universities, large medical centers, large parks containing metropolitan attractions. A city needs railroads: it can use waterfronts for economic advantage and for amenity; it needs some expressways (especially for trucking).

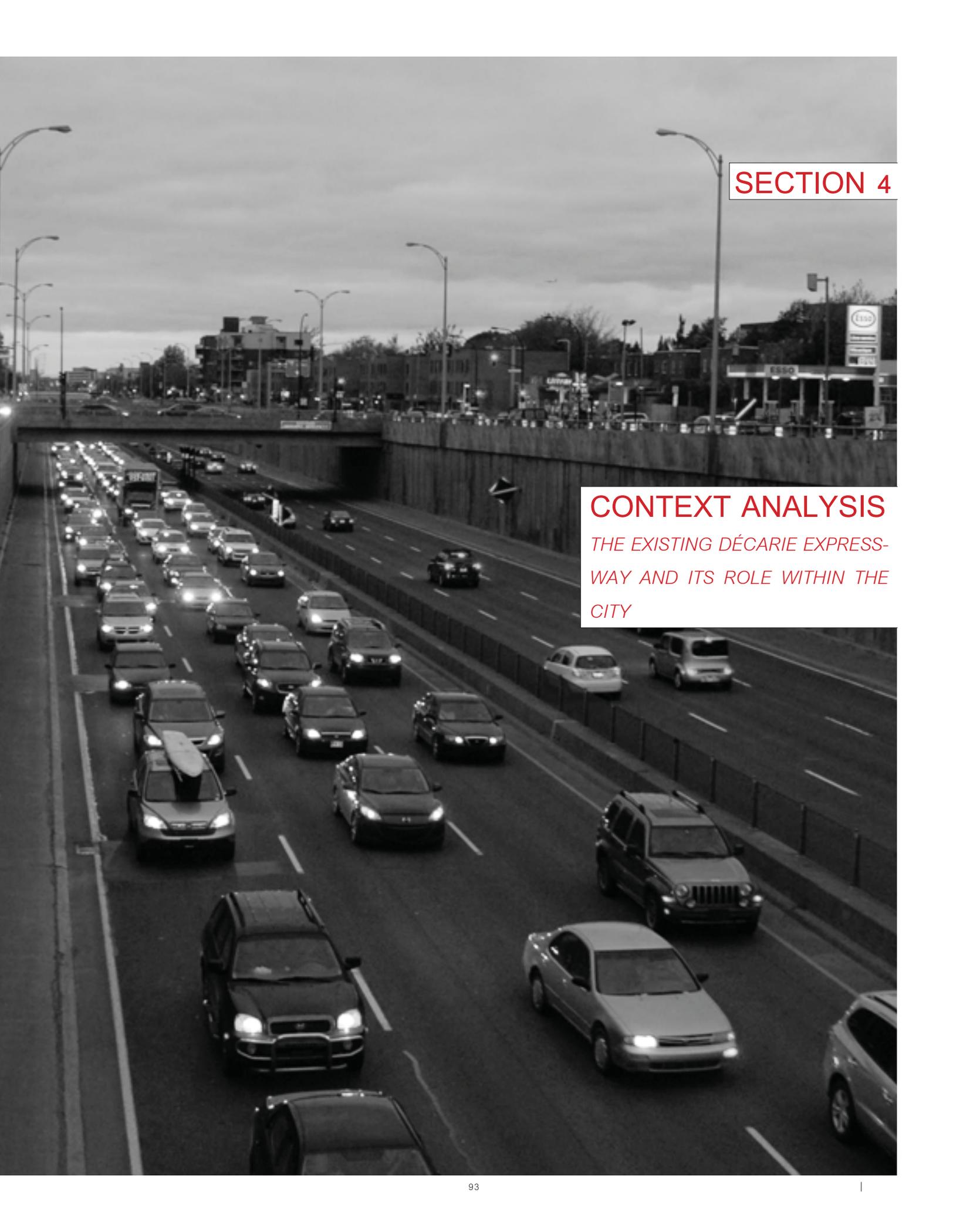
The point is hardly to disdain such facilities as these or to minimize their value. Rather, the point is to recognize that they are mixed blessings.

If we can counter their destructive effects, these facilities will themselves be better served. It is no blessing to most of them, or to those who use them, to be surrounded by dullness or vacuity, let alone decay.”

Jacobs, J. (1961). In *The Life and Death of American Cities* (p. 265). New York: Random House.



The Existing Décarie Expressway



SECTION 4

CONTEXT ANALYSIS

*THE EXISTING DÉCARIE EXPRESS-
WAY AND ITS ROLE WITHIN THE
CITY*

SECTION 4 - THE EXISTING DÉCARIE EXPRESSWAY - AND ITS ROLE WITHIN THE CITY

HISTORICAL BACKGROUND

In 1650, Ville-Marie was a small but rapidly expanding colony on the Island of Montreal. Native Canadian attacks were frequent and the city needed better protection. Paul de Chomedey, the first Governor of Montreal began leasing lands to a few brave families to act as a buffer from the attacks and also to increase food production for the blossoming city. The Décaries were a part of the small group of families that were leased land and in the 1660's they began farming the west side of Mont-Royal Mountain.

Sandwiched between the St-Lawrence River and Mont-Royal, the Décarie farm enjoyed a micro-climate and a proverbially fertile land that made it ideal for growing apples, tomatoes, melons and all sorts of produce. The area was famous for growing the Montreal Melon. It was world renowned; the fruit once fetched a high price in restaurants all across Boston and New York.

The charming rural characteristics and fertile farmland eventually led to the development of two towns called Notre-Dame-de-Grâce (NDG) and Côte-des-Neiges (CDN). They were officially annexed by the City of Montreal in the 1900s and then joined to form a single borough. By 1930, the population exploded to approximately 50,000 thanks to an extensive street car network that ran through the city. A large boulevard (The Décarie Boulevard) located between the two towns acted as a transportation and commercial spine for the area and was named after the Décarie family.¹

During the 1960s, vehicular traffic was increasing and expressways were being proposed all over the island. Naturally, the Décarie boulevard was an obvious choice because of its strategic location, and because it was large enough to support a multilane expressway. The original proposal was met with much criticism; many citizens thought the project cost too high and they were afraid of the consequences it would have for the local merchants. After several revisions, the project's future seemed uncertain.

It was Expo '67 that catalysed the creation of what is presently the Décarie Expressway. It was touted to be the much needed link between the newly constructed east-west expressway and the site of the eventual world fair. The Décarie Expressway began construction in 1964 and was completed just in time for Expo '67's grand opening.



Figure 4.1 - Farming the Montreal Melon.



Figure 4.2 - A view of down Décarie Boulevard pre Expressway.



Figure 4.3 - A view of Décarie Expressway 2012.

1 Pelland, Y. (2009, 01 29). Story of NDG. Retrieved 04 19, 2013, from www.n-d-g.com: http://www.n-d-g.ca/english/?page_id=3

THE DÉCARIE EXPRESSWAY'S ROLE AS ROAD INFRASTRUCTURE

The Décarie Expressway is the main North/South Artery of the city part of Autoroute 15. It connects northern Quebec with the United States, an important trade route.

The Expressway is delineated by the city's two East/West Autoroutes. It divides the Côte-des-Neiges-Notre-Dame-de-Grâce borough in two.

It is also a direct link to the Champlain Bridge, the busiest in Canada.²



Figure 4.5 - The Décarie Expressway is the most direct link to the USA in Quebec north of the St-Lawrence River and it connects Montreal's two main east-west autoroutes going through Montreal.

2 Transport Canada. (2012, 11 16). *What is the importance of the Champlain Bridge Corridor?*. Retrieved 01 09, 2013, from www.tc.gc.ca: <http://www.tc.gc.ca/eng/programs/bridges-new-bridge-for-the-st.lawrence-2812.htm>

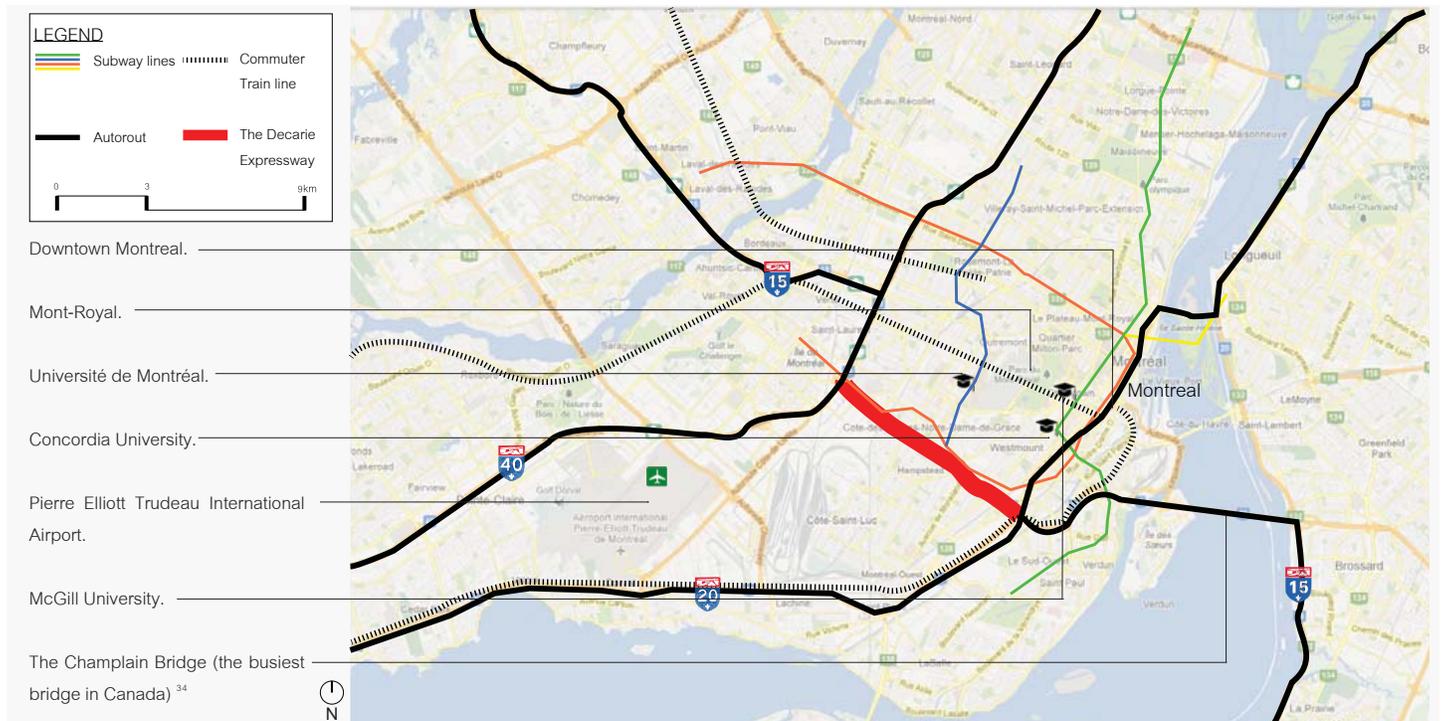
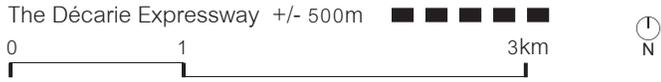


Figure 4.4 - The Décarie Expressway's location within Montreal's transportation network.

THE DÉCARIE EXPRESSWAY WITHIN THE CITY CONTEXT

The Décarie Expressway is a major transit artery, centrally located in Montreal, and it plays an important role in how people experience the city.

It is in close proximity to major attractions, iconic landmarks, an international airport, major train stations, the Mont-Royal mountain, Downtown and the Old Port.



Univeristé de Montréal



Downtown Montreal



Le Quartier International de Montréal



St-Joseph's Oratory



Mont-Royal



Old Port



Snowdon Theatre



MUHC (The Superhospital)



The Turcot Interchange



The Lachine Canal



The St-Lawrence River

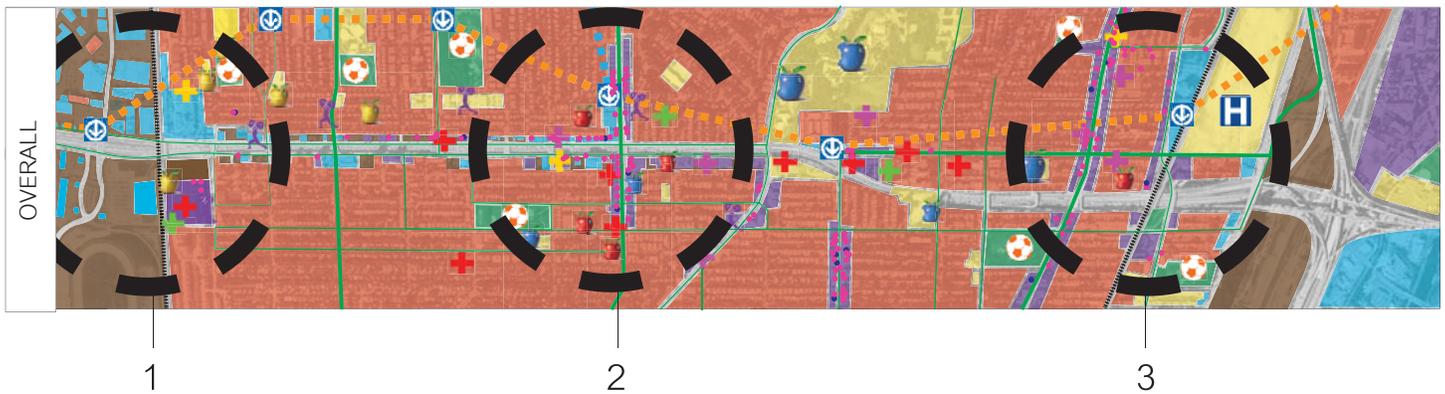
THE DÉCARIE EXPRESSWAY CONTEXT ANALYSIS (+/- 500m)

There are three transit nodes along the Décarie Expressway that are perfectly situated for intensified transit oriented development.

1. The commercial sector to the north is located next to a major highway interchange, filled with vacant lots and it is serviced by a metro station and a shopping mall.

2. The intersection of Queen Mary Rd. and the Décarie Expressway is located right in the middle and in proximity to Snowdon metro station, which is a junction between the orange and blue metro lines. It is also located next to several schools and various commercial establishments.

3. The Superhospital (completion slated for 2014), located at the south end of the site and in proximity to a metro station, is expected to draw thousands of people daily to the area. Mixed-use urban intensification is anticipated to follow the hospital's completion, facilitating the ability for people to live and work in the same area.



LEGEND			
- Commercial		- Montreal's Super Hospital (completion in 2014)	
- Residential		- Dentists	
- Mixed-Use		- Alternative medicine clinics and research institutions	
- Institutional (Schools, Hospitals, Churches, etc.)		- Veterinary hospitals	
- Parks and green space		- Health, physiotherapy and orthopaedic clinics.	
- Vacant/parking lots			
- Metro Stations		- Restaurants	
- Metro Route		- Bars	
- Railway			
- Bus routes		- Parks	
- Bus routes that run every 10min.		- Fitness centers	
- Specialty schools (music, languages, etc.)			
- Elementary schools			
- High Schools			
- Jewish schools			

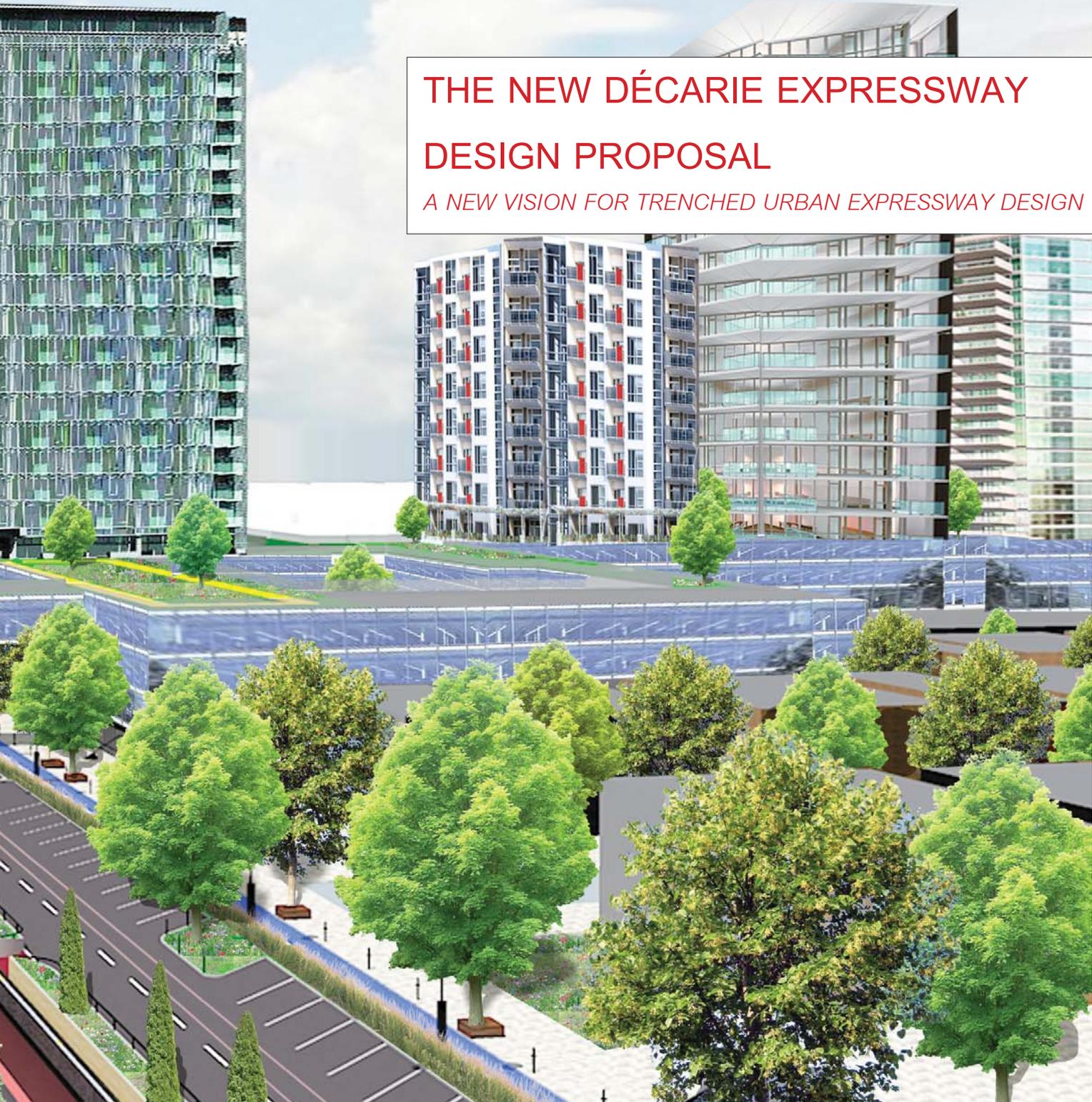


Context analysis per type of program. Images by author, base images by Google maps.



THE NEW DÉCARIE EXPRESSWAY DESIGN PROPOSAL

A NEW VISION FOR TRENCHED URBAN EXPRESSWAY DESIGN



SECTION 5 – THE NEW DÉCARIE EXPRESSWAY

A NEW VISION FOR TRENCHED URBAN EXPRESSWAY DESIGN

The intention for the following design proposal is to be a preliminary study into the potential of the Décarie Expressway. Because of the immense scope of the project, the plans are schematic and the vignettes are meant to give a sense of the character of what's envisaged while not intending to be specific design proposals. Colors, materials, building massing etc. are all subject to change as the project moves forward into the future; where public consultations and stakeholders can impose some design constraints further refining the proposal. This preliminary study provides all parties involved with a document of ideas to fuel the discussion.

The stakeholders in such a large scale project would most likely include the government of all levels (federal, provincial, municipal), the citizens of Montreal and the surrounding business and property owners. Very much similar to how the Quartier International de Montréal was financed.

The New Décarie Expressway represents a new vision for trenched urban expressways (TUEs), a vision that challenges TUE design to be much more conscious of its role within the city.

It is envisioned to be more than just an expressway but a major gateway. A gateway that portrays Montreal as an urban center prime for economic investment, as a leader in environmental sustainability, public transportation and most importantly that it is a desirable city to live in.

The New Décarie Expressway is a destination and a transit artery rather than strictly the latter; filled with iconic architecture, beautiful streetscapes and a vibrant/healthy atmosphere.

Congestion within the Décarie Expressway is the main problem surrounding the area. The Décarie Expressway is congested because more and more people are commuting by car into the city from the neighbouring regions.¹

Implementing an environmental remediation strategy, beautifying the area and capturing the unused space over the expressway to intensify transit nodes and to increase mobility options will reduce congestion, encourage public transportation, entice people to live on the island and catalyze the area for future development. Ultimately, when combined, these interventions will reduce the negative effects the Décarie poses to the health, environment and the economy of the entire city and the massive amount of space it takes up within the urban fabric will become more productive.

On the right is a synthesis of the design principles and the major lessons learned from the previous sections. In the subsequent pages [The New Décarie Expressway](#) will be further elaborated upon, providing an example of such development.

1 Statistics Canada. (2009, 08 21). [www.statcan.ca](http://www12.statcan.gc.ca/census-recensement/2006/as-sa/97-561/p32-eng.cfm). Retrieved 02 13, 2013, from *Commuting Patterns and Places of Work of Canadians, 2006 Census: Portrait of the largest census metropolitan areas in the country's regions*: <http://www12.statcan.gc.ca/census-recensement/2006/as-sa/97-561/p32-eng.cfm>

Enhance Public Transportation

1. Utilize the plan and profile of the existing expressway to create new space at grade. Then use that new space to re-configure the ancillary roads and introduce other forms of transportation, effectively enhancing the existing public transportation network and reducing the motor vehicle congestion along the Decarie.
2. Reach out to areas of commuter concentration and provide them with safe and efficient public transportation. Provide shelter for transit users at all stops. Also, provide spaces for commuters coming from further away to park their cars and enter the public transportation network.
3. Layer the varying modes of transportation in proportion to their danger to pedestrians, the speed at which they travel and the frequency of stops they make in order to make the area safer for pedestrians and ensure a balanced transportation network less saturated with motor vehicles.

Sensitive Residential Integration

4. The Decarie Expressway is an aggressive polluter and since it is in direct proximity to people's homes, an equally aggressive environmental remediation strategy is called for.

Vegetation is an excellent air/water purifier and it has been proven to help improve the economic success of nearby commercial establishments. Therefore, the unused and newly captured space along the expressway should be used to maximize landscaping opportunities.^{2,3}

5. Strategic artificial lighting must be thoughtfully introduced to minimize light pollution.
6. Safety is another important element that must be taken very seriously if these dangerous expressways are to be integrated into residential neighbourhoods.

Speed mitigation measures, large sidewalks and physical barriers between fast moving traffic and pedestrians must be implemented all along the Decarie Expressway's ancillary roads.
7. The general attractiveness of the area is important as well as it attracts people to frequent it. Local materials and context sensitive architecture help the local economy and respects the area's building culture.

Intensify Transit Nodes

8. There are numerous benefits to encourage the use of public transportation: it is healthier, safer, it reduces congestion because it encourages people to forgo their cars and it improves the state of the city's economy by providing jobs and reducing the amount of road infrastructure maintenance/construction.⁴

Encourage public transportation by intensifying mixed-use developments around transit nodes along the Decarie Expressway.
9. Orient the building massing and adjust the programming to shelter as much as possible the residential units from air/noise and light pollution.
10. Give the priority to pedestrians and commercial establishments on the ground plane.
11. Incorporate large open gathering spaces to encourage social interactions.

2 Ville de Montréal. (2005). *Politique de l'arbre de Montréal*. Montréal: Ville de Montréal.

3 Nowak, D. J. (2002). *The Effects of Urban Trees on Air Quality*. Syracuse: USDA Forest Service.

4 Board of Trade of Metropolitan Montreal. (2004). *Public transit: a powerful economic development engine for the metropolitan Montreal region*. Montréal: Board of Trade of Metropolitan Montreal.

SITE DELINEATION

The Décarie Expressway is bounded by two major interchanges, the Turcot interchange to the South and the Décarie Interchange to the North. The Northern and Southern sections of the Décarie do not represent typical trenched urban expressway conditions as outlined in Section 1. They are much wider, some parts are not trenched and in certain areas surface level service roads do not exist.

The image on the right establishes a rough delineation of where the Décarie embodies typical trenched urban morphology and as such the following pages will deal only with this part of the Décarie.

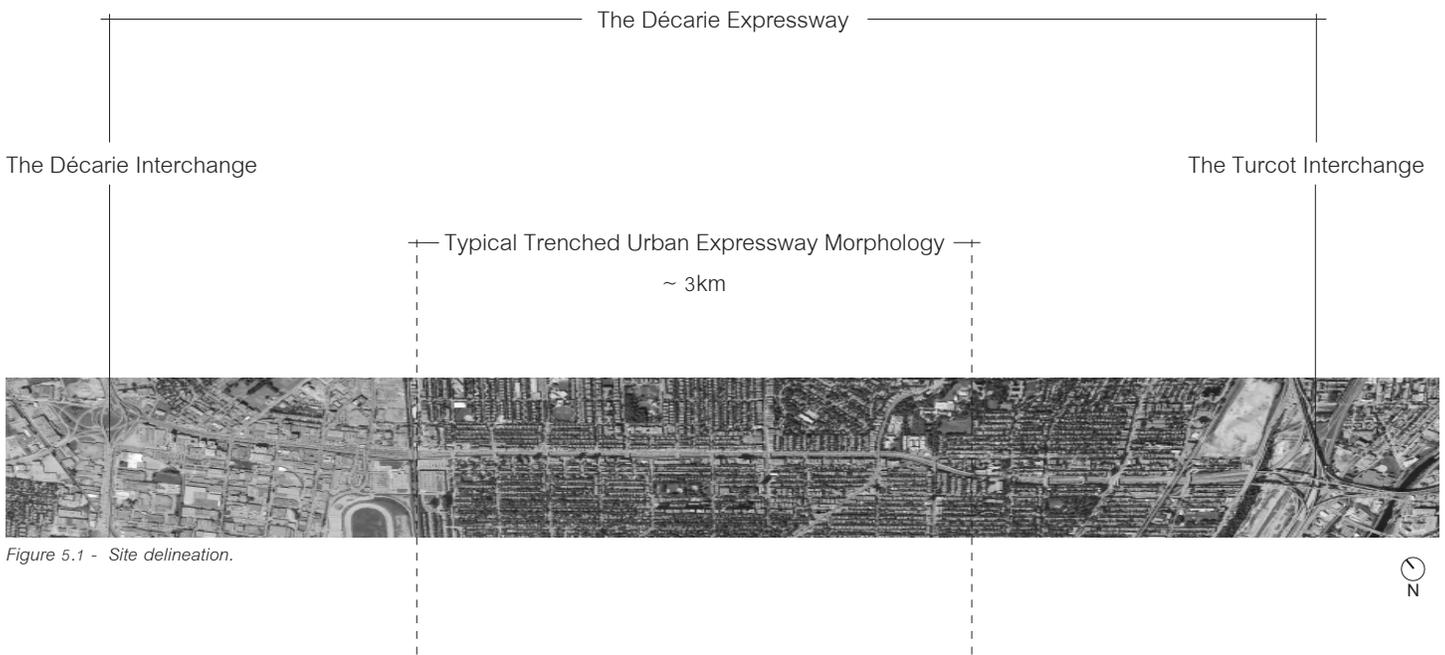
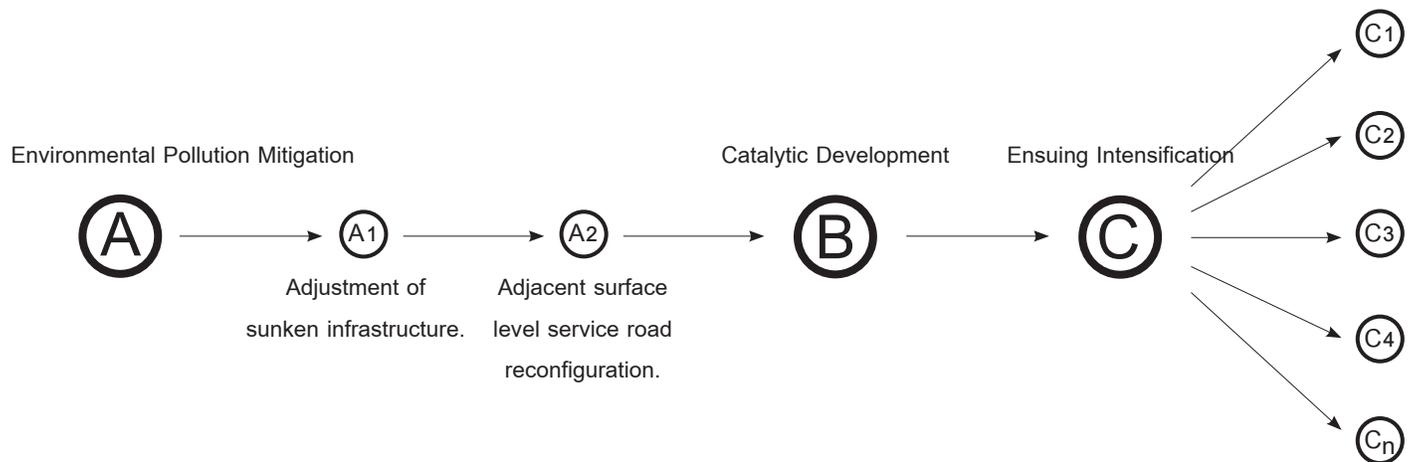


Figure 5.1 - Site delineation.

PHASING

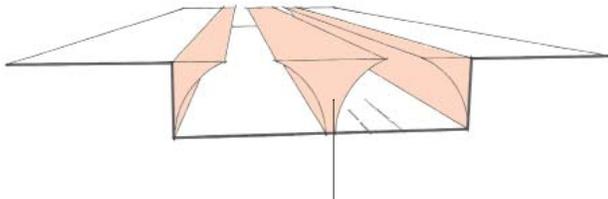
The interventions have been grouped into three general phases. The phases are organized in order of importance in time.



A Environmental Pollution Mitigation

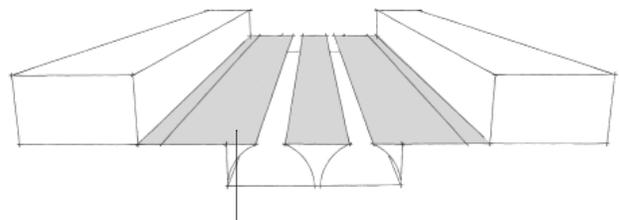
Phase “A” represents the environmental pollution mitigation of the expressway and the reconfiguration of the adjacent surface level service roads. This is the most important phase since it reduces the expressway’s negative effects. The new environment surrounding the expressway will encourage future development along its borders and make the area a healthier place to be in. Phase “A” is divided into two smaller phases.

A1 Adjustment of trenched infrastructure.



Install arched noise barriers inside the expressway trench to reduce the amount of air, noise and light pollution that affects the bordering communities.

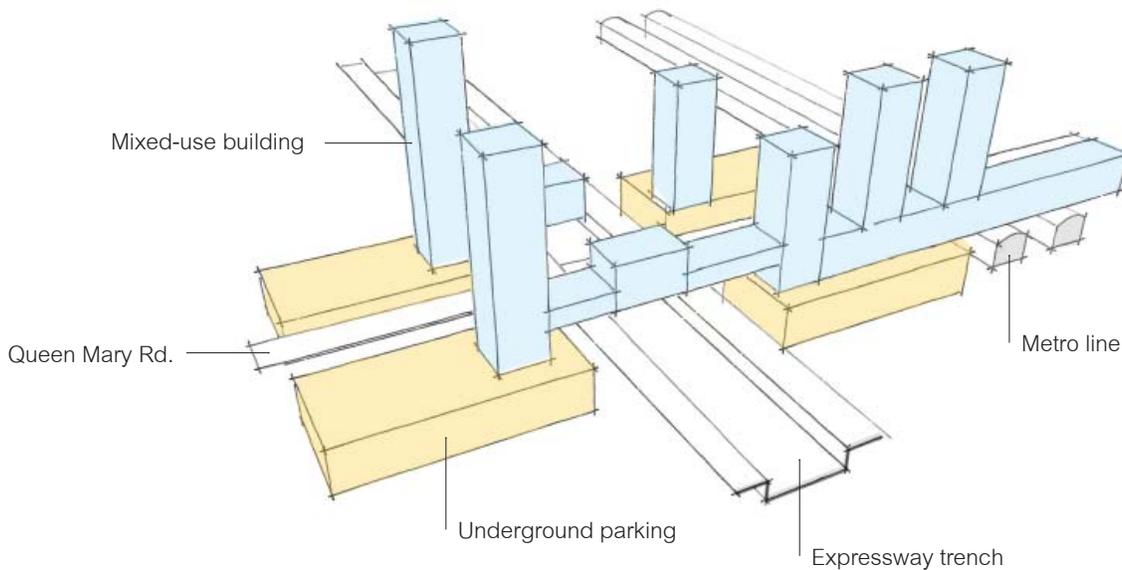
A2 Adjacent surface level service road reconfiguration.



Arched noise barriers create new space at grade that can be used to incorporate a bike path and copious amounts of vegetation without reducing the number of existing traffic lanes.

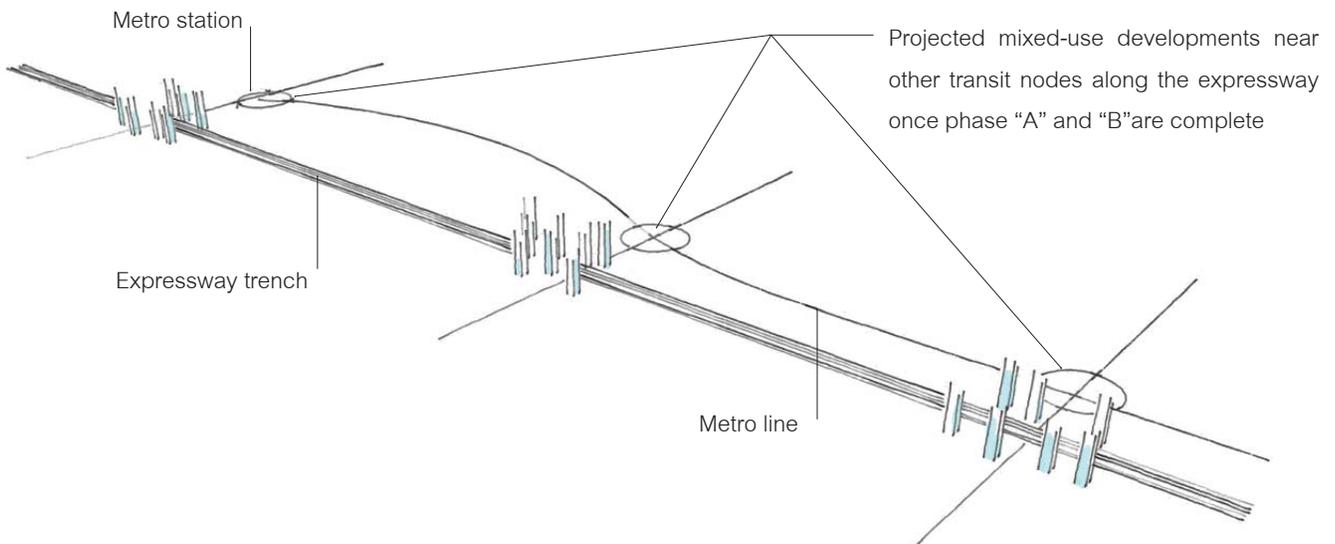
B Catalytic Development

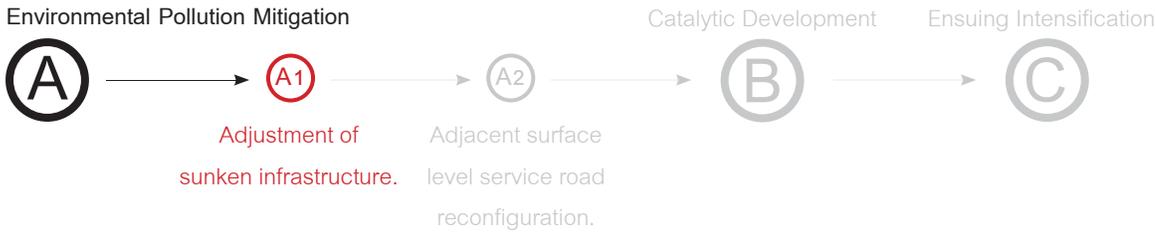
The context analysis on page 97 has targeted an intersection within the delineated site as a transit node that is well situated for intensification. A mixed-use development is envisioned to bridge the expressway and connect physically/figuratively the adjacent neighbourhoods, to break up the expressway's dominance within the urban landscape and to enhance the existing public transportation infrastructure. This development, at the intersection of Queen Mary Rd. and the Décarie Expressway, is projected to be a catalytic investment that will act as an anchored precedent, encouraging future development on sites over the rest of the expressway.



C Ensuing Intensification

Corresponds to the eventual intensification of sites all along the expressway that is envisioned to naturally occur once phase "A" / "B" are completed and the area becomes much more attractive to be in.





PHASE “A1” - ADJUSTMENT OF TRENCHED INFRASTRUCTURE

The problem with the existing expressway’s trench design is that the form of the trench is such that the concrete walls reverberate the sound from the passing motor vehicles and throw it into the bordering neighbourhoods.

As we have seen with the Big Dig, capping the entire expressway is not only astronomically expensive to construct and then to maintain but it creates a dull and stale environment within the tunnel.

Cantilevering arched concrete noise barriers over the expressway mitigates the noise, air and light pollution while at the same time provides an abundance of natural light and air for the people within the expressway trench.

The concrete arches are cast-in-place and structurally secured through tie backs rammed deep into the compacted ground beyond. The wood formwork used for the concrete casting is simply left in place and mechanically secured to the arches. The wood provides additional sound absorption and protection against the corrosive pollutants such as salt and acidic car exhaust fumes.

The arches, unlike the noise barriers installed along the Gran Via de les Corts Catalanes, do not block the visual connection across either side.

According to Dr. Susan Tighe, a professor of civil engineering at the University of Waterloo, it is the sound of the tires hitting the pavement that produces the most noise when motor vehicles are traveling at over 48km/hr (the posted speed limit along the Décarie Expressway is 70km/hr.).⁵ Therefore, the noise absorption chambers are not only located near the focal points of the arched noise barriers but are also located near the wheel bases of passing motorists.

The noise absorption chambers are designed as a series of perforated, precast, glass reinforced concrete (GRFC) panels offset from the wall by anodized aluminum supports and filled with recycled rubber mulch panels. GRFC is chosen specifically for its high performance in high impact and corrosive environments (see page 43). The sound is dissipated through the perforations and the rest of the sound is then absorbed by the recycled rubber mulch panels.⁶

Old tires are recycled and shredded to create the rubber mulch. This material effectively absorbs traffic noise and also pre-

vents the old tires from ending up in a landfill.⁶

Currently the central median is a low concrete wall with a chain link fence mounted on top. The chain link fence provides only some protection from the headlights of oncoming traffic and, more crucially, it is still possible to see an accident or a stall happen on the other side of the expressway which slows down traffic on either side, thus increasing congestion.

Installing arched noise barriers along the central median not only reduces the amount of noise that is able to escape into the bordering neighbourhoods, but it also eliminates the slowdown effect accidents and stalls have on oncoming traffic.

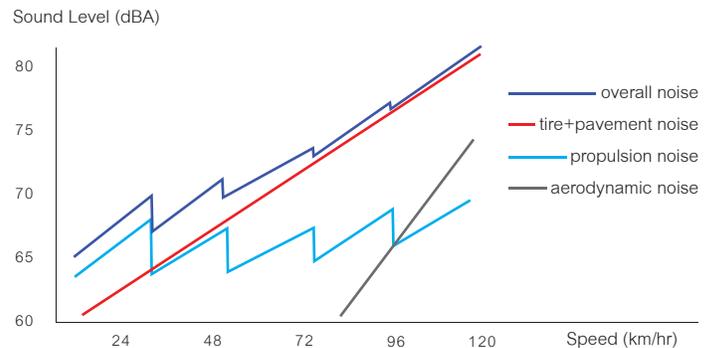


Figure 5.2 - Motor vehicle noise sources vs. motor vehicle speed.⁵



Figure 5.3 - Rubber mulch.

5 Ahammed, M. A., & Tighe, S. L. (2009). Understanding Pavement Noise: A Pavement Designer’s Primer. Downsview: Ministry of Transportation Ontario.

6 F. Asdrubali, F. D. (2008). Sound absorbing properties of material made of rubber crumbs. Perugia, Italy: Università degli studi di Perugia.

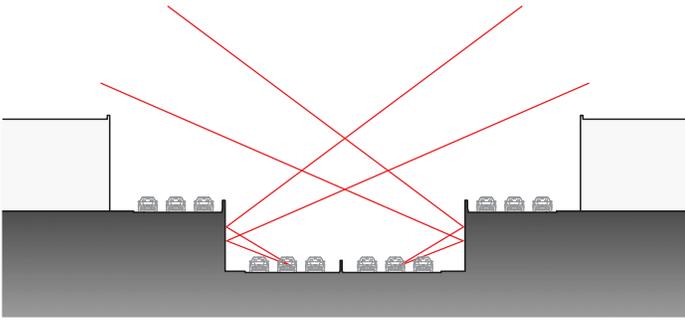


Figure 5.4 - Existing Décarie Expressway section.

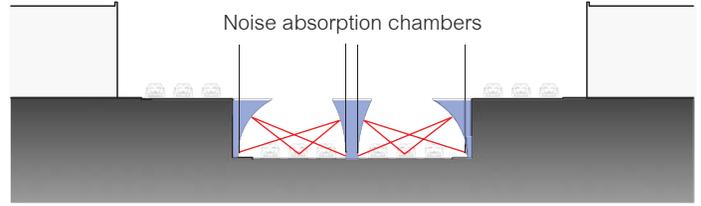


Figure 5.5 - New arched noise barriers with noise absorption chambers.

CONSTRUCTION FEASIBILITY.

The issues surrounding the construction of these arched concrete noise barriers are complex and are extremely important to plan correctly to ensure a minimal disruption to the expressway's daily function. A structural and construction phasing strategy warrants further investigation and consultation but a rough idea of a possible plan of recourse is diagrammed below.

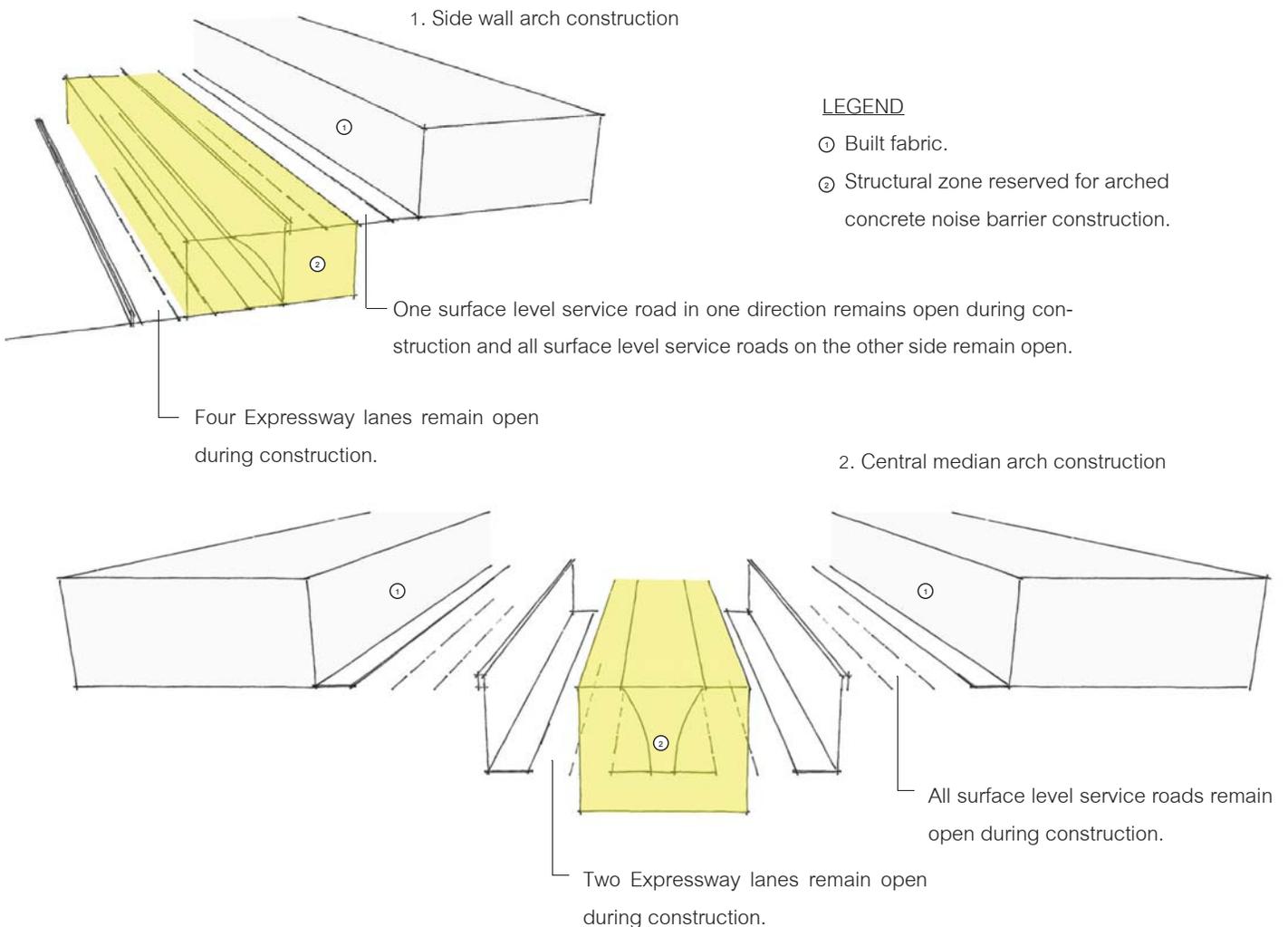


Figure 5.6 - Construction feasibility diagram - showing reserved sidewall and median concrete arch noise barrier construction zone.



High efficient LED lighting strips are integrated into the concrete arches and do not allow direct light to travel outside of the expressway. This lighting strategy eliminates the existing expressways lamp posts that protrude high above the existing expressway's surface, effectively reducing the visual clutter along the surface level service roads and reducing considerably the amount of light pollution entering the neighbouring residences.

Wood strips clad the trench walls. They are reclaimed from the concrete formwork leftover from the casting of the concrete arches.

The wood provides additional sound absorption and it is more resistant to corrosion than concrete or steel. It also gives the trench a warm and welcoming aesthetic.

Finally, the arched noise barriers create new space at grade, which provides an opportunity to reconfigure the surface level service roads and make room for air/water remediation systems, landscaping and other mobility options, while making them more attractive and safe for pedestrians and cyclists.

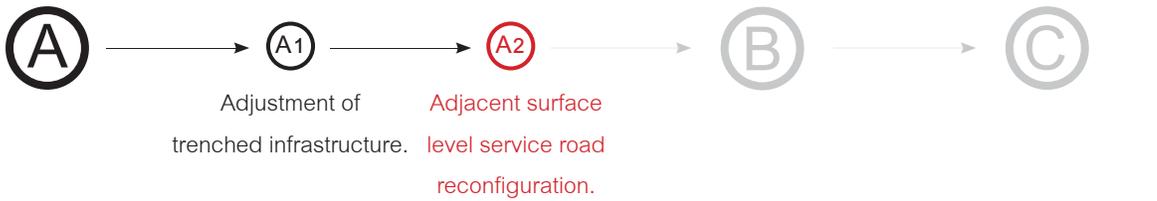


Figure 5.7 - Existing expressway artificial lighting strategy.



Typical new expressway trench. Image by author.

Environmental Pollution Mitigation



PHASE "A2" - ADJACENT SURFACE LEVEL SERVICE ROAD RECONFIGURATION.

Currently, the surface level service roads are monotonously linear and saturated with fast moving motor vehicles with little vegetation and safety barriers. The streetscape is unattractive and uninspiring. The proposed noise barriers introduced in Phase "A1" create new space at grade, which is used to re-configure the adjacent surface level service roads. Ultimately, to create a healthier and safer surrounding urban environment.

The sidewalks are enlarged by 1m. This allows room for the planting of large mature trees and the installation of benches, which increases pedestrian comfort.

Two-way bike lanes are added to encourage human powered mobility, thus reducing motor vehicle congestion. The curbed edges of the bike lanes are lined with large trees, bollards, flowers and grasses to protect the pedestrians and cyclists.

Angled parking spots facilitate efficient parking, help drivers overcome snow banks and provide ease of access to their trunk compartments. They also take less time to park than a parallel parking spots, thus reducing traffic congestion even further. The roadside parking spots are surfaced with porous pavement to allow the natural filtration of greywater runoff.

Street tramways replace the buses along the Décarie. In an area with high air pollution, the street tramway's electric motor produces zero emissions thus reducing overall pollution levels. The charm of the

street tramway will be a welcome infusion of character into the area and will pay homage to its role in the area's development.

LEGEND

1. Sidewalk.
2. Adjacent surface level service roads.
3. Décarie Expressway.
4. Arched noise Barriers.
5. Angled parking spots with porous pavement.
6. Bike path
7. Visually unobstructed connective strips
8. Landscaping opportunities. +

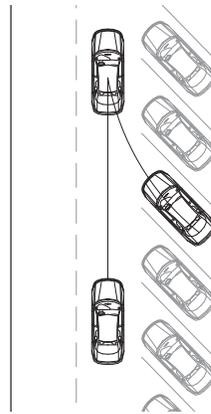


Figure 5.9 - 2 point angled parking procedure.

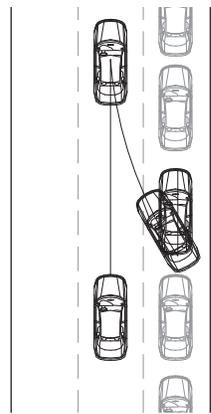
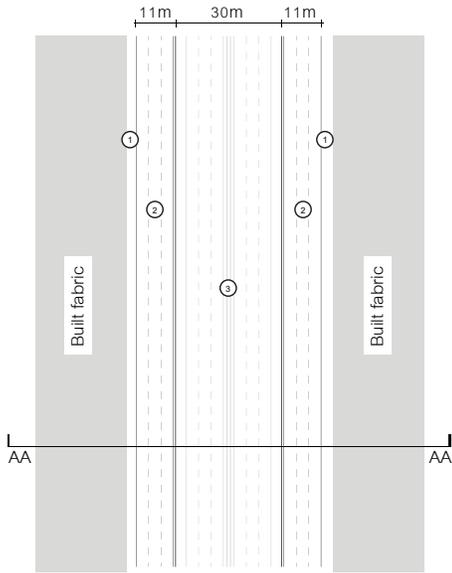


Figure 5.10 - 3 point parallel parking procedure.



Figure 5.8 - Décarie Boulevard pre-expressway showing streetcar tracks.

1. Existing condition.

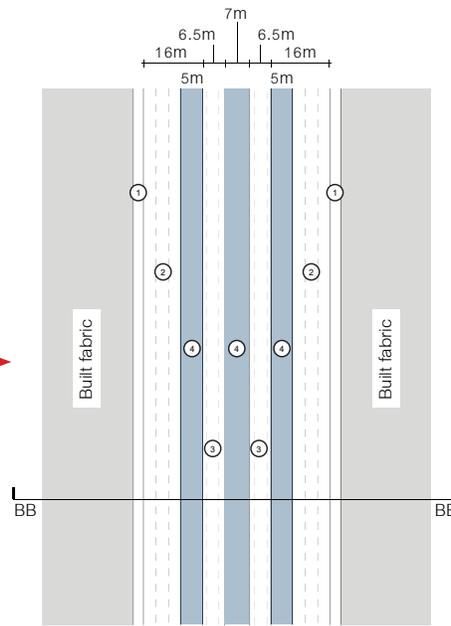


The existing condition, a rigidly linear and monotonous space, does nothing to prevent the environmental pollution created by the expressway from entering the bordering neighbourhoods.

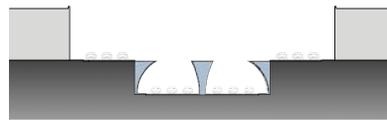


Section AA.

2. Phase "A1" - Adjustment of sunken infrastructure. Install noise barriers.

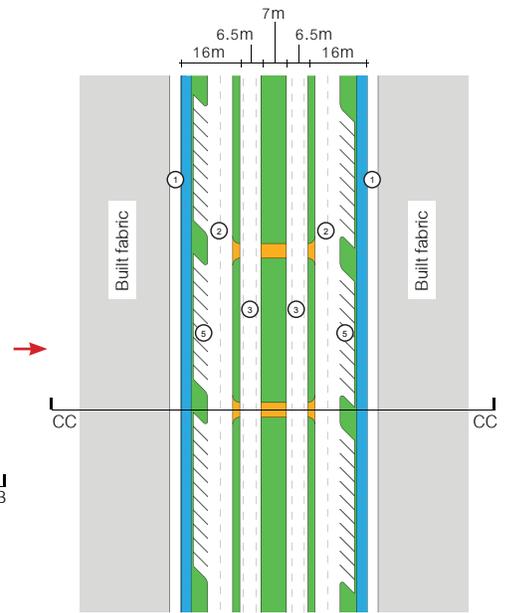


Noise barriers are cantilevered over the expressway to mitigate the environmental pollution while maintaining an abundance of natural light and air inside the trench. Consequently, new space is created at grade and used to incorporate the following:

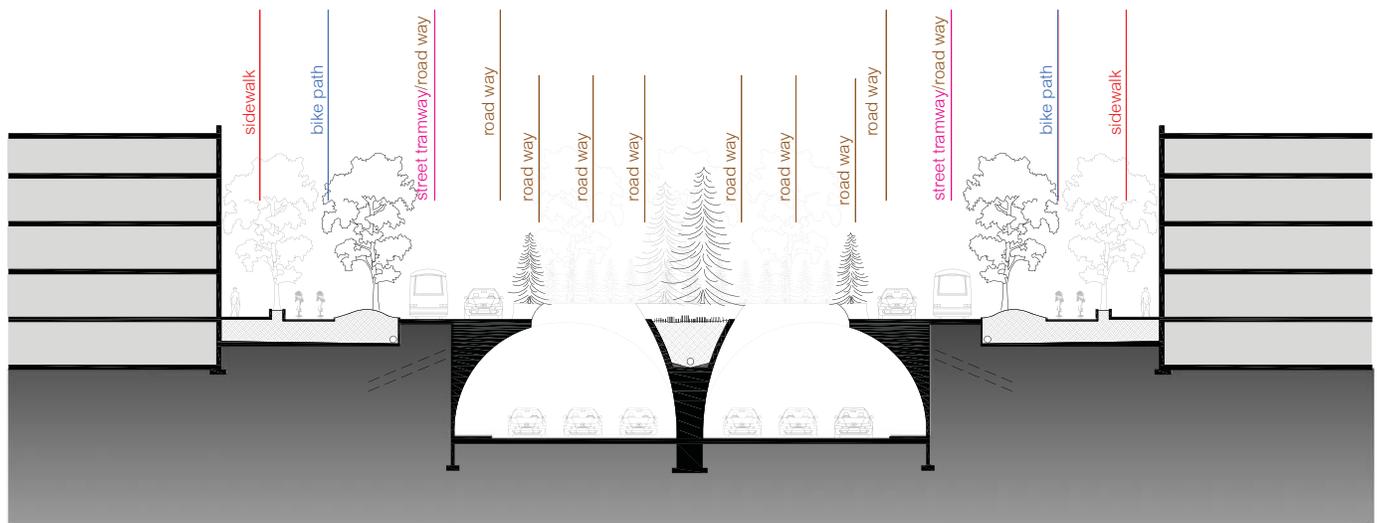


Section BB.

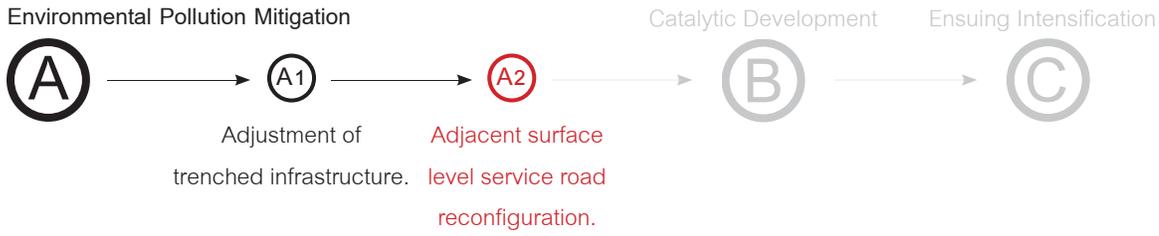
3. Phase "A2" - Adjacent surface level service road reconfiguration. Maximize newly created space.



- 1) Bike paths to encourage human powered transportation and create a safety buffer for pedestrians against road traffic.
- 2) Angled parking with porous pavement. Angled parking is more efficient than parallel parking and the porous pavement filters grey water runoff.
- 3) Unobstructed visual connective strips visually connect the adjacent neighbourhoods.
- 4) Copious amounts of vegetation aides in the economic success of the area and purifies the air and water.



Section CC.

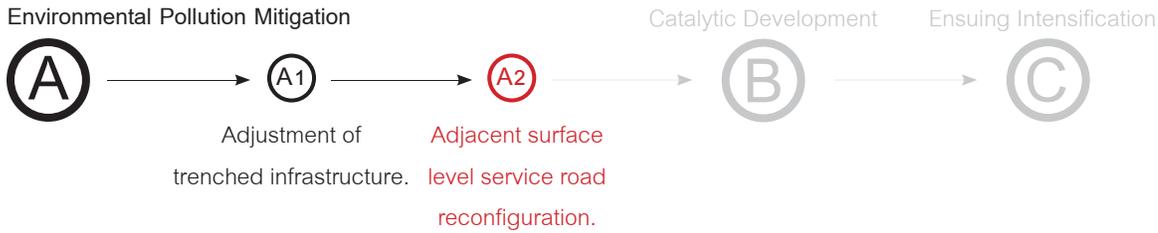


The varying transportation modes within the expressway corridor are organised in a specific hierarchy from fast moving traffic to slow. Large mature trees, curbed edges and bollards separate the varying modes of transportation, increasing the overall safety of the area.

The wood benches around the mature trees act as caps for the trunks and the protruding roots while the below ground tree roots are allowed to spread naturally underneath the new sidewalk, thus encouraging the trees to reach full maturity and increase their effectiveness at reducing noise, light, water and air pollution.



Typical new sidewalk view. Image by author.



The reconfigured surface level service roads create numerous landscaping opportunities which generates interesting views, fosters a healthy environment and makes the area more attractive to look at. Tree lined roads also help increase the economic success of the area.⁷

The new configuration of the surface level service roads visually narrows the horizon, de-emphasizing the road in the urban landscape, and focuses the viewer's attention on the surrounding landscaping and architecture.

Coniferous trees line the edges of the expressway and provide year-long protection against noise, light and air pollution.

Deciduous trees are planted near the built fabric to take advantage of the heating and cooling gains that occur naturally when they lose and grow their leaves.

7 Ville de Montréal. (2005). *Politique de l'arbre de Montréal*. Montréal: Ville de Montréal.



Typical new street view. Image by author.

Environmental Pollution Mitigation

Catalytic Development

Ensuing Intensification



Coniferous trees line the edges of the trench. They provide year-long shelter from noise, air and light pollution.

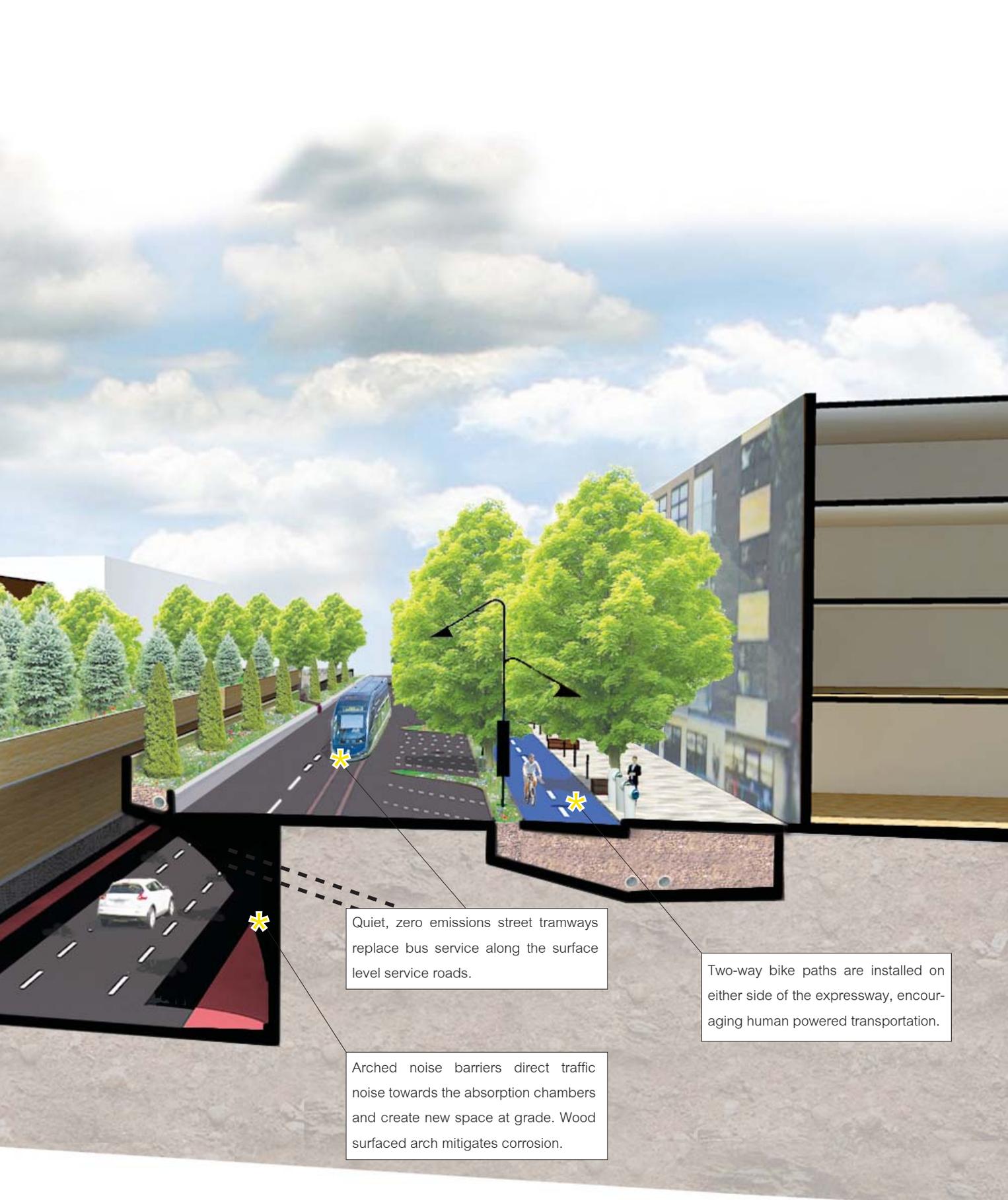
Noise absorption chambers are placed as close as possible to the major sources of noise; the motor vehicles' tires and engines.⁸

The central median provides support for bi-owale integration (an effective water remediation strategy) and can be reinforced to act as a main structural element for future development over the expressway.⁹ Filtered grey water is recuperated through a series of interconnected drainage tubes.

Typical new overall expressway section. Image by author.

8 Ahammed, M. A., & Tighe, S. L. (2009). Understanding Pavement Noise: A Pavement Designer's Primer. Downsview: Ministry of Transportation Ontario.

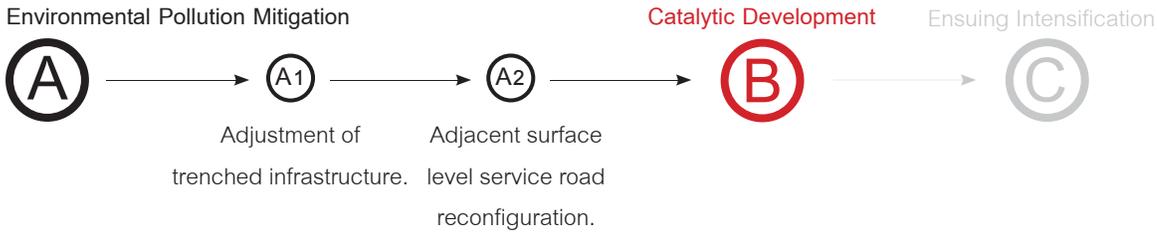
9 Davis, A. P., Shokouhian, M., Sharma, H., & Minami, C. (2001). Laboratory Study of Biological Retention for Urban Stormwater Management. Water Environment Research, 73(1), 5-14.



Quiet, zero emissions street tramways replace bus service along the surface level service roads.

Two-way bike paths are installed on either side of the expressway, encouraging human powered transportation.

Arched noise barriers direct traffic noise towards the absorption chambers and create new space at grade. Wood surfaced arch mitigates corrosion.



PHASE "B" - CATALYTIC DEVELOPMENT

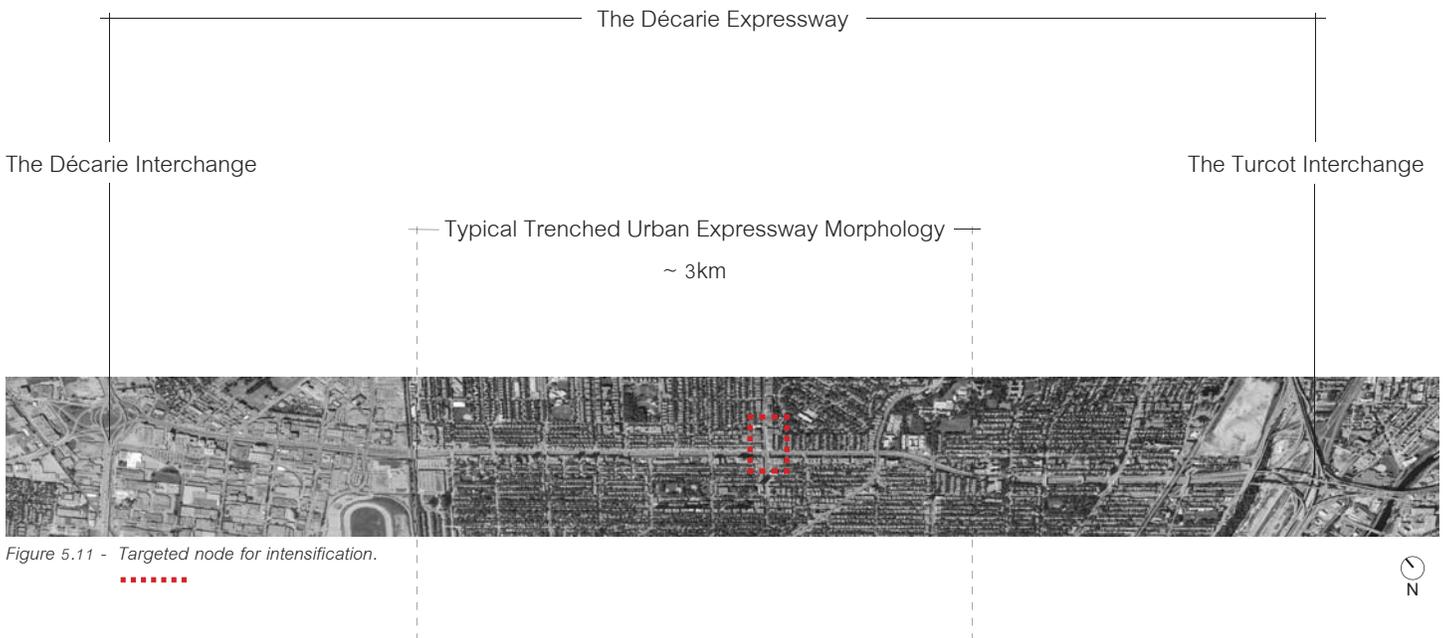
Phase "B" represents the catalytic mixed-use development at the intersection of Queen Mary Rd. and the existing Décarie Expressway.

The new development is intended to replace the derelict surrounding urban fabric with a new healthy and attractive vision for the important transit node.

The major goals of the new development are [1] to encourage public transportation (which would reduce congestion along the expressway), [2] reduce the amount of pollution in the area and [3] to entice people to live in the city by providing attractive dwelling spaces (which would increase property tax revenue for the city of Montreal and reduce urban sprawl saving money on infrastructure/ services costs).

This type of massive development would necessitate the participation of provincial and local governments in order to approve the construction over the expressway. Additionally, public consultation would be important to hold in order to get the public's approval.

In order to finance the project, private developers would build the buildings and would receive subsidies from the government to offset the extra cost of building over the expressway. It would be in the government's best interest to help out the developers because the new development would make the city more competitive and reduce its ecological footprint thus saving the government money.





Derelict streetface.

Building does not engage with street corner and the wide sidewalk is roped off and reserved for parking.

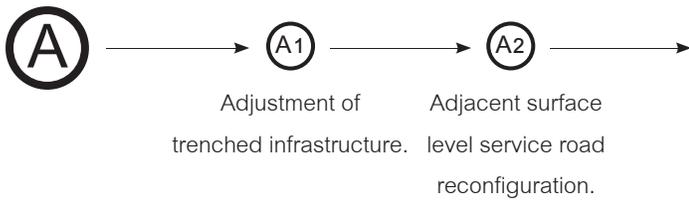
Discontinuous streetface encourages vandalism and provides views of garbage and back-of-houses.

Narrow sidewalks along street corner.

Dead-end street with unattractive streetface.

Typical site conditions. Image by author, base images by Bing maps and Google street view.

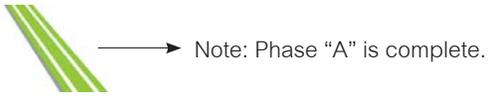
Environmental Pollution Mitigation



Catalytic Development

Ensuing Intensification

PHASE "B" DESIGN DEVELOPMENT DIAGRAM



1 Demolition

Presently, the intersection is rife with narrow sidewalks, vacant lots and old buildings. Some buildings do not face the street as they were leftover consequences from the Décarie's demolition phase. Back alleys and dead end streets attract vandals and create unpleasant views of garbage and back-of-houses.

The proposed demolition (in grey and brown) removes the built fabric that causes these issues.

2 Underground Parking Facilities

Sheltered from the weather, underground parking lots support local residents, visitors and commercial establishments in the area. They also encourage commuters to park their car and enter the city's public transportation network.

The four parking facilities can be accessed along the streets at grade, by the metro station, by the residential and commercial buildings within the development and directly along the expressway itself. The link between the parking garages and the expressway itself allows people to drive directly onto the expressway reducing traffic on the smaller local roads.

Large skylights bring natural light into each parking garage floor.

3 Land is Consolidated

The concrete arched noise barriers installed during Phase "A" are reinforced and provide support for a portion of the Décarie to be decked over, thus creating new land to be developed upon, increasing property tax revenue for the city.



Figure 5.12 - Redundant buildings, Back alleys and dead end streets are removed



Figure 5.13 - Underground parking facilities.



Figure 5.14 - Land is consolidated.



Figure 5.15 - Extrude building volumes to surrounding context.

4 Extrude Building Volumes to Surrounding Context

A mixed-use development is envisioned as the building morphology best suited to intensify life (work and play) around the transit node.

Building volumes are extruded to the height of the surrounding context. They are generously setback from the street, creating wide sidewalks and encouraging pedestrianism. They also frame and complete the street face.

— A new metro entrance is built to connect to the new development with the public transportation network.

Public courtyards, accessible from the street, are incorporated into most of the land parcels to provide a car free zone that shelters people from noise/air pollution, increases dramatically the commercial frontage and provides open gathering spaces for the public.



Figure 5.16 - Extrude residential towers.

5 Extrude Residential Towers

Residential towers are extruded to increase urban dwellings around the transit node thus encouraging people to live on the island and use public transportation, which ultimately reduces traffic congestion on the Décarie.

The towers are oriented to maximize solar heat gain and to limit the amount of shadow cast onto neighbouring buildings.

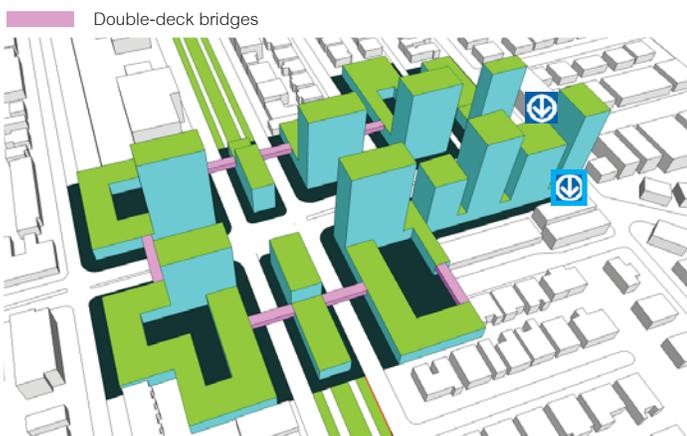


Figure 5.17 - Recreational path.

6 Recreational Path Connects Developments

The new developments are connected via double-deck bridges, which provide a direct link to the metro station. The lower decks are closed and sheltered from the weather. The upper decks are open to the air and connect the rooftops creating a new public park directly accessible from the street and from the residential towers.

This new beautifully landscaped park can be used by the public as a place for gatherings, walks, cross-country skiing, urban farming, etc.

Environmental Pollution Mitigation

Catalytic Development

Ensuing Intensification



Adjustment of
trenched infrastructure.

Adjacent surface
level service road
reconfiguration.



Site plan. Image by author, base image by Google maps.

SITE PLAN



0 100 300m

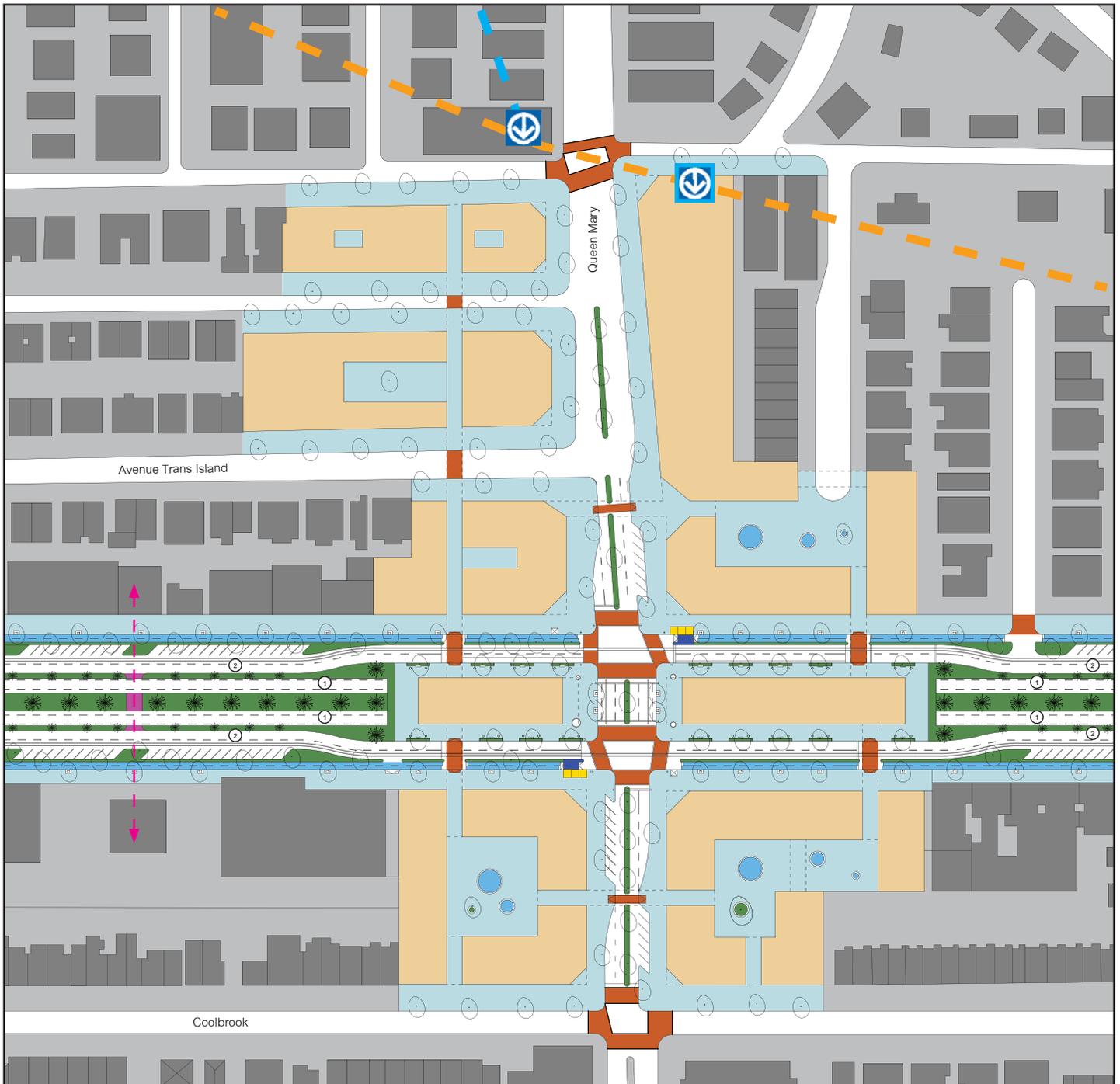
LEGEND

- New buildings
- Crosswalks
- Bike path
- Landscaping
- Water features
- Décarie Expressway
- Surface level service roads
- Deciduous trees
- Coniferous trees
- Street tramway stop
- Parking garage access
- elevator
- Visually unobstructed connective corridors
- Metro lines
- New metro station entrance

The plan at street level is organized to offer pedestrians many ways to move around the site encouraging community connections.

The recreation path's bridges shelter the crosswalks below.

The building volumes are cut on street corners and the buildings cantilever over to provide a semi-sheltered pedestrian buffer zone.



Plan at street level. Image by author, data from Google maps.

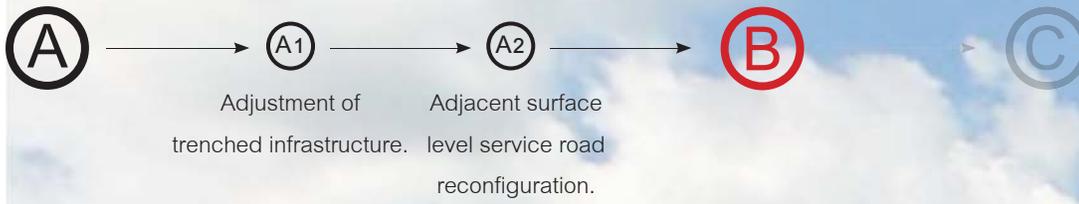
PLAN AT STREET LEVEL



Environmental Pollution Mitigation

Catalytic Development

Ensuing Intensification



Adjustment of
trenched infrastructure.

Adjacent surface
level service road
reconfiguration.

A recreation path unites the development's rooftops, creating a car-free amenity. Urban farming, exercise, dog walking and kids learning how to ride bikes are a few of the envisioned uses of the new space.



Underground parking provides an amenity for the local residents and for the nearby commercial establishments. It also encourages commuters to park their cars and enter the public transportation system.

The parking facilities are directly connected to the New Décarie Expressway via a dedicated tunnel, reducing the traffic along the surface level service roads.

Skylights bring natural light into the New Décarie Expressway during the day and create interesting lighting effects at street level at night as the light from the passing cars below shines through.

Overall section of the proposed Queen Mary Rd. and Décarie Expressway building development. Image by author.



The Development extends itself to Snowdon Metro Station by a series of linking climate controlled pathways, which shelters people from Montreal's often harsh weather. The direct link from the development to the major metro station, ultimately, encourages public transit use.

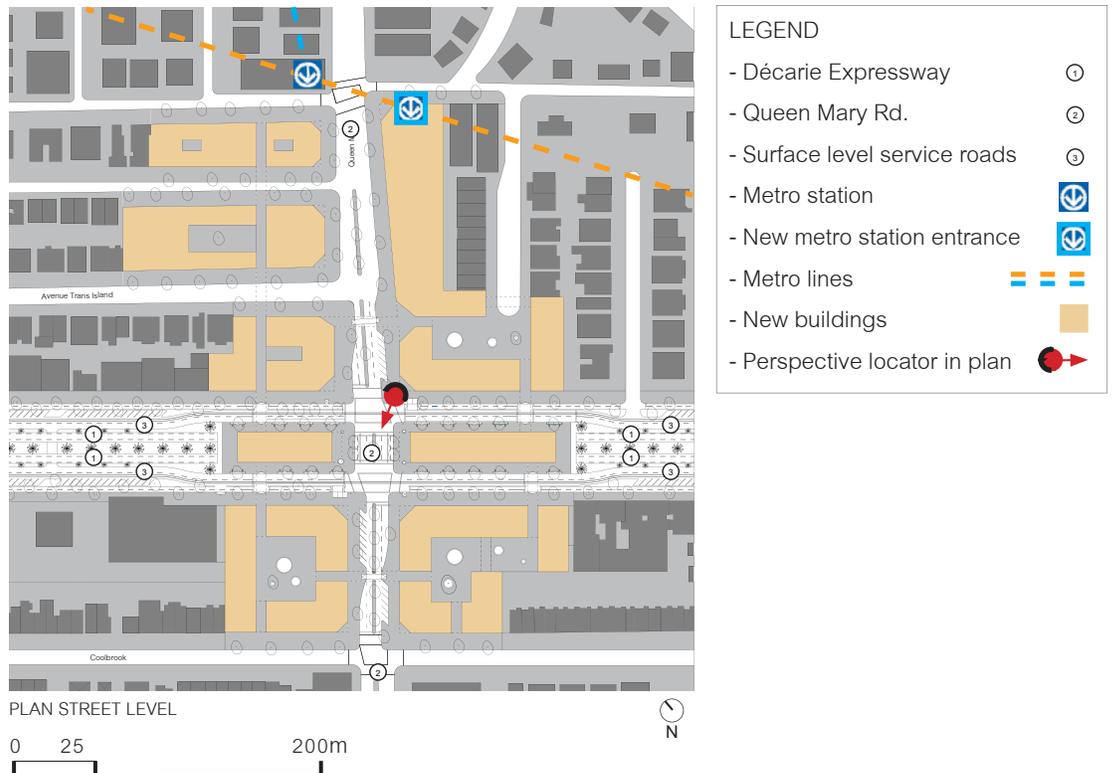
Environmental Pollution Mitigation

Catalytic Development

Ensuing Intensification



The intersection traffic lights are designed to reduce visual clutter by performing many functions such: support for signage, traffic signalling and garbage disposal. Partially powered by solar panels they possess a minimalist character within the streetscape.





Typical Queen Mary Rd. and Décarie Boulevard intersection. Image by author.

Environmental Pollution Mitigation

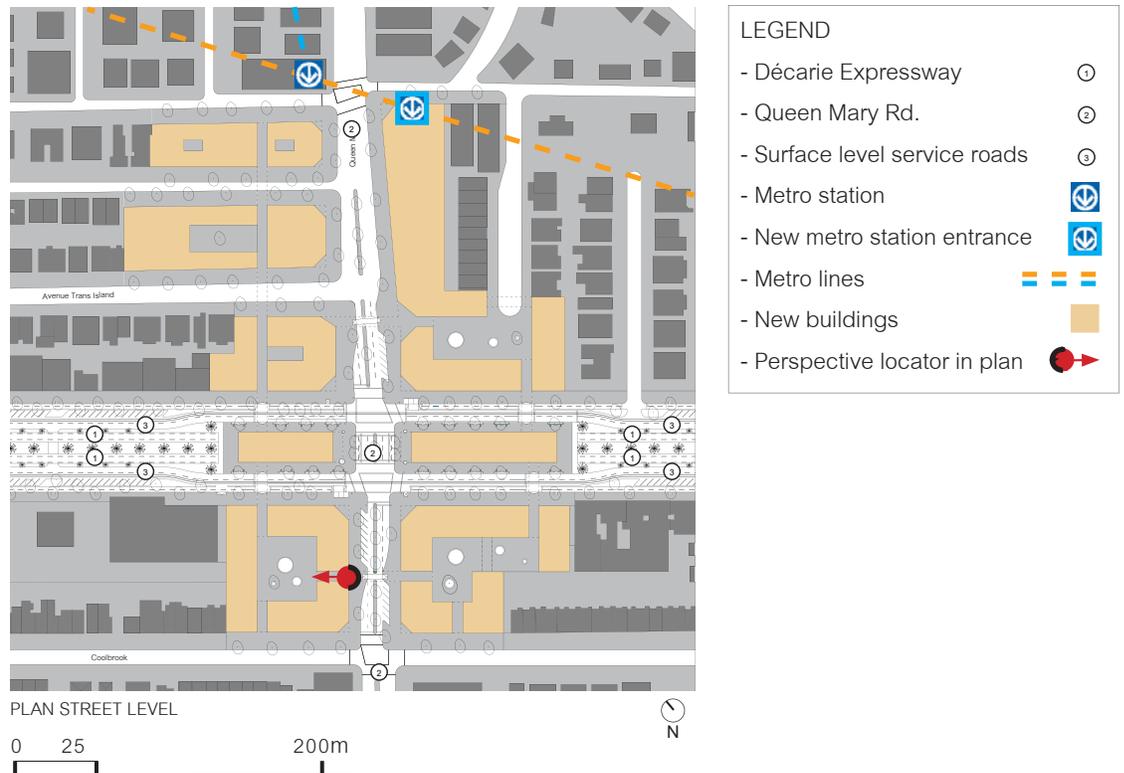
Catalytic Development

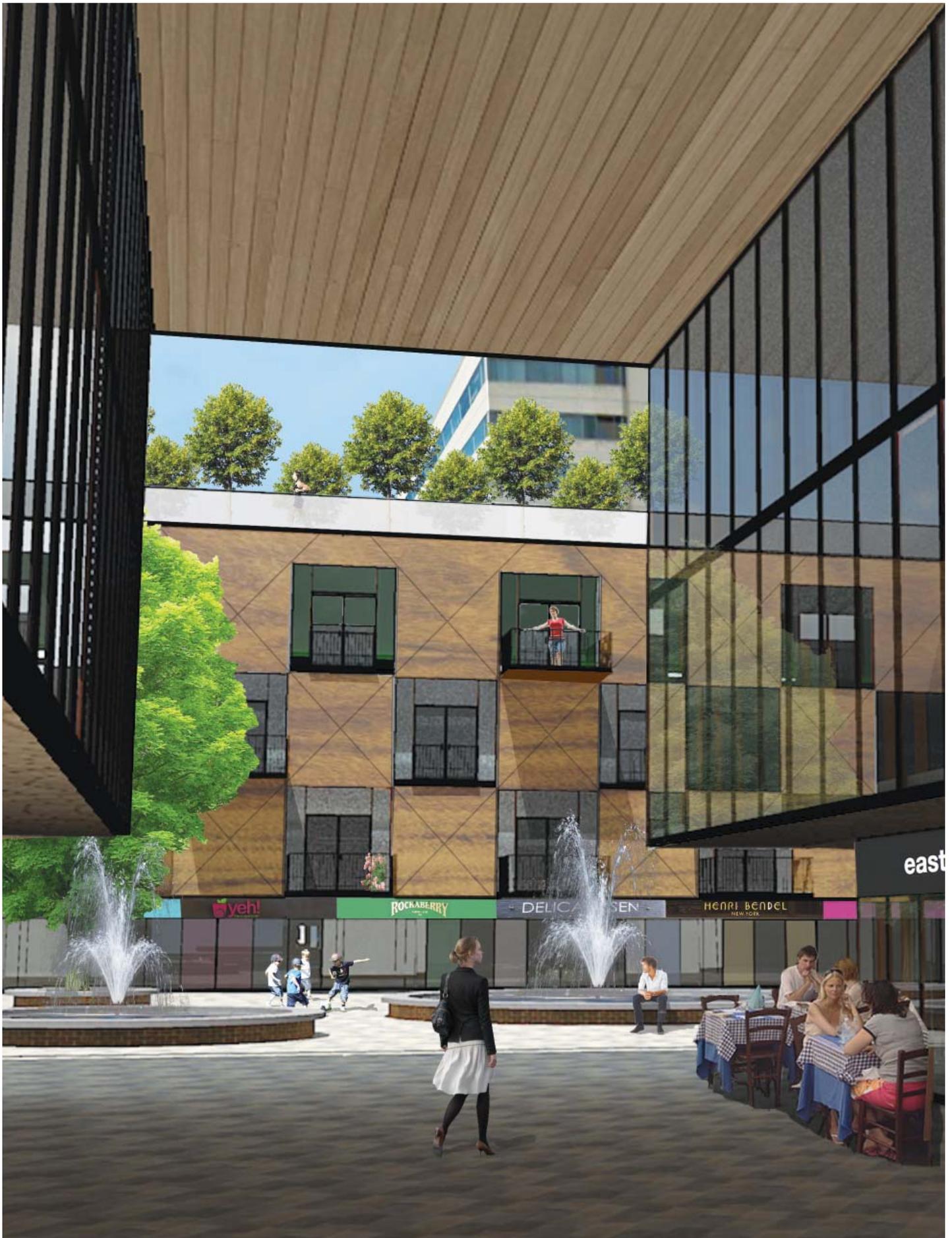
Ensuing Intensification



Courtyard developments create a car-free open space for people to enjoy.

Typologically they increase the commercial frontage and the building mass shelters residents from noise, air and light pollution originating from the roads beyond.





Typical courtyard. Image by author.

Environmental Pollution Mitigation

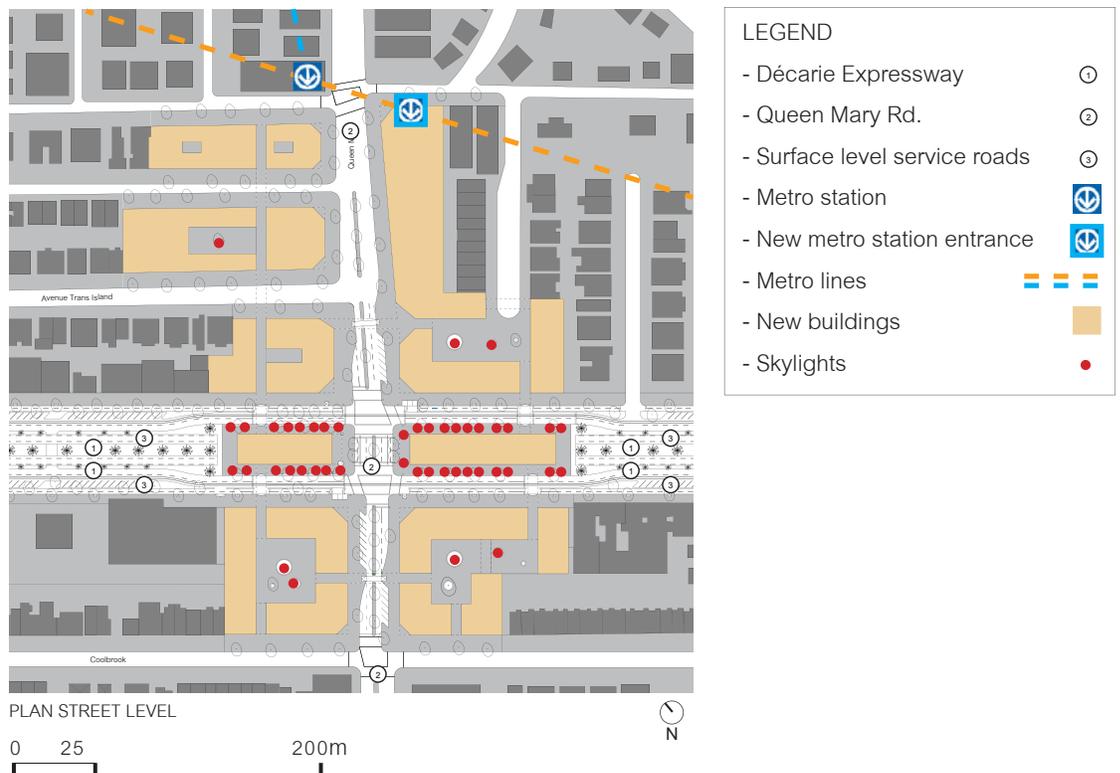
Catalytic Development

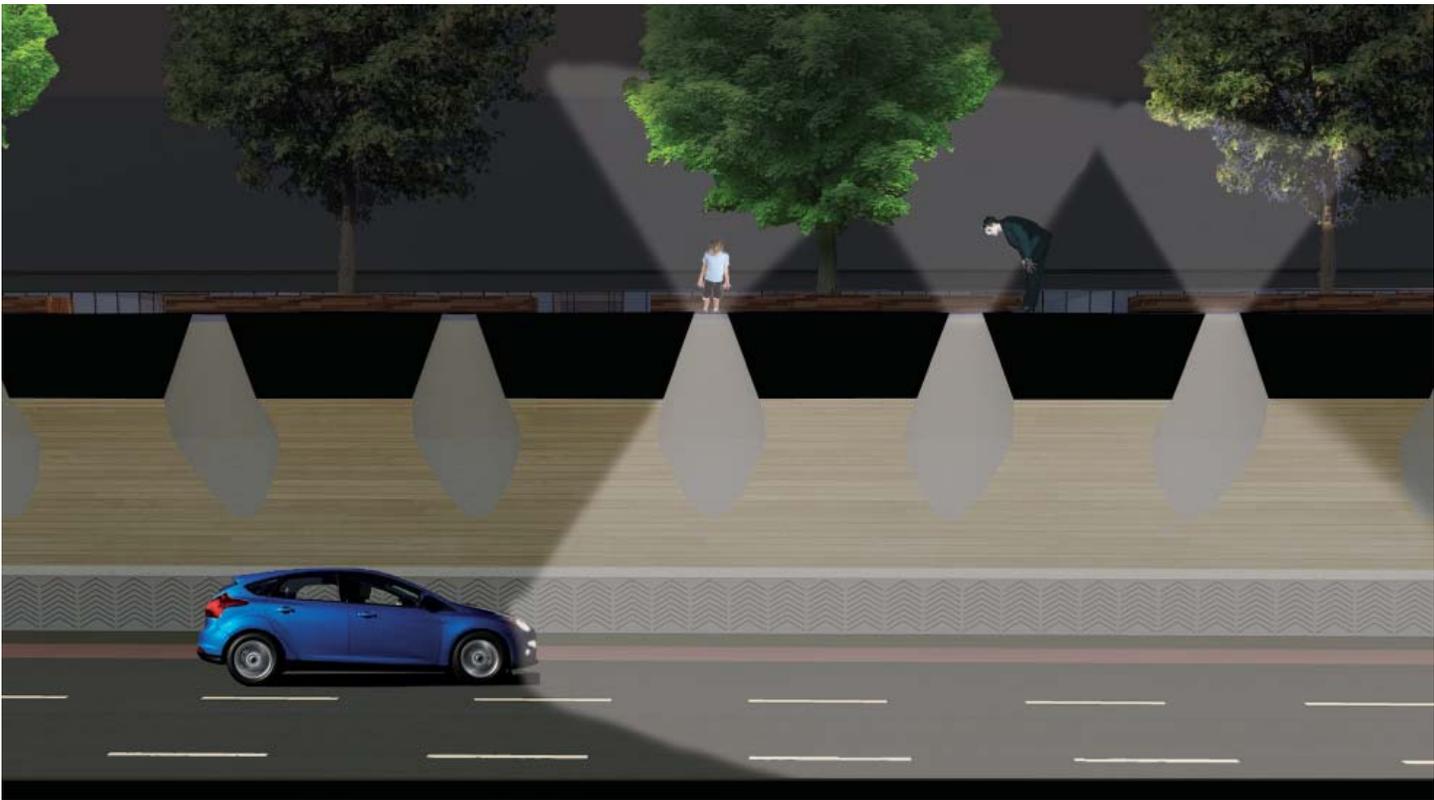
Ensuing Intensification



Skylights installed in the decked portion of the development bring natural light into the tunnel created below. At night, the passing motor vehicles create dynamic lighting effects as their headlights shine through.

The water features located in the development's courtyards double as skylights that bring natural light into all levels of the underground parking garages.





Typical section of expressway skylights. Image by author.

Environmental Pollution Mitigation

Catalytic Development

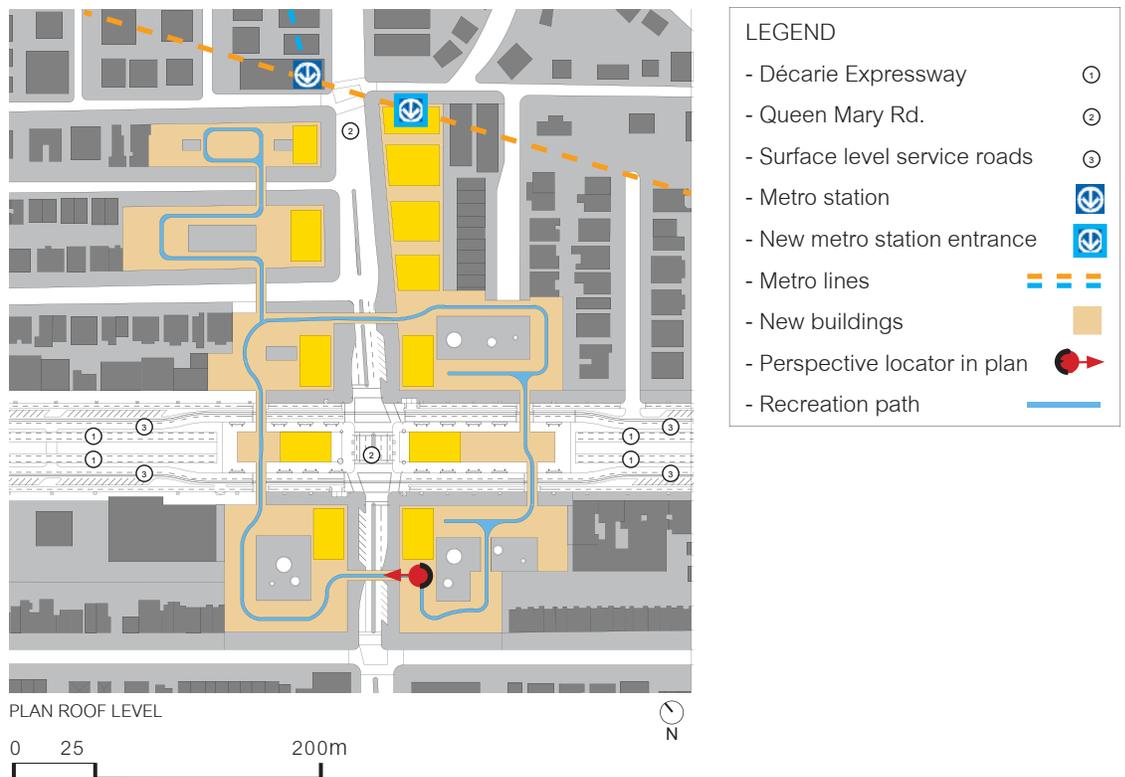
Ensuing Intensification



A recreation path is created on the development's rooftops by bridging over the expressway and surrounding roads, physically connecting the once bisected neighbourhoods.

The space can be used for exercise, urban farming, dog-walking, etc. It can be accessed from the street and from the residential units.

This physical connection affects the psyche of the area's users as they see that trenched urban expressways can be places of interest and that community and healthy living are values that are able to flourish even in the most urban of environments.





Typical recreation path. Image by author.

CONCLUSION

The New Décarie Expressway challenges the traditional vision of trenched urban expressway (TUE) design and explores ways to render them more productive, healthy and attractive places to be in. Travelling around North American cities one can see that this discourse has already begun and that many cities are opting for the revitalization of these spaces. Most people are realizing that our future now lies in the quality of our urban spaces due to the growing world population and strain on the planet's resources. Given the massive amount of space that these infrastructures take up in our urban environments, the issues surrounding their sensitive integration become vastly complex and have a profound effect on cities worldwide, moreover on architecture as a whole. Community health, walkability, effective/productive transportation and the quality of urban life in general are at the heart of modern day mobility infrastructure dialogue and thus it has made these types of spaces quite relevant in the professional discourse.

More now than ever, architects are getting involved in the design of these types of spaces and rightfully so. The amount of people that pass through TUEs daily render them extremely important public spaces within the city. The design of the New Décarie Expressway has tried to view the existing TUE as such and has utilized the bank of knowledge gained from the previous sections to explore an achievable vision for the future. A broad base of knowledge gained by exploring the background and problems of typical trenched urban expressways, the study of several contemporary projects that investigated solutions for the successful integration of TUEs and by the discussion of current urban design principles surrounding the future of urban living has infused the proposal with an intelligible comprehension of the issues at hand.

The problems auto-centric planning has created have far reaching economic and health consequences for the city. Air/noise/light pollution, flooding, discontinuous urban fabric and environmental destruction all add up to multi-billion dollars in health and maintenance costs.

Several case studies have been presented that explore the varying architectural interventions architects are implementing across the planet to solve these problems. Layered infrastructure, full capping/phased capping and sensitive residential integration were the varying approaches explored in the study. The projects were chosen to represent the most common solutions the profession is taking towards reconciling trenched urban vehicular infrastructure with the city.

In combination with the lessons learned from the case

studies, three major urban design principles were established to provide a framework with which to rely upon while designing the New Décarie Expressway namely: enhancing public transportation, intensifying transit nodes and sensitive residential integration. The three principles share a common goal and that is to try to achieve a holistic urban way of life, where a healthy, attractive and economically thriving urban community can co-exist adjacent to a trenched urban vehicular thoroughfare.

Enhancing public transportation reduces the amount of motor vehicles on the road. Ultimately, it reduces traffic congestion and all the negative effects it produces. Public transportation not only reduces traffic congestion but it has been proven to improve the health of its users and the economy of the city.^{1,2}

Intensifying transit nodes with mixed-use developments further enhances the public transportation network as it increases the likelihood of its use. It also entices people to live in the city and consequently reduces the economic, environmental and health costs of urban sprawl.²

A sensitive approach to the overall integration of trenched urban vehicular expressways into residential neighbourhoods ties the first two principles together and puts the focus on human desires and needs. Pedestrianism, physical connection and community building in combination with context sensitive architecture transforms these undesirable spaces into productive and attractive urban landscapes.

The design of the New Décarie Expressway drew from the bank of knowledge gained and delivered a vision of what the Décarie Expressway can become. It adapted and implemented improved versions of many of the strategies explored in the case studies and relied on the design principles as guides to achieve a cohesive project.

Air, noise and light pollution have been largely eliminated thanks to an artificial lighting strategy integrated within landscaped arched concrete noise barriers. Visual connective strips allow the unobstructed visual connection between both sides. Increased pedestrianism and human powered mobility options reduce the amount of motor vehicles on the roadways. The reconfiguration of the surface level service roads increases pedestrians safety by creating landscaped buffer zones. Pollution sheltered residential developments and a commercial ground plane support urban life. Skylights, courtyard developments and careful massing maximize natural light and solar exposure. Finally, an extensive landscaping strategy optimizes the power of vegetation to purify the air and water while beautifying the streetscape.

Many stakeholders are envisioned to be involved in the project, ranging from all levels of government to local residents. Like the precedents previously analysed, the New Décarie Expressway is foreseen to be commissioned by the government. They are the only ones with the political and financial power to materialize such a large development. Then, once commissioned, the project is subdivided into smaller lots that can be bought up by developers.

A general outline with a series of pertinent renderings of the new Décarie Expressway was put forward as a preliminary study into the potential of the Décarie Expressway but public consultations, feasibility studies, development studies, infrastructural impact studies etc. are all required to move the project forward. An attempt to touch on every aspect of the project was made but further development is necessary. Three major issues are targeted for further analysis.

The first is the economic feasibility of such a proposal. I have given this issue much thought, and I believe the increased revenue and the health benefits that would materialize from the proposed interventions should outweigh the final cost of the project. Furthermore, given the advancements of electronic tolling technology and, if for example, users of the expressway were charged 1\$ per use, the amount of revenue generated could total 278 000\$/day.³ This would add up quickly and could pay for the construction costs.

Secondly, additional form and material testing is needed to maximize the effectiveness of the noise barriers. Basic physics and some research into appropriate materials has been implemented in the proposed design but, in order to maximize the benefits of the design intervention, scaled tests and consultation with acoustic professionals, among other types of consultants, should be considered.

Finally, a construction strategy has been suggested but again the complexity of the project would require a much more in depth analysis of the issues in order to safely and efficiently erect the noise barriers and the developments that bridge over the expressway so that the interruption of the expressway's function is limited.

Reconciling trenched urban vehicular infrastructures with the city is a challenging task for architects but one that is increasingly needed in today's growing cities. The amount of urban fabric these infrastructures negatively affect put them at the forefront of urban spaces that require attention. More productive and sensitive visions of these types of infrastructures are important for the future development of our cities.

The future is bright for these massive infrastructures. They have enormous potential to be vibrant, healthy and productive armatures in the city, to become treasured spaces within the urban fabric and improve the quality of life of everyone they touch. The new vision for the Décarie Expressway ultimately argues for the implementation of such architecture.

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