Department of Architectural Sciences

Evaluation of Critical Factors from Residential Adaptive Reuse Projects Within the context of Toronto, Ontario

By

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Abstract

Adaptive Reuse is a growing phenomenon embraced by cities as one of the low carbon strategies in their climate change agenda which shifted the focus from new construction to existing buildings. The research study is based upon cross-case analysis of four case study buildings selected from the inventory of conversion projects located within the context of Toronto. Analysis of the archived project documentations and unstructured interview with the involved architects were performed to identify key criteria and design strategies adopted for residential conversion. The key findings revealed that although the housing functions could be accomodated easily within the converted buildings; both interior and exterior aspects were demolished for residential configuration within both heritage and non-heritage adaptive reuse projects. The architects felt that such demolitions were necessitated due to lack of flexibility within its interiors; provisions for daylighting and thermal comfort; code compliances for fire and acoustic separations. Furthermore, findings from the current building regulations revealed a necessity for a separate policy tool due to lack of clarity for residential conversion within Toronto.

Key words: adaptive reuse; building conversion; code compliances

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List of Acronyms

CMHC	Canadian Mortgage and Housing Corporation
EIFS	Exterior Insulation and Finish System
GHG	Greenhouse Gas
LCA	Life cycle assessment
NBC	National Building Code
NRCAN	Natural Research Council of Canada
OBC	Ontario Building Code
OHC	Ontario Housing Corporation
POE	Post-Occupancy Evaluation
SHGC	Solar Heat Gain Coefficient
TGS	Toronto Green Standard

Chapter 1: Introduction

1.1 Setting the context: Toronto

Since buildings accounts for more than 50% of greenhouse gas (GHG) emissions, there are widespread concerns about the environmental impacts of existing buildings in the city. Therefore, Toronto City Council adopted climate change strategies[1] to address energy efficiency and resource conservation (Toronto Atmospheric Fund, 2013).

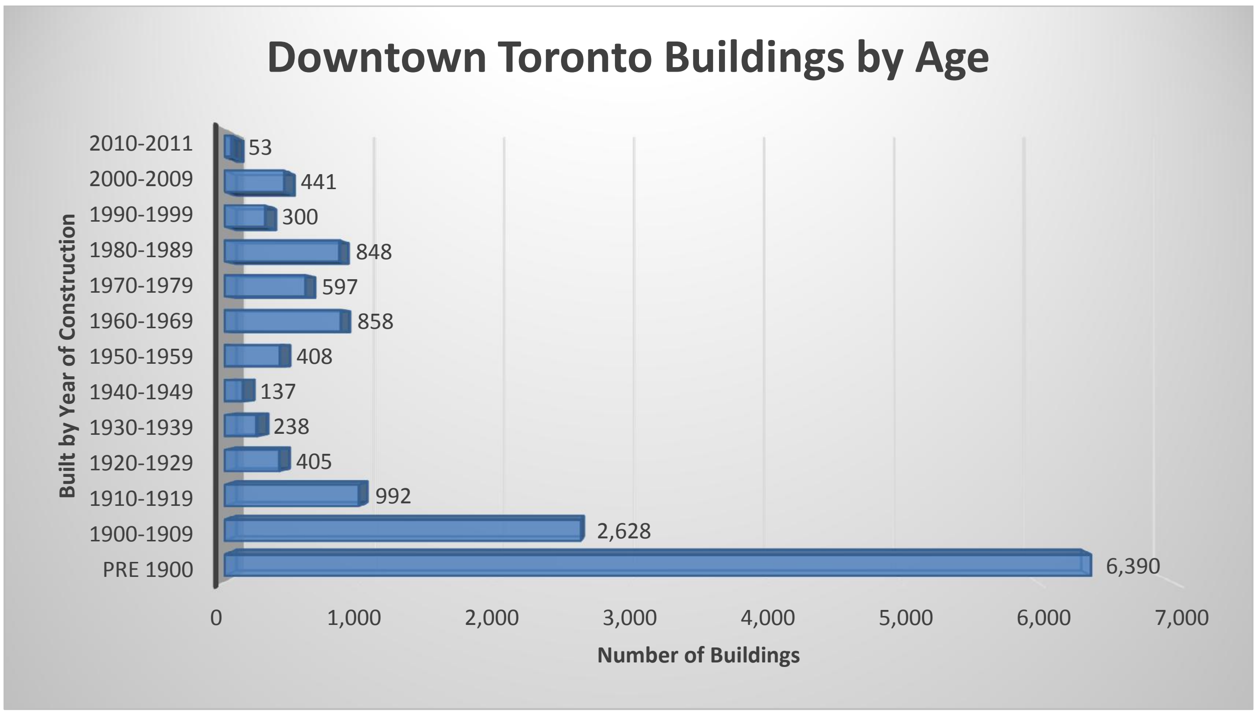

Figure 1 Existing buildings in Downtown Toronto (Toronto City Planning, 2013)

A recent survey by Toronto City Planning revealed that more than 75 percent of downtown Toronto's built environment are more than hundred years old (Figure 1). Most

[1] Climate Change Agenda undertaken to target Toronto as a low carbon city with 80 percent reduction in greenhouse gas emissions by 2050 with the mitigation goals to reduce emissions, improve air quality and reduce energy costs and adaptation goals to minimize negative impacts of climate change (Toronto Environment Office, 2008)

of the existing buildings in downtown Toronto were constructed much before building codes, standards and energy performance measures came into existence (National Research Council Canada, 2012). Since 1834, the existing built environment in downtown Toronto experienced significant changes in form, fabric and function first due to industrialization, then suburbanization and lastly revitalization in the early 1990s (CMHC, 1996) (Toronto, 2014). As a result, some vacant industrial buildings were converted to different uses, but mostly to high-end office space or residential lofts.

In some cases, additional floors were added atop the existing structure by developers, taking advantage of this opportunity to increase density requirements as per current zoning laws (Shipley, Utz, & Parsons, 2006). An interesting example of this is a new mixed-use development of incorporating the addition of seven floors of upmarket residential units atop fourteen floors of an existing 1960's office building, further built atop existing retail shops at 130 Bloor Street in Toronto (Quadrangle Architects, 2012).

1.2 Problem statement

As Brand (1997) said that all buildings were built only for one purpose, it is evident that some buildings do not adapt well to ever changing scenarios as the original architects and engineers had not even considered various future possibilities during the initial design stages for buildings. In either way, it often resulted in demolition in part or whole of the building and then replacement, which are major contributors to environmental stress and landfill. Kincaid (2002) argued that building conversion can be an alternative to demolition and new construction, but it still does not determine any particular occupancy for any particular building. Even though recycling existing building stock can provide environmental benefits and embodied energy savings, the problem is that not every existing building is a good candidate for adaptive reuse (Rabun & Kelso, 2009) (Wilson, 2010) (Burton, 2013). Due to more focus on new construction than existing buildings, it is often found that building conversion is not taking place on a large scale. The reason could be due to limited knowledge on building conversion. Hence there is a need to analyze the adaptive reuse potential within the existing buildings.

1.3 Research Questions

Therefore, the research study seeks to answer the following questions:

- Using several case studies, which key factors (both direct and indirect) of the existing building played a significant role for residential conversions; spatial and technical capabilities and their limitations?
- How are code compliances and energy conservation measures addressed within the converted building due to change of occupancy?

1.4 Research Output

The research findings from this study can have important implications for interested developers to initiate any residential adaptive reuse project. Furthermore, it could offer valuable insights to the architects on the decision-making factors that played a significant role in residential project outcomes, thus avoiding any major demolitions. By addressing such issues, it is also intended to provide the policy makers sustainable recommendations to redevelop existing built-up areas and enhance adaptive reuse process within the municipalities so that negative environmental impacts are minimized and reduced construction waste towards landfill.

Chapter 2: Literature Review

A review of pertinent literature was undertaken in two sections before and after in-depth analysis of the case studies. This was done due to a need to interpret common variables from the case studies such as building parameters, code compliances and associated construction technology.

- The first section focussed on academic research published through government papers to scholarly publications. The goal of this was to understand the process of building conversion, critical factors, technical issues and energy conservation measures employed within its existing infrastructure during building conversion/change of occupancy
- The second section analyzed current building regulations for code compliances adopted during residential conversion within the context of Toronto in Ontario
- Lastly, it concludes with an overall summary of the two parts of literature review along with the principles of adaptive reuse

2.1 Section I: Adaptive Reuse Scenario:

This first section presents an overview of several theories based on the field of adaptive reuse interpreted differently through several perspectives of researchers, planners, architects and policy makers within several disciplines of preservation, sustainability, economy and planning for the built environment.

In generic terms, the process of altering any building is often defined as "adaptive[2] reuse", thus accommodates new functional requirements within its existing structure,

[2] Derived from Latin words: *ad* (to) *apt* (to fit) (Douglas, Building Adaptation, 2006)

thereby extends its useful life and reduces its carbon footprint. Different interpretations for “adaptive reuse” are often known as retrofitting, conversion, adaptation, rehabilitation, refurbishment, etc (Brand, 1997) (Langston, 2011) (Douglas, 2006). Several design strategies were employed in converting buildings such as building within (connection between spaces), building over (additions or extensions), building around, building adjacent, etc (Douglas, 2006).

Douglas (2006) and Bullen (2007) explained the difference between adaptation and adaptive reuse is that adaptation does not necessarily involve any change in use or function, instead it is viewed as refurbishment with upgrades to its energy performance.

Traditionally, this preservation strategy for conservation of cultural heritage was often used for recycling structurally-sound historic structures across Canada to economically new uses as a cost-effective maintenance method to avoid disrepair and decay; also to prevent demolition (Cantell, 2005) (Langston, 2011). Examples are Evergreen Brick Works, originally brick-making industry converted to an educational campus, Distillery District (formerly manufacturing block) converted to an entertainment centre, etc.

Comparison studies analyzed the environmental impacts associated with building reuse and new construction with life cycle assessment tool[3] (LCA) over a 75-year life span in six different building typologies shown in Figure 2. The outcome findings revealed that it would take approximately 10 to 80 years for new energy efficient buildings to overcome

[3] LCA is a framework tool to assess any product or service in terms of direct and indirect environmental impacts associated with inputs and outputs throughout its life cycle (Preservation Green Lab, 2012)

the carbon-related impacts due to construction, which obviously refers to embodied energy, operational energy and its demolition.

Building Type	Chicago	Portland
Urban Village Mixed Use	42 years	80 years
Single-Family Residential	38 years	50 years
Commercial Office	25 years	42 years
Warehouse-to-Office Conversion	12 years	19 years
Multifamily Residential	16 years	20 years
Elementary School	10 years	16 years
Warehouse-to-Residential Conversion*	Never	Never

Figure 2: Comparison of Carbon-related impacts (year equivalency)[4] for New Construction Versus Existing Building Reuse (Preservation Green Lab, 2012)

Furthermore, the large gap between 10 and 80 years could be attributed to different building typologies based on its locality and climatic zone as presented in Figure 2. But for warehouse to residential conversion[5], it did not show any significant environmental savings because of quantity and quality of construction materials (Preservation Green Lab, 2012). Other comparison studies of life cycle energy analysis on three case study scenarios of renovating, reusing and replacing an historic building demonstrated how

[4] Year equivalency refers to the number of years for a new building 30% more energy efficient than existing building to recover the carbon-related impacts related to the construction process; in other words net carbon emissions savings for the replacement building would begin only after the specified number of years as shown in Figure 2 (Preservation Green Lab, 2012).

[5] Refer to Appendix "A" for specific details on building typologies and comparison of warehouse to residential conversion (Preservation Green Lab, 2012)

the reused building with 70 percent of its embodied energy along with improved energy standards (operating) resulted in 34.2 years in total life cycle energy savings, 53.3 years for renovated building (30% energy efficiency standards) and 57 years for the partially demolished building. The determining factor was attributed to the historic building's (embodied energy) large volumes of durable building materials (Jackson, 2005).

The above findings conclude that building layout, quantity and type of building materials benefit building reuse. Furthermore, environmental impacts can be reduced more by reusing existing buildings with less material input along with energy efficiency upgrades.

2.1.1 Evolution of the Built Environment:

This part of literature review explored several articles on what makes any green building truly sustainable and to clear up the misconception about energy efficiency and sustainability in relation to the green building industry. Literature studies clarified that energy efficiency is often related to economic savings and reductions of energy consumption whereas sustainability is often related to lower environmental impacts associated with GHG (Eldemery, 2014).

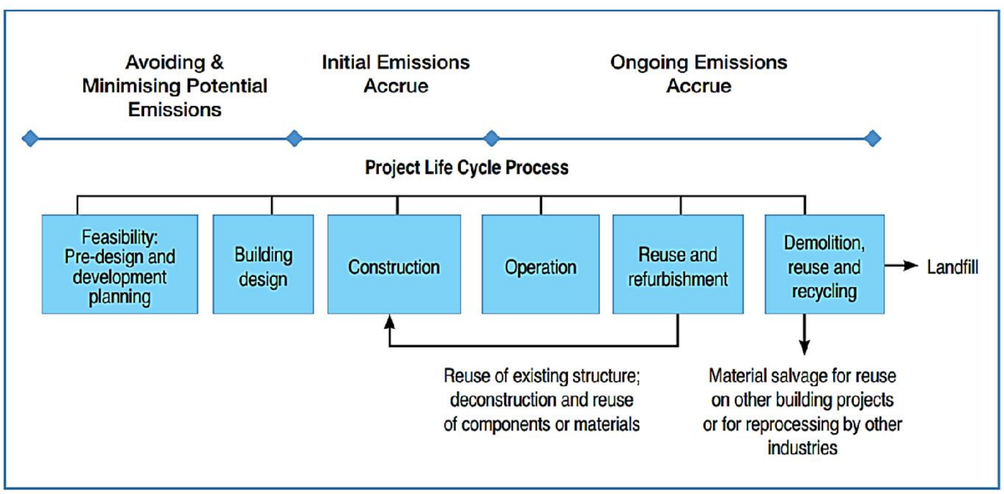

Figure 3: Life Cycle of Building (UNEP, 2009)

Due to the growing energy-conscious practices for the past few decades, thus emerged a different perspective about the current building's life cycle with additional stages such as reuse, deconstruction and recycling as opposed to the traditional "cradle to grave"[6] approach presented in Figure 3 (Graham, 2003).

Scientific studies on life cycle energy usage[7] of wood, steel and concrete framed buildings revealed how their building envelopes, structures and systems dominated seventy five percent of the initial embodied energy; although their overall life cycle stages had significant environmental aspects, especially when their operational energy displayed the largest part (more than 80%) of total energy demand (Kernan & Cole, 1996). Yet more comparison studies were studied on life cycle energy demand for both conventional and low energy buildings[8] from nine countries (both residential and non-residential) over 50 year life span. The findings revealed that total life cycle energy usage in conventional buildings showed larger proportions as compared to that of low-energy buildings. Also embodied energy within low energy buildings was much higher (maximum of 46%) than that of conventional buildings (maximum of 38%); inspite of that, their operational energy usage still dominated in both cases. Further findings

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[6] "cradle to grave" refer to any product right from its creation to disposal (www.businessdictionary.com)

[7] Life cycle energy usage of a building is derived by summation of initial embodied energy (refers to energy from extraction of natural resources till installation); recurring embodied energy (refers to energy for maintenance and refurbishment) and operating energy (refers to energy used by building occupants over its life span such as heating, cooling, lighting, etc.) (Cole & Kernan, 1996) (Sartori & Hestnes, 2007)

[8] Conventional building refers to a building constructed as per common practice and low-energy building refers to a building built with energy efficient technology to minimize the building's operating energy (<121 kWh/m² year) (Sartori & Hestnes, 2007)

revealed that buildings constructed to Passive House (Passivhaus[9]) Standard proved more energy efficient as compared to self-sufficient solar house (Sartori & Hestnes, 2007). The above findings support that as the building's operational energy improves due to imposed strict building regulations and energy-efficient technology; the building's embodied energy shows relatively more significance.

This part of literature review was explored on the relevance of the building's longevity by using the key terms "durability", "service life" and "design life".

Table 1: Key Terms and Definitions for Building Longevity

Key terms	Definition
Durability	Ability of any building, components or materials to resist the action of degrading agents for a long time
Service life	Actual life span or period of actual time during which the building or any of its components performs without unforeseen costs or disruptions for maintenance or repair
Design life	Predicted service life or intended life span of any product when subject to the test conditions according to a prescribed maintenance

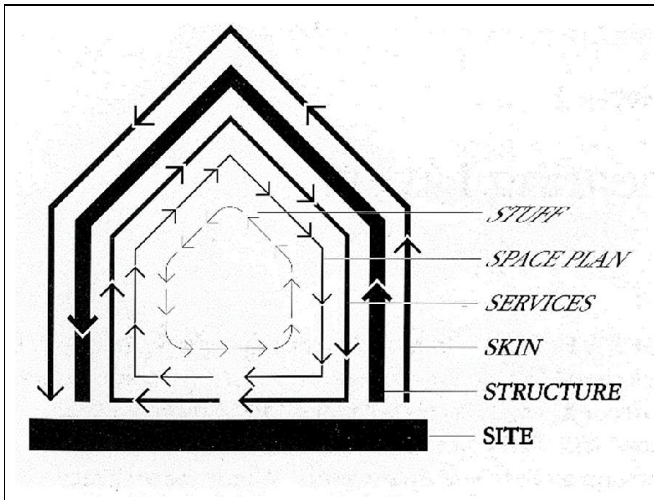
Adapted from (Nireki, 1996) (Kesik, 2002) (Douglas & Ransom, 2007)

According to Kesik (2002), the guidelines for durability in Canadian buildings "CSA S478-95 (R2001)" stipulated that heritage buildings should be designed for a minimum period of 100 years of service life; for residential, office and commercial buildings should be designed for service life between 50 and 99 years. Any building's service quality is

[9] The Passivhaus (PH) standard is a set of voluntary criteria for an ultra-low energy use home. The primary Passivhaus target criteria are: (a) total heating & cooling demand of <15 kWh/m^2/year ; (b) total primary (i.e., source) energy of <120 kWh/m^2/year and (c) airtightness 0.6 ACH@50 Pa or less (Straube, 2009)

instrumental in determining durability implications of any two buildng products even with similiar service life, they may deteriorate differently (Kesik, 2002).

Stewart Brand's observational studies on different buildings and their evolution over their entire life developed a building model with shearing layers as presented in figure 4. It was argued that the shearing layers within a building have different life expectancies and for a building to be truly adaptive, these layers should be accessed easily instead of being enclosed together within any building system (Brand, 1997).



Layer	Life Expectancy
Site (Location)	Permanent
Structure (Slab)	30-300 years
Skin (Envelope)	20 years
Services (HVAC)	7-15 years
Space (Interiors)	3-30 years
Stuff (Occupants)	Daily

Figure 4: Stewart Brand's building model with shearing layers (Brand, 1997)

From Brand's model, it can be summarized on how any building can deteriorate within itself if such physical layers cannot be accessed for service and regular maintenance to increase the durability of such buildings and if left unattended, such buildings could worsen with age and decay (Douglas & Ransom, 2007).

To determine relationship between building longevity and durability of structure, survey studies were conducted on 227 demolished buildings in Minnesota by building age, building type and structural materials; findings revealed major reasons for demolition such as area redevelopment (35%), physical condition due to poor maintenance (31%)

and buildings unsuitable for intended use (22%); also the majority of demolished steel and concrete buildings were less than 50 years old. It concluded that there was no relationship between the structural system and actual useful life of the building; furthermore most buildings were demolished not due to durability problems, but due to lack of adaptability[10] (Athena , 2004) (Connor, 2004).

Survey studies was performed on experienced building professionals across Canada on actual service life spans of 230 components (including equipments) in MURBs (over five floors in height) and their results were compared with Ontario Housing Corporation (OHC) life expectancy data; their findings revealed that they were higher than OHC life expectancies for 66% of the building elements (IBI Group, 2000).

Economic studies on converted projects in Ontario dispelled the common assumption that reusing existing buildings are cheaper than new construction, hence the construction expenses of building conversion depends on the depth of client's requirements, size and function type, but the return on investment (ROI) for heritage development was found to be higher than that of non-heritage designated buildings (Shipley, Utz, & Parsons, 2006) (Stas, 2007). For example: the rate of construction costs for the conversion of a former power plant to Nova Scotia Power headquarters office was estimated at 2600 dollars[11]/m² due to the clean-up for contaminated areas; but for the conversion of former Sears headquarters to government building at 222

[10] Adaptability is defined as the capacity of a building to absorb minor or major changes and several criteria of adaptability are convertibility, deconstruction, expandability and flexibility (Douglas, Building Adaptation, 2006)

[11] To calculate prices per square meters, the calculation is as follows: (price/ft²) x 10.764 = price/m²

Jarvis Street in Toronto, it was 2400 dollars/m^2 and yet for converted office building (heritage-designated) at 111 Richmond Street West, it was 1700 dollars/m^2 and comparative costs for new construction varies between 1900 dollars/m^2 to 2150 dollars/m^2 in Toronto (Blanchaer, 2013). Therefore it concludes that there is not much difference between the development and construction costs for both new buildings and converted buildings except for buildings on contaminated sites.

2.1.2 Obsolescence

Building obsolescence is defined as the process of declining performance over time until the end of its service life; also it has been termed as the fourth dimension in building because it determines the timing of either adaptive reuse or demolition of a building, while the other three dimensions are length, breadth and depth within space (Douglas, 2006) (Thomsen & Flier, 2011).

Studies by Thomsen and Flier (2011) explored various literature articles on the role of obsolescence and its effect on the built environment. Their findings concluded that any building can technically be obsolete before the end of its physical life (age); how the differentiation in residential and non-residential buildings is marked by longer life cycle expectancy (stability) in housing as compared to shorter cycle of usage within offices or retail; how circumstantial factors for decay and obsolescence are determined by its physical design (spatial and structural flexibility), construction quality, occupants' behaviour (high utility expenses) and building management.

Other research studies defined several types of building obsolescence during its service life differently in terms of both external and internal factors. They are characterized by physical (environmental factors due to deterioration, incompatibility between materials or elements and structural failure due to seismic factors), economic (factors due to change of current market, rental rates, capital value, etc.), functional (occupant activities, degree of usefulness or insufficiency within building configuration or lack of maintenance), technological factors (due to modern equipment, information age), social (changes in style or expectancy levels), legal (code compliances, changes in policy, asbestos) and aesthetic (lack of appeal in existing architectural style, example: offices) (Langston, 2008) (Douglas, 2006).

According to Douglas (2006), there are two types of problems which determine the feasibility of building conversion as follows; remedial type refer to poor thermal standards, construction defects, inadequate structural capacity and inadequate mechanical services which can be corrected through adaptive reuse; but for impractical type, it refers to factors such as poor location due to inaccessibility, inadequate building morphology due to restrictive parameters[12] and severity of site contamination, therefore cannot be considered for any project redevelopment and should be demolished. Adaptive reuse is considered as one of the most effective strategies to counteract building obsolescence and other major strategies also include regular maintenance, refurbishment and upgrading (Douglas, 2006) (Langston, 2008).

2.1.3 Decision making Process

This part of literature review researched first on the scenario of residential conversion across Canada and subsequently on the decision-making approach on the suitability of the existing building for its proposed use.

[12] Building parameters refer to ceiling height, floor plate width and depth, spacing of columns, etc.

CMHC studies (2004) showed how residential conversion of obsolete non-residential buildings involved warehouses, religious buildings, educational facilities and offices were due to various reasons such as brownfield reclamation, affordable housing, revitalization, urban infill across Canada. For example, residential conversion in Montreal was adopted out of a need for affordable housing[13] (CMHC, 2006), but for Toronto, it was used as downtown revitalization for the surrounding neighborhoods to generate tax revenues when the industrial buildings were abandoned (Mawani, 1997). According to Kincaid (2000), there is no standard method in determining any building conversion for any particular use as every building is different. Studies by Rabun and Kelso (2009) on building evaluation for adaptive reuse provided guidance on exterior and interior inspections for the existing building on its suitability for reuse. Furthermore, it evaluates structural and material integrity of existing buildings along with mechanical, electrical and plumbing systems according to its construction period. It also identifies the causes of building failures ranging from masonry spalling to foundation issues (Rabun & Kelso, 2009). For typical new project development, the standard procedure consists of typical phases such as site selection, pro-forma[14] analysis, feasibility and acquisition, design, financing, marketing, leasing, construction and operations. But for adaptive reuse development project, a different approach is adopted due to the proximity of the existing building to the surrounding neighbourhood and therefore this

[13] Affordable housing refers to housing for low income families that does not exceed 30% of their income. Sometimes it is called Social Housing (CMHC, 2006)

[14] Microsoft excel worksheet with financial estimates with inputs such as project costs, market rents, mortgage rates and operating expenses for positive return on investment (Rabun & Kelso, 2009)

particular decision-making procedure goes through certain phases such as market analysis, pro-forma analysis, feasibility studies for the proposed occupancy[15], analysis of existing site for any contamination, current zoning, check for heritage designation of the existing building, footprint size of the building for spatial configuration and physical compatibility; code compliances for its proposed use (Rabun & Kelso, 2009) (Bond, 2011) (Wilson, 2010). Due to the complexity of conversion within today's buildings, intensive collaboration emerges between several specialists from different backgrounds as it was felt that if done right at the beginning, it results in energy savings throughout the project as against the traditional collaboration between only architect, developer and contractor team arrangement (Rabun & Kelso, 2009).

For the existing building on detailed evaluation, the first approach is to determine its economic feasibility; then technical audit to determine building history by date and its previous use; walk-through visual inspections of the building envelope for identifying any incurred damages due to moisture, human-inflicted and seismic; then preliminary assessment of building permits for fire safety and code issues, verification of existing working drawings with the existing condition and determining whether it is heritage designated or not (Rabun & Kelso, 2009). For heritage designated buildings, preservation specialist is often employed for collaboration and in such cases, the exterior fabric is maintained in its original condition and interior modifications often occur

[15] Occupancy means the use or intended use of a building or any part of a building for the shelter or support of persons, animals or property (Service Ontario, 2012)

within the existing structure. But the practice of façadism[16] is a commonality in most cases (Stratton, 2003). Furthermore, survey studies were performed by Wilson (2010) among several property developers on their selection criteria of industrial buildings for adaptive reuse in Toronto and the results revealed critical factors presented in table 2.

Table 2: Building Selection Criteria by Developers within Toronto

Critical factors	Reasons
Avoidance of brownfields[17]	incurred expenses for clean-up of site contamination
Structural condition	Desirable choices for both timber and concrete, but most preferably concrete ones due to higher load capacity for additional floors above
Building flexibility	Preferably high ceilings and internal open layout
Financial incentives	Beneficial to reduce construction costs
Imperative location within downtown Toronto	Due to strong real estate market values, regardless of the existing condition of neighborhood

Research studies by CHMC (2004) revealed potential factors for residential conversion of non-residential buildings such as access to basic amenities (example: grocery, etc.); access to public transit; zoning approvals for residential purposes (if existing site is in a

[16] Façadism is the practice of a new structure being inserted behind a restored façade (front elevation) or for preservation of historic façades while demolishing the rest of the structure

[17] The term "brownfields" refers to vacant or underused properties with environmental contamination problems often due to former industrial or commercial activity types (CMHC, 2004)

non-residential zone); building's previous use (determined by parameters, load capacity, etc.) as they are often associated with incurred expenses for proposed conversion.

Table 3: Typical criteria factors for residential conversion

Frame Type	Electrical	Plumbing	Heating/Cooling
Layout Plan	Fire Exits	Load Capacity	Hazardous Materials
Building Height	Elevators	Solid Waste	Service Access
Building Envelope	Stair wells	Water/Sewer links	Floor to Floor Height

Adapted from (CMHC, 2004)

2.1.4 Energy Conservation Measures:

For new constructions, low energy-saving strategies are typically employed during the initial design stages such as its climatic orientation as per local zone; built form for daylight harvesting, energy-efficient and durable building materials. But the approach for renovating existing buildings is different and therefore, this part of literature work reviewed adoption of energy conservation measures (ECMs) during building conversion for both heritage and non-heritage types.

Studies on typical construction technology in most of the existing building stock across Canada revealed that those built before Second World War were of load bearing masonry walls with little or without any insulation along with punched windows (Straube & Schumacher, 2007). Even though steel and reinforced concrete were discovered earlier, they became a commonality in the early 20th century. Buildings were typically constructed with skeletal structural systems often with non-load bearing walls, higher window to wall ratios and heavy mechanical systems. Economy and speed of construction were of prime importance at that time. Investigation studies on the first generation curtain-wall systems (1958-73) in the office buildings located at Manhattan revealed that most of them were of single glazed type and not feasible for adaptability due to tight column spacing (6m by 6m as compared to 12-14m today), low ceiling heights (2.44m) and insufficiency load capacity of the façades to support the weight of double glazed systems. Comparison studies on total energy usage for retrofitted building (15 F.A.R[18]) versus replacement building (21.6 F.A.R) was simulated with eQUEST[19] program. Findings showed 40% energy reductions with payback period of 44 years for retrofitted building (15 F.A.R) and 5% operational energy savings for replacement building (21.6 F.A.R). But for replacement building, the embodied energy required to deconstruct the existing structure for a new one would be offset by 15.8 to 28 years (Browning, Hartley, Corey, Ryan, & Kallianpurkar, 2013).

Straube (2012) emphasized that the first step to improve overall energy performance of any existing building was exterior application of continuous insulation protected by cladding over the entire building enclosure to control thermal bridging[20] and airtightness; this ensures protection from temperature and moisture fluctuations. And for buildings with higher WWR or curtain wall systems, Straube (2012) advised that the window

[18] F.A.R stands for Floor Area Ratio is the ratio of gross net floor area of a building to the total area of the plot on where it is built. The higher FAR is, it leads to increase of density

[19] eQUEST program is a quick energy simulation tool for building energy use analysis

[20] Thermal bridge is a localised area with reduced thermal resistance than intended for the building assembly. It typically occurs near steel stud walls (due to high conductivity of steel) or exposed concrete slabs (floor, balcony, etc.) and causes surface condensation (Straube, 2012)

selection should be limited to double glazing with low-e coatings, low u-value[21] and low SHGC[22] types (SHGC type depends on specific site conditions and exterior shading, if it exists) with thermally broken window frames for greater energy savings and thermal comfort. But for heritage designated buildings, exterior insulation strategy is not suitable due to concerns about elimination of their distinct historic features and restrictions under Ontario heritage act[23], therefore interior insulation with spray foam (depends on construction type) were recommended as alternatives applied to address current energy standards or thermal comfort; the disadvantage resulted in reductions of the interior floor areas and does not prevent thermal bridging in certain areas such as structural penetrations (Straube, 2012).

Field studies on hygrothermal performances of historic masonry exterior wall systems (within steel frame type) were carried out with several sensors placed at specific areas for comparison of thermally insulated (semi-rigid fibreglas type) wall applied with vapour barrier (aluminium foil) and ventilated air space technique on the interior side and non-insulated wall; findings revealed temperature differences across both walls (figure 5), thermal bridging between the junction of floor and masonry walls and moisture changes

[21] U-value is heat transfer coefficient or thermal transmittance or thermal conductivity; it is also the reciprocal of R-value; metric units are W/m² ºC

[22] Solar Heat Gain Coefficient (SHGC) is the ratio of solar heat gain that is transferred through the window glass to the total incident solar radiation; it is a significant factor for determining cooling loads within buildings

[23] Ontario Heritage Act came into force in 1975 and it is the empowerment (Ontario Regulation 9/06) for the protection of any building, streetscape, district or landscape of cultural or historic value by the Municipality/Provincial government to prevent demolition (Ontario, 2006).

within walls along with surface condensation; renovated (insulated) wall showed increased thermal resistance by 47% to 63% more than uninsulated wall (Results showed RSI[24] value of 1.9 for uninsulated wall and insulated wall with RSI value of 1.2) (Maurenbrecher, Shirtliffe, Rousseau, & Saïd, 1998).

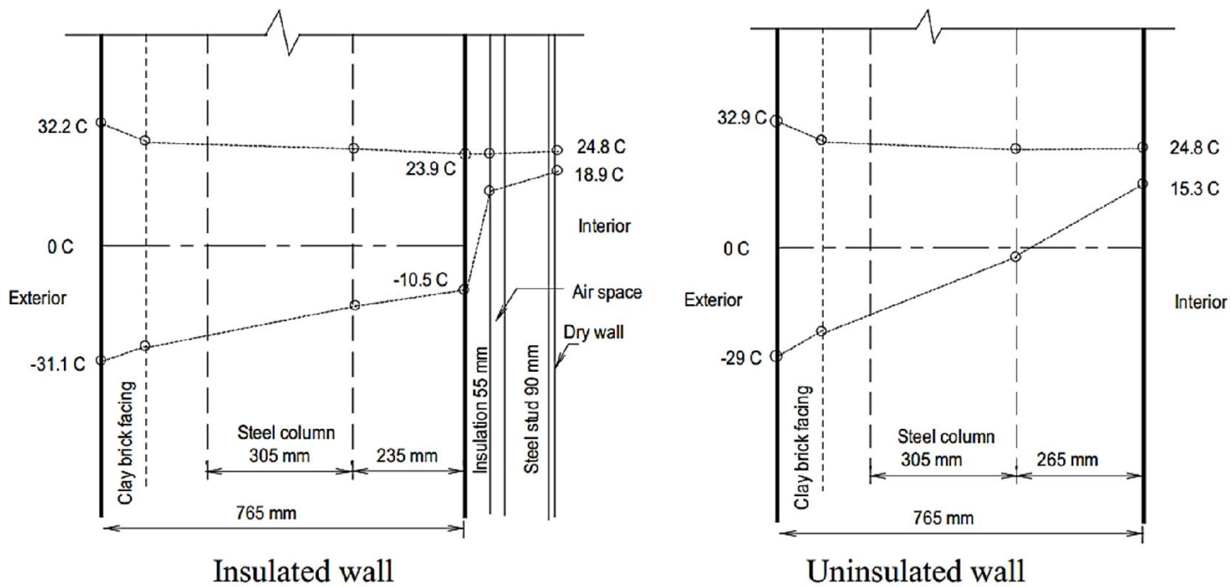


Figure 5: Comparison of Hygrothermal Performances within Insulated and Uninsulated Masonry Walls (Maurenbrecher, Shirtliffe, Rousseau, & Saïd, 1998)

Other field monitoring studies with sensors was performed for comparison of insulation strategies for joist ends within masonry walls of the unheated apartment building along with frost dilatometer[25] to check for impact of efflorescence[26] on their durability. The

[24] RSI is the metric R-value of measuring the effectiveness of insulating materials (thermal resistance); the higher the RSI value, the more resistance of the material against heat flow. RSI value= 0.176 x R-value. (Hutcheon & Handegord , 1995)

[25] Frost dilatometer refers to testing for freeze-thaw mechanisms at various saturation levels to determine the critical degree for expansion; data in terms of density, absorption and capillary uptake

interior walls of the building were retrofitted with three layers of 2 inches of extruded polystyrene (XPS) insulation adhered to existing masonry with polyurethane adhesive and wood 2x4 framing was installed for mechanical services along with spray foam at the joints (Figure 6). Their findings revealed how the north and east sides of the building displayed higher moisture content inspite of lack of decay within the wood members; south side (solar-heated) demonstrated decent moisture content (10%-13%) thus proving that climatic orientation matters for unheated buildings. Further findings showed reductions in their freeze-thaw cycles by half for uninsulated walls, thus increasing the rate of cooling. After addition of interior heating, it helped in drying up joists (Ueno, Straaten, & Schumacher, 2013).

Figure 6: Comparison of Insulation Strategies for Heritage Masonry Buildings (Ueno, Straaten, & Schumacher, 2013)

Further investigation studies by Tzekova (personal communication, 2014) were carried out on an historic 3-storey solid masonry structure, Barrymore building in Toronto with Vented Masonry Retrofit (VMR) system. Due to the porosity of bricks and increased

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[26] Efflorescence refers to fine white crystalline deposit of water-soluble salts left on surface of masonry walls as the water evaporates.

frequency of freeze-thaw cycles due to the addition of thermal insulation, it is necessary to reduce the moisture content of the masonry structure. This insulation strategy contains an application of 2 layers of 10mm Mortairvent placed against the brick wall to create a vented cavity (20mm) located between solid masonry walls and spray-applied urethane foam insulation. Side by side tests were monitored by assessing wetting and drying cycles on vented and non-vented masonry walls for one and half years. Results showed that the vented cavity on south and east facades removed 4.8kg and 12.3kg of moisture, respectively, thus proving effectiveness in moisture removal during both winter and summer (Tzekova, Pressnail, Binkley, & Pearson, 2011)

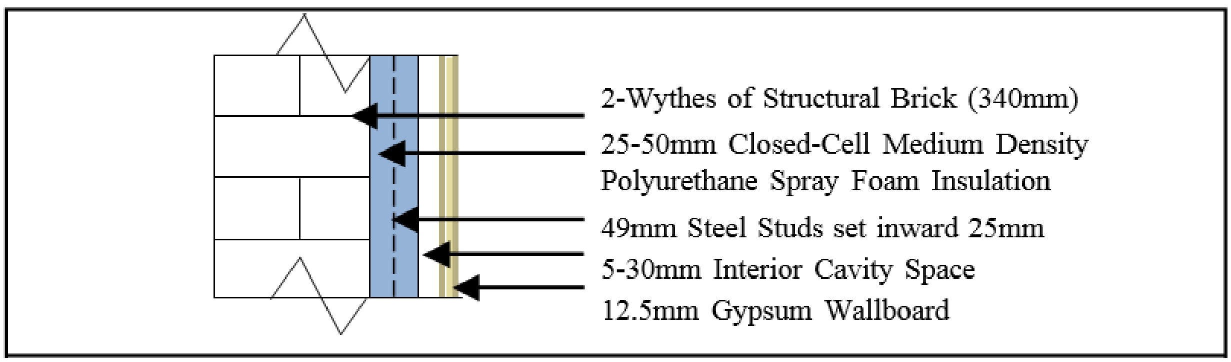

Figure 7: Standard Wall Retrofit approach (Tzekova, Pressnail, Binkley, & Pearson, 2011)

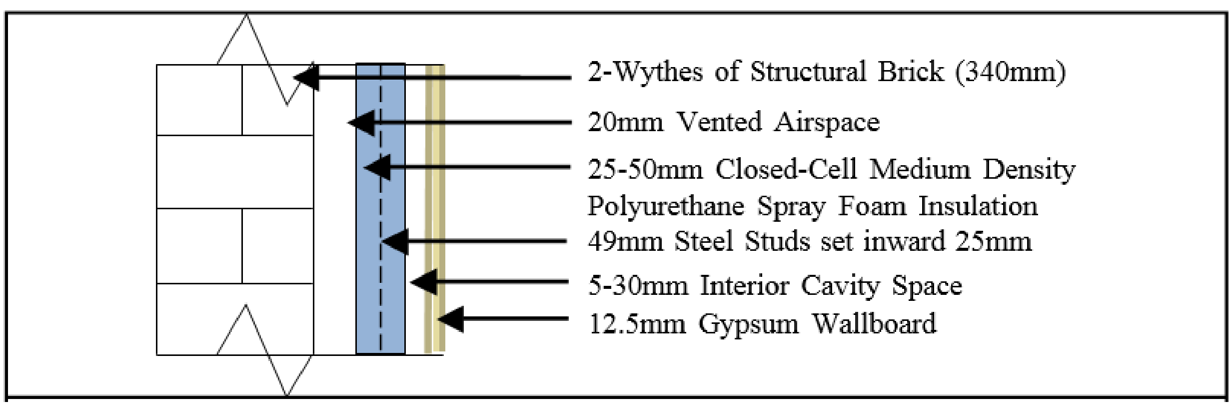

Figure 8: Vented Masonry Retrofit approach (Tzekova, Pressnail, Binkley, & Pearson, 2011)

Straube(2012) emphasized that windows are often the major source for air leakage and moisture penetration thus increasing cooling loads or heating loads, depending on the climatic zone. Therefore they are often targeted as the first option for improving a building's thermal performance. Further literature review on historic windows were carried out and field studies were monitored with thermocouples at the window corners for performance issues on window condensation as a result of residential conversion of heritage building in Ottawa. Findings for single-glazed windows with wood-frame and metal-frame types revealed that condensation occurred at exterior temperatures of -10°C or lower when the interior conditions were at temperature of 21°C and relative humidity (R.H.) of 35%; condensation occurred on the metal frames, but not on wood frames. To address such issues, the dew point of the air adjacent to the window should be less than the temperature of the window. Therefore two options were considered; replacement of the single glazing with double-glazed units (low-e[27] +13 mm air space) resulted in RSI value of 0.35 at centre and RSI value of 0.20 at the edges; other option was by addition of air-tight storm windows to the interior of the original window as the third layer of glazing; as a result that their improved thermal performance led to reductions in window condensation (Brown, 1997).

Infrared thermography inspections were performed to address thermal patterns and identify freeze-thaw problems within historic buildings and it concluded that infrared thermography should be used for early detection of problem areas as timely remedial

[27] Low-e refers to low-emissivity coatings applied to window glazing to reduce heat loss from inside without reducing solar gain from outside (Robertson, n.d.)

actions would ensure long-term life cycle of heritage buildings (Colantonio, 1997). From the above conclusions, it showed a commonality in durability issues such as interior condensation for both windows and interface between insulation and masonry walls; risks of freeze-thaw cycles within masonry walls and replaced mechanical systems.

Simulation studies by using IES-VE[28] software were performed on occupancy patterns due to conversion of office building to residential apartment within urban settings to check on performance implications if heating and cooling demands were affected by change of occupancy associated by function within the existing building. The method of street geometry with ratio of H/W[29] was calculated along with climatic orientations as urban settings. For isolated settings, the dominant office energy need was for cooling and for residential buildings, it was heating. Findings revealed that daytime shadowing improved energy performance for offices (reduced cooling loads) and increased heating loads for residential buildings within urban settlings. Yet during nighttime, findings showed reduced heating loads for residential buildings and increased cooling loads for offices. The findings conclude that a closer examination of the urban settings of a building, in conjunction with its intended use, can be instrumental in decision-making for improved energy performance (Futcher, Kershaw, & Mills, 2013).

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[28] IES-VE software is an integrated suite of applications linked by common user interface and provides an environment for detailed building evaluation with regard to comfort criteria and energy use (Crawley, Hand, Kummert, & Griffith, 2005). It was employed due to its suitability for examining energy performances of multiple buildings at the same time (Futcher, Kershaw, & Mills, 2013)

[29] H/W is height of building to width of road (Futcher, Kershaw, & Mills, 2013)

2.2 Section II: Analysis of Code Compliances for Residential Conversion

This section first reviews the current building regulations in Canada and subsequently analyzes code compliances only for residential conversion from National Building Code of Canada (NBC), Ontario Building Code (OBC) and Toronto Green Standard (TGS).

Building codes are legal documents that set minimum requirements for every building to qualify for any construction work and it does not prevent any builder from exceeding them in Canada (Potworowski, 2010). Building codes are upgraded every few years on a regular basis to address changing needs of the society and technological advances in building products. Historically in Canada, building codes were safety regulations concerned with consequences of poor hygiene, building failures and fire protection; at that time, its purpose was to avoid loss of property and life (Hutcheon N. B., 1969). Over the years, the building codes have expanded to include barrier-free accessibility and energy conservation requirements (OBOA, 2014). CMHC studies showed that a large number of buildings in Canada were constructed much before the building codes were introduced in 1941.

Engineers find it a straightforward process to apply building code requirements to new buildings due to their alternative design options as compared to existing buildings as the existing buildings have limited options for economic design and constraints (Hansen, 1984). Adaptive reuse projects typically face difficulties in code compliances especially when the original function of the building is fundamentally changed to another function due to different requirements as per occupancy classification in current building regulations (Green, 2012). Still, code compliances are mandatory as they are the minimum standards set for the life safety of the building occupants.

2.2.1 National Building Code of Canada (NBC):

By definition, National Building Code of Canada (NBC) is one of the five model national construction code system established by the National Research Council of Canada (NRC). Furthermore they are reviewed every five years and the current version is dated 2010; their main objectives are based on safety, health, accessibility, fire and structural protection of buildings across Canada, but different provinces or territories have additional codes such as water conservation and energy efficiency. Hence they serve only as model codes[30] and become legal if they are adopted by territories and provinces. Even though NBC was first introduced in 1941, Part three[31] (Use and Occupancy[32]) of NBC was first introduced in 1980; subsequently, guidelines for existing buildings were introduced only in 1993 (NRCAN, 2012). Prior to 1941, the Canadian municipalities would develop their own building codes for construction. The findings conclude that there is no reference to "change of use" in existing buildings within National Building Code of Canada.

[30] Model Codes are technical documents with minimum building requirements which apply to the construction, renovation or alteration of all buildings and become law only when they are adopted officially by province or city in Canada. (Potworowski, 2010) There is a difference between codes and standards as Building Standards are defined as voluntary industrial technical requirements for testing, compatibility and performance. (National Research Council Canada, 2013)

[31] Part 3 refers to Fire Protection, Occupant Safety and Accessibility in both large non-residential and residential buildings greater than three floors and greater than 600 square metres in built up area.

[32] Occupancy means the use or intended use of a building or any part of a building for the shelter or support of persons, animals or property (Service Ontario, 2014)

2.2.2 Toronto Green Standard (TGS):

Historically Toronto Green Development Standard was first introduced as voluntary standards in 2006 due to environmental concerns from high rise glazed buildings amongst both public and private sector in the city of Toronto. In 2010, it was renamed as Toronto Green Standard (TGS) under the Planning Act (Kesik & Miller, 2008).

On further analysis of TGS, it contains two-tier set of energy conservation targets for both site and building design in Toronto. Tier one became mandatory for new constructions since 2010 while Tier two is based on voluntary type with more aggressive measures than Tier one. According to TGS, there are two type of building categories characterized by: low-rise residential (maximum of three floors and five units) and mid-rise to high-rise (any major occupancy[33] with minimum of four floors). Additionally, if buildings met specific targets within Tier two, they were eligible for twenty percent refund of developmental charges. Currently, TGS increased energy targets for Tier one: 15% above current OBC 2012 or 25% above Model National Energy Code for Buildings (MNECB)[34] and for Tier two, it is 25% above current OBC or 36% above MNECB.

[33] Major occupancy means the principal occupancy for which a building or part of a building is used or intended to be used. (Service Ontario, 2014)

[34] Model National Energy Code for Buildings (MNECB) was first published in 1997 and was never adopted by any province; but it was used as national standard for building energy performance as well as reference building in energy simulation programs. The second edition of National Energy Code of Canada for Buildings (NECB) was published in 2011; their reference building was an improvement of 25% over MNECB reference building. It becomes law only when adopted by any province. (NRCAN, 2014)

Even though, the current TGS does not address code compliances for conversion or renovation of the existing buildings, but Toronto municipal code specified that for any building conversion, the zoning compliance should be followed as per permitted building occupancy (Toronto, 2011). And furthermore, the building is defined not lawfully existing if fifty percent or more of the main walls of the first floor or above are removed or replaced (Toronto, 2014).

According to TGS Tier two, voluntary measures are included for reuse of the existing building. In the previous version of TGS, the option “reuse of building materials” under Section “SW 2.1” in Tier two of TGS specifies that at least 5% of the existing building content should be reused. Recently, the updated version of TGS improved the terms under “reuse option” in Section SW 2.1 (Tier two) which stipulates that existing buildings not listed on the heritage register should reuse minimum of 55% of its existing structure and envelope (City of Toronto, 2014). Its main goal was to preserve the city’s built form and reduce waste towards landfills (City of Toronto, 2013).

2.2.3 Ontario Building Codes:

Historically, Ontario Building Code (OBC) was first introduced in 1975 and applies to the entire province of Ontario, enforced under Building Code Act 1992 by the Ministry of Municipal affairs and Housing (MMAH) (Govt of Canada, 2013). According to OBC, an existing building is defined as any building which already existed for a minimum of five years. Any building which exists less than five years is required to be upgraded to the current standards of OBC (Code Reference: 1.1.2.6) (Service Ontario, 2014). In Toronto, whenever any existing building is reused and in such cases the occupancy usage is changed for example: from factory to residential, retail showroom to offices.

Due to change of occupancy, there may be fire and code issues due to different requirements; therefore both Part 10: Change of Use and Part 11 for Renovation within OBC addresses code compliances for any building conversion (Service Ontario, 2014). Fire and life safety, structural aspects, plumbing, mechanical and accessibility requirements are identified as priority areas in such cases. Part 10 on "Change of Use" stipulates that the reused building should satisfy the requirements of the new occupancy. Furthermore, if the reused building has multiple occupancies for example, live-work units, then the building which has more built up area with a certain occupancy as long as the performance level of the converted building is not less than the performance level of the previous occupancy (Code reference: 10.3.2).

Conversions of Existing Buildings falls into three types as follows:

a) Classification according to major occupancy: Every existing building or any part of it should comply with requirements of the proposed occupancy such as life safety, fire ratings of the existing building assemblies, plumbing, sewage and accessibility as per major occupancy listed in Part 3 of OBC
b) Building size and Construction type: This refers to structural evaluation for dead and live loads of the proposed occupancy, building size (based on built-up area and overall building height) and for combustible or non-combustible construction
c) Classification according to construction index (CI)[35] based on construction type and Hazard Index (HI)[36] based on occupancy type (code reference: Part 11.2.1.1)

[35] Construction Index is a number between one and eight; with one for the lowest fire protection performance level, and two types of construction based on combustible and noncombustible.

as presented in Table 4. If the existing building (applies to small and medium size only) is surrounded by multiple streets, then HI credit of 1 can be subtracted from HI of the proposed occupancy for reduced upgrades required.

Example: If this warehouse with Group F- Division 3 industrial occupancy (low hazard) is converted to Group D (office) or Group C (residential) occupancy. Then C.I and H.I are compared for analysis of any additional upgrades to the existing building. If results show that H.I is higher than C.I., then additional upgrades will be prescribed as per list of compliance alternatives in OBC. In such cases, typical solution could be sprinkler system for fire code compliances (OBC Reference: 11.4.3.4.A).

Table 4: Comparison of Hazard Index (Service Ontario, 2014)

Occupancy Type	Hazard Index		
	Small	Medium	Large
Residential (Group C): Apartments	3	4	6
Residential (Group C): Live/Work Units	4	5	7
Business (Group D): Offices	3	4	5
Business (Group D): Public Heritage	3	-	-
Industrial (Group F Division 3)[37]: Warehouse	2	3	4
Industrial (Group F Division 3): Public Heritage	3	3	-

[36] Hazard Index is measured on a scale of one to eight and based on occupancy type and building size. It is for the safety of the occupants in terms of fire exits, difficulty of egress, etc.

[37] Group F Industrial Occupancy are classified in three divisions; F1 are high hazard industrial, F2 are medium hazard and F3 are low hazard industrial (Service Ontario, 2014)

Even though energy conservation requirements were enforced for all new construction since 2012, but they are not required to be upgraded for existing buildings except on altered parts during renovations and additions (OBC reference: 11.3.3.2).

OBC Part 11 on Renovation are classified in two types: Basic Renovation and Extensive Renovation (OBC Reference: 11.3.3). During basic renovations, minor alteration work could be carried out as long as the structure, fire separations or fire exits remains intact. When there is a change of use, for example: office or industrial type to residential type, building codes upgrades are required because residential occupancy have a completely different set of safety regulations in terms of fire-resistance ratings and acoustic separations (passage of sound between apartments). For extensive renovation work on removal and construction of building assemblies, then structural and fire-resistance standards of new building assemblies should be constructed according to the current building regulations for new buildings. The building height and building area are used for determing fire resistance rating requirements. Part 4 on Structural Design compared the specified uniformly distributed live loads as per occupancy type presented in Table 5

Table 5: Comparison of Live loads as per occupancy type (Service Ontario, 2014)

Occupancy Type	Live Load
Factory or Industrial	6.0 kPa
Office	2.4 kPa (for floors above first level)
	4.8 kPa (for basement and first level)
Residential	1.9 kPa

For building conversions, additional upgrades are required for fire, structural, plumbing, sewage and other service systems according to occupancy type and occupant load.

2.2.4 Heritage Designated Structures:

Toronto's current inventory of heritage properties already contains 9,000 properties within the City of Toronto, approximately 4,500 of them are legally designated under the Ontario Heritage Act (City of Toronto, 2014).

For Toronto, listing properties of historic or cultural value is the responsibility of Heritage preservation services (HPS) appointed by Toronto city council since it was formed in 1973 and their inventory is further subdivided into inventory of heritage properties[38] and heritage conservation districts[39] under Ontario Heritage Act (City of Toronto, 2014).

Building codes were unfavored by preservationists as they felt that building codes resulted in a loss of several heritage buildings. Fire sprinklers and other fire safety systems were often used as practical alternatives for heritage buildings and some building codes were revised to provide flexibility without loss of life safety (Green, 2012). Typical code upgrades occur during conversion of buildings (non-heritage) such as installation of modern mechanical systems for new occupants, life safety, seismic and accessibility requirements. But if the existing building is heritage designated, then it is compulsory for the developers to apply for permission from the municipality permit on either alteration or demolition of any of the elements in that building as per Ontario

[38] Inventory of heritage properties is a list of individual properties which identifies Toronto's built cultural heritage designated under Part IV of the Ontario Heritage Act

[39] Heritage Conservation District (HCD) is an area of the city protected by a municipal by-law passed under Part V of the Ontario Heritage Act (OHA), by City Council.

Heritage Act. Furthermore there may be relaxations from the building codes as long the chief building official has the authority to declare it impractical if it is detrimental to the preservation of the heritage attributes according to the compliance alternatives (OBC Reference: Section 10.4).

Furthermore, the municipal codes of Toronto in Chapter 629-43 to 629-49 on Property standards defined that there should not be any alteration or any demolition of heritage properties unless permitted by Ontario Heritage Act (Toronto, 2013). When a heritage designated building is converted to another use, it is referred to rehabilitation according to the Ontario Heritage Act and it allows certain exceptions in other parts of Ontario Building Codes, but mandatory for structural and fire code requirements.

2.3 Section III: Summary on Principles of Adaptive Reuse

This part summarized the existing literature on adaptive reuse of existing buildings and current building regulations for residential conversion. Literature-driven observable factors expected to have an impact on project outcomes were identified for location of the building, physical characteristics, influence of heritage designation and other factors are used as explanatory variables for analysis of the case studies. To sum up, physical building characteristics have been frequently pointed out as the most important factors that affected the selection of residential adaptive reuse projects. Furthermore, the success of residential conversion is also influenced by other major factors such as construction technology, quality and type of building material, context of heritage designation (depends on number of intervention levels); spatial configuration and technical considerations. A summary on the relevance of each major factor is presented in Table 6 with research highlights.

Table 6: Literature Review: Summary of Key Research Findings

Major Factor	Research Highlights	Author
Environmental benefits (embodied energy)	Building reuse with improved energy standards offer more carbon savings compared to energy-efficient new construction; Building layout matters due to quantity and type of material;	(Preservation Green Lab, 2012) (Graham, 2003)
Obsolescence	Obsolescence termed as fourth dimension of building space; Demolished buildings due to lack of flexibility	(Athena , 2004) (Douglas, 2006)
Zoning	Zoning of site to be checked for residential use; If not permitted, application is required for municipal approval; in some cases, residential density is increased due to current zoning; Check for heritage designation (building)	(Douglas, 2006) (Langston, 2008) (CMHC, 2004)
Site	Marketing potential of building location; Access to public amenities; Contamination in Industrial sites are common;	(Wilson, 2010) (Douglas, 2006)
Physical Characteristics	Age of Property; Evaluation for Building height, Built form for residential plan; structural layout; Floor to Ceiling height and Floor plate depth for spatial configuration	(Rabun & Kelso, 2009) (Langston, 2008)
Building Regulations	life safety regulations for residential conversion depends on degree of combustibility within existing frame type, hazard type (industrial), occupant density for egress and fire safety systems; Acoustic separations between Suites	(Service Ontario, 2014) (Green, 2012)
Load Capacity	Buildings such as industrial and business are suitable for residential conversion due to higher load capacity, but not vice-versa; load capacity of roof for additional floors above	(Service Ontario, 2014) (Wilson, 2010)
Service Accessibility (maintenance; replacement)	Fast cycling elements like HVAC, ductwork and pipes not to be embedded with slow cycling elements such as structural system, masonry walls for ease of replacement and routine service. Example: mechanical parts become obsolete due to technological advances and also shorter life expectancies. Failure to do so, expenses arise.	(Brand, 1997) (Graham, 2003) (Douglas, 2006) (Kesik, 2002)
Heritage Designation	First listed in Inventory of Heritage Properties by Toronto City Council; later on, officially designated under Ontario Heritage Act; Some parts of Building Codes relaxed, but Fire Codes and Accessibility are mandatory;	(City of Toronto, 2014) (Service Ontario, 2012)
Economic studies	No difference in cost comparison for new construction and building reuse; Expenses varies due to depth of work (clean-up of contamination, function and size); Financial Incentives for heritage rehabilitation preferred by developers; ROI for heritage buildings higher than non-heritage types due to client's demand (aesthetic taste)	(Shipley, Parsons, & Utz, 2006) (Stas, 2007) (Wilson, 2010)
Energy Strategies and Insulation techniques	Replacement of HVAC and glazing systems for high performance systems; Exterior insulation for non-heritage; Interior insulation for heritage; Material Compatibility with existing structure to prevent moisture damage and durability issues;	(Straube, 2012) (Straube & Schumacher, 2007) (Tzekova et al., 2012)

Chapter 3: Research Methodology

Based on relevant literature review findings, this research study seeks to investigate decision-making strategies adopted by architects for their residential adaptive reuse projects, identify constraints with code compliances and energy conservation measures. Literature review on qualitative research methods for case study analysis revealed two types: in-depth analysis of a single object in real-life context and cross case analysis for similiarities and differences among several case studies (Schwandt, 2007) (Creswell, 2003). With the research questions in mind, it was felt that cross-case analysis of adaptive reuse projects was best suited in order to check for the commonalities among the converted buildings.Therefore, this research study was undertaken in three parts, first part on thorough literature review for background, second part on selecting case study buildings from the inventory of adaptive reuse projects for individual analysis and third part was on comparative analysis of collected data from all three study buildings with an overall evaluation.

3.1 Selection of Case Study Buildings

Due to an abundance of adaptive reuse projects across Canada, the study area was narrowed down to the context of Toronto within the province of Ontario. An online survey revealed several residential adaptive reuse projects and the next step was to email involved architects with such residential adaptive reuse projects. Based on the architects’s responses, the selected building typology was further narrowed down to residential type, irrespective of the previous occupancy. Table 7 shows an overview of the selected case study buildings (post conversion) that were studied.

Table 7 : Overview of the Residential Conversion Projects

Case Study	Year Built	Year Converted	Number of Units	Number of Floors	Dwelling Type
Tip Top Lofts	1929	2006	243	5(existing) & 6(new)	High-Rise[40]
Printing Factory Lofts	1917	2010	274	3(existing) & 8(new)	Mixed type
Imperial Plaza	1957	2014	403	23	High-Rise
130 Bloor Street	1960	2010	15	14 (existing) & 7 (new)	High-Rise

Personal trips were made to their offices for in-situ analysis of the project archives along with additional information from the architects' (questionnaire[41]). The following parameters were analyzed: physical description of building before and after conversion; construction material, frame type, building parameters in terms of depth, width, height, etc., design strategies, energy conservation measures, code compliances and issues faced during the conversion process.

3.2 Limitations and Assumptions

Considering an extensive amount of time already spent on this research work, an exhaustive review and technical evaluation of the buildings was not feasible due to lack of specific information concerned with building documentations and mechanical data. Additionally, most of the mechanical drawings of the converted buildings were missing/unavailable due to the observation that they were not archived. Only the

[40] High Rise buildings are defined as those built with a minimum of four storeys according to Toronto Green Standards (City of Toronto, 2013) and those built with seven storeys or higher according to Ontario Building Code (Service Ontario, 2014)

[41] Please refer to Appendix B for more details on the questionnaire for selected adaptive reuse case studies

demolition plans and post conversion documentations were accessible from the architects's offices. Therefore, whatever missing technical information of the buildings were required, they were retrieved by online governmental sources. Even though it was easy to find several case studies on adaptive reuse, but the researcher found it difficult to retrieve financial data and utility records from unwilling property management offices and architects. They attributed it to their clients' privacy concerns and due to the Condominium Act which prevents them from divulging or disclosing any information of any kind.

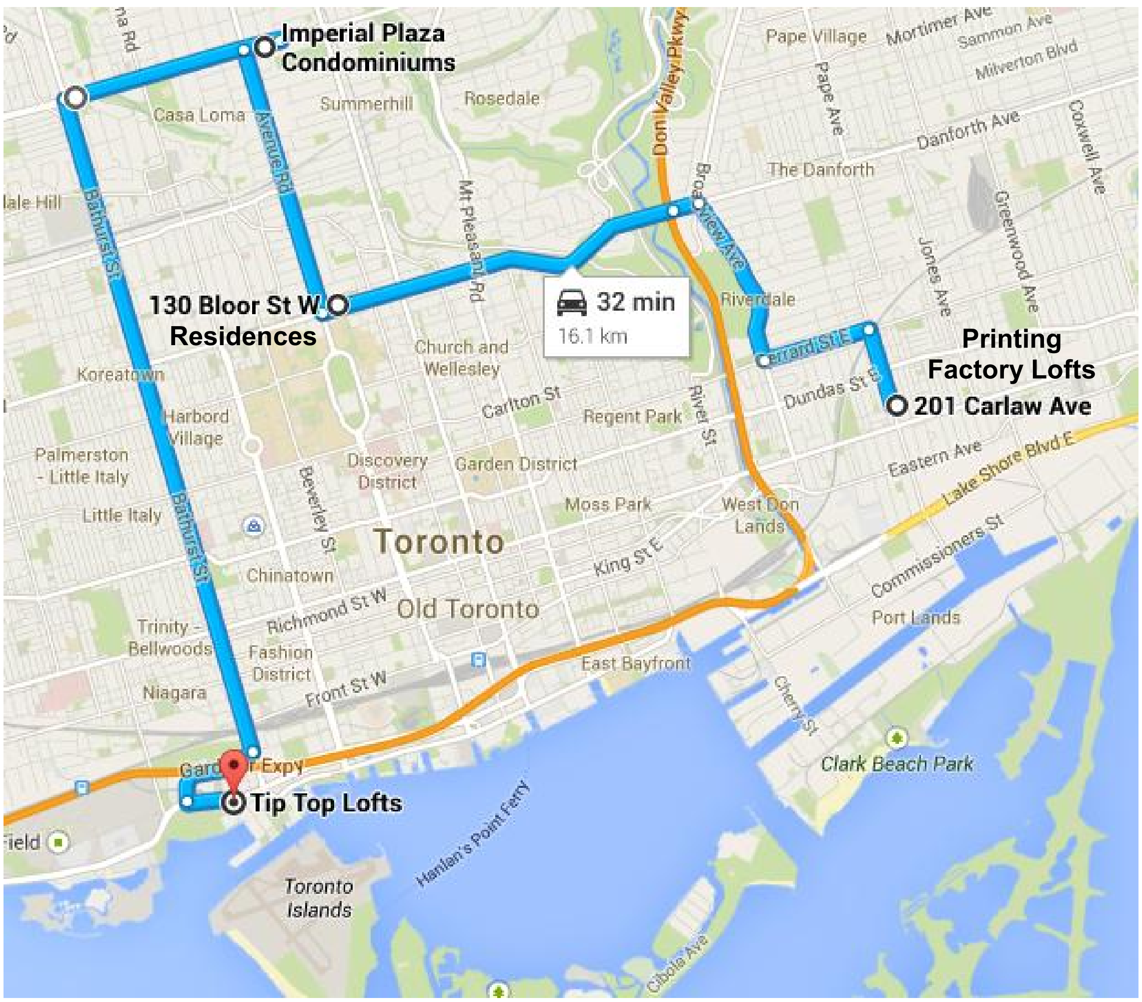

Figure 9: Location of the Selected Case Study Buildings at Toronto

Chapter 4: Case Study Buildings

4.1 Tip Top Lofts at 637, Lakeshore Boulevard West, Toronto[42]

Before Conversion: Tip-Top Tailors Building (Toronto Public Library, 1930)

Post Conversion: Tip Top Lofts (Bing Maps, 2014)

4.1.1. Before Conversion:

The Tip Top Tailors building is located on the southwest corner of Lake Shore Boulevard West and Stadium road. Built in 1929, it was designed by Bishop and Miller Architects as the headquarters for Tip-Top Tailors, a menswear clothing retailer. Its original occupancy was industrial even though its main functions included both warehousing and office operations. Later on, this industrial building was abandoned due to the Great Depression. The historic structure with art deco elements was added by City of Toronto to their inventory of heritage properties in 1973, but officially designated in 2003 under Ontario Heritage Act (City of Toronto, 2002).

Built form: The existing five-storey building was built as a U-shaped structure (figure 8) with a central courtyard and four corner towers with sculpted cornices. The raised

[42] Refer to Appendix C for working drawings and construction details

basement with window openings was provided for underground parking. The primary construction material was of concrete type with 4m high windows and concrete fluted columns.

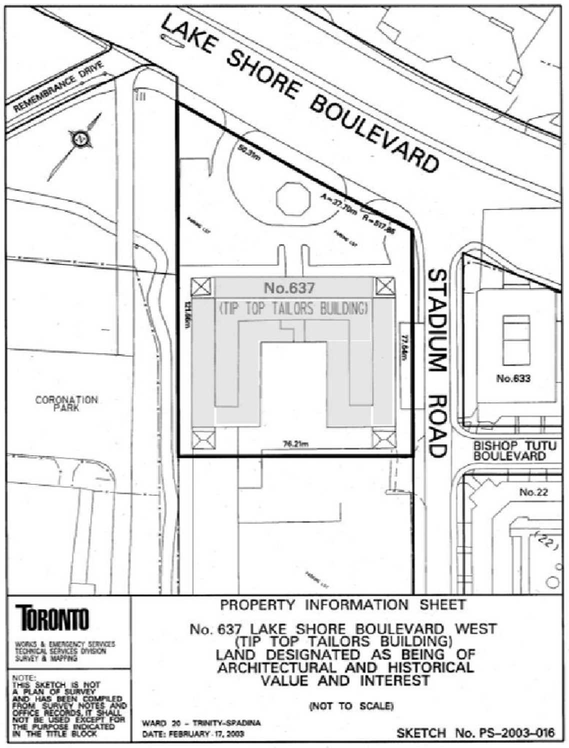

Figure 10: Built form of Tip Top Tailors Building (City of Toronto, 2003)

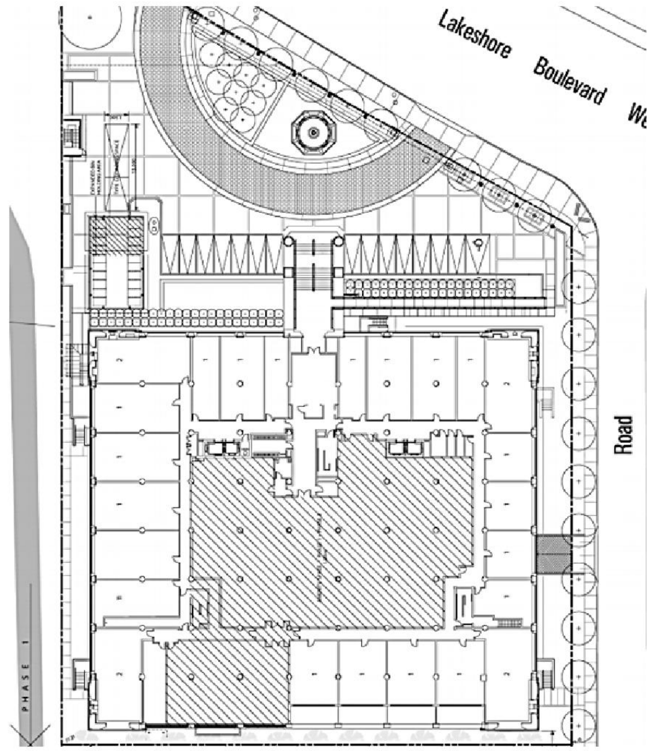

Figure 11: Layout Plan of Tip Top Lofts at Ground level (City of Toronto, 2004)

4.1.2. Post Conversion:

Context Development company acquired the industrial site in 2002 and their proposal was to develop the industrial site in two phases. The heritage fast track process was adopted along with heritage ease agreement with Phase 1 scheduled for the rehabilitation work of the historic structure and Phase 2 scheduled for new development on the south part of the site (City of Toronto, 2002). The rehabilitation work undertook a period of four years from design stage till project completion by 2006. An extension of six floors of penthouses was built atop the existing fifth floor of the existing building. Its overall (exterior) building height came to 47.5m. The converted building comprised of 243 residential units, including two-level penthouses above the existing structure with 50 different layouts varying from 55.74m² to 240m². The original ceiling height of the typical floors was 4.28m within the existing structure while the ceiling height inside the lobby was 4.55m and for the penthouse suites (extended building), average floor to floor height was between 2.8m to 3.0m.

In a conversation on 23rd January 2014, the architect, B.Robinson explained on how the original plan was to build the new building extension out of concrete above the existing concrete structure. But the structural engineers felt that if the concrete material was chosen for the building extension, then it would be limited to four storeys due to its load-bearing weight. Therefore, lightweight steel construction was chosen as the main frame type with exterior insulation finish systems (EIFS) in order to enable six additional storeys atop the existing roof. Steel transfer structure with crawl space was introduced on the sixth floor level as extra reinforcement. Since the floor layouts were different from those above the existing structure, the crawl space served the purpose of transferring out mechanical works such as piping, fittings, etc. The steel transfer structure was tied into the elevator shear walls along with the new stair wells and existing columns for extra support (personal communication, January 23, 2014).

From the documentations, it was evident that the new steel construction was set back by three metres from the concrete structure on the fifth floor level with full height glazing to the eleventh floor level as per heritage regulations. Thus the setback space served as open terraces without any damage to the decorative elements on the parapet walls. The exteriors of the building were kept intact while the configuration work was done within the interiors of the building.

The architect, B.Robinson confirmed that the heritage designated fountain was removed from the frontage lawns of the existing building so that excavation work on three underground levels could be carried out for additional parking. Once the construction was over, the fountain was restored to its original position. Even the decorative elements along with the signboard were maintained and restored whenever renovation was carried out within exterior and interior works. The existing basement level was maintained without any changes except for the connection between main entrance stairs and ramp was constructed for access to the parking underneath (personal communication, January 23, 2014).

Zoning: As per original zoning, it was industrial type; therefore an application was made in 2002 for rezoning to permit residential conversion of the existing industrial building; for both approval of the proposed six-storey addition and to increase residential density to 24,763 m^2 for the complex (City of Toronto, 2002).

Code Compliances:

- As per residential occupancy standards, it was found that existing car parking requirements were less than required. Therefore, the front parking area was excavated beneath to incorporate additional parking (155 indoor parking bays) on three underground levels along with 15 outdoor bays.
- Barrier free ramp was installed next to the entrance stairs for accessibility.
- Since there was only one existing stairwell, four new elevators were installed along with two new stairwells built on opposite sides of the building due to change of

occupancy from industrial type “F” to residential type “C” according to number of occupants.

- According to B.Robinson, there were code issues as per acoustic requirements and fire-ratings within the existing interior walls as per the proposed residential occupancy. Therefore all interior walls were demolited and replaced by new partition walls to ensure not only code compliances from both fire rating standpoint and meeting acoustic requirements, but also for interior configuration (personal communication, January 23, 2014).
- The architect, B.Robinson was questioned about whether any problems with asbestos or harmful substances were faced in the existing building, his assumption was that the contractors had taken care of the asbestos removal prior to the building conversion (personal communication, January 23, 2014).

4.1.3. Observations:

Architectural documentations: It was observed that the pre-conversion drawings were not archived and post-conversion archived drawings were on transparent paper. On further analysis of the drawings, insulation was not evident on the existing building exteriors because it was mandatory to maintain the original condition with art-deco elements as per heritage act, therefore the metal stud furring with semi-rigid insulation on the inner perimeter walls was provided for the existing structure. And for the extension building, it comprised of exterior insulation finishing system (EIFs). Since the massive window openings were grandfathered[43], they were maintained in their sizes. But existing window glazings were replaced by insulated glazing units (IGU's).

Mechanical systems: According to the mechanical engineers, existing documentations of both original and existing mechanical systems were not archived once the project completed its construction (email communication). But the architect, B. Robinson confirmed that the previous mechanical and electrical systems were replaced by new energy-efficient systems. The old mechanical systems were not reused due to its worn out condition (obsolescence). But the mechanical systems were different for the existing structure and new extension. For mechanical working, the two-pipe heat pump system was installed in each unit of the building while the radiant system installed on the perimeter provided heating comfort for the existing structure. Sometimes more than two heat pumps were provided for the residential units, depending on their sizes (personal communication, January 23, 2014). On visual observation, exposed duct work was evident within the existing structure. The mechanical station, cooling towers and the elevator machine rooms were installed on the roof.

[43] Grandfathered means legal use of a property based on the legal existence of the use prior to a modification of zoning ordinance or building code

4.1.4 Summary of Findings:

	Before Conversion	**Post Conversion**
Zoning	Industrial Commercial (density 3.0 times area of plot); Residential uses not permitted	Rezoned and Residential density increased to 24,763 m^2
Occupancy	Group F (Industrial)	Group C (Residential)
Building Parameters		
Built Form	U-shaped	Unchanged with new extension atop existing
Depth of Floor Plate	16m	Unchanged
Heritage Designation	Added to City of Toronto Inventory of Heritage Properties in 1973	Officially under Part IV of the Ontario Heritage Act in 2003 and registered in Heritage Easement Agreement
Number of Floors	5	11
Building Height	25m (Towers incl.: 31.44m)	47.5m
Frame type	Concrete	Unchanged
Ceiling height	4.28m(Typical); 4.55m(Lobby)	Unchanged
Building Extension (New Construction)		
Frame type		Lightweight steel
Exterior wall cladding		EIFS
Floor to Floor height		3m
Number of Units		243 units
Dwelling type		Suites (existing); two-level penthouse (within building extension)
Architectural Drawings		Available
Mechanical Drawings		Not archived
Code Compliances for Existing Structure only (Post Conversion)		
Acoustic		Existing demolished; New
Fire Rating		Existing demolished; New
Lifts/Stairs	Existing stairs demolished	2 new lifts;2 new stairs
Parking Requirements		Additional 155 car bays (excavated in front)

4.2 Printing Factory Lofts at 201 Carlaw Avenue, Toronto[44]

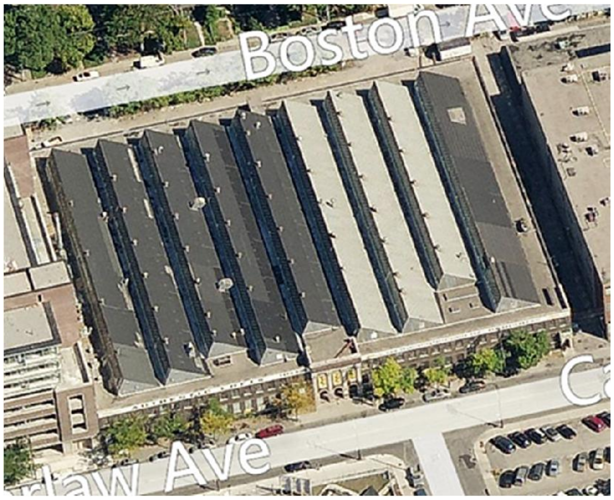

Figure 12: Before Conversion: Printing Factory (Bing Maps, 2014)

Figure 13: Post Conversion: Printing Factory Lofts (ArchDaily, 2011)

4.2.1 Before Conversion:

The lithography and printing facility was originally created in 1917 after two rival firms amalgamated to form Rolph-Clark-Stone Limited. It was located at Leslieville, one of the former industrial districts within Toronto. Its main function was for the printing presses and therefore its occupancy type was defined as industrial (ArchDaily, 2011).

Zoning: The existing site was previously zoned as Employment lands. Around 1999, it was rezoned to mixed industrial-residential type with maximum height limit of 18 metres. It was enforced as part of Carlaw/Dundas neighbourhood improvement plan for Toronto (City of Toronto, 2006).

Built Form: The original building was built as a rectangular three-storey masonry structure with the classical main entrance portico faced towards Carlaw Avenue and

[44] Refer to Appendix D for construction drawings and calculations for demolished area

constructed on a raised underground level for workers's parking (Figure 10). The rectangular site along with building measured 97.49m (length) and 89.47m(depth). Its building area was 7347 m^2. The building was clad with red brick walls and concrete bands above recessed windows. It exhibited typical industrialized features such as concrete floors, concrete columns, exposed brick masonry walls, high ceilings with heights up to 7.3m. Industrial saw-tooth skylights were provided for the workers' daylighting purposes (City of Toronto, 2006).

4.2.2 Post Conversion:

The joint venture between Montgomery Sisam Architects and Chandler Graham Architects converted the abandoned industrial complex to a mixed type of residential development. The residential complex consisted the central core of an eight storey condominium tower (new construction) flanked by two garden courtyards on either sides at podium level and surrounded by the U-shaped existing structure (Figure 11). Furthermore, three groups of stacked townhouses (new construction) were located behind the condominium tower and faced towards Boston Avenue on the east (ArchDaily, 2011).

Heritage Designation: Prior to building conversion, this industrial building was not even heritage designated[45]. After submission of the building permits, the factory building was only recommended for inclusion on the City of Toronto Inventory of heritage properties[46] in 2007. Therefore the West (Main) façade facing Carlaw Avenue along with first three

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[45] Designated is a term for properties under Part IV of the Ontario Heritage Act, or are located within a Heritage Conservation District designated under Part V.

bays of South façade and its interior lobby with the staircase were listed as the heritage attributes (City of Toronto, 2006).

Zoning: Even though the site was already zoned as mixed industrial-residential type, the rezoning application was made to increase building height from 18m to 28.5m and from 127 live-work units to 274 live/work units. Also the site was located between higher density mixed use areas on the north and lower density residential buildings on the east. Therefore, the proposed development in terms of massing showed a transition in between the higher scale of the condominium tower on the north and west and the low scale height of three storey townhouses on the east of Boston Avenue. Furthermore, the sun and shadow studies were also performed to show proof of access to light by adjacent streets and residences. The application got approved from the Municipality in 2006 (City of Toronto, 2006).

Built form: The mixed type of residential complex preserved the front façade and south façade of the existing factory building as per heritage restrictions. About 65%[47] of the central part of the existing structure were demolished into a U-shaped configuration bordering the north, west and south property lines as seen in figure 12. The U-shaped building (existing structure) was converted to live/work units, with two-level units at ground level and underground level.

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[46] **"Listed"** is a term used for heritage elements or properties built within Toronto for which Toronto City Council has adopted a recommendation to be included on the Inventory. It is based on criteria related to architecture, history, and neighborhood context. Such inclusion is a clear statement that such heritage attributes of these properties should be preserved. This procedure is typically used before recommended for Ontario Heritage Act

[47] Please refer to Appendix "D" for detailed calculations of demolished areas specified in layout plans

Above: View of the stacked townhouses on the East behind the glazed condominium (KellerWilliams, 2014)

Above: Industrial site before construction

Above: Demolition of the central part

Above: Existing Residential Complex

Figure 14: Design strategies employed in the residential development seen on right (ArchDaily, 2011)

The reason for this demolition was necessitated due to deep floor-plate issues, therefore narrow residential floor plates were designed on an average of six metres depth on opposite sides of existing structure. The cutouts within the residential complex were implemented for daylighting and natural ventilation. The residential unit sizes varied from 50m² to 175 m². As per OBC minimum requirements, the ceiling heights for newly built townhouses was 2.7m; 3m for condominium and for existing live/work units, their ceiling heights varied from 3m to 7.3m. The conversion project completed its construction in 2010 and its overall project area including 274 residential units was calculated to be 21,470 m².

Code Compliances: Typical fire rating upgrades also involved fire escape stairs; acoustic separation requirements; accessibility requirements such as ramps, etc. Furthermore, 257 parking spaces were provided for the whole residential complex which includes 224 spaces for residents and 33 spaces for visitors (City of Toronto, 2006).

Elements reused: The window opening sizes were maintained within the existing structure and some of the original sawtooth industrial skylights were integrated into the two storey loft units within the existing structure; Existing supply lines were reused for mechanical services (B.Collard, personal communication, February 21, 2014).

Elements demolished:

- Some of the original steel trusses for the skylights were replaced with structural metal stud framing systems because the steel trusses were too embedded within the demising walls (B.Collard, email communication, February 24, 2014)
- 65% of existing structure were demolished for U-shaped building configuration bordering the north, west and south property lines
- architectural ceilings; partition walls; exterior metal fire escape stairs; roof membranes and roof cladding due to their worn out condition (obsolescence).

4.2.3 Observations:

From both existing documentations and site observation, it was evident that the heritage designated facades were not insulated on both sides of the walls, but the rest of the complex were insulated and constructed as per current standards for new construction within OBC.

4.2.4 Summary of Findings:

	Before Conversion	**Post Conversion**
Zoning	Mixed Industrial-Residential; Total gross floor area permitted up to three times of plot area (Residential floor area should not exceed 2.0 times of plot area) Maximum allowable height: 18m	Approved to increase from 127 units to 274 units; Increase permitted height to 28.5m for the Condo in central part; Mixed type Approved as per massing
Occupancy	Group F (Industrial)	Group C (Residential)
Building Parameters (only Existing Structure)		
Built Form	Square-shaped	U-shape (65% demolished)
Depth of Floor Plate (Existing Structure)	75.461m x 91.382m	19m (West); 14.2m (North & South)
Heritage Designation	No	Listed after submission of permits; Front (West) façade; first three bays of South façade; flat roof above heritage-designated façades; entrance lobby and staircase
Number of Floors	2	3
Building height	9.8m	Unchanged
Frame type	Masonry	Unchanged
Ceiling height	7.3m	Varies
Insulation	No	Not for heritage structure;
Dwelling type	n/a	2-level Penthouse (existing); Suites (New Condominium); Townhouses (New)
Number of Units		274
Building Parameters (Condo Tower)		Building Height: 28.36m+4m (mechanical); Floor plate depth: 12.5m; 9 floors
Architectural Drawings		Available
Mechanical Drawings		No response
Code Compliances (for Existing Structure)		
Acoustic		Existing demolished; New
Fire Rating		Existing demolished; New
Lifts/Stairs	Existing stairs maintained	4 new stairs; existing stairs
Parking Requirements		257 car bays (excavated beneath Condominium Tower)

4.3 Imperial Plaza Residences, 111 St Clair Avenue West, Toronto[48]

Figure 15: Historic View of Imperial Oil Headquarters (Barnicke, 2007)

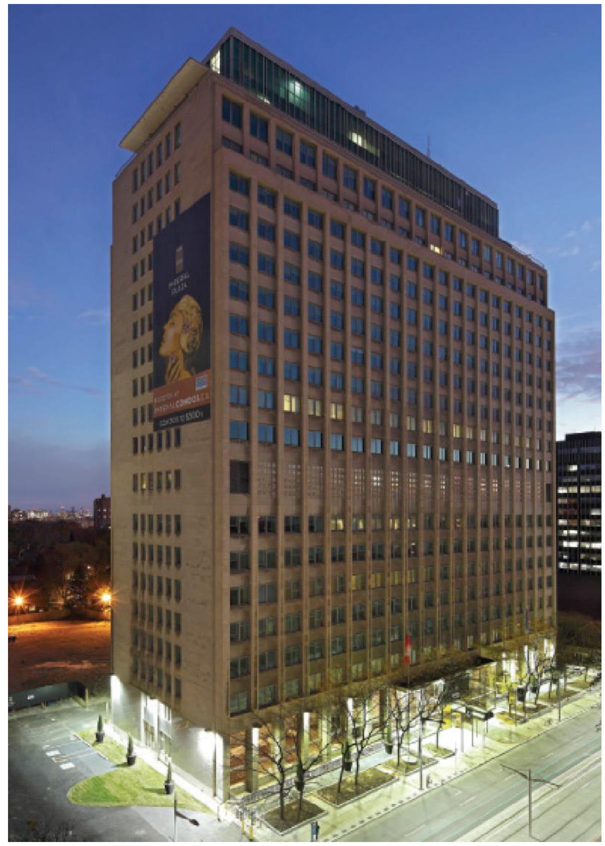


Figure 16: Present View of Imperial Plaza (Camrost-Felcorp, 2011)

4.3.1 Before Conversion:

The original building was built as the Imperial Oil Corporate Headquarters in 1957 and designed by the architectural firm, Mathers and Haldenby. Originally designed for Toronto's City hall, Nathan Phillips (Previous Mayor of Toronto during 1955) held an international competition and in the end, Imperial Oil bought the design for their head office in Toronto. The Imperial Oil Building is located two blocks west of Yonge Street

[48] Refer to Appendix E for working drawings and construction details

and St. Clair and situated close to the subway transit in Toronto (City of Toronto, 2011) (Micallef, 2011).

Zoning: Mixed Used Areas (City of Toronto, 2012)

Built Form: The exterior building footprint measured in length of 74.37m (244feet) and width of 25.91m (85feet). The headquarters comprised of twenty floor levels of office space above grade, including the owner's two-storey penthouse at the rooftop set back on the flat roof with an observation deck and three floors for mechanical rooms at the rooftop level (figure 13). Three underground levels were provided only for building services and 350 outdoor parking bays for the office staff and workers. The total area of the old building was calculated to be 37,904 m² (Barnicke, 2007).

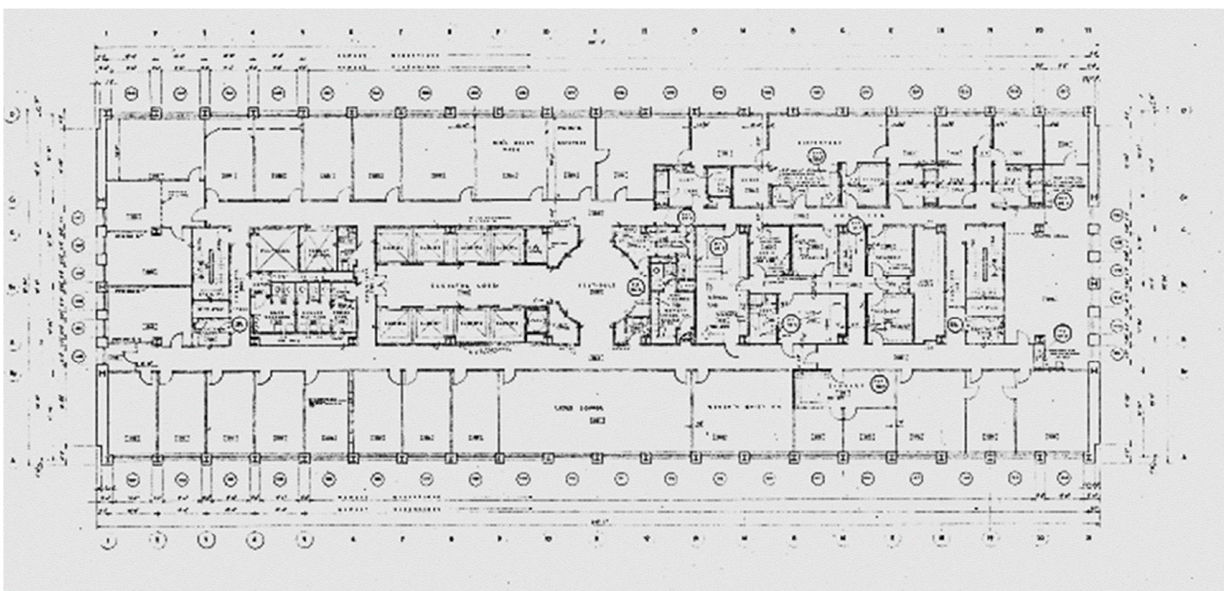


Figure 17: Built form of Imperial Oil Building before conversion (R.Rowbotham, personal communication, May 5, 2014)

Heritage Designation: In February 2005, the Imperial Oil building was listed in the Inventory of Heritage Properties by City of Toronto and then legally designated on October 4, 2012 under Part IV of Ontario Heritage Act. Since the building was one of the first steel-framed types in Canada, therefore it was heritage-designated. Other aspects such as exterior limestone façade, marble and granite lobby, 10 metres high wall murals "The Story of Oil" and domed ceilings were also heritage designated (City of Toronto, 2012).

Construction Technology: The exterior façade was of Indiana Limestone cladding for the upper floors and polished pink granite for the lower two floors located at the base of the building. The original frame type was welded structural steel system. The floor type was tile/carpet over concrete filler on precast concrete slabs and ceiling type was plaster. The original two elevator banks comprised a total of eight elevators along with freight elevator. The original glazing of the windows were of single-glazed type. The original light fixtures included a built-in cooling coil to assist in removing the heating load (Barnicke, 2007)

Original Mechanical Systems (Barnicke, 2007):

- three natural gas fired boilers and fuel oil as back up; 8036 kW (27,420,000 BTU/h); perimeter hydraulic heating radiators (sill heaters) embedded into exterior walls; heating coils (peripheral heaters) mounted in ceilings for offices
- Two chillers in lower basement and cooling towers on top level with 600/800 tons
- Twelve air handling units provided ducted supply and return air to all areas.

4.3.2 Post Conversion:

After the Imperial Oil Company relocated their operations to Calgary in 2004, the office building was vacant for five years. In 2009, the developers, Camrost-Felcorp purchased the site along with vacant office building in 2010 and hired the architects, OneSpace Unlimited for the building conversion (Micallef, 2011). The proposal for the site was in two phases, first phase was to renovate the office into 23 storey residential building and second phase was to construct townhouses behind the Condominium (City of Toronto, 2012). It was converted to “The Residences of Imperial Plaza” with 403 residential units with varying sizes from 51.56m² (555ft²) to 445.93m² (4800ft²); the construction started in 2011 and completed in 2014.

Zoning: Mixed Used Areas (City of Toronto, 2012)

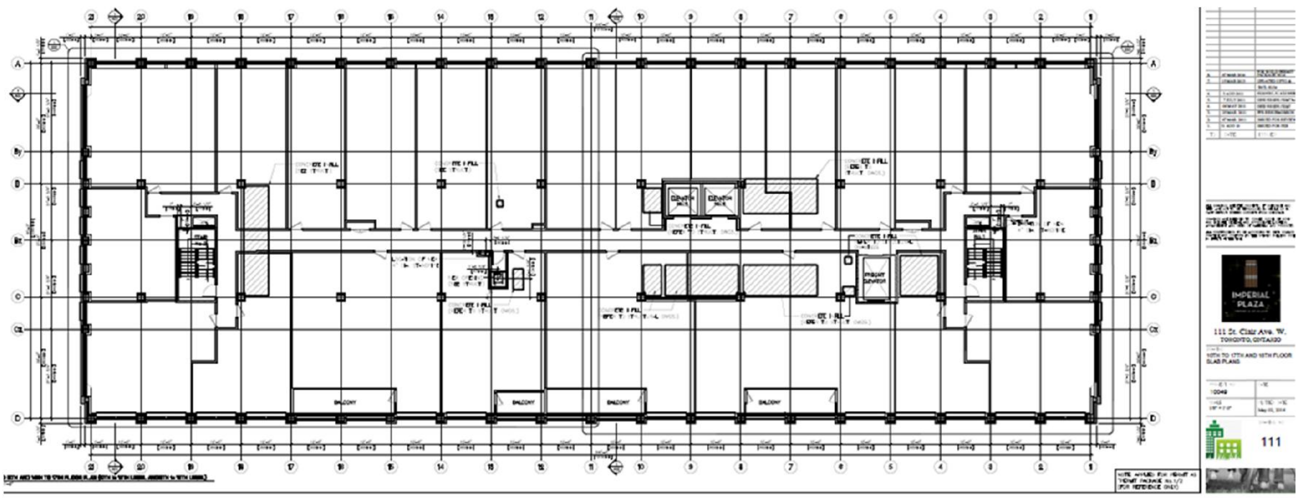


Figure18: Built form of Imperial Plaza after conversion (R.Rowbotham, personal communication, May 5, 2014)

Built Form: The existing building was maintained in its rectangular built form without any changes to its exterior façade, but the interiors were demolished for reconfiguration of residential units (Figure 16). The wood paneling in the lobby suffered moisture damages from the recent floods, therefore it was stripped. Some ceiling openings were filled up at certain floor levels; both eighth and ninth floors had ceiling heights of 4.88m (16feet) which comprised of outdated air-exchanger and heavy-duty pipes and they were all demolished. As a result, 54 two-storey lofts were inserted both on eighth (24 lofts) and ninth floors (30 lofts). The existing mechanical system was also demolished from the roof and additional residential floors were added to the vacant space. All the existing space-consuming massive mechanical equipment were removed from basement levels and the vacant space was designed for amenities such as indoor pool, lounges, fitness centre and retail areas. All existing windows, glazing and frames were replaced by extruded aluminium double-glazed sealed units, even though the existing window openings were maintained. All electrical fixtures were replaced also. Overall building area was calculated to be 42,746m² (R. Rowbotham, personal communication, May 5, 2014).

Code compliances as per Residential Occupancy, Type “C”:

- Rezoning application was made for site plan approval and additional parking requirements were provided in the three existing underground levels.
- Rest of the code compliances were followed according to both parts 3 and 9 of OBC. All aspects of OBC section 3.8 have been addressed for accessibility barrier-free design throughout. Asbestos was removed as part of demolition work. Acoustic requirements of the OBC were addressed also.
- Major challenges were faced due to difficulties in working within existing welded steel framing and floor systems because of upgrades required for fire ratings and acoustic separations as per OBC standards (the architect, R.Rowbotham, personal communication, May 8, 2014).

4.3.3 Observations:

From analysis of the documentations, it is evident that the floor plate depth was found to be 26.75m before building conversion. But the floor plate depths varies on different levels for residential suites and the maximum depth was found to be 12.5m for each residential suite. Interior ceiling heights varied from 2.7m to 4.5m, but higher in some penthouses. Each floor plate measured 180m² with existing column spacing of 3.7m (12ft) x 8.84m (29ft). The existing window sizes were 3m (10 ft) wide by 2.6m (8.5 ft) in height and its sill height was 0.76m (30 inches).

According to R.Rowbotham, the architect explained that there was no insulation anywhere before conversion and since the insulation could not be applied on its exterior façade due to the heritage regulations, spray foam (R19) insulation was instead applied on the interior side of the building envelope for improved energy performance (personal communication, May 5, 2014).

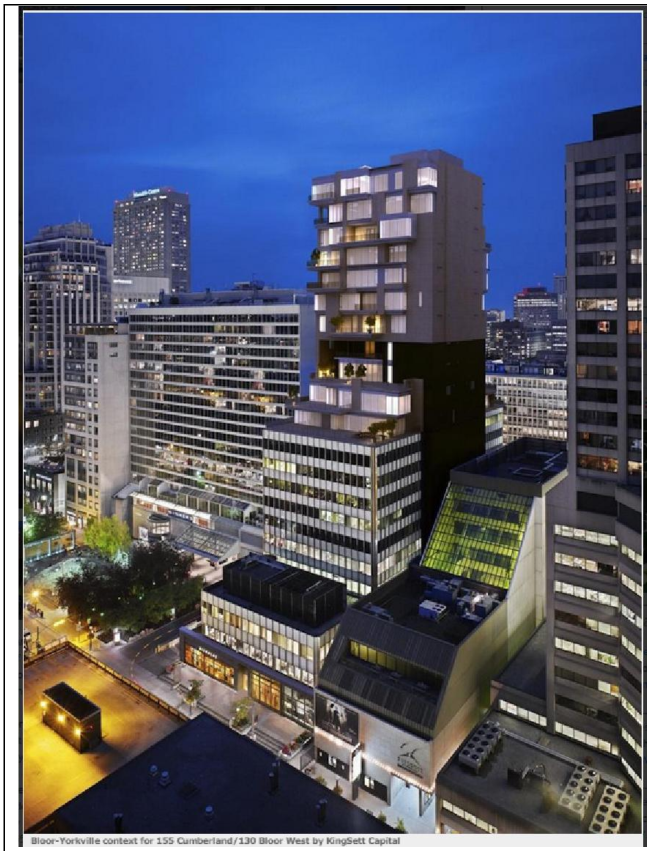
All existing mechanical systems were removed due to their massive size and obsolete conditions and replaced by new compact mechanical technology with 2 pipe fan coil system for both heating and cooling requirements. The rooftop chiller disperses heat to provide air-conditioning and boilers heat water distributed throughout the building for heating (R.Rowbotham, personal communication, May 8, 2014).

R.Rowbotham, the architect, confirmed about whatever evidence of asbestos was removed as part of the demolition work (personal communication, May 5, 2014). Furthermore, the documentations showed that the longer side of the existing building is orientated along east-west axis and research studies have shown that rectangular buildings elongated on east-west axis are better suited for maximizing their daylighting access (Straube, 2012) (Robertson, n.d.)

4.3.4 Summary of Findings:

	Before Conversion	Post Conversion
Zoning	Mixed Use Areas	Unchanged
Occupancy	Group D (Business)	Group C (Residential)
By Year	Original built: 1957	Construction: 2011-2014
Building Parameters (Existing Structure)		
Built Form	Rectangular	Unchanged
Length x Depth	75m x 26.75m	Unchanged
Depth of Floor Plate	Office: 6.5m (opposite sides)	Residential suite: 12.5m (on opposite sides)
Heritage Designation	Yes; Listed since 2005	Officially designated in 2012
Number of Floors	23 floors (19 typical + 1 penthouse + 3 mechanical)	Unchanged (3 mechanical floors converted to residential)
Building height	90m	Unchanged
Frame type	Welded Structural Steel (Limestone Cladding for upper floors; Polished Granite for Lower floors)	Unchanged
Ceiling height	Varies (2.7m-4.8m)	Unchanged
Insulation	Not insulated	Spray foam (R19) applied on interior side of existing heritage structure
Dwelling type	n/a	2-level Penthouse (Input of Mezzanine Levels on 8th and 9th Floor levels); Suites (other)
Number of Dwelling	n/a	403
Architectural Drawings	Available	Available
Mechanical Drawings	Available from online sources	No response
Mechanical systems	Natural Gas Boilers for heating; Cooling towers and chillers; Air handling units	Replaced by high performance 2-pipe fan coil system for heating & cooling
Glazing type	Single	Extruded Aluminium Double Glazed Units
Code Compliances (Interior Areas within Existing Structure)		
Acoustic Separation		Existing demolished for New
Fire Rating		Existing demolished for New
Lifts/Stairs	Existing stairs maintained	2 existing stairs; 8 existing lifts closed; 2 new lifts
Parking Requirements	Existing Outdoor parking provided for 350 cars	Additional car bays provided on 3 existing basement levels

4.4 Residences at 130 Bloor Street West, Toronto



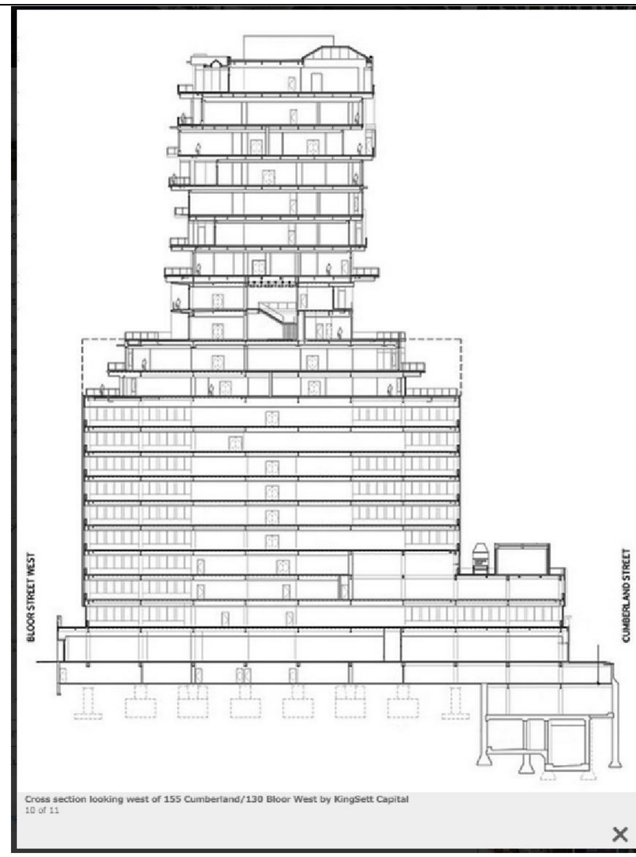


Figure 19: Mixed-Use Complex at 130 Bloor Street and Building Section (ArchDaily, 2011)

4.4.1 Before Conversion:

The original office building with the rooftop penthouse was constructed in 1960 built by businessman Noah Torno. It was constructed on top of the existing Toronto subway system in Yorkville. It was designed with retail on ground level and typical offices from 2nd to 12th floor. On each floor level, the office space was 1500m² (16,000 ft²). The penthouse was built with a two-storey central atrium, high ceilings and wood paneled walls. The total floor area of the penthouse is 1000m² (11,000 ft²) plus terrace space of 420m² (4,500 ft²). Furthermore, the original office building comprised of approximately

1900m² (20,000 ft²) of retail space and 3,000m² (140,000 ft²) of office space built above on ten floors along with underground parking facility (ArchDaily, 2011).

4.4.2 Post Conversion:

Quadrangle Architects designed the converted building as an integrated mixed-use project and its construction was completed in 2010. But the existing penthouse was maintained in its originality on the 13^{th} and 14^{th} floor levels because of its heritage-designation and it was set at an asking price for $30 million dollars. The high-end residential suites along with the existing heritage designated penthouse were equipped with a private gated entrance at 155 Cumberland and express elevators to a secluded rooftop and the office building was accessed from Bloor Street through the renovated lobby. The 21-storey mixed-use complex contained 10 floors of office space of 12545 m² (135,000 ft²) above retail shops and on top of the office space, it comprised 15 condominium residences on another 10 floors along with below-grade parking and retail shops at ground level. After converting 11th and 12th floors of the office space to residences, a building extension of seven new floor levels were stacked on top of the penthouse. The extension building was cladded with Indiana limestone and each floor contained high-end individual residential suite. The existing two floors below the penthouse, which were previously used for office space, were cut back to hold four new half-floor residential suites (ArchDaily, 2011).

Built form: The overall rectangular built form contained 21 storey structure with the new extension of seven new floor levels built over the existing penthouse on the 14^{th} floor level. As a result, the overall building height was increased to 88.7m (291 feet) with 14 residential suites and heritage penthouse. Portions of the existing structure on 10th and

11th floors were demolished to create large terraces and residential spaces. As a result, some floors have two residential units and other floors have just one residential suite. Each residential suite ranged from 280m² (3000 ft²) to 560m² (6000 ft²) while the built-up area of the heritage designated penthouse was found to be 1000m² (11,000ft²). Their ceiling heights were 3.35m high with floor-to-ceiling glass to capitalize on the outdoor views of the city (ArchDaily, 2011).

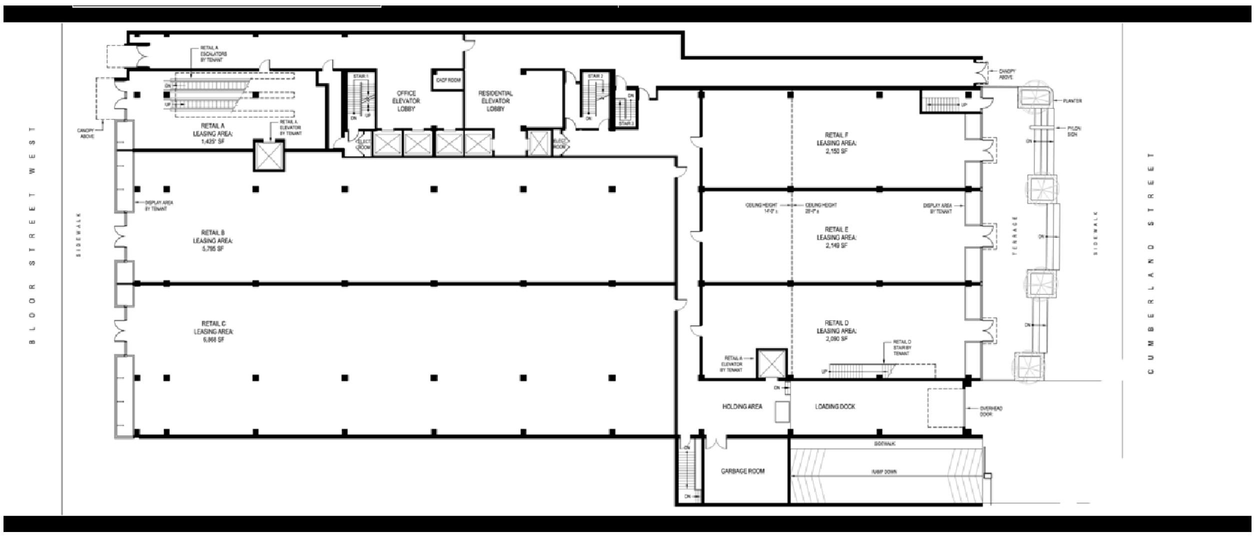


Figure 20: Ground Floor Layout Plan of the Mixed-Use Complex

Code Compliances (Derven, 2010):

- The offices and retail were upgraded to current standards for new construction
- Structural Modifications as per current seismic codes: The existing building was analyzed for its structural capacity. It was found that the addition of seven floors to 130 Bloor Street required reinforcing the existing office building from its top down through the parking garage and around the existing subway system. This method strengthened the building load capacity as well as structural upgrades to

meet new earthquake codes. The architect, Brian Curtner felt that it was a cost-effective solution for the integrated complex (Derven, 2010).

4.4.3 Observations:

It was observed that the existing built form was rectangular and is conveniently accessed on both sides for the residents and workers. Although the offices had generous floor to floor heights, which enabled greater day-lighting potential within the existing building. But it is obvious that only one new residential suite was setback on each floor level to overcome the constraining factor of deep floor plate issues.

4.4.4 Summary of Findings:

	Before Conversion	**Post Conversion**
Zoning	Mixed Use Areas	Unchanged
Occupancy	Group D (Business)	Group C (Residential)
By Year	Original built: 1960	Construction: 2010
Building Parameters (Existing Structure)		
Built Form	Rectangular	Unchanged (for office
Heritage Designation	Yes (only for penthouse)	
Number of Floors	10 floors	21 floors (10 offices + 1 penthouse + 10 residential)
Building height	---	88.7m
Frame type	Steel frame	Unchanged (existing offices) and Limestone Cladding for upper floors (new)
Ceiling height	Varies (2.7m-4.8m)	Unchanged (existing office)
Dwelling type	Retail (ground level) and offices from 2nd-12th floors	Retail (existing); 11th and 12th office floors to residential; Suites (typical)
Number of Dwelling	1	15 (14 new in building extension)
Code Compliances (Interior Areas within Existing Structure)		
Acoustic Separation	--	Existing demolished for New
Fire Rating	--	Existing demolished for New
Lifts/Stairs	2 stairs + for office	3 lifts+1 stairs(office); 1 lifts+1 stairs(residents);2 escalators(retail)
Parking Requirements	Existing underground	Existing underground parking

Chapter 5: Conclusions

5.1 Future Work and Recommendations

Due to the researcher's several attempts to retrieve required data on existing buildings within Toronto, it was felt that there is a strong necessity to create a database for the existing building stock such as building age, typology, construction technology in terms of historical background, building materials, mechanical services, plumbing and electrical systems, total built-up area based on occupancy types within existing buildings in Toronto. Such database can encourage researchers to perform energy assessment, evaluation of renovation potential of the existing building stock and retrofit strategies for building conversion.

Other recommendations for more research work are:

1) Comparison of Energy Utilization Index (EUI)[49] of the converted buildings versus that of new buildings to promote better energy standards for heritage buildings
2) Baseline comparison studies on thermal performance (air-tightness) of building envelope within suites between new building and converted building (heritage and non-heritage) through fan pressurization method.

5.2 Comparison of Case Study Findings:

After analyzing the case studies, the summary findings from each case study building are input and compared for commonalities to determine the key factors as follows:

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[49] EUI stands for Energy Utilization Index and it is calculated by total energy usage divided by gross area of the building

Parameter	Tip Top Lofts	Printing Factory	Imperial Plaza	130 Bloor St.
Previous Function	Warehouse Office	Warehouse	Office	Office
Previous	Group F Industrial	Group F Industrial	Group D Business	Group D Business
Zoning Application	Yes (changed to residential and increase density)	Yes (increase building height as per massing)	No	No
Heritage Designation	Yes	Listed on permit submission	Yes	No (existing); yes (penthouse 13^{th} & 14^{th}))
Architectural Drawing	No	Yes	Yes	No response
Mechanical Information	Not archived	No response	No response	No response
Existing Built form	U-shaped	Square	Rectangular	Rectangular
Converted Built form	Unchanged (with additional floors)	Demolition of centre for U-shape	Unchanged	Unchanged (with additional floors)
Demolished (Exterior)	No	Yes (except façade)	No	Yes (11^{th} & 12^{th} for residential)
Frame	Concrete	Masonry	Welded Steel	Steel
Frame type (New)	Lightweight Steel	Window-Wall	---	--
High Ceilings	Yes (4.2m)	Yes (7.3m)	Varies(2.9-5.3m)	Varies(2.9- 4m)
Floor Plate	Narrow (16m)	Deep (75m)	Moderate (26m)	Deep
WWR	High (unchanged)	High (unchanged)	High (unchanged)	High (unchanged)
Interior	Yes	Yes	Yes	Yes
Elevators	2 new	2 (Condominium)	8 closed & 2 new	New; varies
Staircase	2 new	4 (existing) 2	2 (existing)	2 (existing)
Mechanical	Replaced	Replaced	Replaced	Replaced
Electrical systems	Replaced	Replaced	Replaced	Replaced
Fire Upgrades	Yes	Yes	Yes	Yes
Seismic Upgrades	--	--	--	Yes
Acoustic (Floors)	No (Existing Concrete)	No (Existing Concrete)	Yes (Concrete levelling on top)	Yes
Additional parking requirements	Yes (excavation in front)	Yes (beneath new Condo tower)	No (underground mechanical floors)	No (underground)

5.3 Conclusions

From the research work, it is often found that building conversion is a way of reusing vacant buildings in Toronto; yet both industrial and office buildings posed constraints and benefits during the process of building conversion for the Architects. Like for example, when there is change of use from Industrial type to Residential type, higher parking requirements are often achieved by excavating unused land. Not only for industrial buildings, but also post-war and 1950s office buildings exhibit moderate floor to ceiling heights and deep floor plates, which often are problematic to provide daylighting within residential units. This example could be seen from major demolition of the central portions of this particular industrial building, Printing Factory. The question remains on whether the Printing Factory Lofts should be considered as an adaptive reuse project? The researcher felt otherwise and considered Printing Factory Lofts as any other new project, not adaptive reuse project even though the front and side walls were preserved. Again this project cannot be considered for sustainability especially when the embodied energy from the old building are lost and all of which is added to the carbon footprint of the city. In view of the additional floors, they are suited for industrial buildings due to their high ceilings and it is considered as an investment for developers. But in terms of sustainability, it provides additional housing (live/work) for workers to live closer to their place of employment and minimize transportation from other areas.

It was observed that all the converted buildings were initiated by private developers. Also the developers prefer heritage buildings to non-heritage buildings because of higher return on investment (ROI). The reason could be due to their clientele’s aesthetic preferences and finanacial incentives for heritage development, beneficial for reducing incurred expenses during the later stages of construction. The researcher felt that among the case studies, Imperial Plaza (business occupancy) compared far better than the rest in terms of existing zoning regulations already in place, existing underground levels for parking, simplicity of rectangular built form and less demolition work. When compared to business occupancy and industrial occupancy, the findings concludes that office buildings are better suited for residential conversions than warehouses and industrial buildings, but it depends on type of existing built form and structure type.

Research Goals: The major research goal of this research study was to determine the key factors that influenced residential adaptive reuse projects outcomes. Therefore, the key factors were compiled together along with brief explanations as listed below:

1) Zoning Regulations: Zoning regulations were instrumental for determining building heights as additional floor levels were constructed atop TipTop Lofts, massing as per surrounding buildings and increased residential density for Printing Factory Lofts. Applications for zoning approval were made for TipTop Lofts and Printing Factory Lofts except Imperial Plaza Residences and 130 Bloor Street Residences. Due to additional parking requirements, excavation was undertaken for both industrial buildings. For Bloor Street Residences and Imperial Plaza Residences, existing underground levels were just converted for car parking, even though there was already existing outdoor parking bays due to the previous (business) occupancy for Imperial Plaza Residences only.
2) Physical Characteristics: Building parameters such as floor plate depths and ceiling heights played an important role in spatial configuration for residential suites. Another observation noted that additional two-level units were input for certain floor

levels with ceiling heights greater than 4.6m. Since the minimum ceiling height was 2.3m as per residential standards (Service Ontario, 2014), therefore extra ceiling height was taken advantage by installing mezanine levels for penthouse suites.

3) Built Form (Architectural): The type of existing built form and load capacity of roof are relevant factors that influenced residential adaptive reuse projects written below.

   - For Printing Factory Lofts, the existing square compact form was demolished by 65% due to deep floor plate issues (75m x 91m) and configured into U-shaped form with narrow floor plate depths of 14m surrounding the complex.
   - For TipTop Lofts the existing U-shape built form was maintained, but six additional floors were built on top of the concrete roof due to high load capacity and to take advantage of current zoning regulations for density.
   - For Imperial Plaza Residences, it was observed that the existing rectangular built form was orientated along east-west axis, which is an advantage for reducing electrical demand and maximise daylighting.
   - For 130 Bloor Street Residences, the built form was rectangular with the short edges (width) faced towards the streets and longer edges (length) without any windows due to adjoining walls. Therefore, the new extension was set back from the existing façade for one residential suite per floor from 15^{th} to 21^{st} levels. For the 10^{th} and 11^{th} floors, the interiors were demolished for input of two-level penthouse suites on opposite sides. This strategy was due to deep floor plate issues for 130 Bloor Street Residence.

- Another commonality observed within all the converted buildings that the new construction on the upper floors were setback within line of sight to contribute towards existing streetscape.

Code Compliances for Residential Conversion:

1) Another commonality from the case studies was demolition of interior partitions for fire ratings and fire exiting requirements, acoustic separations and accessibility as code compliances and also for residential configurations. For Imperial Plaza Residences, concrete levelling was poured atop existing floor for acoustic separation. It was found that there were no acoustic issues from the existing concrete floors in other buildings. Even though the architects did not mention any seismic upgrades for most converted buildings except for Residences at 130 Bloor Street West. For the other converted buildings, one possibility could be that they were already structurally sound. Even though Toronto is not in a high-risk seismic area, current codes stipulate that structural upgrades are required for earthquake protection, especially for old buildings. For Residences at 130 Bloor Street West, the existing office building was reinforced from its top down through the parking garage and around the existing subway system underground.
2) Installation of new stairs and new elevators were installed for TipTop Lofts (industrial building) for the occupants but the existing stairs were maintained for both Printing Factory Lofts and Imperial Plaza Residences. The existing elevator shafts were closed and new elevators were installed for Imperial Plaza Residences, but no installation of new elevators for Printing Factory lofts due to its low-rise type (two floor levels).

Energy Conservation Measures addressed within converted building:

1) Even though energy efficiency requirements stipulated from the current building regulations were exempted for heritage buildings, insulation strategies were interior application of spray foam insulation in the case of Imperial Plaza building and interior batt insulation within the existing walls of TipTop Lofts. But there was no evidence of insulation for the existing façade in Printing Factory Lofts (maybe thermal mass could have helped as a passive energy strategy!). Also another observation was that not all case study buildings adopted the same insulation strategy due to different construction materials.
2) Another commonality was observed for outdated mechanical, electrical and glazing systems. Replacing the windows with double glazing types, replacement of HVAC systems and electrical systems with energy efficient ones were typical strategies employed for better energy performance.
3) For the existing window openings in all the case studies, they remained unchanged due to “grandfathered[50] codes”. Since window area or window-to-wall ratio (WWR) is an important variable which affects energy performance in any building, high window-to-wall ratios could lead to unwanted solar heat gains, increased heating and cooling loads, thus costly. But it was considered as a financial advantage for the developers of residential adaptive reuse projects.

[50] "Grandfathered" means legal use of property based on the legal existence of the use prior to a modification of zoning ordinance or building code. In other words, it can be defined as "legal, non-conforming.”

Bibliography

ArchDaily. (2011, July). *The Printing Factory Lofts / Montgomery Sisam Architects*. Retrieved from Selected Works: www.archdaily.com/148969/the-printing-factory-lofts-montgomery-sisam-architects/

ArchitectsAlliance. (2014, January 26). Tip Top Tailors. (Susan, Interviewer)

Ashrae. (2013, October 24). New IECC includes sweeping changes for existing buildings. New Jersey, USA.

Athena . (2004, February). *Minnesota Demolition Survey.* Retrieved from http://www.athenasmi.org/wp-content/uploads/2012/01/Demolition_Survey.pdf

Barnicke, D. (2007, November). *For Sale: 111 St. Clair Avenue West.* Retrieved from CRL Network: http://www.crlnetwork.com/data/CRL0000012384.pdf

Blanchaer. (2013). *Adaptive reuse of older buildings helps meet density requirements.* Retrieved from Daily Commercial News: http://www.dcnonl.com/article/id58266?search_term=architect

Boake , T. M. (n.d.). *Zero is a number: Carbon Neutral Design Pushes the Science back into the Building Envelope.* Retrieved from http://www.tboake.com/pdf/NBEC-zero_paper.pdf

Boehland, J. (2003, February). *Future-Proofing Your Building: Designing for Flexibility and Adaptive Reuse*. Retrieved from Building Green: http://www2.buildinggreen.com/article/future-proofing-your-building-designing-flexibility-and-adaptive-reuse?ip_login_no_cache=fe9f48e40688fb061d880eeff620700d

Bond, C. (2011, June). *Adaptive Reuse: Explaining Collaborations within a Complex Process.* Retrieved from University of Oregon:

https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/11680/Bond%20Adaptive%20Reuse%20final_cbond.pdf?sequence=1

Brand, S. (1997). *How Buildings Learn: What happens after they're built.* London: Phoenix Illustrated.

Brown, W. C. (1997). *Window Condensation in Historic Buildings that Have Been Adapted for New Uses.* Retrieved from NRCAN: http://archive.nrc-cnrc.gc.ca/obj/irc/doc/ctu-n5_eng.pdf

Browning, W., Hartley, A., Corey, S., Ryan, C., & Kallianpurkar, N. (2013). *Midcentury (Un)Modern: An Environmental Analysis of the 1958-73 Manhattan Office Building.* Retrieved from Terrapin Bright Green: http://www.terrapinbrightgreen.com/wp/wp-content/uploads/2014/03/Midcentury-unModern_Terrapin-Bright-Green-2013.pdf

Buhagiar, V. (2009, June). *Occupant Satisfaction in Post-Refurbishment of Historic Buildings.* Retrieved from PLEA 2009 - 26th Conference on Passive and Low Energy Architecture: http://www.plea2009.arc.ulaval.ca/Papers/2.STRATEGIES/2.3%20Post-Occupancy%20Evaluation/ORAL/2-3-03-PLEA2009Quebec.pdf

Bullen, P. (2007). *Adaptive reuse and sustainability of commercial buildings.* Retrieved from Facilities: http://www.emeraldinsight.com/journals.htm?articleid=1593178

Bullen, P., & Love, P. (2011). *Factors influencing the adaptive re-use of buildings.* Retrieved from Journal of Engineering, Design and Technology, 9(1), 32-46.: http://media.proquest.com/media/pq/classic/doc/2657902871/fmt/pi/rep/NONE?hl=&cit%3Aauth=Bullen%2C+Peter%3BLove%2C+Peter&cit%3Atitle=Factors+influencing+the+adaptive+re-

use+of+buildings&cit%3Apub=Journal+of+Engineering%2C+Design+and+Technology&cit%3Avol=9

Burton, B. (2013, April 17). Retrieved May 2, 2013, from Monster Commercial: http://www.monstercommercial.com/adaptive-re-use-of-buildings-part-2/

Camrost-Felcorp. (2011). *Imperial Plaza.* Retrieved from http://www.imperialcondos.ca/

Canadian Mortgage and Hosuing Corporation. (2013). *Enhancing Energy Performance.* Retrieved 2013, from Healthy High-Rise: http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/hehi/upload/Enhancing-Energy-Performance.pdf

Cantell, S. F. (2005, May). *The Adaptive Reuse of Historic Industrial Buildings: Regulation Barriers, Best Practices and Case Studies.* Retrieved from Virginia Polytechnic Institute and State University: http://sig.urbanismosevilla.org/Sevilla.art/SevLab/r001US1_files/r001_US_1.pdf

City of Toronto. (2002, June 17). *Tip-Top Tailor Building: Application to amend Zoning By-law 436-86.* Retrieved from Toronto Staff Report: http://www.toronto.ca/legdocs/2002/agendas/committees/to/to020702/it009a.pdf

City of Toronto. (2002, June 5). *Toronto Staff Report.* Retrieved from www.toronto.ca/legdocs/2002/agendas/committees/to/to020917/it016b.pdf

City of Toronto. (2003, April 16). *637 Lake Shore Boulevard West: By-Law No. 261-2003.* Retrieved from Toronto City Council and Committees: http://www.toronto.ca/legdocs/bylaws/2003/law0261.pdf

City of Toronto. (2004, April 19). *Preliminary Report: Phase 2 of 637 Lakeshore Blvd.* Retrieved from Toronto City Council and Committees: By-laws and Municipal Code: http://www.toronto.ca/legdocs/2004/agendas/committees/ts/ts040504/it019.pdf

City of Toronto. (2006). *201 Carlaw Avenue: Rolph-Clark-Stone Limited Building* . Retrieved from Reasons for Listing : http://www.toronto.ca/legdocs/mmis/2007/te/bgrd/backgroundfile-1048.pdf

City of Toronto. (2006, June 27). *Rezoning of 201 Carlaw Avenue.* Retrieved from Toronto Staff Final Report: http://www.toronto.ca/legdocs/2006/agendas/committees/te/te060711/it006.pdf

City of Toronto. (2007, January 22). *201 Carlaw Avenue – Inclusion On Heritage Inventory.* Retrieved from Staff Report Action Required: http://www.toronto.ca/legdocs/mmis/2007/te/bgrd/backgroundfile-1046.pdf

City of Toronto. (2011, August 18). *Intention to Designate and HEA- 111 St.Clair Avenue West.* Retrieved from Staff Action Report: http://www.toronto.ca/legdocs/mmis/2011/te/bgrd/backgroundfile-40063.pdf

City of Toronto. (2012, January 25). *111 St Clair Avenue West.* Retrieved from Official Plan and Zoning Amendment Applications: http://www.toronto.ca/legdocs/mmis/2012/te/bgrd/backgroundfile-44828.pdf

City of Toronto. (2012, October). *To designate the property at 111 St. Clair Avenue West (Imperial Oil Building)* . Retrieved from BY-LAW No. 1234-2012 : http://www.toronto.ca/legdocs/bylaws/2012/law1234.pdf

City of Toronto. (2013, May 23). *Toronto Green Standard Review and Update.* Retrieved from http://www.toronto.ca/legdocs/mmis/2013/pg/bgrd/backgroundfile-59341.pdf

City of Toronto. (2014). *Heritage Preservation Services*. Retrieved from http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=104752cc66061410VgnVCM10000071d60f89RCRD

City of Toronto. (2014). *Tier 1 Checklist & Standards: Information for Developers and Consultants.* Retrieved from Toronto Green Standard: http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f85552cc66061410VgnVCM10000071d60f89RCRD

CMHC. (1996). *Kings Regeneration Initiative.* Retrieved from Residential Intensification Case Studies: Municipal Initiatives: http://www.cmhc-schl.gc.ca/en/inpr/su/sucopl/upload/The-Kings-Regeneration-Initiative-Toronto-Ont.pdf

CMHC. (2004, January). *Residential Intensification Case Studies.* Retrieved from Research Report: http://www.cmhc-schl.gc.ca/odpub/pdf/63520.pdf?fr=1358005023062

CMHC. (2006). *Canadian Housing Observer.* Retrieved from Canada Mortgage and Housing Corporation: http://www.cmhc-schl.gc.ca/odpub/pdf/65102.pdf?lang=en

Colantonio, A. (1997). *Thermal Performance Patterns on Solid Masonry Exterior Walls of Historic Buildings.* Retrieved from Journal of Building Physics: http://jen.sagepub.com/content/21/2/185

Cole, R. J., & Kernan, P. C. (1996, July). *Life-Cycle Energy Use in Office Buildings.* Retrieved from Building and Environment: http://www.sciencedirect.com/science/article/pii/0360132396000170#

Collard, B. (2014). Printing Factory Case Study. (S. Puttoo, Interviewer)

Connor, J. (2004, October). *Survey on actual service lives for North American buildings.* Retrieved from http://cwc.ca/wp-content/uploads/2013/12/DurabilityService_Life_E.pdf

Crawley, D., Hand, J., Kummert, M., & Griffith, B. (2005, July). *Contrasting the Capabilities of Building Energy Performance Simulation Programs.* Retrieved from U.S.Department of Energy:

http://apps1.eere.energy.gov/buildings/tools_directory/pdfs/contrasting_the_capabilities_of_building_energy_performance_simulation_programs_v1.0.pdf

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* Retrieved from Harvard University: http://isites.harvard.edu/fs/docs/icb.topic1334586.files/2003_Creswell_A%20Framework%20for%20Design.pdf

CRHP. (2012). *Standards and Guidelines for the Conservation of Historic Places in Canada*. Retrieved from Canada's historic places: http://www.historicplaces.ca/media/18072/81468-parks-s+g-eng-web2.pdf

Douglas, J. (2006). *Building Adaptation.* Oxford, UK: Elsevier Ltd.

Douglas, J., & Ransom, B. (2007). *Understanding Building Failures.* New York: Taylor & Francis Group.

Durmisevic, E. (2009, June). *Lifecycle Design of Buildings, Systems & Materials.* Retrieved March 9, 2013, from International Council for Research and Innovation in Building and Construction: http://cibworld.xs4all.nl/dl/publications/Pub323.pdf

Eldemery, I. (2014). *Green Urban Communities Sustainability & Energy Efficiency.* Retrieved from 2014 International Conference on Future Environment and Energy: http://www.ipcbee.com/vol61/020-ICFEE2014-S3005.pdf

Ferdous, T. (2012). *Determining The Effect Of Building Geometry On Energy Use Patterns Of Office Developments.* Retrieved from Theses and Dissertations: http://digital.library.ryerson.ca/islandora/object/RULA:1483

Futcher, J. A., Kershaw, T., & Mills, G. (2013, April). *Urban form and function as building performance parameters.* Retrieved from Building and Environment: http://www.sciencedirect.com/science/article/pii/S0360132313000449

Goertz, G., & Mahoney, J. (2012, November 27). *Methodological Rorschach Tests: Contrasting Interpretations in Qualitative and Quantitative Research.* Retrieved from Sage Journals: http://cps.sagepub.com/content/early/2012/11/27/0010414012466376

Goncalves, J. C. (2010). *The Environmental Performance of Tall Buildings.* London & Washington, DC: Earthscan Ltd.

Govt of Canada. (2013, 2 25). *Canada's National Model Construction Codes Development System.* Retrieved 4 2, 2013, from National Model Construction Code Documents: http://www.nationalcodes.nrc.gc.ca/eng/code_development.html

Graham, P. (2003). *Building Ecology: First Principles for a sustainable built environment.* Retrieved from ftp://178-84-99-92.dynamic.upc.nl/inetpub/wwwroot/rt/0Portal/book/gr_book/book/23_Building_Ecology_First_Principles_For_A_Sustainable_Built_Environment.pdf

Green, M. (2012). *Building Codes for Existing and Historic Buildings.* New Jersey: John Wiley & Sons, Inc.

Hansen, A. T. (1984, January). *Archived CBD- 230: Applying Building Codes to Existing Buildings.* Retrieved from National Research Council Canada: http://archive.nrc-cnrc.gc.ca/eng/ibp/irc/cbd/building-digest-230.html

Hutcheon, N. B. (1969, June). *Archived CBD-114 Safety in Buildings.* Retrieved from National Research Council Canada: http://archive.nrc-cnrc.gc.ca/eng/ibp/irc/cbd/building-digest-114.html

Hutcheon, N., & Handegord , G. (1995). *Building Science for a Cold Climate.* National Research Council of Canada.

IBI Group. (2000, May). *Service Life of Multi-Unit Residential Building Elements and Equipment.* Retrieved from Canada Mortgage and Housing Corporation: http://www.cmhc-schl.gc.ca/odpub/pdf/62280.pdf?fr=1373564715188

International Code Council. (2011, April). *2012 International Existing Building Code.* Retrieved January 15, 2013, from Law Resource: https://law.resource.org/pub/us/code/ibr/icc.iebc.2012.pdf

Jackson, M. (2005). *Embodied Energy and Historic Preservation: A Needed Reassessment.* Retrieved from The Association for Preservation Technology International: http://www.jstor.org/stable/40003163

KellerWilliams. (2014). *The Printing Factory: Authentic Loft Living at Queen & Carlaw*. Retrieved from Urbanopolis Realty & Brokerage: http://www.urbanopolis.com/Printing-Factory-Lofts

Kernan, P., & Cole, R. (1996, July). *Life-cycle energy use in office buildings.* Retrieved from Building and Environment: http://www.sciencedirect.com/science/article/pii/0360132396000170#

Kesik, T. (2002, September). *Enclosure Durability.* Retrieved from Architectural Science Forum: http://www.canadianarchitect.com/asf/enclosure_durability/

Kesik, T., & Miller, A. (2008, October). *Toronto Green Development Standard: Cost-Benefit Study.* Retrieved from University of Toronto; John H. Daniels Faculty of Architecture, Landscape and Design:

http://www.daniels.utoronto.ca/sites/daniels.utoronto.ca/files/old/Kesik_TGDS_CB-Study_Oct2008.pdf

Kincaid, D. (2002). *Adapting Buildings for Changing Uses: Guidelines for Change of Use Refurbishment.* London, UK; New York, USA: Spon Press (Taylor & Francis Group).

Landau, J. (2013, September 15). *Imperial Plaza.* Retrieved from UrbanToronto.ca: http://urbantoronto.ca/forum/showthread.php/3894-Imperial-Plaza-(111-St-Clair-Av-W-Camrost-Felcorp-Goldfarb-23s-Onespace-ERA)/page8

Langston, C. (2008). *The Sustainability Implications of Building Adaptive Reuse*. Retrieved from Bond University: http://epublications.bond.edu.au/cgi/viewcontent.cgi?article=1003&context=sustainable_development

Langston, C. (2011). *Green Adaptive Reuse: Issues and Strategies for the Built Environment.* Retrieved from http://download.springer.com/static/pdf/777/chp%253A10.1007%252F978-3-642-15243-6_23.pdf?auth66=1402178731_3820bd736849f8c3626752327087c2cd&ext=.pdf

Langston, C. (2011). *On Archetypes and Building Adaptive Reuse.* Retrieved from Pacific Rim Real Estate Society (PRRES): www.prres.net/papers/langston_on_archetypes_and_building_adaptive_reuse.pdf

Lukman, N. (2011, May 31). *A typological approach to daylighting analysis.* Retrieved from Architectural Science Review: http://www.tandfonline.com/doi/pdf/10.1080/00038628.2011.582374

Maurenbrecher, A., Shirtliffe, C. J., Rousseau, M. Z., & Saïd, M. (1998). *Monitoring the Hygrothermal Performance of masonry wall With and Without Thermal Insulation.*

Retrieved from National Research Council Canada: http://archive.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc42462.pdf

Mawani, J. Z. (1997). *From Office to Home: Adaptive Reuse of Office buildings to Residential Use in the core of the city of Vancouver.* Retrieved January 15, 2013, from University of British Columbia: https://circle.ubc.ca/bitstream/id/16754/ubc_1997-0440.pdf

Merriam-Webster. (n.d.). Retrieved from http://www.merriam-webster.com/dictionary/typology

Micallef, S. (2011, May 04). *The Imperial Oil Building reborn: a Mad Men era.* Retrieved from YongeStreet: http://www.yongestreetmedia.ca/features/imperialplaza0504.aspx

Ministry of Muncipal Affairs and Housing. (2011, July 1). *Supplementary Standard SB-10 Energy Efficiency Supplement.* Retrieved January 25, 2013, from Building Regulations: http://www.mah.gov.on.ca/AssetFactory.aspx?did=9227

MMAH. (2004). *Brownfields Showcase II.* Retrieved from Ministry of Muncipal Affairs and Housing, Ontario: http://www.mah.gov.on.ca/AssetFactory.aspx?did=4860

National Research Council Canada. (2012, November 29). *Historical Editions of the National Construction Codes.* Retrieved May 1, 2013, from http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/historical_codes_titles.html

National Research Council Canada. (2013). *Canada's National Model Construction Codes Development System*. Retrieved from National Model Construction Code Documents: http://www.nationalcodes.nrc.gc.ca/obj/doc/code_development_system.pdf

Natural Resources Canada. (2011, November 15). *Improving Energy Performance in Canada.* Retrieved from Natural Resources Canada: http://oee.nrcan.gc.ca/publications/statistics/parliament11-12/parliament11-12.pdf

Nireki, T. (1996, July). *Service life design.* Retrieved from Construction and Building Materials: http://www.sciencedirect.com/science/article/pii/0950061895000453#

NRCAN. (2002, December). *Survey 2000 Commercial and Insitutional Building Energy Use: Detailed Statistical Report.* Retrieved from Natural Resources Canada: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/data_e/CIBEUS_ENG.pdf

NRCAN. (2011, September). *2008 Commercial & Institutional Consumption of Energy Survey: Summary Report.* Retrieved from Natural Resources Canada: http://oee.nrcan.gc.ca/publications/statistics/cices08/pdf/cices08.pdf

NRCAN. (2012, 11 29). *Historical Editions of the National Construction Codes.* Retrieved from http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/historical_codes_titles.html

NRCAN. (2014, April). *Canada's energy code*. Retrieved from National Resources Canada: https://www.nrcan.gc.ca/energy/efficiency/buildings/eenb/codes/4037

OBOA. (2014). *The Purpose of the Ontario Building Code.* Retrieved from Ontario Building Officials Association: http://www.oboa.on.ca/ps/BuildingCode2014.pdf

Ontario. (2006). *Ontario Heritage Tool Kit*. Retrieved from Designating Heritage Properties: http://www.mtc.gov.on.ca/en/publications/Heritage_Tool_Kit_DHP_Eng.pdf

Potworowski, J. A. (2010, March). *The Transformation of the National Building Code of Canada: From Prescriptions to Objectives.* Retrieved May 1, 2013, from Inter-Jurisdictional Regulatory Collaboration Committee: http://www.irccbuildingregulations.org/pdf/Building_code_case_study.pdf

Preservation Green Lab. (2012, January). *The Greenest Building: Quantifying the Environmental Value of Building Reuse.* Retrieved from National Trust for Historic Preservation:

http://www.preservationnation.org/information-center/sustainable-communities/green-lab/lca/The_Greenest_Building_lowres.pdf

Pressnail, K. D., Gray, S., & Rose, D. D. (2013, March). *Older Masonry Buildings: Exploring the benefits, risks and design approaches for adding interior insulation to historical projects.* Retrieved from Kenilworth: http://www.kenilworth.com/publications/cc/de/201303/files/48.html

Quadrangle Architects. (2012). *Built Work*. Retrieved March 29, 2013, from Quadrangle Architects: http://www.quadrangle.ca/our-projects/built-projects/rogers-broadcast-centre/

Rabun, J., & Kelso, R. (2009). *Building Evaluation for Adaptive Reuse and Preservation.* New Jersey: John Wiley & Sons Inc.

Robertson, K. (n.d.). *Daylighting Guide for Buildings.* Retrieved from Canada Mortgage and Housing Corporation: http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/Daylighting-Guide-for-Buildings.pdf

Rowbotham, R. (2014). Imperial Plaza Residences Case Study. (S. Puttoo, Interviewer)

Sartori, I., & Hestnes, A. G. (2007, March). *Energy use in the life cycle of conventional and low-energy buildings: A review article.* Retrieved from ScienceDirect: Energy and Buildings: http://www.sciencedirect.com/science/article/pii/S0378778806001873

Schwandt, T. A. (2007). *The SAGE Dictionary of Qualitative Inquiry, Third Edition.* Retrieved from Sage Journals: http://srmo.sagepub.com/view/the-sage-dictionary-of-qualitative-inquiry/n62.xml

Service Ontario. (2012, July 1). *2006 Building Code compendium.* Retrieved 2013, from Publications: http://www.publications.serviceontario.ca/ecomlinks/510129_OBC_Amendment_7.pdf

Service Ontario. (2014). *Building Code Act 1992, Ontario Regulation 350/06.* Retrieved from e-laws: http://www.e-laws.gov.on.ca/html/revokedregs/english/elaws_rev_regs_060350_e.htm

Service Ontario. (2014). *Building Code Act 1992: ONTARIO REGULATION 332/12*. Retrieved from e-laws: http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_120332_e.htm

Shipley, R., Parsons, M., & Utz, S. (2006, January). *The Lazarus Effect: An Exploration of the Economics of Heritage Development in Ontario.* Retrieved from University of Waterloo: http://uwaterloo.ca/heritage-resources-centre/sites/ca.heritage-resources-centre/files/uploads/files/lazarus-jan20-verA_0.pdf

Shipley, R., Utz, S., & Parsons, M. (2006, November). *Does Adaptive Reuse Pay? A Study of Business of Building Renovation in Ontario, Canada.* Retrieved April 5, 2013, from University of Waterloo: http://www.environment.uwaterloo.ca/planning/publications/Shipley_reuse_economics.pdf

Stas, N. (2007). *The Economics of Adaptive Reuse of Old Buildings: A Financial Feasibility Study & Analysis.* Retrieved from University of Waterloo: https://uwspace.uwaterloo.ca/bitstream/handle/10012/2707/Thesis%202007.pdf?sequence=1

Straka, V., & Mackenzie, A. D. (2002, June 5-8). *Civil Engineering in the nineteen fifties.* Retrieved from http://pedago.cegepoutaouais.qc.ca/media/0260309/0378334/SCGC-BON/Documents/GE050-Straka-MacKenzie.pdf

Stratton, M. (2003). *Industrial Buildings: Conservation and Regeneration.* Taylor & Francis.

Straube, J. (2009). *BSI-025: The Passive House (Passivhaus) Standard.* Retrieved from Building Science Corporation: http://www.buildingscience.com/documents/insights/bsi-025-the-passivhaus-passive-house-standard

Straube, J. (2012, 10 24). *High Performance Enclosures.* Somerville, MA: Building Science Press. Retrieved from Building Science Corporation: http://www.buildingscience.com/documents/digests/bsd-007-historical-development-of-the-building-enclosure

Straube, J., & Schumacher, C. (2007, March). *Interior Insulation Retrofits of Load-bearing Masonry Walls in Cold Climates.* Retrieved from Building Science: http://www.buildingscience.com/documents/digests/bsd-114-interior-insulation-retrofits-of-load-bearing-masonry-walls-in-cold-climates

Thomsen, A., & Flier, K. V. (2011, June 30). *Understanding obsolescence: a conceptual model for buildings.* Retrieved from Building Research & Information: http://www.tandfonline.com/doi/pdf/10.1080/09613218.2011.576328

Toronto. (2011). *Toronto Municipal Code: Chapter 363, Building Construction and Demolition*. Retrieved from Toronto: http://www.toronto.ca/legdocs/municode/1184_363.pdf

Toronto. (2013, May 10). *Chapter 629, Property Standards*. Retrieved from Toronto Municipal Code: http://www.toronto.ca/legdocs/municode/1184_629.pdf

Toronto. (2014, May 9). *City of Toronto Zoning By-Law.* Retrieved from Zoning & Environment: http://www.toronto.ca/zoning/bylaw_amendments/pdf/9_May_2014_Part1.pdf

Toronto. (2014). *Toronto History*. Retrieved April 2013, from Toronto: http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=4284ba2ae8b1e310VgnVCM10000071d60f89RCRD

Toronto Atmospheric Fund. (2013, June). *RE: Toronto Green Standard Review.* Retrieved from City of Toronto: http://www.toronto.ca/legdocs/mmis/2013/pg/comm/communicationfile-38334.pdf

Toronto City Planning. (2013). *Downtown Properties by Year Built.* Toronto: Policy & Analysis.

Toronto Environment Office. (2008, April). *Ahead of the Storm: Preparing Toronto for Climate Change.* Retrieved from City of Toronto: http://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Our%20Goals/Files/pdf/C/ahead_of_the_storm_highlights.pdf

Toronto Public Library. (1930). *Tip-Top Tailors Factory.* Retrieved from Toronto Public Library: www.torontopubliclibrary.ca/detail.jsp?Entt=RDMDC-PICTURES-R-2845&R=DC-PICTURES-R-2845

Tzekova, E., Pressnail, K., Binkley, C., & Pearson, N. (2011). *INTEGRATING A VENTED AIRSPACE INTO A SPRAY-FOAM INSULATED SOLID MASONRY HISTORIC BUILDING IN A COLD CLIMATE: A CASE STUDY.* Retrieved from The 13th Canadian Conference on Building Science & Technology: http://becwinnipeg2011.webs.com/

Ueno, K., Straaten, R. V., & Schumacher, C. (2013, May). *Interior Insulation of Mass Masonry Walls: Joist Monitoring, Material Test Optimization, Salt Effects.* Retrieved from Building Science Corporation: http://www.buildingscience.com/documents/bareports/ba-1307-interior-insulation-mass-masonry-walls

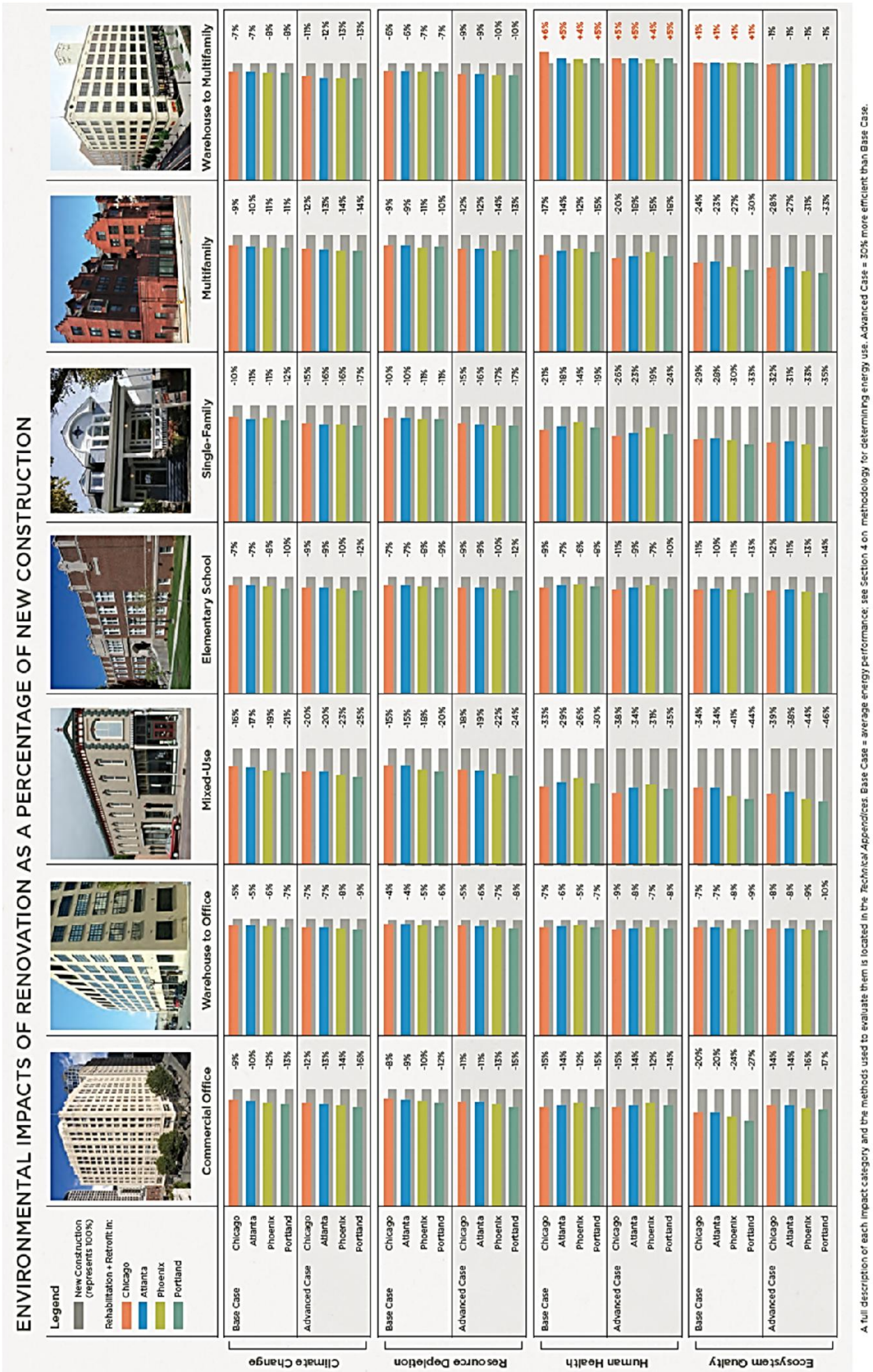
UNEP. (2009). *Buildings and Climate Change.* Retrieved from UNEP SBCI: Sustainable Buildings and Climate Initiative : http://www.unep.org/sbci/pdfs/sbci-bccsummary.pdf

UNFCCC. (2014). *Kyoto Protocol*. Retrieved from United Nations Framework Convention on Climate Change: https://unfccc.int/kyoto_protocol/items/2830.php

Uniacke Breen, M. (2012, June 16). *The View from Up here.* Retrieved from Camrost Felcorp: http://camrost.com/beta/category/blog/ip/

Wilson, C. A. (2010, January). *Adaptive Reuse of Industrial Buildings in Toronto, Ontario.* Retrieved March 25, 2012, from Queen's University: https://qspace.library.queensu.ca/bitstream/1974/5540/1/Wilson_Corey_A_201001_MPL.pdf

Appendix A: Life Cycle Analysis Comparison (Preservation Green Lab, 2012)

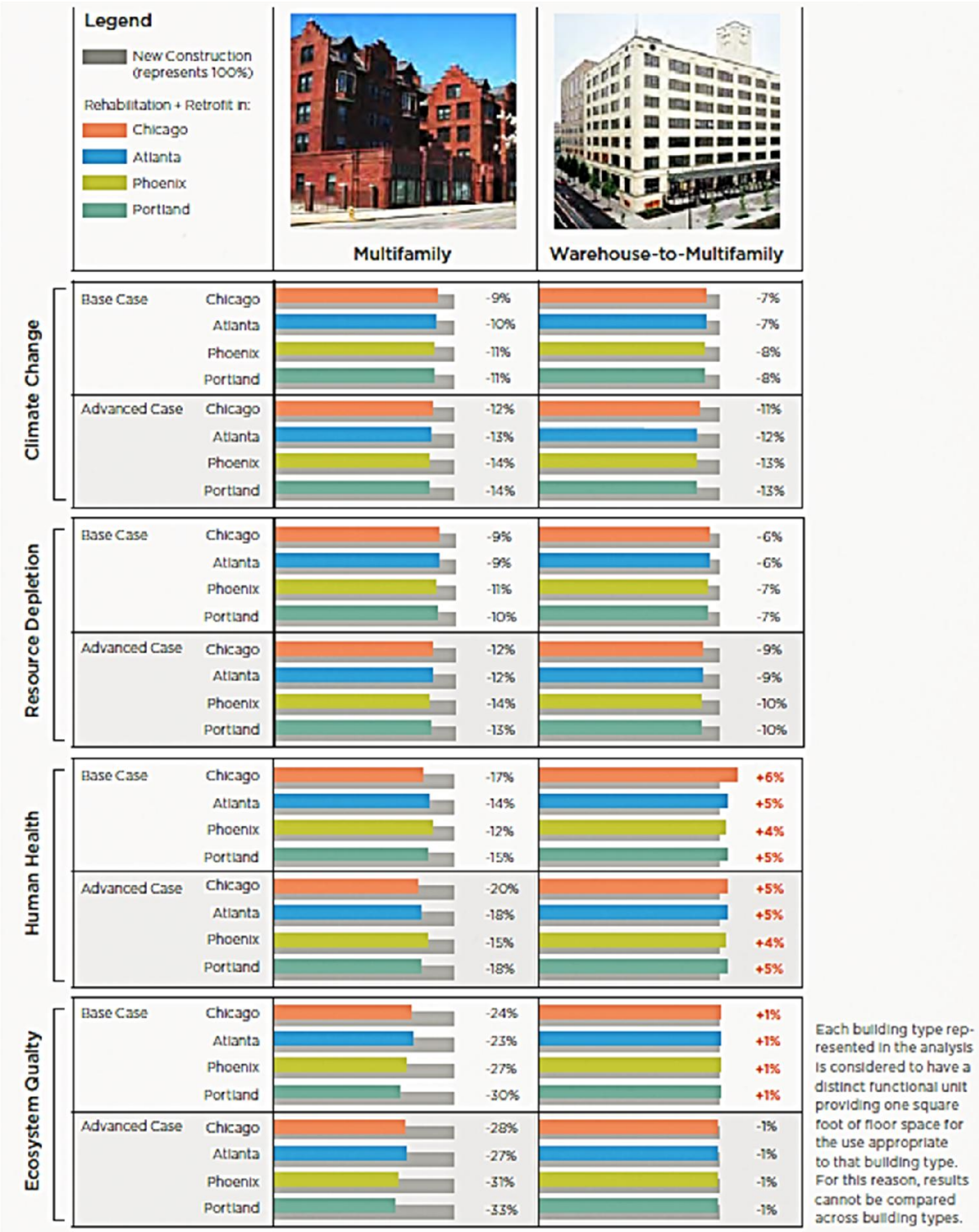


Summary of Results from Quantifying the Environmental Value of Building Reuse

Base Case refers to Average Energy Performance

Multifamily Residential

			
	New Construction	**Rehabilitation and Retrofit**	**Warehouse Rehabilitation and Retrofit**
Building Name	Block 49	New Holland Apartments	The Avenue Lofts
Location	Portland, OR	Danville, IL	Portland, OR
Year Built	Anticipated 2012	1906 with a 1927 addition	1923
Year Renovated	N/A	2006	2004
Building Height	6-story	5-story	7-story
SPACE SUMMARY			
Square Footage	167,180 residential, 19,640 retail excludes parking	73,875 including basement	215,000-sf excluding basement
Building Program Elements	209-unit rental, ground floor commercial, 2,000-sf community space, underground parking	47-unit, rental, 1- , 2- and 3-bedroom units	153-unit loft-style condos
Renovation Description	N/A	Ground source heat pump, replacement windows, masonry rehabilitation, lead paint and asbestos removal	Complete exterior refurbishment, high performance windows, full interior renovation, new vertical transportation, open atrium
Normalized	Removed parking & raised slab on grade to ground floor, assumed full build-out of retail space	N/A	Removed underground parking
CORE & SHELL			
Structure Type	Concrete, CMU, dimensional lumber	Concrete	Concrete
Envelope	Storefront, vinyl windows, 2x6 framing, batt insulation, membrane roofing	Operable windows, masonry and metal stud wall system, batt insulation, 3-tab asphalt roofing	Masonry wall system with elastomeric coating, operable windows, rigid and batt insulation, SBS roofing
Cladding	Brick veneer & metal panel	Brick	Brick
% Glazing (window : walll)	30%	20%	28%
HVAC System	Air to air heat pump per unit	Ground source heating and cooling, natural ventilation	Fan coils, electric heating coils and DX refrigerant lines
INTERIOR			
Scope	Gypsum wallboard, carpet and resilient flooring, plastic laminate countertops	Gypsum wallboard, wood framing, clay tile/plaster, carpet and vinyl flooring	Wood floors and trim, ceramic tile, metal framing drywall, exposed ceilings



Impact	Case	City	Multifamily	Warehouse-to-Multifamily
Climate Change	Base Case	Chicago	-9%	-7%
		Atlanta	-10%	-7%
		Phoenix	-11%	-8%
		Portland	-11%	-8%
	Advanced Case	Chicago	-12%	-11%
		Atlanta	-13%	-12%
		Phoenix	-14%	-13%
		Portland	-14%	-13%
Resource Depletion	Base Case	Chicago	-9%	-6%
		Atlanta	-9%	-6%
		Phoenix	-11%	-7%
		Portland	-10%	-7%
	Advanced Case	Chicago	-12%	-9%
		Atlanta	-12%	-9%
		Phoenix	-14%	-10%
		Portland	-13%	-10%
Human Health	Base Case	Chicago	-17%	+6%
		Atlanta	-14%	+5%
		Phoenix	-12%	+4%
		Portland	-15%	+5%
	Advanced Case	Chicago	-20%	+5%
		Atlanta	-18%	+5%
		Phoenix	-15%	+4%
		Portland	-18%	+5%
Ecosystem Quality	Base Case	Chicago	-24%	+1%
		Atlanta	-23%	+1%
		Phoenix	-27%	+1%
		Portland	-30%	+1%
	Advanced Case	Chicago	-28%	-1%
		Atlanta	-27%	-1%
		Phoenix	-31%	-1%
		Portland	-33%	-1%

Base Case: EEMs for average energy use intensity

Advanced Case: Additional EEMs (30% more energy efficient than average)

Figure: Comparison studies of Multifamily and Warehouse-to-Multifamily (Preservation Green Lab, 2012)

Appendix B: Questionnaire

Questionnaire for the Respondent
The purpose of this questionnaire is to collect detailed information on adaptive reuse project such as type of occupancy before and after conversion within the context of Toronto. Required data is to be collected on the type of construction technology; code compliances, building materials, mechanical systems, lighting, insulation and energy strategies. The primary goal is to understand the process of building conversion and what steps were taken on change of occupancy.
BEFORE CONVERSION:
Original building name:
In which year was the building originally built?
Original (previous) occupancy:
Original Architects:
Was it heritage designated prior to conversion or not?
Original building parameters as follows:
• Total building area (Include all enclosed floors such as basement, mechanical areas, etc.) If you don't know the exact area, please provide the nearest estimate in square metres or square feet:
• Typical floor area on mid-level:
• Exterior Building Height:
Number of floor levels above grade:
Number of floor levels below grade:
Number of car parking bays originally provided:
Original building materials as follows:

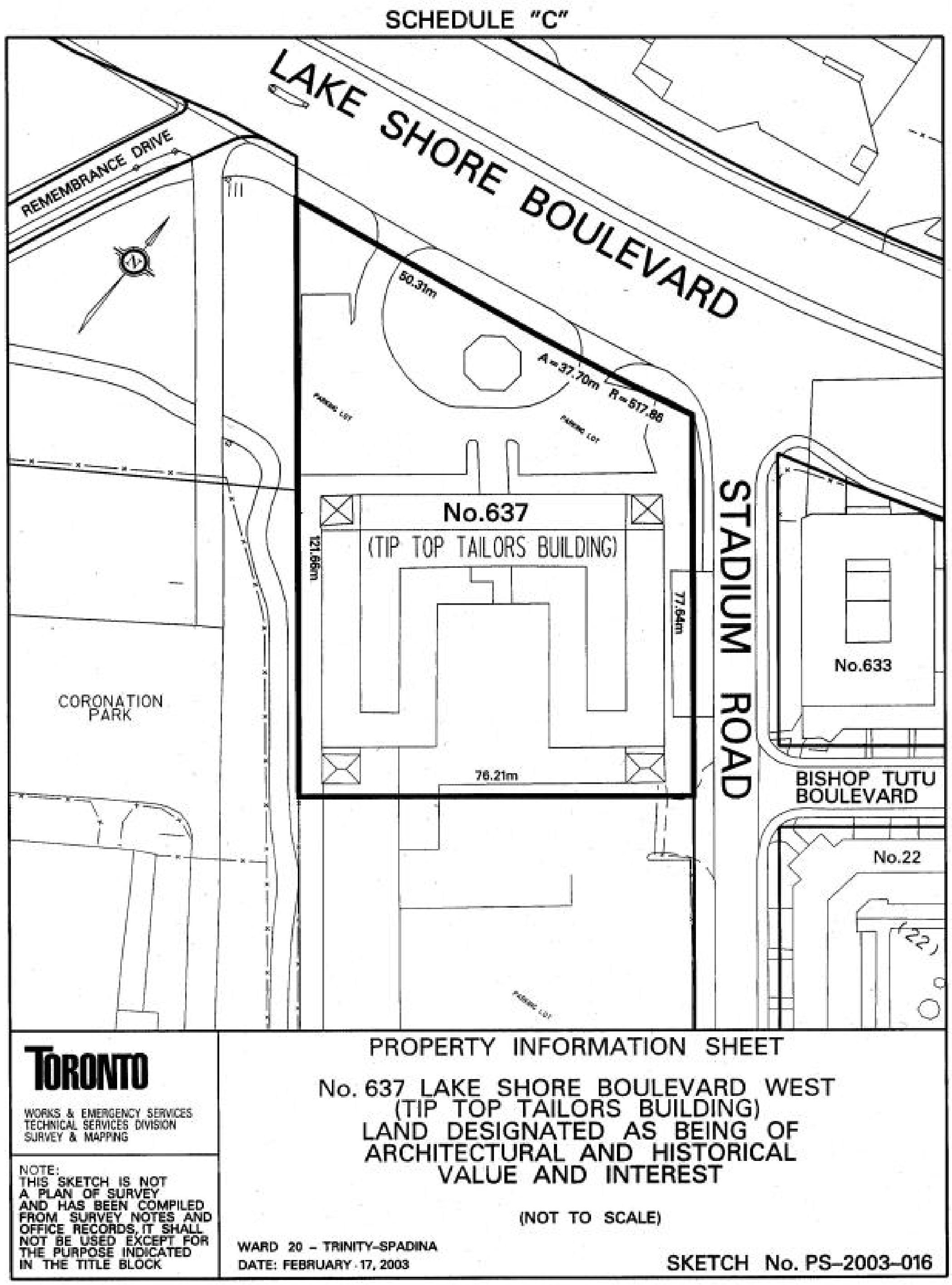
Roof:
Floor (typical mid-floor):
Ceiling (typical)
Exterior Façade:
Partition walls:
Was there any original insulation? If yes, please specify below:
• Roof: • Floor (below ground, if there is basement) • Floor (above ground) • Exterior wall:
Original depth of the floor plate
Original interior ceiling height:
Original column spacing:
Original window openings dimensions:
Original glazing type:
Original type of heating equipment used for space heating?
Original type of cooling equipment used for space cooling?
Was there any issues prior to building conversion in terms of decision making?
Reasons for building obsolescence:
Was there any fire exits/egress:
Any existing stairwell and dimensions
Issues with structural aspects (load capacity)
Were there any accessibility provisions for disabled:
Was there any hazardous materials such as asbestos, etc.? If yes, what steps

AFTER CONVERSION:
New Building Name:
New Occupancy:
Ownership (Public or Private):
In which year the renovation was completed?
Was there any zoning application for the existing building? Reason:
Total built up area(after conversion):
Floor area on mid-level (length and width):
Additional floor levels above grade:
Additional floor levels below grade:
Any change to the depth of the floor plate:
Any changes to the original window openings:
Was the original elevators kept? If no, please specify the reasons
Please indicate whether the main energy sources have changed as follows:
Space heating: Space cooling: Water heating:
Was the original heating equipment used for space heating? If no, please specify the new heating equipment?
Was the original cooling equipment retained for space cooling? If no, please specify which type was installed?
Was the original air handling unit (AHU) replaced? What is the existing type?
Was the existing distribution system of pipes retained? Were the pipes insulated or not? What type and specifications?

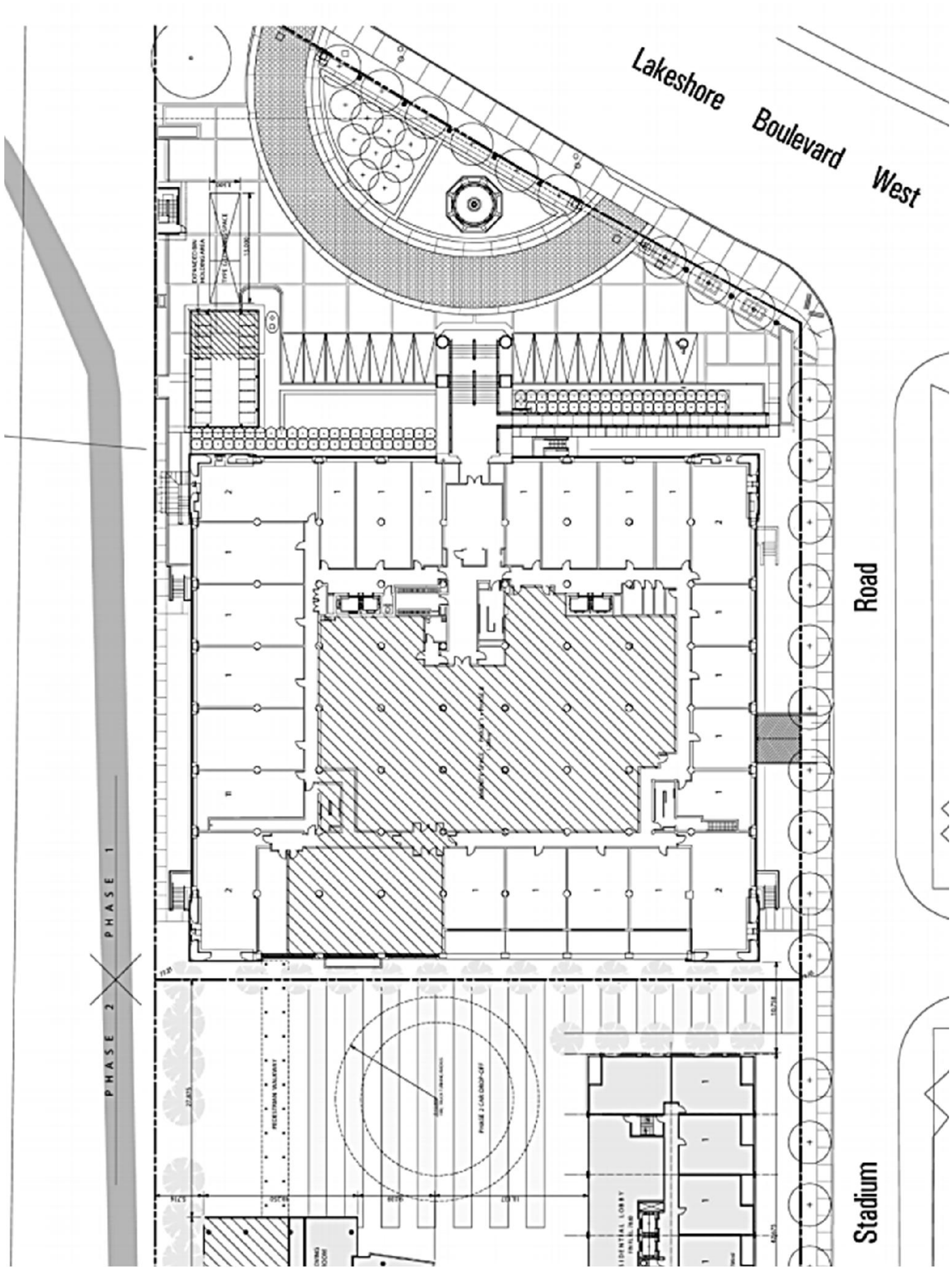
Were there any changes to the electrical system? Please specify which lighting features were installed:	
Was the original equipment for water systems retained? If no, please specify:	
Please specify which parts of building codes were applied as compliances for change of occupancy:	
How Code Compliances were tackled on terms of:	
Fire safety measures:	
Accessibility for the disabled:	
Insulation additions to building envelope:	
Acoustic requirements:	
Please indicate whether renewable energy sources have been installed, which systems and for what purpose?	
Other energy efficiency measures were adopted during conversion? Please check below to all that apply and if necessary, please attach additional pages	
Ventilation system	
Outdoor Air Economizer	
Energy-efficient lighting controls	
Programmable thermostat methods	
Occupancy sensors	
Connection to district steam heating system	
Connection to deep lake water cooling system	
Water-efficiency features	
Other energy strategies:	

Appendix C: Tip Top Lofts

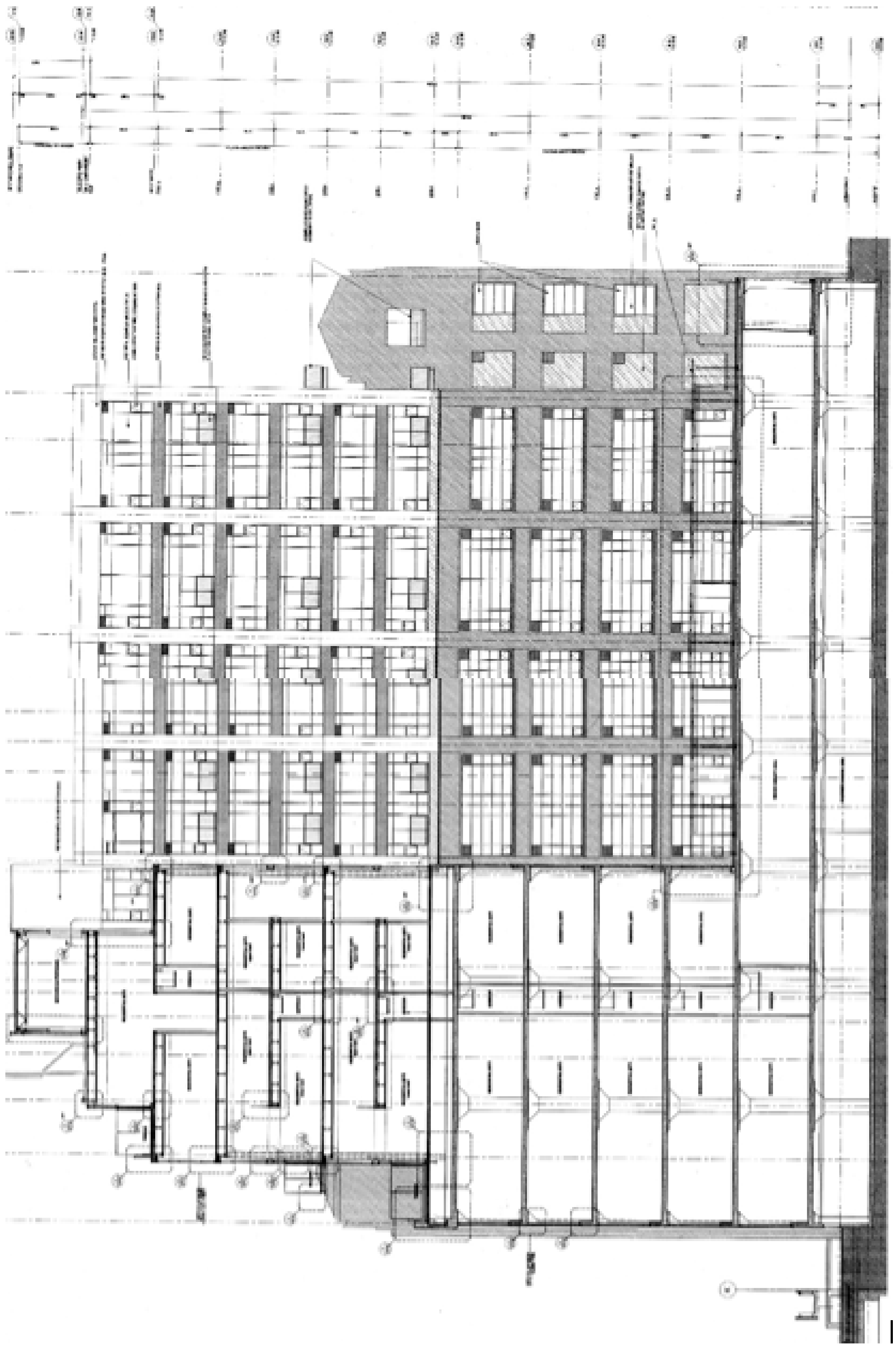
City of Toronto By-law No. 261-2003



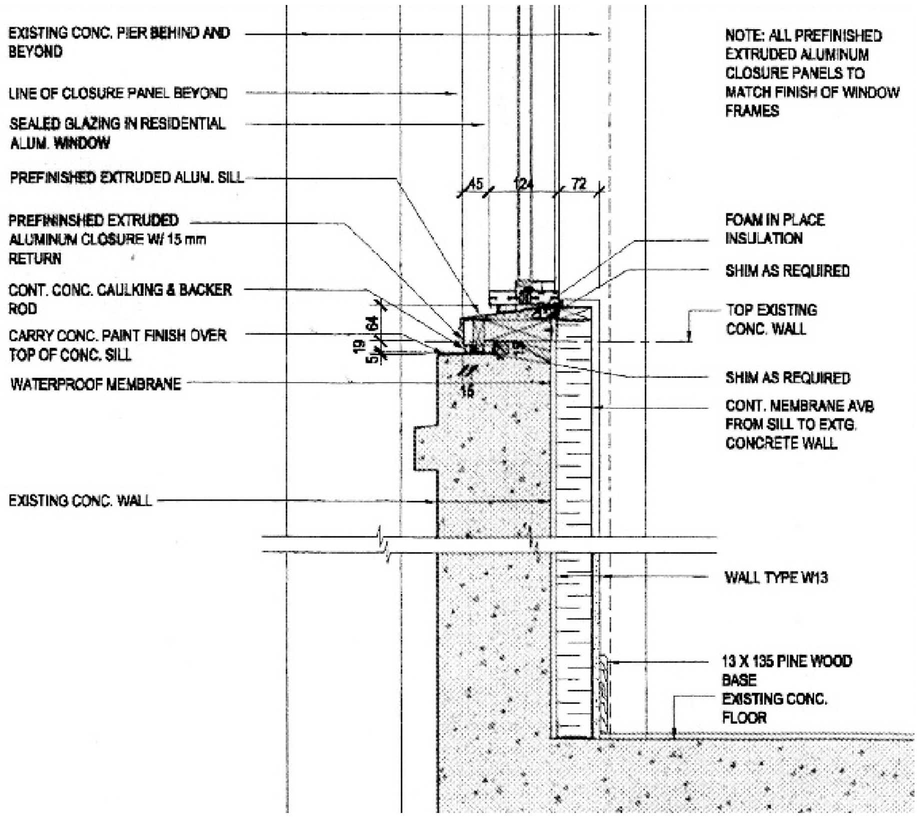
Site Plan of the Original Tip Top Tailor Industrial Building (City of Toronto, 2003)



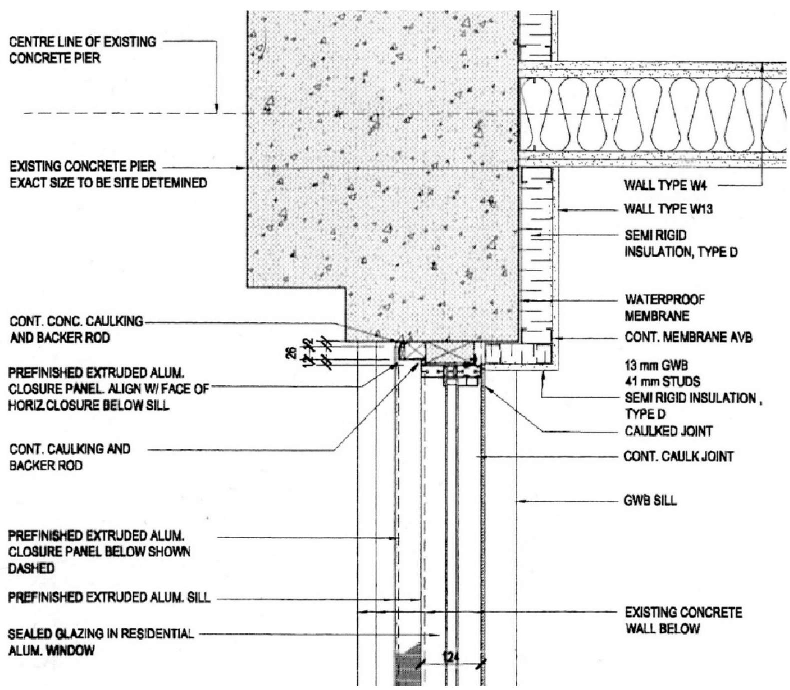
Layout Plan of Tip Top Lofts at Ground level (City of Toronto, 2004)



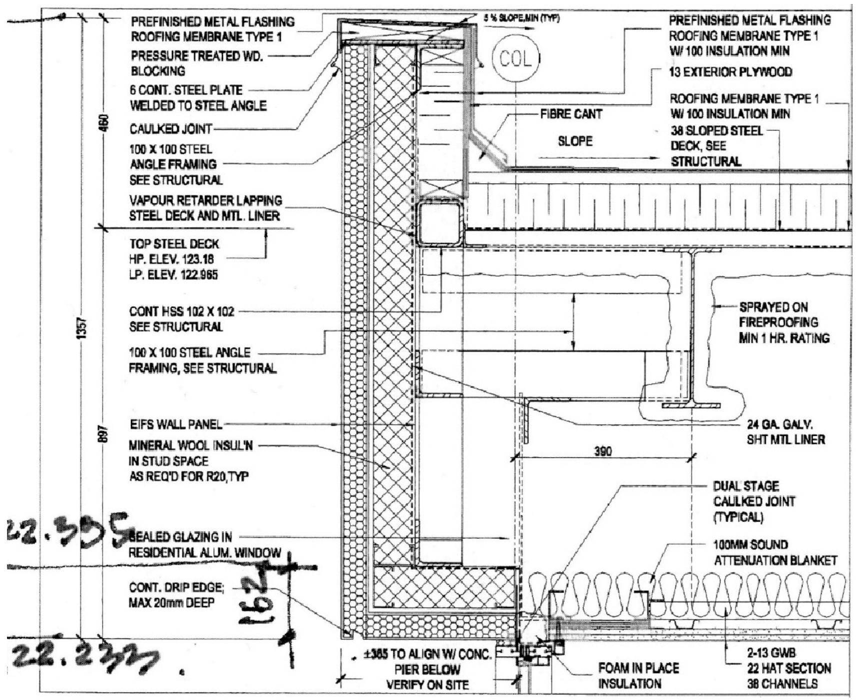
Section of Tip Top Lofts (ArchitectsAlliance, 2014)



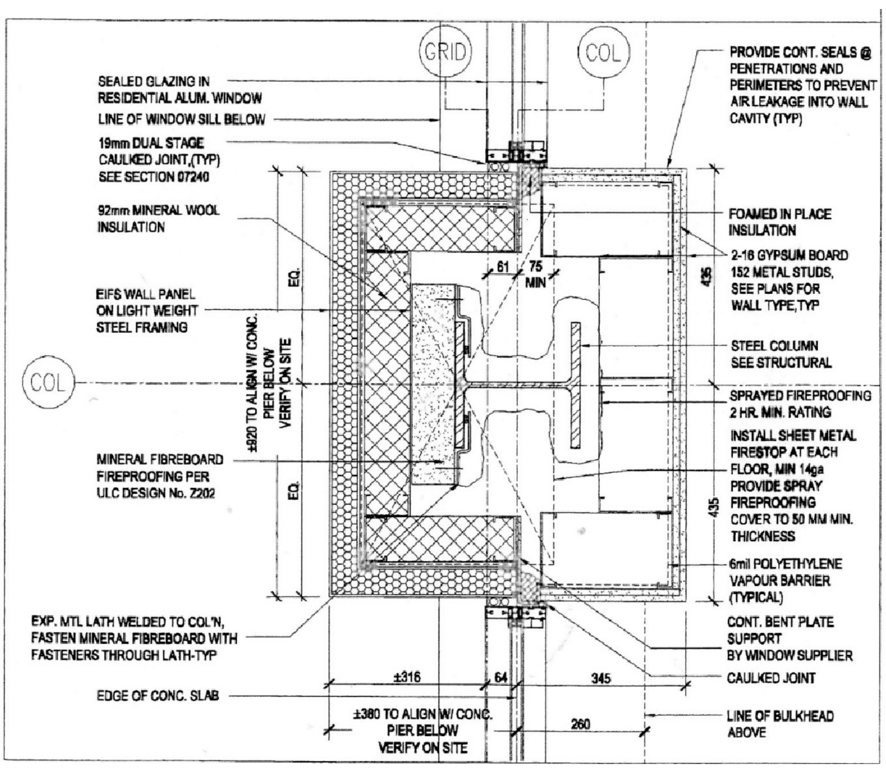
Detailed Section of Existing Concrete Wall



Detailed Plan of Existing Concrete Wall

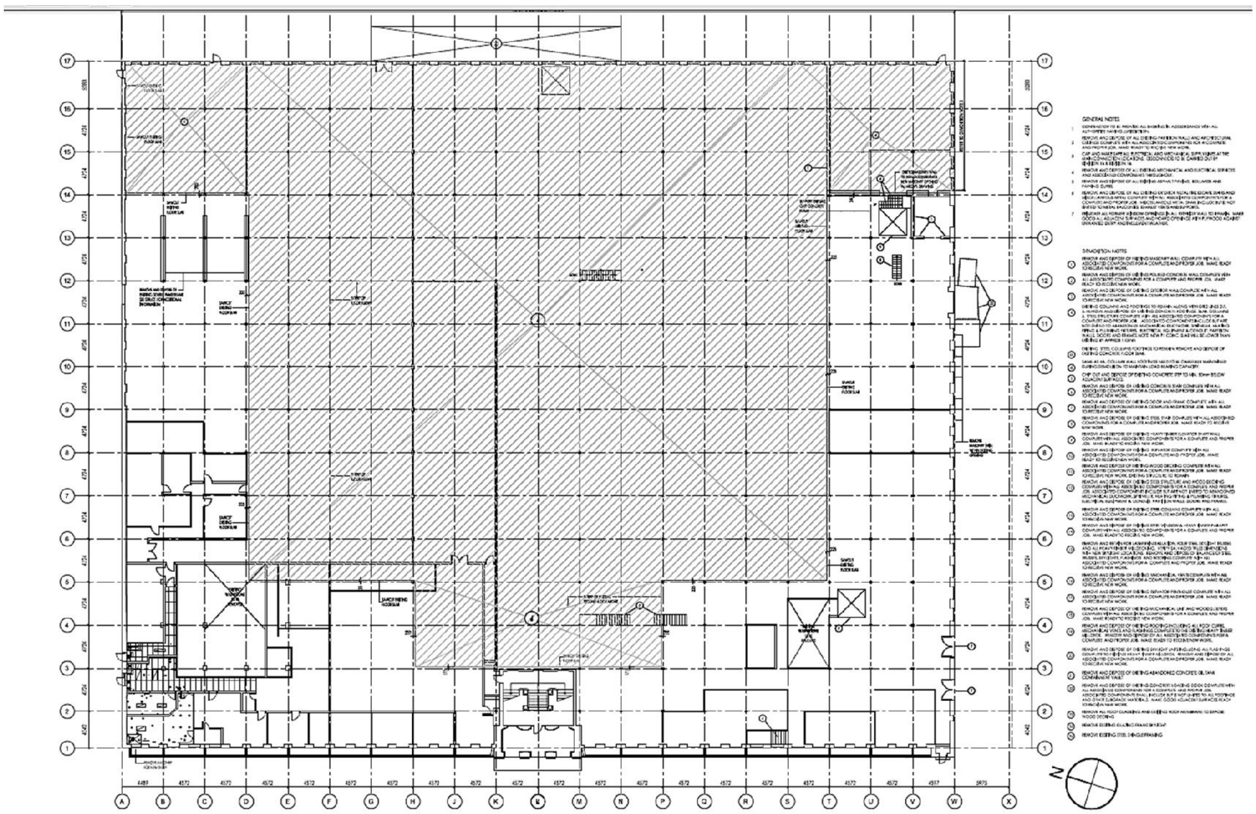


Detailed Section of Roof (New Extension)



Detailed Plan of EIFS (new extension) above Existing Building

Appendix D: The Printing Factory Lofts



Above: Demolition Plan (hatched pattern shown for demolished area) (B.Collard, personal communication, February 21, 2014)

Calculation of built up area before and after demolition:

Depth of Building: 75.461m; Length of Building: 91.382m

Original built up area on ground level before demolition: 7346.8m²

Demolished area on ground level: 7346.8 – 2570= 4776.8m² (65%)

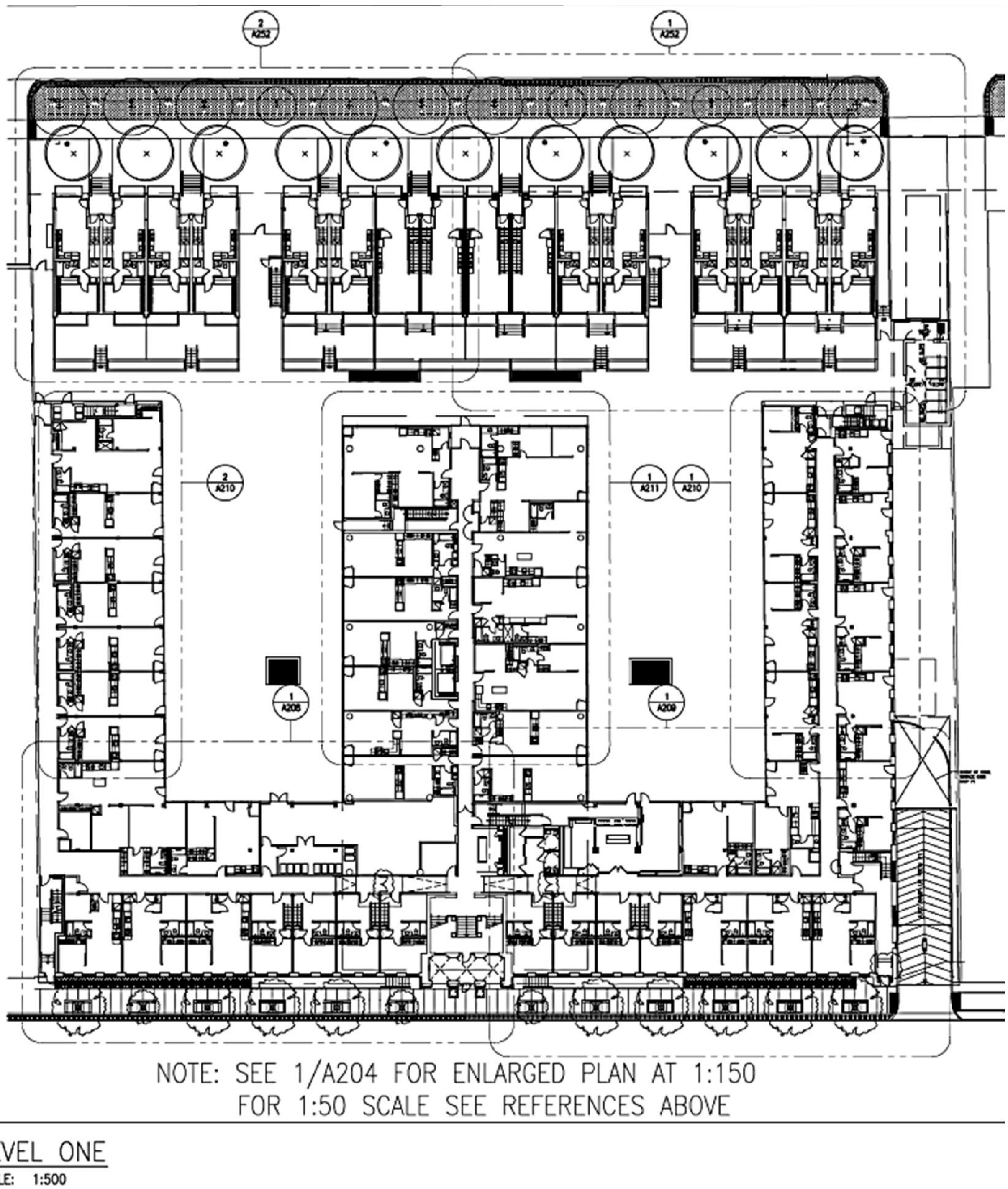
Existing built up area after demolition: 2570m² (approximately)

Additional built up area (newly built) for tower on ground level: 1425.5m²

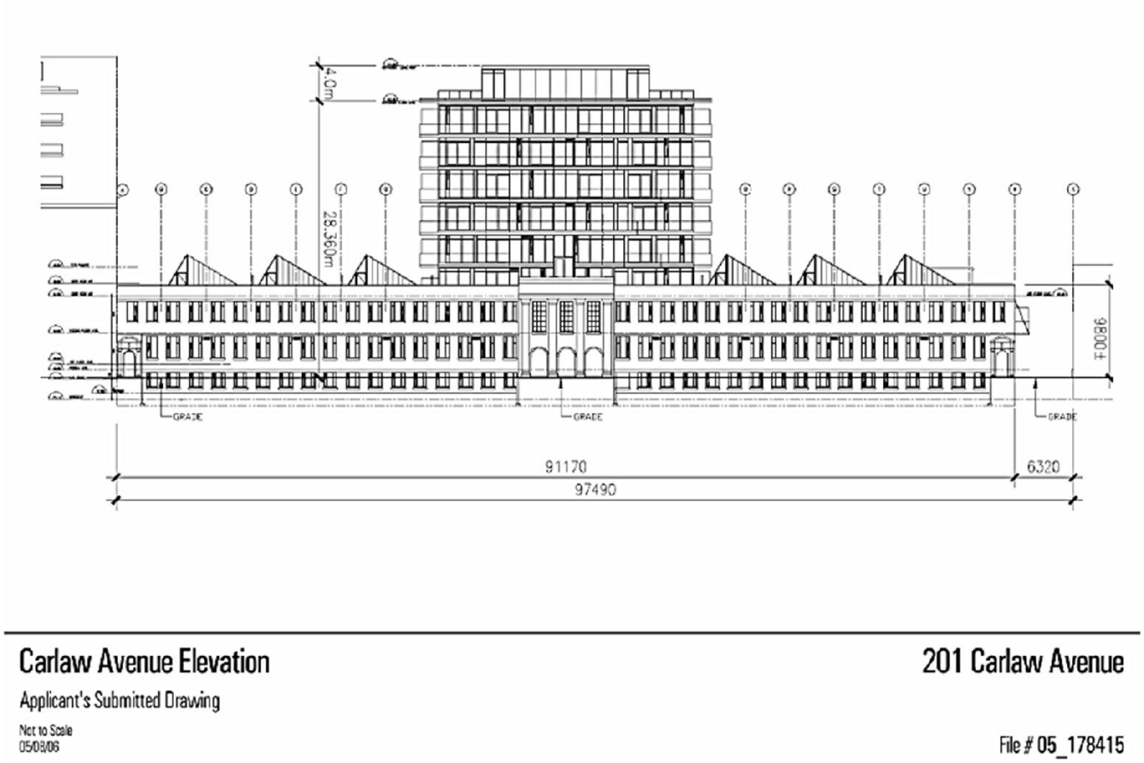
Total built up area for existing structure (2 storeys of hard lofts): 5140m²

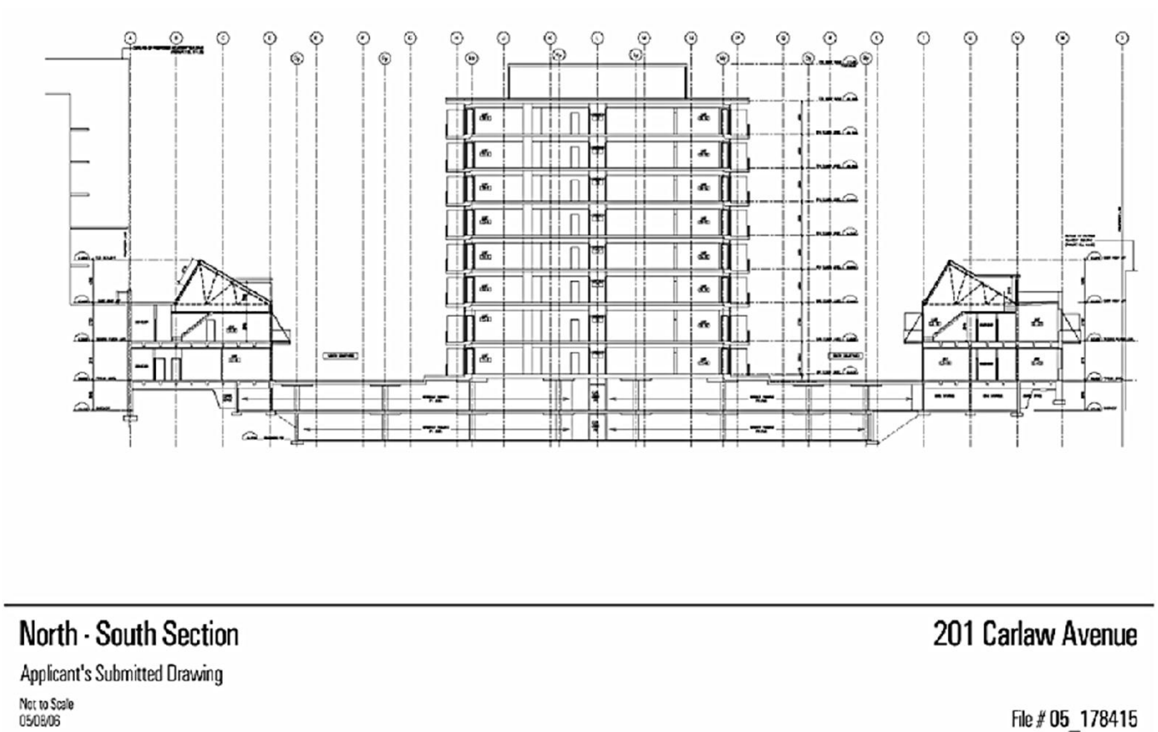
Total built up area for tower (8 storey): 11,404m²

Overall built up area: (townhouses included): 21,470m²

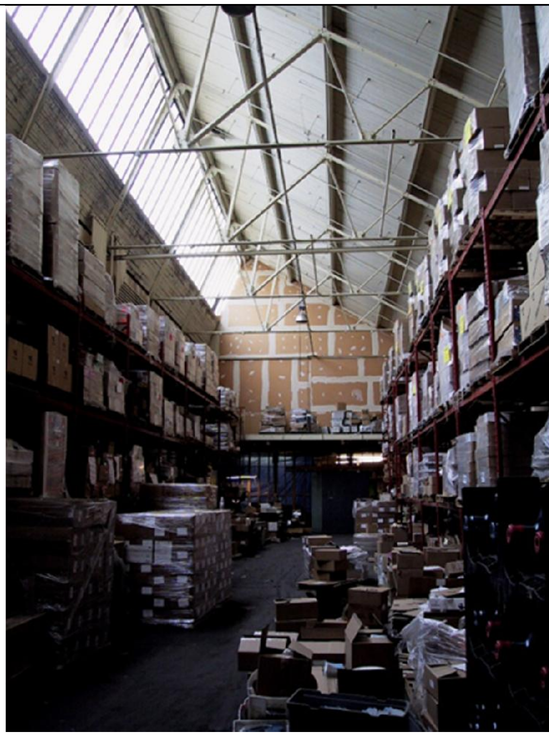


Existing Layout Plan at Ground level with three-storey townhouse on the east (Boston Avenue); Lofts in existing two-storey structure and eight storey glazed condominium at center with surrounding courtyards (B.Collard, email communication, February 21, 2014)



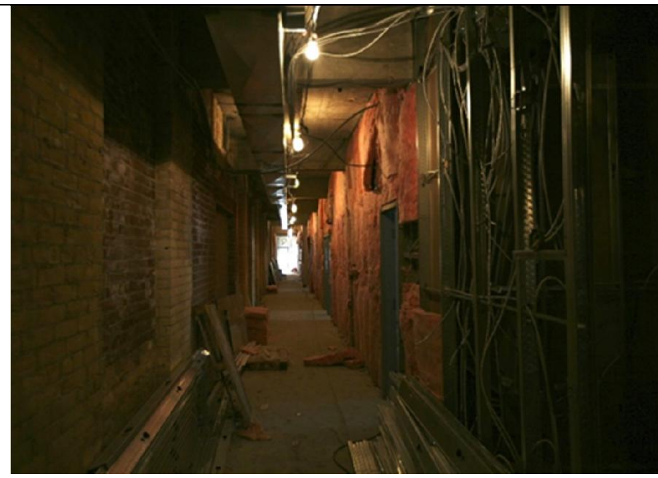


Post Conversion drawings of Printing Factory Lofts (City of Toronto, 2006)



Before Conversion: Interior View

Demolished structure within Building



Above: Insulation work at progress

Above: View of Corridor and Existing wall (at left)

Above: Installation work within Existing Structure

Construction Pics of Printing factory Lofts (B.Collard, email communication, February 21, 2014)

For ceiling assemblies:

38mm metal carrying channels@1200 on center (o.c) along with 22mm metal furring,13mm gypsum wall board (gwb) and 200 mm insulation type 1 (R32)

For P1 level at garage entrance, the underside of ceiling concrete slab was insulated with 89mm insulation type 3 (R14), but for mechanical units, it is R27 thickness of 175mm insulation

Roof Assemblies:

- For Existing flat roof: Fire rating resistance of one hour; 45mm heavy timber and 25mm of gypsum wall board was provided to all existing and new steel supporting structure. The roof composition is as follows: 50mm stone ballast; insulation type 3 (R20); 6mil polyethylene separation sheet, 2mm protection course; roof membrane type 1 (2-ply hot rubber); sloped asphalt-impregnated fibreboard adhered to substrate with mechanical fasteners, 13mm deck board & 13 mm type “x” GWB
- For Condominium tower: New roof (250mm concrete slab-2 hours F.R.R)

Wall Assemblies:

- Existing masonry to remain as it is; no insulation for interiors and exteriors
- New walls: exterior cladding; R-20 insulation, Z-bar sub-girts, air barrier/vapour retarder, backer board, 152 mm structural stud and 13mm GWB

Floor Assemblies:

- New concrete slab on grade insulated with 75mm type 3 (R12),
- Existing concrete slab was 175 mm along with 16mm thick of lightweight concrete levelling compound.

- Loft mezzanine level was 62mm concrete deck with 38mm composite deck along with fireproofing (F.R.R of 1 hour)
- New concrete floor of Tower: (2 hour FRR) 250 mm concrete slab with gypsum board ceiling.

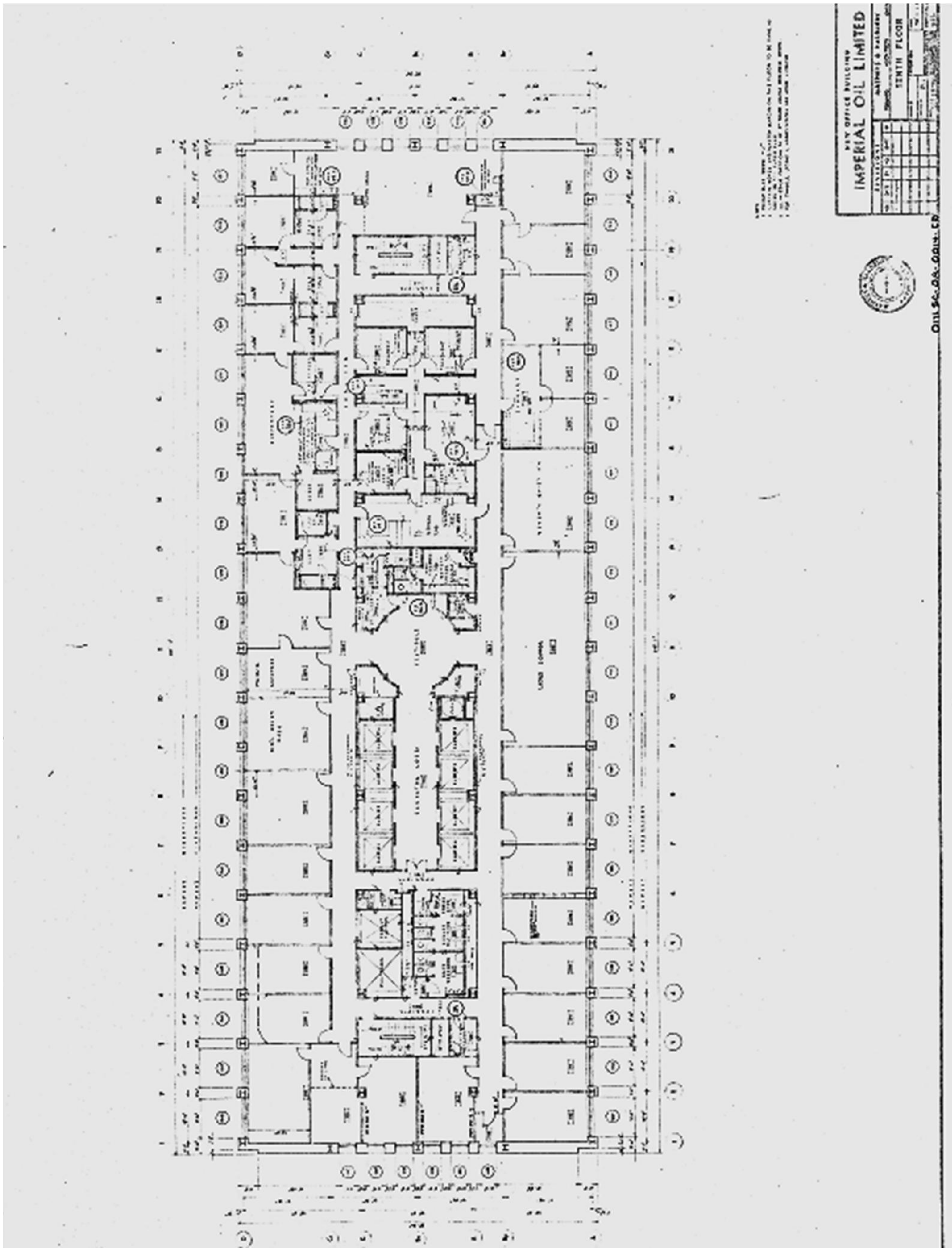
Above: Sawtooth skylights integrated in Lofts

View of central courtyard in the Printing Factory Lofts

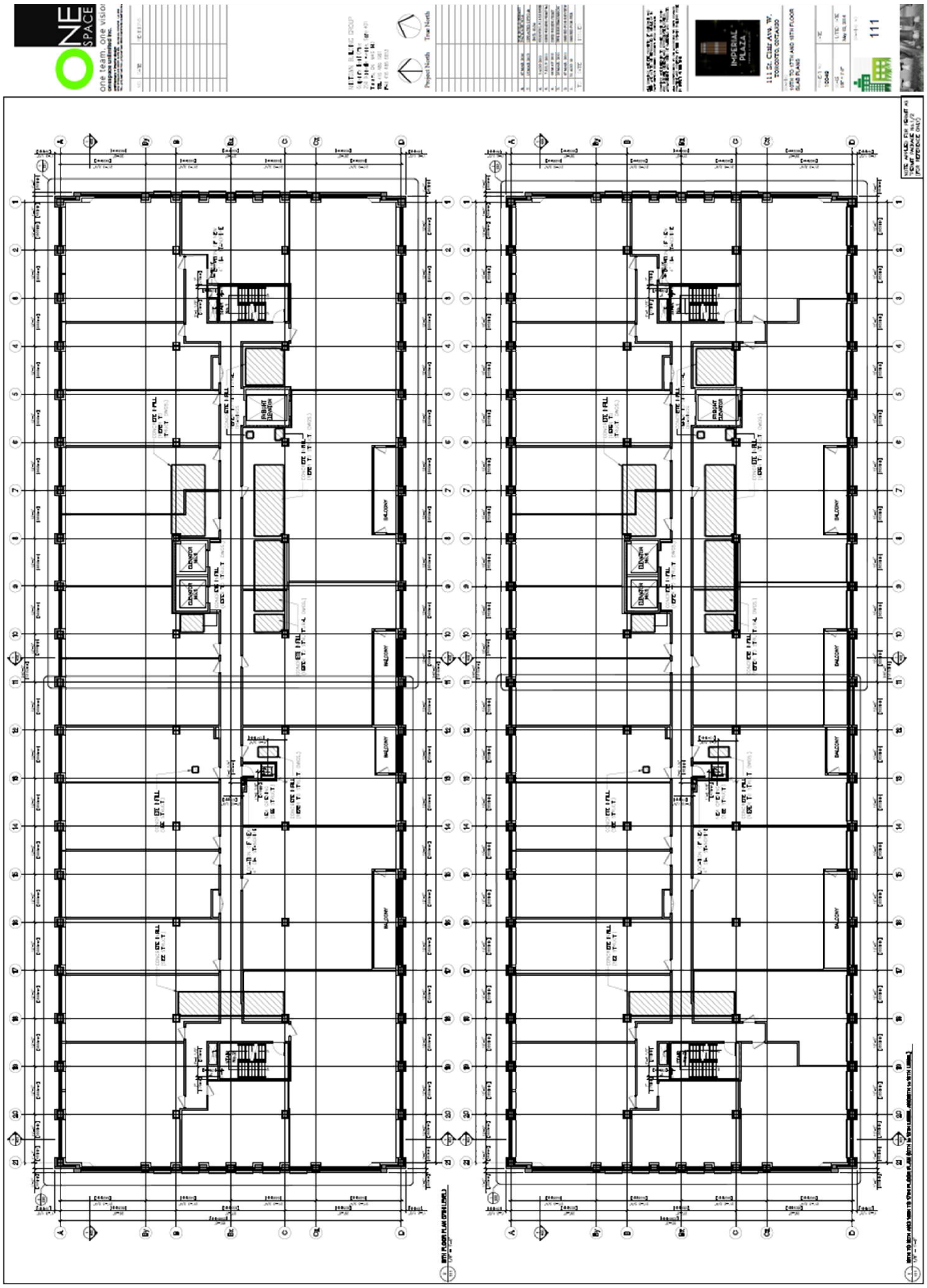
(glazed condominium tower on right and existing 2 storey structure with penthouses on left)

(B.Collard, email communication, February 21, 2014)

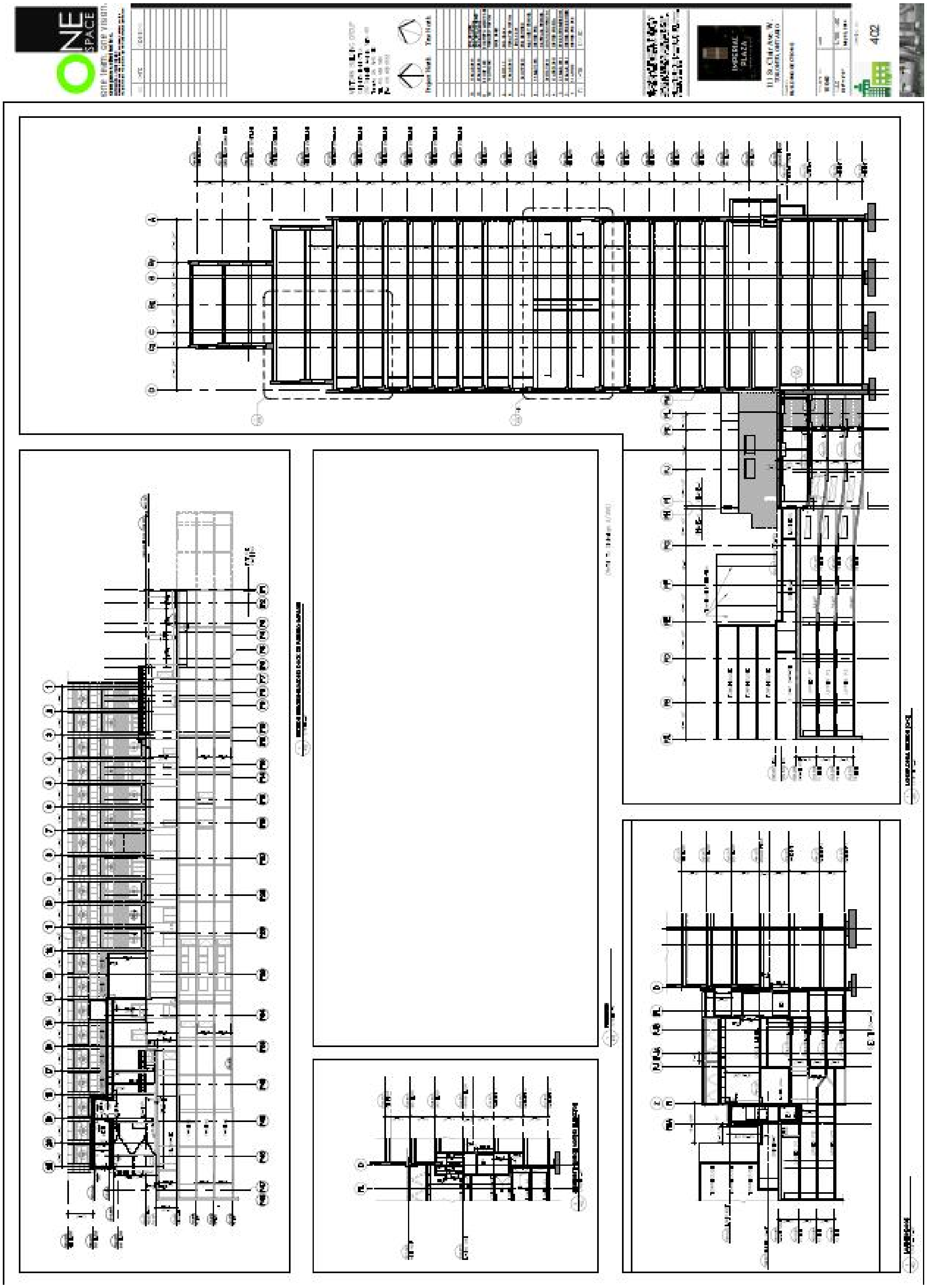
Appendix E: Imperial Plaza Residences



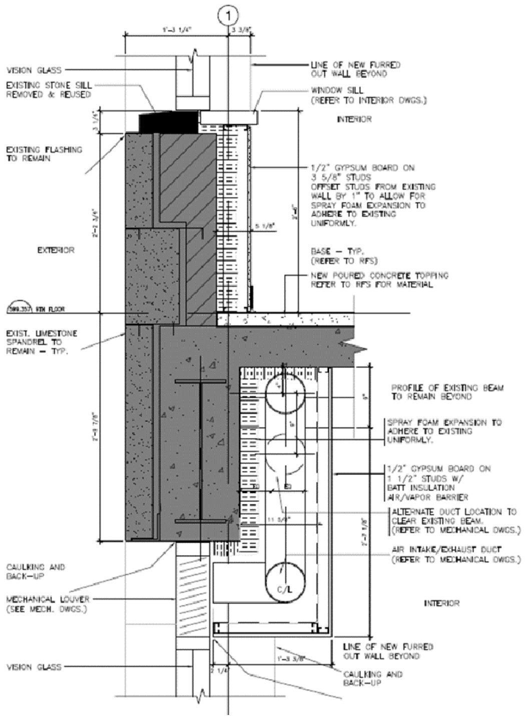
Plan of Imperial Oil Headquarters (R.Rowbotham, email communication, May 5, 2014)



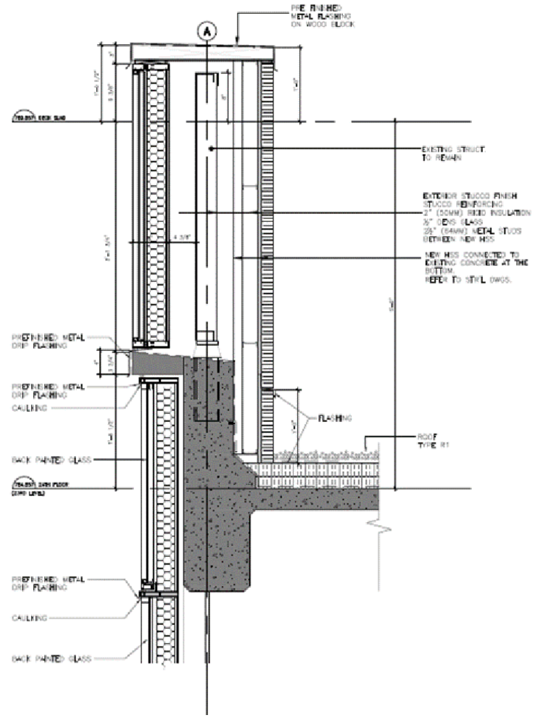
Plans of Imperial Plaza Residences (R.Rowbotham, email communication, May 5, 2014)



Building Sections (R.Rowbotham, email communication, May 5, 2014)

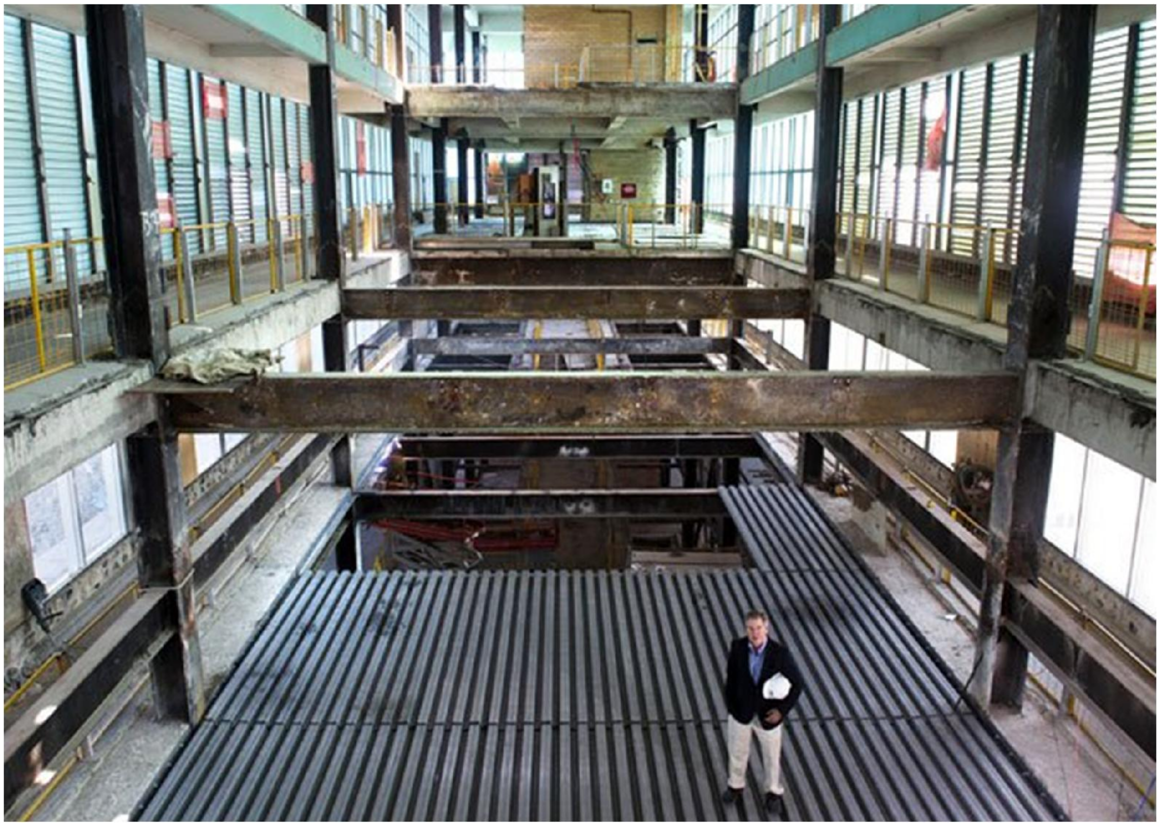


Insulation detail of existing Limestone Façade

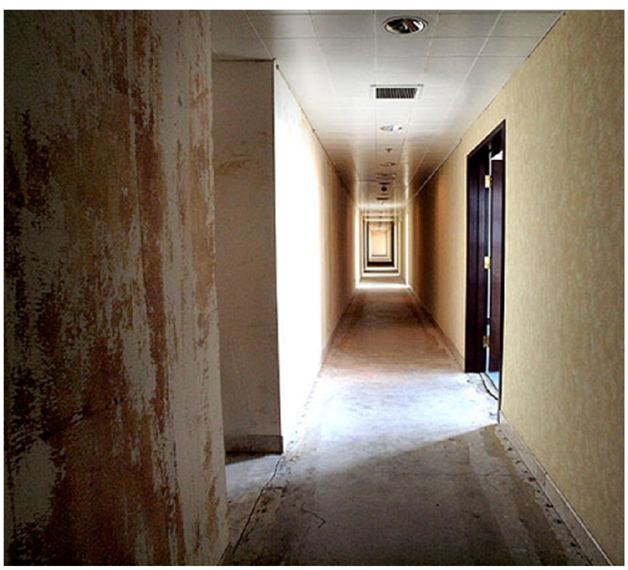


Detail of Rooftop at Deck level (23rd floor level)

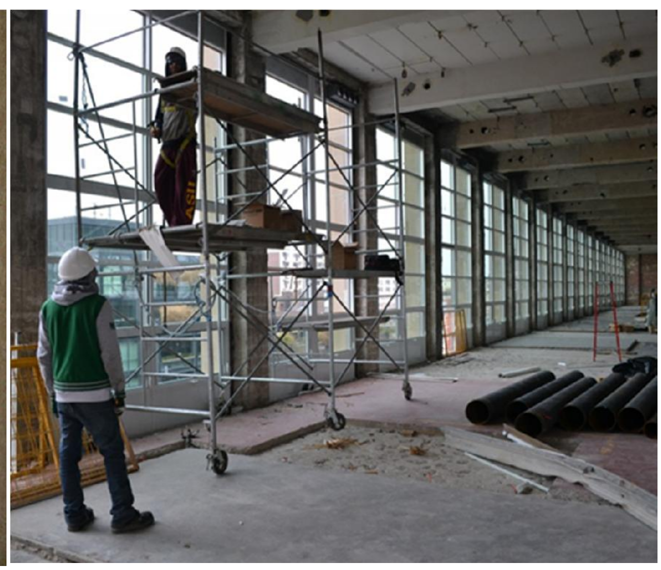
Imperial Plaza during construction stages (Landau, 2013)



Interior view of former mechanical plant (three floor levels) (Uniacke Breen, 2012)



Corridor between Office and Central Core (staircase and lifts, etc.)



View of massive windows and ceiling height (4.8m) on the ninth floor levels