Policy Brief: Bus Network Redesigns and the Distribution of Jobs Accessibility

Access in Motion: Bus Network Redesigns, Jobs Accessibility, and the Story of Three Canadian Cities

Context

Between 2021 and 2025, Edmonton, Ottawa, and Winnipeg each redesigned their bus networks. These redesigns are typically justified on grounds of efficiency, ridership recovery, or budget alignment, but their effects on who gains or loses access to jobs are rarely evaluated directly. This brief summarizes findings from a cumulative opportunity accessibility analysis of the three redesigns, paired with an equity lens comparing accessibility change to household income at the census tract level.

What the Data Show

Winnipeg posted median accessibility gains at all three travel time thresholds examined (30, 60, and 90 minutes), the only one of the three cities to do so across the board. The largest median gain, approximately 9 percent, occurred at the 60-minute threshold. These gains were not fully explained by changes in route density alone, suggesting that network restructuring, not simply more service, played a role.

Ottawa saw median accessibility declines at all three thresholds. The clearest loss zone sits east and southeast of the airport. Ottawa's redesign was budget-driven, and the network changes were comparatively modest in structural terms, which is consistent with a pattern of losses concentrated in specific corridors rather than broad citywide change.

Edmonton showed a threshold-dependent pattern: slight median declines at 30 and 60 minutes, but a modest gain of approximately 3.5 percent at 90 minutes. This divergence across thresholds is itself a finding worth flagging to planners, since it means a single summary statistic can mask real variation depending on how far riders are willing or able to travel.

Equity Implications

None of the three cities used accessibility as an explicit planning target when designing their redesigns. The distributional outcomes captured in the bivariate maps (accessibility percent change paired with median income by tract) are therefore emergent rather than designed. Where low-income tracts overlap with accessibility losses, this represents an unintended regressive outcome. Where they overlap with gains, the outcome is progressive but incidental. This distinction matters for planners: a redesign can appear neutral in aggregate ridership or coverage terms while still shifting job access away from lower-income residents in specific areas.

Recommendations for Transit Planners

1. Report accessibility change at multiple thresholds. Edmonton's divergence between the 30/60-minute and 90-minute results shows that a single threshold can misrepresent who is affected.
2. Pair accessibility outputs with income data before finalizing a redesign, not after. Retrospective equity analysis, as done here, can only diagnose outcomes that have already occurred.
3. Treat coverage and frequency trade-offs as equity decisions, not purely operational ones. Winnipeg's gains suggest that structural redesign, not just added service hours, can improve access, while Ottawa's losses show that budget-constrained redesigns can quietly erode access in specific corridors.
4. Use accessibility as an explicit design metric, not only an evaluation metric, in future redesign processes.

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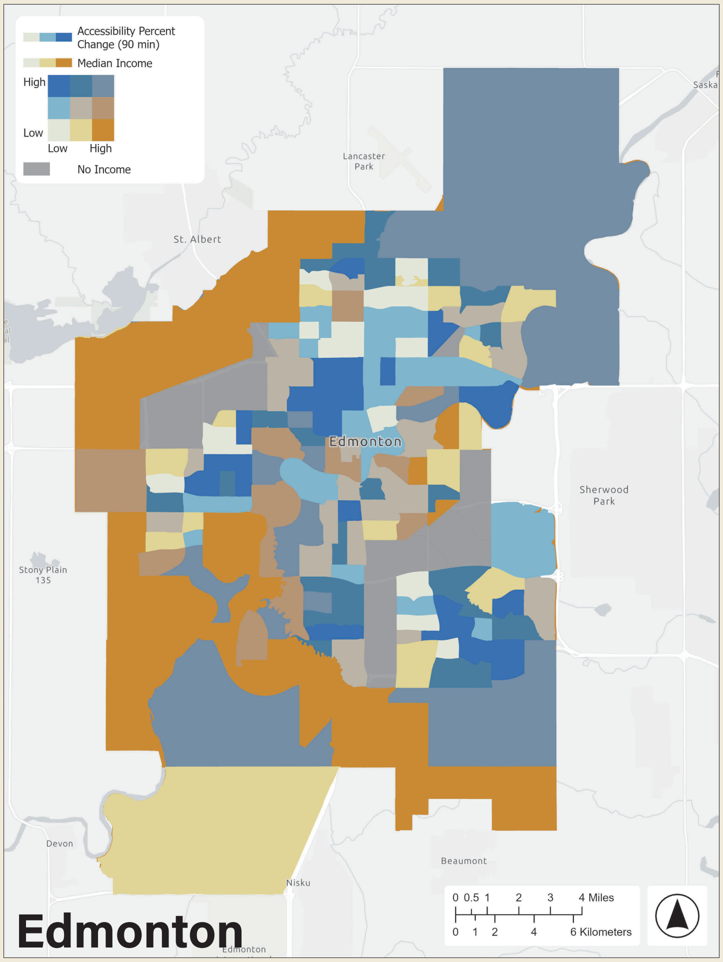
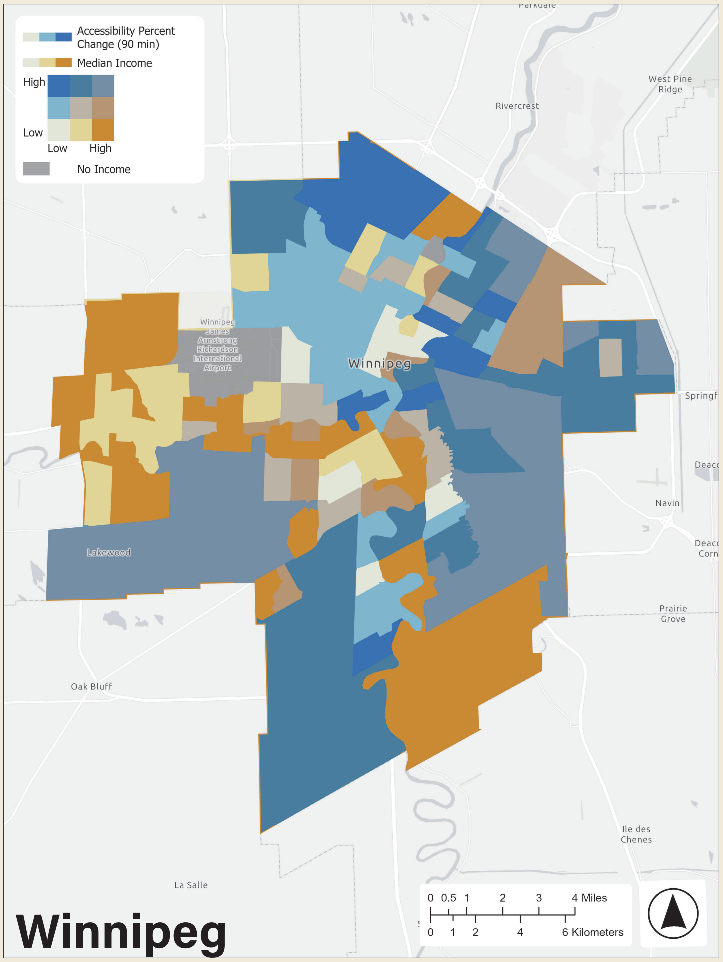
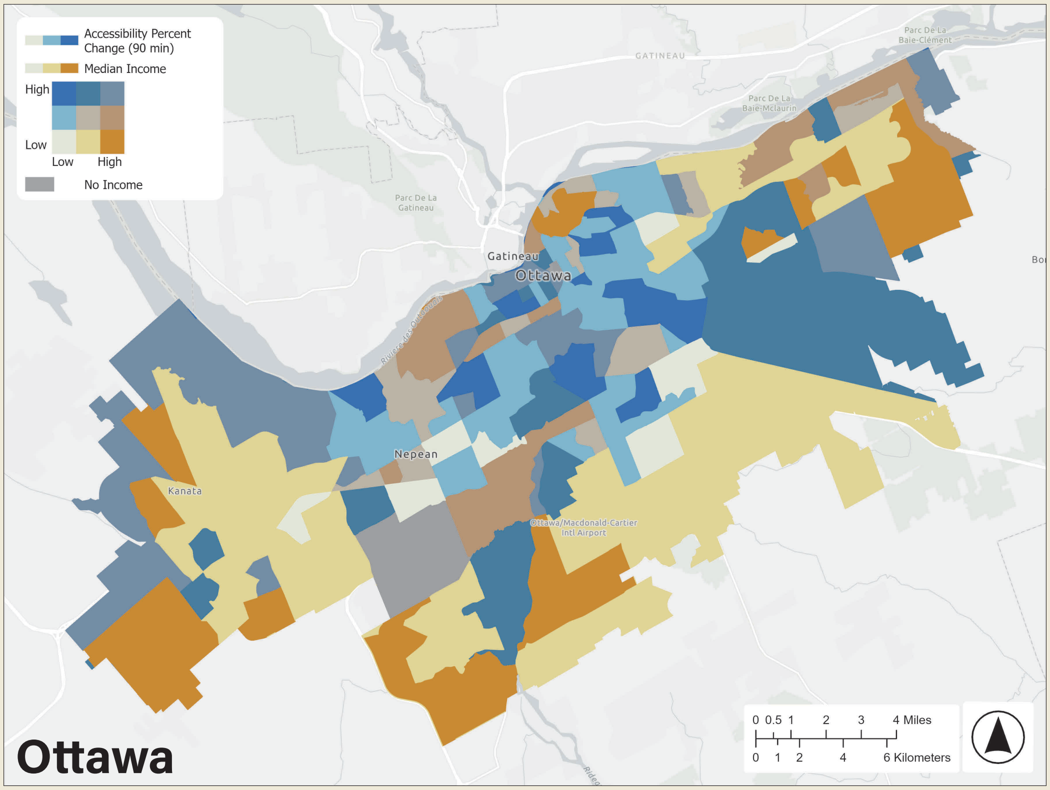


Accessibility Percent Change (90 min)
Median Income
High
Low
Low
High
No Income
St. Albert
Lancaster Park
Edmonton
Sherwood Park
Stony Plain 135
Devon
Nisku
Beaumont
0 0.5 1 2 3 4 Miles
0 1 2 4 6 Kilometers
Edmonton



Accessibility Percent Change (90 min)
Median Income
High
Low
Low
High
No Income
Rivercrest
West Pine Ridge
Winnipeg James Armstrong Richardson International Airport
Winnipeg
Lakewood
Navin
Prairie Grove
Oak Bluff
Ile des Chenes
La Salle
0 0.5 1 2 3 4 Miles
0 1 2 4 6 Kilometers
Winnipeg



Accessibility Percent Change (90 min)
Median Income
High
Low
Low
High
No Income
GATINEAU
Parc De La Baie-Clément
Parc De La Baie-Mclaurin
Parc De La Gatineau
Gatineau
Ottawa
Nepean
Kanata
Ottawa/Macdonald-Cartier Intl Airport
0 0.5 1 2 3 4 Miles
0 1 2 4 6 Kilometers
Ottawa

Access in Motion

Bus Network Redesigns, Jobs Accessibility, and the Story of Three Canadian Cities

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Access in Motion

Access in Motion is a research project examining how bus network redesigns affect job accessibility in three Canadian cities: Edmonton, Ottawa, and Winnipeg. The study is intended to inform transit planners and policymakers who are directly involved in planning, evaluating, or funding network changes. Its central questions are practical ones: when a city restructures its bus network, do residents end up with better or worse access to jobs, and are those changes felt equally across income groups?

The study is motivated by three forces that have converged on Canadian transit in recent years. The global pandemic fundamentally disrupted where and how people travel, leaving many legacy bus networks misaligned with actual demand and prompting cities to reconsider their network structures from the ground up. At the same time, persistent budget pressures have pushed transit agencies to deliver more service value with fewer resources, often through consolidation or restructuring. Beneath both pressures sits an equity concern: the communities most reliant on bus service tend to be the most vulnerable to service disruptions, and the evidence on whether redesigns help or harm these riders remains thin.

The three cities studied each underwent meaningful bus network redesigns at different moments in this period. Edmonton restructured its network in 2021. Ottawa and Winnipeg completed their respective redesigns in 2025. While all three are mid to large Canadian urban centres, they differ in size, geography, and transit context.

The analysis is built on three data inputs processed through a common analytical framework. GTFS data captures the scheduled bus network for each city before and after its redesign. OpenStreetMap provides the underlying street and pedestrian network. Statistics Canada census data supplies employment counts and income distributions at the census tract level. These inputs are fed into R5R, a high-performance routing engine built for large-scale transit accessibility analysis, which computes cumulative opportunity accessibility measures. These measures count the number of jobs reachable from each census tract within a fixed travel time by transit, before and after the redesign. Disaggregating those results by income group allows the study to assess whether accessibility gains and losses fall disproportionately on lower-income residents.

The findings make clear that there is no single outcome cities can count on from a bus network redesign. Networks that lost density without compensating gains in frequency saw overall accessibility decline. Networks that gained in frequency and reliability achieved net improvements, even where route coverage contracted in some areas. But in every case studied, the results were uneven across the city. Some neighbourhoods gained new connections while others lost service, and the distribution of those gains and losses did not always follow the lines of need. The study presents these findings not as a verdict on any individual city, but as evidence that transit planners and policymakers must weigh both efficiency and equity when designing, evaluating, and communicating network changes.

1. Introduction

1.1 Transit as a Public Good and Equalizer

Public transit is one of the most consequential public goods that urban governments provide. For the many residents of Canadian cities who do not own or cannot afford a car, the transit network is the primary means by which they reach work, healthcare, education, and the broader social and economic life of their city. In this sense, transit carries a promise that is fundamentally about equity: the promise that one's ability to participate in urban life should not depend entirely on access to a private vehicle. Yet this promise is not automatically fulfilled by the existence of a transit system. It depends on how that system is designed, how frequently it runs, and how well its routes align with the actual distribution of people, jobs, and services across urban space.

The relationship between transit investment and equitable access has received growing attention in the urban planning and transport geography literature. Research in the United States has generally found that low-income communities and communities of colour tend to have worse transit access to jobs and services, even when they are more transit-dependent (Ermagun and Tilahun, 2020; Jomehpour Chahar Aman and Smith-Colin, 2020). The Canadian picture, however, is more nuanced. Foth et al. (2013) found that in Toronto, some of the most socially disadvantaged areas of the city also had the highest access to jobs via transit, reflecting a different pattern of urban development and income geography. This contrast underscores the importance of studying transit equity in the Canadian context specifically, rather than simply extending conclusions drawn from American cities.

This paper examines how bus network redesigns (BNRs) affect jobs accessibility in three Canadian cities: Edmonton, Alberta; Ottawa, Ontario; and Winnipeg, Manitoba. Each city has undergone a significant restructuring of its bus network. By measuring cumulative job opportunities reachable by public transit before and after each redesign, and by examining whether the resulting changes are distributed equitably across income groups, this research contributes to a growing but still limited evidence base on the real-world accessibility outcomes of transit network restructuring in Canada.

1.2 The Rise of Bus Network Redesigns

Across North America, transit agencies have increasingly turned to bus network redesigns as a tool for improving system performance. The underlying logic of a BNR is typically straightforward: by consolidating routes, eliminating duplication, and concentrating service on high-demand corridors, agencies can offer higher frequencies on core routes without necessarily increasing their overall operating budgets. The result, in theory, is a network that is faster, more reliable, and more useful for a greater share of potential riders.

The Houston METRO 2015 redesign is frequently cited as a landmark example. By rebuilding the network almost entirely from scratch, Houston achieved substantial increases in ridership and service frequency, particularly during weekend and off-peak periods, and the redesign attracted widespread attention from planners and researchers alike (Walker, 2024). Since then, many other cities have undertaken similar exercises, ranging from partial restructurings of individual corridors to wholesale reimaginings of entire networks. The COVID-19 pandemic accelerated this trend in many respects: ridership collapses led to severe revenue shortfalls, and at least some of the redesigns examined in this study were driven directly by the resulting budget pressures rather than by a purely proactive desire to improve service. Agencies were forced to rationalize their networks, often cutting lower-productivity routes and reinvesting in core corridors.

This efficiency orientation, however, carries an inherent tension. Consolidating routes and eliminating coverage in lower-density areas can reduce access for riders who depend on those services, often the same riders who are most transit-dependent. The trade-off between efficiency (frequency, directness, cost-effectiveness) and coverage (geographic reach, access for peripheral communities) is at the heart of most BNR debates. Resolving this tension in a way that is both operationally sound and socially equitable is a central challenge for transit planners. When agencies redesign their networks under fiscal pressure, these trade-offs risk being made without the benefit of evidence-based accessibility analysis, rendering the distributional consequences largely invisible until after the fact.

1.3 The Canadian Context and Three Case Cities

Canada offers a particularly important but understudied setting for examining BNR outcomes. Canadian cities differ from their American counterparts in several relevant respects: patterns of income geography tend to differ compared to American cities; transit dependency is distributed differently; and the historical development of transit networks reflects different planning traditions and funding structures. These differences mean that findings from American studies of BNR outcomes cannot be straightforwardly applied to the Canadian context.

This paper examines three Canadian cities that have each recently undertaken a bus network redesign. Edmonton, the capital of Alberta, completed a major redesign of its transit network in 2021. With a population of about 1.1 million in the city proper and roughly 1.5 million in its metropolitan area, Edmonton is a mid-sized Canadian city with a transit system that has historically struggled to serve a low-density, car-oriented urban form. Ottawa, the national capital of Canada and a city of approximately one million people in the urban area, implemented a redesign in 2025, a process shaped in part by the disruptions and operational challenges associated with its light rail transit (LRT) system. Winnipeg, the capital of Manitoba and home to approximately 835,000 people in its census metropolitan area, also redesigned its bus network in 2025, with goals centred on improving frequency, reliability, and accessibility across the city. Together, these three cities provide a comparative lens through which to examine how BNRs play out across different urban contexts, transit histories, and planning goals.

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Importantly, the three cities do not yield a uniform story. As this research will show, the effects of a bus network redesign on jobs accessibility are neither guaranteed nor consistent. Edmonton's 2021 redesign produced a mixed result: slight median declines at the shorter travel time thresholds and a modest gain at the longest, with those changes spatially uneven across the city. Ottawa's 2025 redesign is a more complicated case: despite limited visible changes to the overall network structure, the redesign resulted in significant reductions in accessibility for several census tracts, alongside gains in others, with median accessibility declining overall. Winnipeg's results reveal a different pattern again, with stronger median gains but persistent spatial unevenness and a notable gap between measured accessibility improvements and the lived experience of riders. Taken together, these cases challenge any simple narrative that BNRs are straightforwardly beneficial, and they underscore the importance of rigorous, city-specific evaluation.

1.4 Accessibility as an Analytical Lens

Accessibility, broadly defined, refers to the ease with which people can reach desired destinations. Hansen (1959) defined it as the "intensity of the possibility of interaction," a formulation that has anchored the concept in transport research for decades. Accessibility is distinct from mobility: where mobility measures how far or fast one can travel, accessibility measures what one can reach. This distinction matters enormously in transit planning. A bus route that runs frequently but does not connect riders to concentrations of employment, healthcare, or services generates mobility without meaningful accessibility.

This research uses cumulative opportunity measures of accessibility, computed using the R5R routing engine (Pereira et al., 2021). Cumulative opportunity measures count the number of destinations reachable within a given travel time threshold. In this study, the destination type is jobs, and the thresholds used are 30, 60, and 90 minutes of travel by public transit and walking. This approach was chosen for its simplicity and robustness: it is transparent and interpretable by practitioners, and well suited to comparative analysis across cities and time periods. It has been widely used in transit accessibility research, including in the Canadian literature (Foth et al., 2013).

The equity dimension of the analysis is examined through a bivariate approach that overlays income data onto accessibility change scores at the census tract level. This allows for a spatial reading of which communities, distinguished by income group, experienced gains or losses in jobs accessibility following each redesign. Areas combining low income with high positive accessibility change, and those combining low income with negative change, are of particular interest, as they represent the clearest cases of equitable benefit and potential harm, respectively.

Jobs accessibility is the specific metric used here for several reasons. Employment is one of the most important trip purposes in urban travel, and the ability to reach a diverse range of job opportunities by transit is a core determinant of economic participation for transit-dependent residents. Measuring job accessibility also allows for a direct assessment of whether a redesigned transit network is better or worse at connecting people to economic opportunity, which is often cited as a primary goal of transit investment. At the same time, it is important to acknowledge that job accessibility is only one dimension of transit's role in urban life; healthcare access, educational opportunities, and social connectivity are equally important, though they fall outside the scope of the present study.

A further limitation of accessibility metrics, made apparent by the cases examined here, is that measured improvements do not always translate into better rider experiences. In Winnipeg, for example, overall accessibility scores improved following the redesign, yet riders reported frustration at being required to make multiple transfers for trips that had previously been served by a single route. This gap between what metrics capture and what riders feel points to the importance of interpreting accessibility findings alongside qualitative and experiential evidence, a consideration that informs the discussion chapter of this paper.

1.5 Research Gap and Motivation

Despite the growing number of BNRs undertaken in North American cities, the evidence base on their accessibility outcomes remains limited, particularly in Canada. Most existing studies focus on ridership and service frequency rather than on accessibility metrics, and few use before-and-after comparisons grounded in detailed routing data. Equity analyses are even less common: while the transit equity literature has grown substantially over the past two decades, it has rarely been applied systematically to the specific context of network redesign outcomes in Canadian cities.

This research addresses these gaps by applying a consistent, reproducible accessibility measurement framework, using General Transit Feed Specification (GTFS) data, OpenStreetMap data, and Statistics Canada census information, across three Canadian cities and two time periods. By examining both the aggregate accessibility effects of each redesign and their distribution across income groups, the study provides evidence that is relevant both to academic debates about transit equity and to the practical decisions facing transit planners and policymakers.

1.6 Research Questions

This research is organized around two primary research questions:

RQ1: How do bus network redesigns change jobs accessibility in Edmonton, Ottawa, and Winnipeg?

RQ2: Are these changes distributed equitably across income groups?

The first question is descriptive and evaluative: it asks what happened to job accessibility in each city following the redesign, and whether the direction and magnitude of change varied across space and across travel time thresholds. The second question is normative and analytical: it asks whether the benefits and costs of the redesign were distributed in a way that is consistent with equity goals, specifically whether lower-income residents experienced comparable or greater accessibility gains relative to higher-income residents.

Together, these questions allow for both a technical and a social assessment of each redesign. They also allow for a comparative analysis across cities, examining whether the outcomes of BNRs in the Canadian context share common patterns or are highly contingent on local conditions.

2. Literature Review

This literature review synthesizes four interconnected bodies of work that together frame the research: the practice and rationale of bus network redesigns; the measurement of transit accessibility; equity in transit planning and service delivery; and the use of accessibility-based methods to evaluate transit projects. It concludes by identifying the specific gaps that this research addresses.

2.1 Bus Network Redesigns: Rationale and Practice

Bus network redesigns have become an increasingly prevalent response to the challenges facing public transit agencies across North America. Byala et al. (2019), in a comprehensive synthesis of practice drawing on surveys of 36 transit agencies in Canada and the United States, identify three primary motivations driving the trend toward redesign: a desire to improve network efficiency and reduce operating costs; the need to adapt to changing land use and travel demand patterns that post-war transit networks were not designed to serve; and the imperative to reverse sustained declines in bus ridership, which fell by more than eleven percent in the United States between 2012 and 2017. These motivations are not mutually exclusive, and agencies frequently pursue redesigns in response to several pressures simultaneously.

The most common stated goals among the agencies surveyed by Byala et al. (2019) include simplifying the network for ease of public use, improving on-time performance and reliability, increasing service frequency on core corridors, and controlling or reducing operating costs. A recurring theme in the synthesis is the tension between frequency-oriented and coverage-oriented network design philosophies. High-frequency networks concentrate service on a smaller number of routes to offer more reliable, attractive service; coverage networks spread service more thinly to reach a greater proportion of the geography. Byala et al. (2019) find that most redesigns lean toward the frequency model, often explicitly inspired by the Houston METRO redesign of 2015.The most common stated goals among the agencies surveyed by Byala et al. (2019) include simplifying the network for ease of public use, improving on-time performance and reliability, increasing service frequency on core corridors, and controlling or reducing operating costs. A recurring theme in the synthesis is the tension between frequency-oriented and coverage-oriented network design philosophies. High-frequency networks concentrate service on a smaller number of routes to offer more reliable, attractive service; coverage networks spread service more thinly to reach a greater proportion of the geography. Byala et al. (2019) find that most redesigns lean toward the frequency model, often explicitly inspired by the Houston METRO redesign of 2015

The Houston redesign is perhaps the most studied BNR in the literature, and Pritchard (2015) provides one of the most detailed accessibility analyses of its effects. By comparing service coverage, frequency, and demographic access before and after the Re-Imagining, Pritchard finds that the new grid-based network delivered improvements in frequent service access across most of the city, with gains for younger residents and higher off-peak service coverage. Notably, access to higher-income jobs improved more than access to lower-wage employment, a finding that points to the limits of treating overall accessibility gains as necessarily equitable. The

Houston case established several principles that have since become influential in BNR planning: the value of all-day service frequency, the importance of building a network around connections rather than point-to-point routes, and the political and public engagement challenges that attend large-scale restructuring.

A structurally significant type of BNR involves shifting from a radial, CBD-focused network to a decentralized, multi-destination structure. Bhattacharya et al. (2013) study precisely this transition in Tallahassee, Florida, where StarMetro restructured its entire bus network in 2011 from a downtown-oriented radial system to a decentralized grid. Using before-and-after rider surveys, travel demand model outputs, and socioeconomic census data, they find that the restructuring increased walk times to stops, as routes became less numerous and more spread out, but that shorter, more direct in-vehicle travel times more than compensated, producing a net reduction in total travel time and an overall increase in accessibility to destinations for most trip interchanges. Importantly from an equity standpoint, Bhattacharya et al. (2013) find that the restructuring neither disproportionately harmed nor disproportionately benefited neighbourhoods with higher concentrations of transit-dependent, low-income, or minority residents.

Grise, Stewart, and El-Geneidy (2021) provide a detailed methodological account of how a BNR can be planned and evaluated, using the city of Longueuil, Quebec, as a case study. Their work is particularly relevant to the present research in two respects. First, it demonstrates that transitioning from a direct-service, door-to-door network to a high-frequency, transfer-based network can increase accessibility to jobs for many residents, even without adding new vehicles or budget. Second, it shows that this transition comes at a cost: some residents, particularly those in lower-density areas, may experience a reduction in geographic coverage. The authors propose a systematic planning process that iterates between coverage analysis, job accessibility measurement, and travel time analysis, a process whose logic closely parallels the approach adopted in this research. Grise et al. (2021) also note that rider resistance to transfers is a significant challenge in implementing transfer-based networks, a finding that resonates with the experience of Winnipeg's 2025 redesign documented in this study.

The literature consistently emphasizes that network structure, not merely network size or budget, is a primary determinant of what a redesign achieves. A thinner but faster and more frequent network can outperform a denser but slower and less reliable one on accessibility metrics, even when the two systems operate at identical cost. This insight underpins the analytical approach taken in this research, which evaluates each redesign not just by the number of routes or the total kilometres of service, but by the number of jobs reachable within defined travel time thresholds.

2.2 Measuring Transit Accessibility

The measurement of transit accessibility has a long history in transport geography, tracing back at least to Hansen's (1959) foundational definition of accessibility as the intensity of the possibility of interaction. Since then, a substantial literature has developed around how best to operationalize this concept for use in planning practice and research evaluation.

Geurs and van Wee (2004) provide an influential typology of accessibility measures, distinguishing among infrastructure-based measures, activity-based measures, utility-based measures derived from mode choice models, and person-based measures drawing on time geography. Each family of measures has distinct theoretical grounding and practical trade-offs. For policy-relevant research, cumulative opportunity measures, a sub-type of the activity-based family, have become especially common. They count the number of destinations reachable within a fixed time threshold, producing results that are intuitive, transparent, and easy to communicate to non-specialist audiences.

Klar et al. (2023) provide a direct empirical comparison of cumulative, gravity-based, and hybrid accessibility measures applied to two Canadian transit scenarios: a BRT expansion in Vancouver and a transit system redesign in Edmonton, the same Edmonton redesign examined in this research. Their findings are instructive for methodological choices. The three types of measures produce notably different appraisal results: depending on which measure is chosen, the same transit intervention can appear to yield net positive or net negative accessibility outcomes. Cumulative measures tend to understate the geographic extent of accessibility change because they apply a binary cutoff rather than a continuous decay function. Despite this limitation, Klar et al. (2023) acknowledge that cumulative measures remain widely used and are particularly valued in practice for their interpretability. Their recommendation is that analysts test multiple measure types to ensure robustness. The present research uses cumulative opportunity measures as its primary analytical tool, consistent with the broader literature reviewed by Klar et al. (2023) and with the approach used in directly comparable Canadian studies.

Tribby and Zandbergen (2012) demonstrate how multimodal network models integrating transit and walking can capture fine-grained spatial and temporal variation in accessibility that cruder measures miss, applying this framework to evaluate new bus rapid transit in Albuquerque, New Mexico. Their work underscores the importance of incorporating walking access to and from stops, a design feature built into the R5R routing engine used in the present research. Handley, Fu, and Tupper (2019) offer a complementary perspective, measuring how a transit centre reconfiguration in Rochester, New York affected the gap between scheduled and realized accessibility, pointing to the limits of schedule-based accessibility models when on-time performance is poor. While the present research, like most in this literature, relies on schedule-based GTFS data rather than real-time tracking, this limitation is acknowledged in the methods chapter.

2.3 Equity in Transit: Concepts and Evidence

Equity has become a central concern in the transit planning literature, though the concept is applied in diverse and sometimes conflicting ways. A useful distinction is between horizontal equity, which requires equal treatment of equal groups, and vertical equity, which requires greater benefit to those with greater need. Transit research increasingly emphasizes vertical equity, recognizing that transit serves as a critical mobility resource for those without access to private vehicles, including many low-income residents, older adults, and people with disabilities.

Manaugh and El-Geneidy (2012) examine proposed transit infrastructure investments in Montreal using both accessibility and travel time measures, asking whether planned expansions would benefit socially disadvantaged neighbourhoods. They find that the most socially and transportational disadvantaged areas, identified by overlaying income, immigration status, and current transit access, do not always benefit most from planned investments. Their methodology, which explicitly combines social need with transportation access to identify double-disadvantaged communities, anticipates the bivariate approach used in the present study. Their findings also reinforce the conclusion from the broader Canadian literature that disadvantage and poor transit access do not map neatly onto each other in Canadian cities, making city-specific analysis essential.

The equity implications of frequency-versus-coverage trade-offs are examined in a planning context by Lovell (2012), who develops a hypothetical productivity-oriented network restructure for the West Seattle neighbourhood and evaluates its distributional effects across several transit-disadvantaged groups, including households below the poverty line, youth, seniors, people of colour, and zero-car households. For four of the five groups studied, census tracts with higher concentrations of transport-disadvantaged residents experienced greater gains under the frequency-oriented scenario than lower-concentration tracts, suggesting that high-productivity restructuring need not come at an equity cost. The exception was tracts with high concentrations of seniors, who gained service but to a lesser degree than other groups. Lovell's (2012) finding that some high-disadvantage, high-impact tracts still experienced negative outcomes underscores a point that surfaces repeatedly in this literature: aggregate equity improvements can coexist with localized harms that require targeted design attention or compensatory service alternatives.

The equity implications of BNRs specifically are examined by Liu, Rahman, and Karner (2023) in their study of Richmond, Virginia. Their analysis of the Richmond Transit Network Plan finds that the redesign produced gains in service frequency and weekend coverage for many riders, and that Black residents and transit-dependent populations experienced improvements in job accessibility. However, grocery store access disparities persisted, and the authors caution that the choice of performance metric significantly affects equity conclusions: a redesign that appears equitable by one measure may appear inequitable by another. Liu et al. (2023) also argue that meaningful public engagement is essential to any equity analysis, as the parameters chosen in any evaluation are themselves value laden.

This point is echoed by Situ and Karner (2025), who review equity analyses conducted across 45 BNRs in 40 agencies and find that most rely on census-based demographic data and proximity-based metrics, both of which can overlook the lived experiences and mobility barriers of older adults, people with disabilities, and caregivers. Situ and Karner (2025) call for a more comprehensive analytical framework that combines systemwide and route-level assessments, incorporates rider-based data sources such as on-board surveys, and integrates community feedback into the design process.

Tilahun and Fan (2014) investigate transit and job accessibility in the Minneapolis-St. Paul metropolitan region, focusing on access to competitive economic clusters. They find substantial variation in transit accessibility to different industry sectors, with some cluster industries significantly harder to reach by transit than others. While not focused on network redesigns, their work reinforces the importance of considering the spatial relationship between jobs and transit when evaluating accessibility outcomes and highlights that aggregate accessibility measures can mask meaningful sectoral and spatial variation.

2.4 Measuring Equity Through Accessibility

A strand of the literature has moved beyond documenting equity problems toward developing methods for evaluating whether specific transit investments or redesigns improve or worsen equity outcomes. This work is directly relevant to the analytical approach taken in the present research.

The core methodological challenge is linking accessibility outcomes to population characteristics. Most approaches do this spatially: by computing accessibility at the census tract or zone level and then matching those values to socioeconomic attributes from census data. The present research follows this approach, overlaying income data onto before-and-after accessibility change scores to produce a bivariate picture of who gained and who lost from each redesign. Manaugh and El-Geneidy (2012) demonstrate a similar approach in Montreal, showing that it can identify communities that are doubly disadvantaged in both social need and transit access, and thus most in need of targeted investment. Klar et al. (2023) apply a similar logic to Edmonton and Vancouver, showing that accessibility-based appraisals can yield different conclusions about who benefits depending on the measure chosen.

Situ and Karner (2025) situate these methodological debates within the institutional context of BNR planning in the United States, where Federal Transit Administration guidelines require agencies to conduct service equity analyses before implementing major service changes. Their review finds that current practice falls well short of what the literature recommends: most equity analyses use proximity-based metrics, which assess whether people live within walking distance of a stop but do not measure whether those stops connect people to jobs or other destinations. Accessibility-based metrics, which ask how many opportunities are reachable within a given time budget, are more demanding but more informative. The present research adopts this more demanding standard.

2.5 Papers Set Aside as Not Relevant

Two papers from this round of the literature review do not make a substantive contribution to the themes of this research and are set aside accordingly.

Saha and Shinstine (2015) analyze bus route expansion options for a small transit agency serving Laramie, Wyoming, a city of approximately 30,000 residents. The focus on routing model development in a small, rural university town context is too distant from the urban BNR and accessibility evaluation questions of this study to be usefully incorporated.

Delmelle, Li, and Murray (2012) propose a GIS-based optimization framework for identifying redundant bus stops on a single route, using simulated annealing to find stop configurations that balance coverage and efficiency. While methodologically interesting, the paper addresses a specific network operations problem at the sub-route level and does not engage with the system-wide redesign outcomes, accessibility measurement, or equity questions central to this research.

2.6 Summary and Research Gaps

The literature reviewed above establishes several things clearly. Bus network redesigns are common, accelerating, and motivated by a combination of efficiency, ridership, and fiscal concerns. Their effects on accessibility are real but spatially uneven: some areas gain substantially while others lose, and the direction and magnitude of change are contingent on local network structure, land use, and pre-redesign conditions. The shift from radial to decentralized network structures, well illustrated by the Tallahassee case and the Longueuil planning process, tends to produce net accessibility gains for most riders but can impose localized losses that require targeted design attention. Equity outcomes are contested and measure-dependent: a redesign that improves aggregate accessibility may still produce inequitable distributional effects, and even those that appear broadly equitable, as in Tallahassee and West Seattle, may leave specific disadvantaged communities worse off. In Canada specifically, the relationship between social disadvantage and transit access does not follow the same pattern as in the United States, making Canadian-specific evidence important.

What the literature has not yet provided is a systematic, accessibility-based evaluation of BNR outcomes across multiple Canadian cities using a consistent methodological framework. Existing Canadian studies are either focused on a single city, methodologically focused rather than outcome-focused, or concerned with proposed rather than implemented redesigns. This research fills that gap by applying a consistent cumulative opportunity accessibility framework, grounded in GTFS data and the R5R routing engine, to three implemented Canadian BNRs, and by examining the distributional implications of each redesign through an income-stratified equity lens.

3. Research Questions

This research is organized around two questions. The first asks what happened to jobs accessibility after each redesign. The second asks whether those changes were distributed fairly across income groups. Together, they allow for both a technical and a social assessment of each redesign.

RQ1: How do bus network redesigns change jobs accessibility in Edmonton, Ottawa, and Winnipeg?

RQ2: Are these changes distributed equitably across income groups?

RQ1 asks what happened to jobs accessibility in each city following the redesign: whether it increased or decreased, by how much, and where. Because the three redesigns took place in different cities, at different times, and under different fiscal and planning conditions, results are presented city by city before a cross-city comparison is drawn.

The word "change" in RQ1 is used carefully. This research does not claim that the redesign caused any shift in accessibility. The before-and-after design can identify associations between the redesign and observed changes in the cumulative opportunity measure, but other factors (population redistribution, employment change, and updates to OSM data) could also contribute. These limitations are acknowledged and addressed in the discussion.

RQ2 asks whether the changes documented in RQ1 were distributed fairly. Specifically, it examines whether lower-income census tracts experienced comparable or greater gains relative to higher-income tracts. A redesign that improves accessibility across the board but disproportionately benefits already well-served, higher-income areas would be considered regressive. One in which lower-income areas gain more, or higher-income areas bear a greater share of losses, would be considered progressive. A neutral outcome would show no systematic relationship between accessibility change and income.

This framing treats equity as a property of outcomes, not intentions. RQ2 does not ask whether agencies set out to design an equitable network, or whether equity analysis was part of the planning process, those questions are taken up in the study area and discussion chapters. RQ2 asks only what the data show about who gained and who lost.

The two questions are linked. RQ1 describes the pattern of accessibility change; RQ2 asks what that pattern means for different groups. Answering both, for each city and then across cities, allows this research to assess whether BNRs in the Canadian context tend toward progressive, neutral, or regressive outcomes, and whether that pattern holds across different urban contexts or varies with local conditions.

In addition to the two research questions, this study examines changes in GTFS-derived service characteristics as a supplementary analysis. Metrics such as vehicle kilometres travelled (VKT), total service hours, average headways, and the number of trips and stops are extracted from the GTFS feeds for each city before and after the redesign. These indicators help characterize the scale and structure of the network changes underlying the accessibility results, and provide context for interpreting the patterns observed in RQ1 and RQ2.

4. Methods and Data

This chapter describes the data sources, routing methodology, and equity framework used to measure how bus network redesigns (BNRs) affected jobs accessibility in Edmonton, Ottawa, and Winnipeg. The approach is designed to be replicable across cities and transparent in its assumptions.

4.1 Case Study Design

This paper employs a comparative case study design, examining three Canadian cities that implemented BNRs at different points in time. A comparative approach offers two advantages. First, it allows within-city before-and-after comparisons that isolate the effect of the redesign from broader structural factors. Second, it enables cross-city comparison of patterns, whether gains and losses in accessibility follow similar distributional logics across different planning contexts.

The three cities were selected based on three criteria: the availability of complete before-and-after GTFS data, the timing of the redesigns (2021 for Edmonton, 2025 for Ottawa and Winnipeg), and geographic diversity across Canada. Edmonton represents a western mid-sized city with a redesign now several years old, offering a longer settlement period. Ottawa and Winnipeg both implemented their redesigns in 2025, allowing a more direct comparison of near-simultaneous changes in different policy contexts. Each city also offers a distinct planning rationale, from ridership optimization to explicit budget reduction, which makes cross-city comparison analytically productive.

4.2 Data Sources

4.2.1 GTFS Transit Data

Transit network data were obtained in the General Transit Feed Specification (GTFS) format, the open standard used by transit agencies worldwide to publish scheduled service information. A GTFS feed contains a set of text files describing routes, trips, stops, stop times, and service calendars, providing everything needed to reconstruct the scheduled network at any given date.

For each city, two GTFS snapshots were collected: one representing the network roughly one month before the redesign, and one roughly one month after. The one-month buffer is intended to avoid capturing transitional service disruptions that sometimes accompany major network changes, ensuring that each snapshot reflects the intended steady-state network. For Edmonton, the before snapshot corresponds to March 2021 and the after snapshot to June 2021, bracketing the April 2021 rollout. For Ottawa and Winnipeg, snapshots bracket their respective May and June 2025 implementation dates.

Service metrics were extracted from each GTFS feed to characterize the network before and after the redesign. These include vehicle kilometres travelled (VKT), total scheduled service hours, trip counts by route, unique stops served, and scheduled headways by route and time. VKT was computed by joining each trip to its associated shape geometry and summing trip-level distances across all trips active on a representative weekday. Service hours were derived as the elapsed time between a trip's first departure and last arrival. Headways were computed as the mean interval between successive departures at the first stop of each route. These metrics provide a quantitative profile of how the supply of transit service changed between periods.

4.2.2 Street Network

Pedestrian and road network data were obtained from OpenStreetMap (OSM), an open-source geographic database maintained by a global contributor community. OSM data were extracted for each city's metropolitan boundary and used by the R5R routing engine to model walking access to and from transit stops. OSM provides sufficiently detailed coverage of sidewalks, crossings, and footpaths to support pedestrian routing at the scale of census tracts.

4.2.3 Employment Data

Jobs data were obtained at the census tract (CT) level from Statistics Canada. Total employment counts by census tract serve as the destination layer in the accessibility calculation, specifically, the number of jobs reachable within a given travel time threshold from each origin tract. Employment figures were drawn from the most recent available census or labour force survey vintage at the time of analysis. Because census data are collected on a fixed cycle, the employment vintage may not perfectly align with the GTFS snapshot year; this limitation is discussed further in Section 4.5. Jobs were assigned to tract centroids for routing purposes, which is standard practice in cumulative opportunity accessibility research.

4.2.4 Income Data

Median household income by census tract was obtained from Statistics Canada, drawn from the Census of Population. Income data are used to construct the equity dimension of the analysis. Census tracts are classified as low-income if their median household income falls within the bottom 25 percent of the income distribution for their respective city. This threshold is defined separately within each city, reflecting local income distributions rather than a national standard. The resulting binary classification, low-income versus non-low-income tracts, allows accessibility changes to be compared across the income distribution, revealing whether BNR-driven gains and losses in jobs access are concentrated in lower-income or higher-income areas.

4.3 Accessibility Measurement

4.3.1 The Cumulative Opportunity Measure

Jobs accessibility is measured using a cumulative opportunity approach, which counts the number of jobs reachable from a given origin within a specified travel time threshold. This measure was chosen for its simplicity and robustness: it is intuitive to interpret, does not require assumptions about travellers' sensitivity to travel time beyond the threshold, and has been widely used in both research and policy contexts (El-Geneidy and Levinson, 2006; Geurs and van Wee, 2004).

4.3.2 Routing with R5R

Travel time matrices were computed using R5R, an open-source R package that interfaces with the Conveyal R5 routing engine. R5R is designed for large-scale multimodal accessibility analysis and supports transit routing directly from GTFS feeds combined with OSM street networks. For each city and each time (before and after), R5R was used to compute the travel time from every census tract centroid to every other centroid, incorporating walking, waiting, and in-vehicle transit time.

Key routing parameters were held constant across cities and time periods. A fixed departure time of 10:00 AM on a representative weekday was used, reflecting a mid-day service scenario that avoids both the best-case frequencies of the morning peak and the reduced service of evenings and weekends. Maximum walking distance was capped to avoid unrealistic pedestrian trips. The number of transfers was not artificially limited, allowing R5R to identify the fastest feasible path under the scheduled network. These parameters were applied consistently to isolate the effect of network change rather than parameter choice.

4.3.3 Travel Time Thresholds

Results are reported at all three thresholds as a co-equal set rather than treating any single threshold as primary. This choice reflects a substantive finding of the analysis: the direction and magnitude of accessibility change in this study are frequently threshold-dependent rather than consistent across thresholds. In Edmonton, for example, median accessibility declines slightly at the 30- and 60-minute thresholds but rises at 90 minutes, a pattern that would be invisible if only one threshold were reported. Reporting all three thresholds in full, for every city, is therefore necessary to capture the threshold sensitivity that the results reveal, rather than a robustness check performed after the fact.

4.4 Equity Analysis Framework

The equity analysis links accessibility outcomes to the spatial distribution of income across census tracts. For each city, accessibility is computed before and after the BNR at the census tract level, and the change is expressed as both an absolute difference and a percentage change. Census tracts are classified as low-income or non-low-income based on the city-specific bottom-25-percent threshold described above, and mean accessibility change is calculated for each group.

This approach allows the analysis to assess whether BNR-related accessibility gains and losses were progressively or regressively distributed, that is, whether low-income areas (where transit dependence tends to be higher) experienced proportionally greater gains or losses relative to higher-income areas. A progressive outcome is one where low-income tracts see relatively larger gains or smaller losses; a regressive outcome is the reverse.

Results are visualized using bivariate choropleth maps, which display two variables simultaneously, income group and direction of accessibility change, using a two-dimensional colour scheme. This technique allows spatial patterns to be read directly from the map: areas that are both low-income and experienced accessibility loss are visually distinguished from areas that are low-income but experienced gains, and so on. Bivariate maps are produced for each city and are a core output of the analysis.

4.5 Limitations

Several methodological limitations should be noted. First, the cumulative opportunity measure treats all jobs within the threshold as equally accessible and does not account for competition among job seekers, skill matching, or hiring barriers. The measure captures the supply of potentially accessible jobs, not the likelihood of attaining any job.

Second, employment data from Statistics Canada are collected on a fixed census cycle and may not perfectly match the year of the GTFS snapshot. Changes in local employment geography between the census vintage and the analysis date introduce some uncertainty, though this is a common limitation of accessibility research using census-based employment data.

Third, the analysis is based on scheduled transit service as encoded in GTFS feeds, not actual operations. Service disruptions, operator shortages, and real-world delays are not captured. To the extent that the redesigns affected operational reliability as well as scheduled frequency, the accessibility estimates may overstate the gains experienced by riders in practice.

Fourth, income data are measured at the census tract level and will mask within-tract variation. A tract classified as low-income may contain pockets of higher-income households, and vice versa. The bottom-25-percent classification is thus an approximation of socioeconomic conditions, not a precise measure.

Fifth, the 90-minute travel time threshold used in this study is generous by the standards of many accessibility studies. While this choice is justified by the commuting realities of transit-dependent populations, it means the accessibility estimates at this threshold may include jobs that would be considered impractical to reach by many travellers. Reporting results at the 30- and 60-minute thresholds alongside the 90-minute threshold helps address this concern, since shorter, more conservative thresholds are presented in full rather than as a secondary check.

Finally, a limitation specific to the percent change statistic used to summarize accessibility change at the tract level became apparent at the 30-minute threshold across all three cities. Percent change is calculated relative to the Before-period job count, and tracts with a very small Before-period count can show an extremely large percent change even from a modest absolute gain. At the 30-minute threshold, this small-denominator effect produces mean and maximum percent change values that are far larger than the median, and that do not reflect the typical tract. The median percent change, which is far less sensitive to this effect, is therefore the more reliable summary statistic at the 30-minute threshold, and mean and maximum values at this threshold are interpreted with caution in the results chapter.

5. Study Area and Context

5.1 Edmonton

5.1.1 City Profile

Edmonton is Alberta's capital city and the northernmost major metropolitan area in Canada, with a population of approximately 1.1 million in the city proper and roughly 1.5 million in the broader metropolitan region. Its urban form is characterized by a relatively low-density footprint shaped by decades of suburban expansion, a grid-dominated street network in older inner areas giving way to curvilinear patterns in newer outer neighbourhoods, and a North Saskatchewan River valley that creates a significant geographic division across the city. Employment is concentrated downtown and in several suburban nodes, with a large public-sector presence anchored by provincial government offices and the University of Alberta. Edmonton's economy has historically been tied to the oil and gas sector, which shapes commuting patterns and transit dependency differently than in more diversified Canadian urban economies.

Edmonton Transit Service (ETS) operates a bus network alongside a Light Rail Transit (LRT) system that has expanded incrementally since its opening in 1978. By the early 2020s, the LRT comprised two lines: the Metro Line running north and the Capital Line running south, connecting the downtown core to suburban terminals. Bus service functions as a complement to the LRT, providing coverage across inner and outer neighbourhoods through a mix of local, express, and crosstown routes. Prior to the 2021 redesign, the bus network reflected decades of incremental route additions rather than systematic design, resulting in a pattern of overlapping and circuitous local services, particularly in inner-area neighbourhoods.

5.1.2 The 2021 Redesign

The 2021 redesign was the direct implementation of principles laid out in Edmonton's 2017 Transit Strategy, a high-level planning document developed following an extensive public engagement process involving over 20,000 residents between 2015 and 2016. The strategy was structured around five pillars covering community planning integration, fare policy, network design, customer experience, and organizational capacity. Pillar 3, on network design, provided the most direct guidance for the redesign: it called for a market-responsive approach that differentiated service between inner and outer areas, concentrated frequency on high-demand corridors, simplified local routing, and accepted longer walking distances as a trade-off for more direct service. The resulting network introduced a tiered service hierarchy organized around the existing LRT spine, with Frequent Bus Routes, Rapid Bus Routes, Crosstown Routes, and Local Routes. Local routes were made less circuitous, with service redeployed from lower-demand areas and time periods toward higher-demand ones.

The strategy's stated goals were oriented around service quality and ridership growth rather than accessibility in the transport planning sense. The document articulates four core attributes as the benchmarks for success: safe, fast, convenient, and reliable. Its performance monitoring framework tracks indicators such as cost recovery ratios, on-time performance, customer satisfaction scores, and safety incident rates. Nowhere in the strategy's guiding principles, actions, or performance indicators does jobs accessibility appear as a planning metric. The term "accessibility" is used in two narrower senses throughout the document: physical accessibility for persons with disabilities, and a general rhetorical claim that transit provides reasonable access for all people regardless of age, ability, or economic circumstance. While one pillar gestures toward transit's role in linking workers with jobs and customers with businesses, this framing is aspirational rather than analytical; it is not operationalized into any measurable target or evaluation criterion.

The redesign was thus guided by a demand-matching logic: service levels should reflect ridership demand, land use density, and customer preferences, with frequency concentrated where it will attract the most riders. Whether this approach would improve jobs accessibility, and for whom, was not a question the planning process was designed to answer. This absence is analytically significant. It means that the accessibility gains and losses documented in this study's results were not anticipated or measured by Edmonton Transit at the time of redesign. Any distributional outcomes across income groups are emergent consequences of network restructuring rather than intended policy effects. The gap between what the redesign set out to achieve and what the accessibility analysis reveals is a central theme this paper returns to in the discussion.

5.2 Ottawa

5.2.1 City Profile

Ottawa is the capital of Canada and the second-largest city in Ontario, with a population of approximately 1.1 million in the city proper and close to 1.5 million in the broader Ottawa-Gatineau metropolitan area. The city occupies a large geographic footprint of roughly 2,796 square kilometres, reflecting a pattern of suburban and exurban expansion that has historically shaped its transit challenges. Ottawa's economy is anchored by the federal public service, which accounts for a significant share of downtown employment, alongside growing technology and health sectors. This employment structure is notable for transit planning: a large, geographically concentrated downtown workforce has historically supported strong peak-hour ridership corridors, even as suburban employment growth has complicated efforts to serve the broader network.

Ottawa's transit system, operated by OC Transpo under the City of Ottawa, has undergone substantial transformation over the past decade. The opening of the Confederation Line (O-Train Line 1) in 2019, followed by the phased Stage 2 expansion that extended the Trillium Line (Line 2) south and added the airport link (Line 4) in January 2025 alongside further Confederation Line extensions, fundamentally restructured the city's rapid transit spine. This rail buildout reached suburban areas including Riverside South and Orleans, and prompted a corresponding reorganization of bus routes around rail feeder functions. By 2025, the LRT network served as the primary trunk for east-west travel across the urban core, with the bus network increasingly designed to provide first- and last-mile connections to rail stations rather than direct crosstown service.

Prior to the 2025 redesign, OC Transpo had conducted similar comprehensive bus reviews in 1997, 2005, 2011, and 2016, the last of which prepared the network for the opening of Line 1 (OC Transpo, 2023). The 2025 Bus Route Review therefore represents the most recent iteration of a long institutional practice of periodically realigning the bus network around major infrastructure investments. The 2023 public consultation report, which shaped the redesign, identified two primary motivations: adapting the network to the expanded LRT, and responding to shifts in travel demand that followed the COVID-19 pandemic. On the latter point, the report documented sustained ridership changes, with many respondents reporting altered commuting patterns and reduced peak-hour usage relative to the pre-pandemic baseline (OC Transpo, 2023).

5.2.2 The 2025 Bus Route Review: Process and Goals

OC Transpo launched its Bus Route Review in January 2023 as a structured, four-phase process. The first phase was devoted to understanding how residents use the system and what they prioritize for its future. Feedback was collected through an online survey (approximately 8,200 respondents initiated the survey, with 6,700 completing it in full), four public open houses, a virtual open house, councillor-led sessions, direct email submissions, and staff outreach at major transit hubs (OC Transpo, 2023). The consultation surfaced several consistent themes. Among the most frequently cited requests were faster and more direct routes (nearly 2,000 open-ended responses), increased frequency across all periods (over 2,600 requests), and better suburb-to-suburb and crosstown connections (OC Transpo, 2023). Bus operators, consulted separately at each of OC Transpo's garages, independently raised concerns about route directness, recovery time, and the need for transit priority signals (OC Transpo, 2023). Phase 2 used this feedback to develop alternative network scenarios. Phase 3 presented scenarios to Transit Commission and City Council for direction through the 2024 budget process. Phase 4 involved implementation, with network changes taking effect in May 2025.

The Ottawa redesign is distinguished from its Edmonton and Winnipeg counterparts by its explicitly budget-constrained context. While all three cities were operating under post-COVID fiscal pressure, Ottawa's redesign proceeded in a period of acute financial difficulty for OC Transpo, compounded by the cost overruns and performance challenges associated with the LRT program. The redesign was not simply a network rationalization driven by planning philosophy; it was also shaped by the need to operate within constrained resources. This context is important for interpreting the intent behind the redesign: a process carried out partly under fiscal pressure may prioritize cost containment alongside service optimization, with implications for which trade-offs agencies are willing to make explicit. In terms of network structure, the 2025 redesign did not produce the kind of dramatic visible restructuring seen in some prominent North American redesigns. The high-level route network retained much of its existing form, with changes concentrated in service levels, routing details, and the alignment of bus service around LRT feeder functions.

5.3 Winnipeg

5.3.1 City Profile

Winnipeg is the capital and largest city of Manitoba, situated at the confluence of the Red and Assiniboine rivers in the geographic centre of Canada. With a census metropolitan area population of approximately 835,000 as of 2021, it is Canada's eighth-largest metropolitan area and the largest city on the Prairies after Calgary and Edmonton. Its location in the interior of the continent produces an extreme continental climate, among the coldest of any major Canadian city, which shapes daily mobility patterns and places particular demands on public transit infrastructure.

Winnipeg's urban form reflects its history as a nineteenth-century railway hub and its subsequent low-density suburban expansion across a predominantly flat landscape. The city is characterized by a relatively expansive land area, sparse densities in outer neighbourhoods, and a downtown core that captures a far smaller share of metropolitan employment than is typical in larger Canadian cities. This geography creates a structural challenge for transit planning: serving a geographically extensive city with moderate overall population density requires either comprehensive coverage, which dilutes frequency, or concentrated trunk service, which leaves lower-density areas underserved

Income and demographic patterns in Winnipeg are relevant to this study's equity analysis. The city has one of the largest urban Indigenous populations in Canada, concentrated in the North End and adjacent inner-city neighbourhoods. Median household incomes are below the national average for a metropolitan area of Winnipeg's size, and spatial income inequality is pronounced: lower-income households are concentrated in inner-city areas north and east of downtown, while higher-income suburbs are found predominantly in the south and southwest. This income geography intersects directly with transit dependency, as car ownership rates are lower in lower-income inner-city neighbourhoods, making the distributional effects of network changes particularly consequential.

5.3.2 The 2021 Winnipeg Transit Master Plan

The planning foundation for Winnipeg's 2025 bus network redesign is the Winnipeg Transit Master Plan (WTMP), approved by City Council in March 2021. The WTMP was developed over two phases between 2019 and 2020, led by Winnipeg Transit in partnership with Stantec Consulting and supported by extensive public engagement. It constitutes the city's first comprehensive, long-horizon transit plan, setting a 25-year vision for service and infrastructure through approximately 2045.

The plan's diagnostic of the existing network was pointed: over half of Winnipeg's bus routes were classified as complex, characterized by loops, indirect paths, and no clear primary purpose, while fewer than one in five were simple routes with a clear, direct corridor function. The WTMP concluded that incremental adjustments to this legacy network would be insufficient to meet the city's growing transportation needs and that a fundamental restructuring was required. The proposed network is organized around a two-tier hierarchy: a Primary Transit Network and a Feeder Network. The Primary Network comprises Rapid lines (service every 5 to 10 minutes), Frequent lines (every 10 to 15 minutes), and Direct lines (every 10 to 20 minutes), all operating as simple, straight routes along major corridors. The Feeder Network includes Connector routes, Community routes, On-Request services, and Winnipeg Transit Plus (the paratransit service), which collectively link lower-density neighbourhoods to the Primary Network. A central claim of the plan is that this restructuring would increase system capacity by 25 percent with no additional service hours, by eliminating route redundancy and enabling more productive deployment of existing resources.

The WTMP articulates nine network goals, of which inclusivity is of particular relevance to this study's equity frame. The plan commits to serving as many people as possible through accessible conventional transit and an improved Winnipeg Transit Plus, with fare parity between the two. The plan also connects its transit goals to the city's climate commitments, targeting an increase in the transit mode share from approximately 7 to 8 percent to 15 percent of all trips by 2030. A long-term rapid transit network is central to the WTMP's vision, with three proposed rapid transit lines converging downtown on Main Street. The Southwest Transitway, opened in two stages in 2012 and 2020, already provides Winnipeg's first rapid transit corridor. However, the full rapid transit buildout is a multi-decade infrastructure project; the 2025 bus network redesign examined in this study is the near-term service reorganization component of the plan, not the infrastructure component.

5.3.3 The 2025 Primary Transit Network

The Primary Transit Network (PTN) redesign, implemented in June 2025, represents the operationalization of the WTMP's first phase of network restructuring. The redesign transformed Winnipeg's bus network from its legacy radial configuration, with most routes oriented toward downtown and back, to a grid structure with stronger cross-town connections. Before-and-after route maps show a clear simplification: the tangle of winding, complex routes was replaced by a more legible network of straighter corridors, with fewer routes but higher scheduled frequencies on core lines.

The stated goals of the 2025 redesign align closely with the WTMP's language: more frequent service on core corridors, simpler and more direct routes, improved cross-town connectivity, and better integration between the Primary and Feeder networks. Winnipeg Transit described the redesign as producing a transit system that is simpler, more intuitive to use, more efficient to operate, and more useful for riders. The frequency threshold of 15 minutes or better on Primary Network lines is presented as a critical target, consistent with the transit planning literature's identification of 15-minute frequency as the threshold at which service becomes usable without schedule consultation.

The 2025 redesign is also notably efficiency-oriented rather than budget-driven: unlike Ottawa's contemporaneous redesign, which was explicitly motivated by a need to reduce operating costs, Winnipeg's restructuring was framed primarily around service improvement within the existing resource envelope. The WTMP had estimated that weekday improvements could be implemented with no net increase in service hours relative to the 2020 operating budget, with only a 12 percent increase in service hours needed for weekend improvements. This framing matters for interpreting the results: the Winnipeg redesign was designed to deliver accessibility gains through smarter network design, not through additional investment.

Despite these aspirations, the redesign generated significant rider pushback. Community concerns centred on increased transfer requirements, particularly for riders in lower-density outer neighbourhoods who had previously accessed multiple destinations with a single-seat ride. The Feeder Network's role in connecting these areas to the Primary Network introduced transfers that were experienced as a degradation of service even where measured accessibility improved. This gap between metric outcomes and lived experience is a central theme in the discussion chapter and reflects a broader tension identified in the transit redesign literature.

Together, Winnipeg's geographic and demographic profile, its documented history of network stagnation, and the ambitious restructuring logic of the WTMP provide the interpretive context for the accessibility and equity results reported in Section 6.3. The city represents the clearest case in this study of a redesign motivated by long-term planning vision rather than immediate fiscal constraint, and produces, as the results show, the strongest median accessibility gains of the three cities examined.

6. Results

This chapter presents the findings of the accessibility analysis for Edmonton, Ottawa, and Winnipeg. Each city is treated in turn, moving from the structural change visible in the route network, to the resulting change in jobs accessibility levels, to the magnitude and direction of that change at the tract level, and finally to how that change was distributed across income groups. The chapter closes with a cross-city comparison that draws out the patterns shared and not shared across the three cases.

Three complementary sources of evidence support the analysis in each city section. The first is the set of accessibility choropleth maps described below, organized by map type (route network, univariate accessibility level, percent change, and bivariate equity). The second is the tract-level summary statistics for the number of jobs reachable Before and After, and for the resulting percent change, reported as the low, mean, standard deviation, median, and high value across all census tracts in each city at each of the three travel time thresholds. The third is a set of supplementary GTFS-derived service metrics, namely vehicle kilometres travelled (VKT), total service hours, total trips, unique stops served, and routes operated, which characterize the scale and structure of each redesign independently of the accessibility analysis itself.

One pattern in the summary statistics is worth noting before turning to the individual results: at the 30-minute threshold, median percent change sits at or near zero in every city, while in Ottawa and Winnipeg the mean percent change and the high value are large and, in some cases, very large (Ottawa's high reaches 3,285.7 percent at 30 minutes). Edmonton is the exception, with a 30-minute mean also near zero. Where it occurs, this divergence between the median and the mean is a known artifact of dividing by a small Before-period job count: a tract with very few jobs reachable within 30 minutes Before redesign can show an extreme percent change After even from a modest absolute gain. The median, which is far less sensitive to this effect, is therefore the more reliable summary statistic at the 30-minute threshold, and the mean and high values at this threshold should be interpreted with caution throughout this chapter.

6.1 Edmonton

Edmonton's redesign took effect in 2021. Read together, the route network maps, the accessibility level maps, the percent change maps, and the bivariate equity map tell a consistent story: a network that was visibly consolidated, an accessibility core that became more contiguous and slightly more extensive at every threshold, and a distribution of those gains that does not track income in any simple way.

6.1.1 Network change

Edmonton is the only one of the three cities where the route network itself changed visibly between Before and After. The After network (Figure 2) shows fewer individual line segments through the residential grids north of the core, between downtown and St. Albert, and in the southwest, consistent with route consolidation: fewer, more direct routes replacing a larger number of shorter, more winding ones. The Before network (Figure 1) shows a denser tangle of routes filling those same residential areas. The downtown core and the main arterials look similarly dense in both maps; the thinning is concentrated in the outer residential

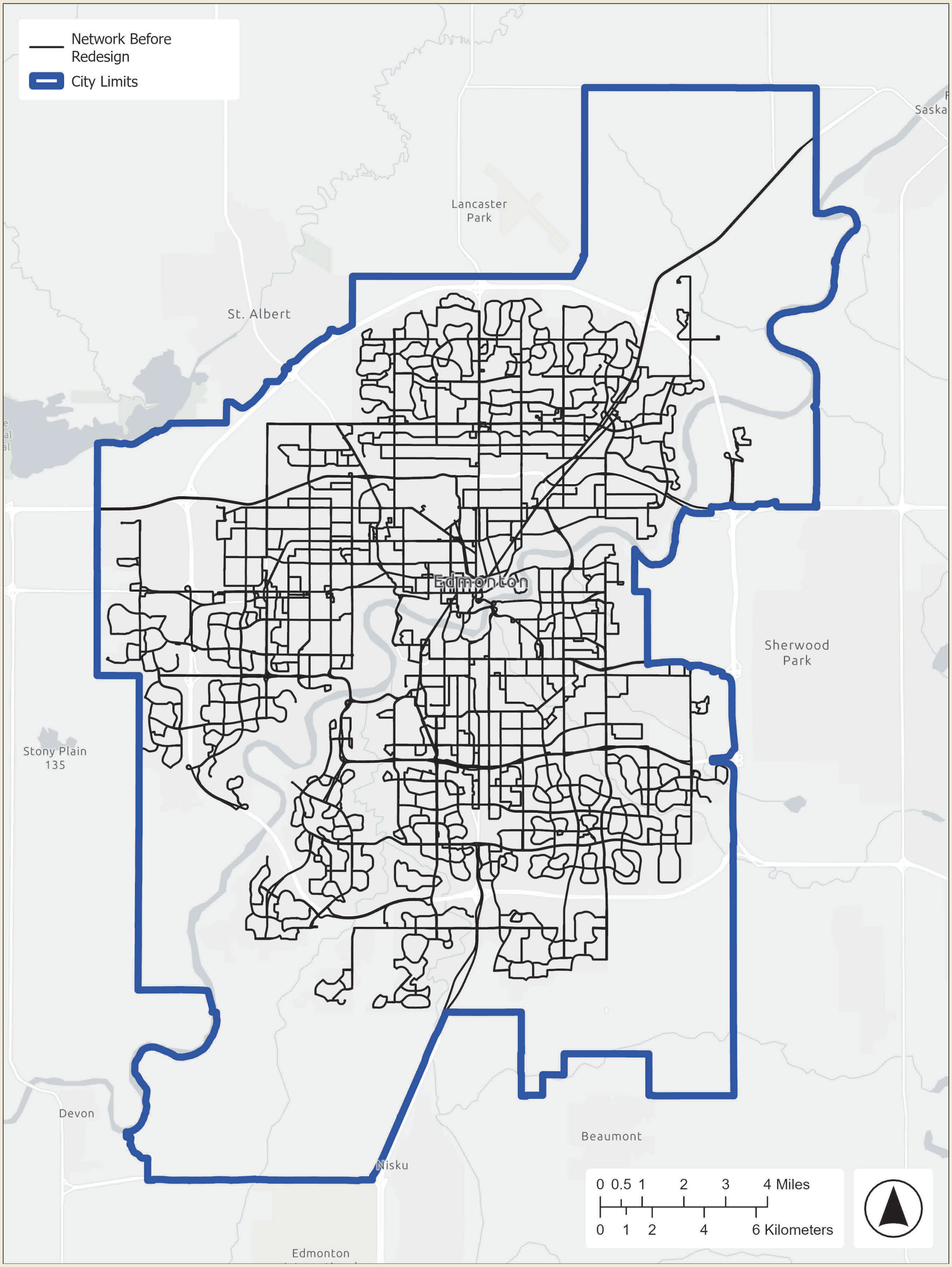

Figure 1. Edmonton, route network before redesign

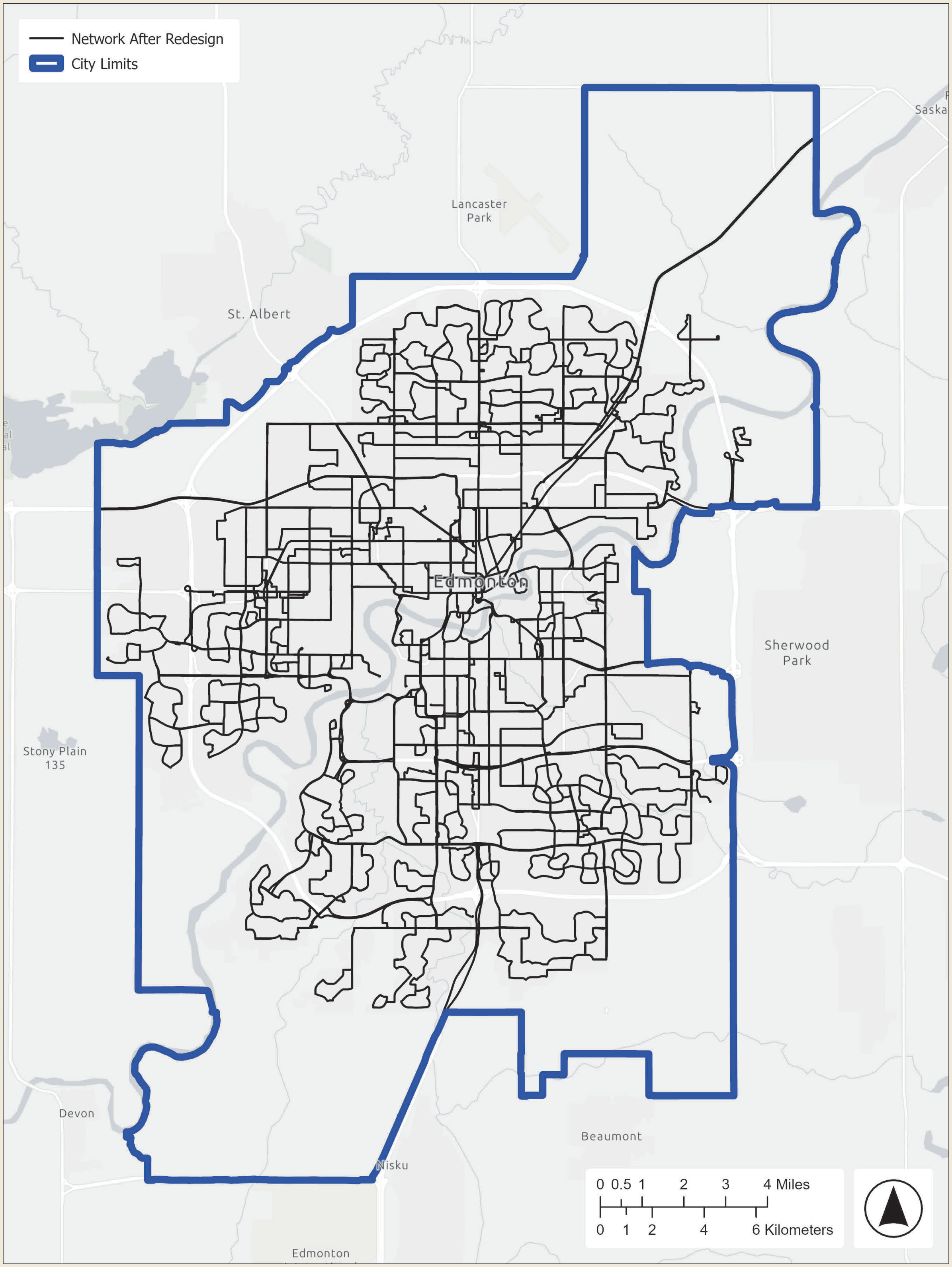

Figure 2. Edmonton, route network after redesign

neighbourhoods rather than the centre.

This pattern is consistent with the GTFS service metrics. Total trips rose by 10.5 percent (from 10,550 to 11,656) and total service hours rose by 7.7 percent, while the number of routes operated fell by 4.2 percent (from 216 to 207) and unique stops served fell by 8.2 percent (from 6,494 to 5,963). Edmonton added service overall while operating it through a smaller, more concentrated set of routes and stops, the GTFS-level signature of the consolidation visible in the network maps.

6.1.2 Accessibility levels

The three univariate threshold pairs (Figures 3 to 8) show a consistent pattern: a tight, dark core of highest accessibility sits in central Edmonton, surrounded by a halo of mid-range values, with the lightest class dominating the suburban and exurban fringe toward St. Albert, Stony Plain, Beaumont, and Devon. At each threshold, the After map shows this core as somewhat larger and more contiguous than the Before map

The tract-level summary statistics tell a more mixed story than the maps alone suggest. At 30 minutes, median jobs accessibility fell slightly, from 4,145 Before to 3,405 After, even as the mean held roughly steady (9,772 Before, 9,709 After), indicating that the modest visual expansion of the second-darkest band coexists with a small decline at the typical tract. At 60 minutes, the median fell more noticeably, from 119,180 Before to 102,785 After, while the mean again moved only slightly (112,119 Before, 109,856 After). At 90 minutes, both measures move in the same, positive direction: the median rose from 296,035 to 303,625 and the mean rose from 266,758 to 281,440, consistent with the more solid and contiguous high-accessibility core described above. Edmonton is therefore a case where the longest threshold shows a clear typical-tract gain, while the two shorter thresholds show a small typical-tract decline that is not obviously visible in the univariate maps, a divergence between the statistical and cartographic evidence that is taken up further in the cross-city comparison.

At 30 minutes (Figures 3 to 4), the difference is modest: the second-darkest band visibly expands around the core, and the core itself appears slightly larger, but most of the mapped extent remains in the lightest one or two classes in both periods, since only short trips concentrated near the centre reach high cumulative job counts within this threshold.

At 60 minutes (Figures 5 to 6), the darkest class covers a much larger, more contiguous area than at 30 minutes, forming a broad band through the city centre with a northwest-southeast orientation that roughly follows the river valley and core road network. The After map shows this darkest class extending further west and forming a more solid block; in the Before map the same area is more fragmented, interrupted by patches of the second-darkest class.

At 90 minutes (Figures 7 to 8), the darkest class forms a large, solid, roughly rectangular block covering most of the central city in both periods, with the second-darkest class extending out to cover nearly the entire urban extent. The Before map shows a narrower, more elongated core running north-south; the After map shows this core as wider and more block-like, with a small gap within the Before core's dark area largely filled in by the After period. Across all three thresholds, the After maps consistently show the high-accessibility core as more contiguous, more block-shaped, and somewhat more extensive than the Before maps, while peripheral low-accessibility areas remain largely unchanged in extent.

6.1.3 Magnitude and direction of change

The percent change maps (Figures 9 to 11) isolate the magnitude and direction of the change described above. At 30 minutes (Figure 9), the dominant pattern is minimal change

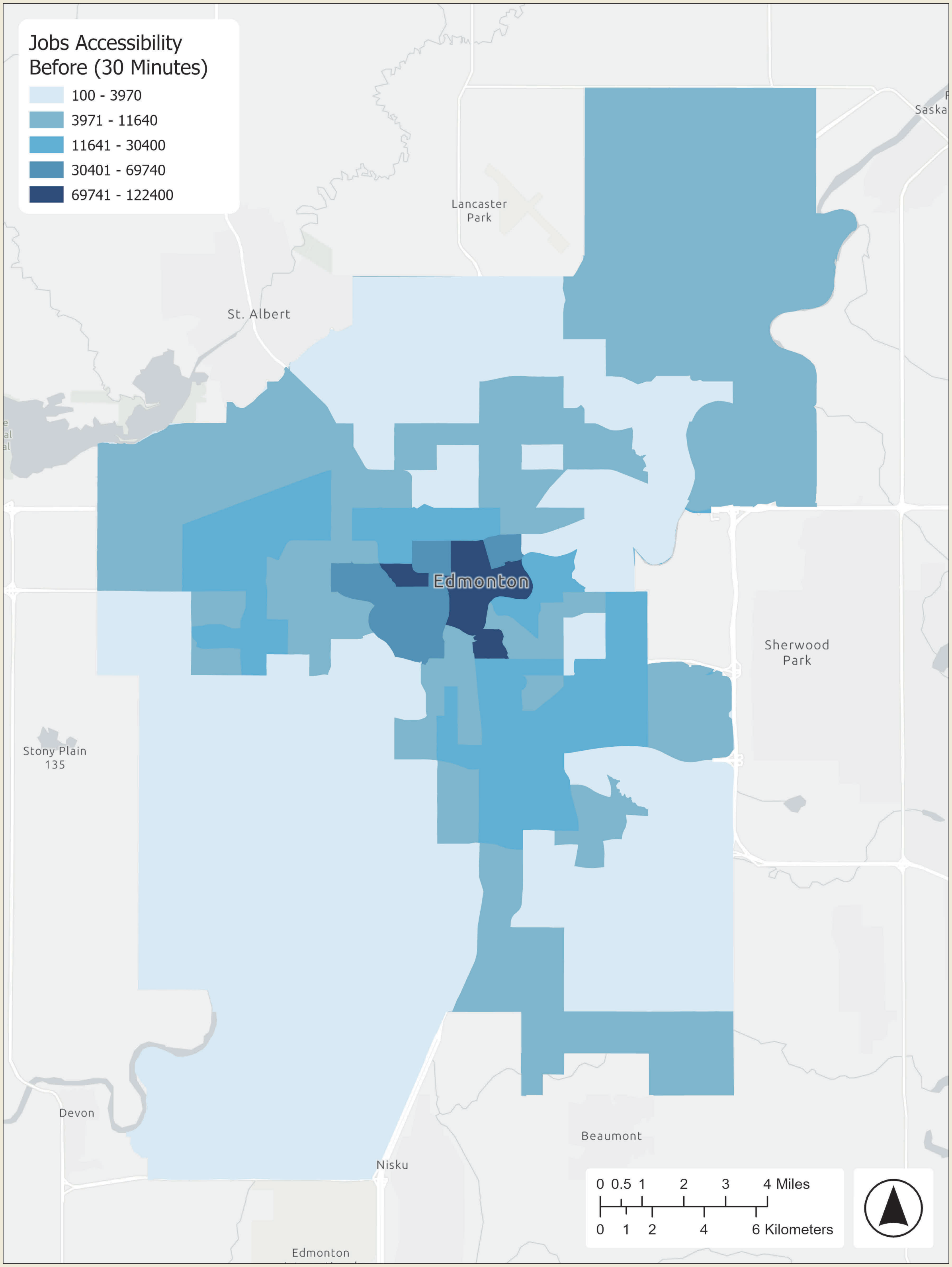

Figure 3. Edmonton, jobs accessibility Before redesign, 30-minute threshold

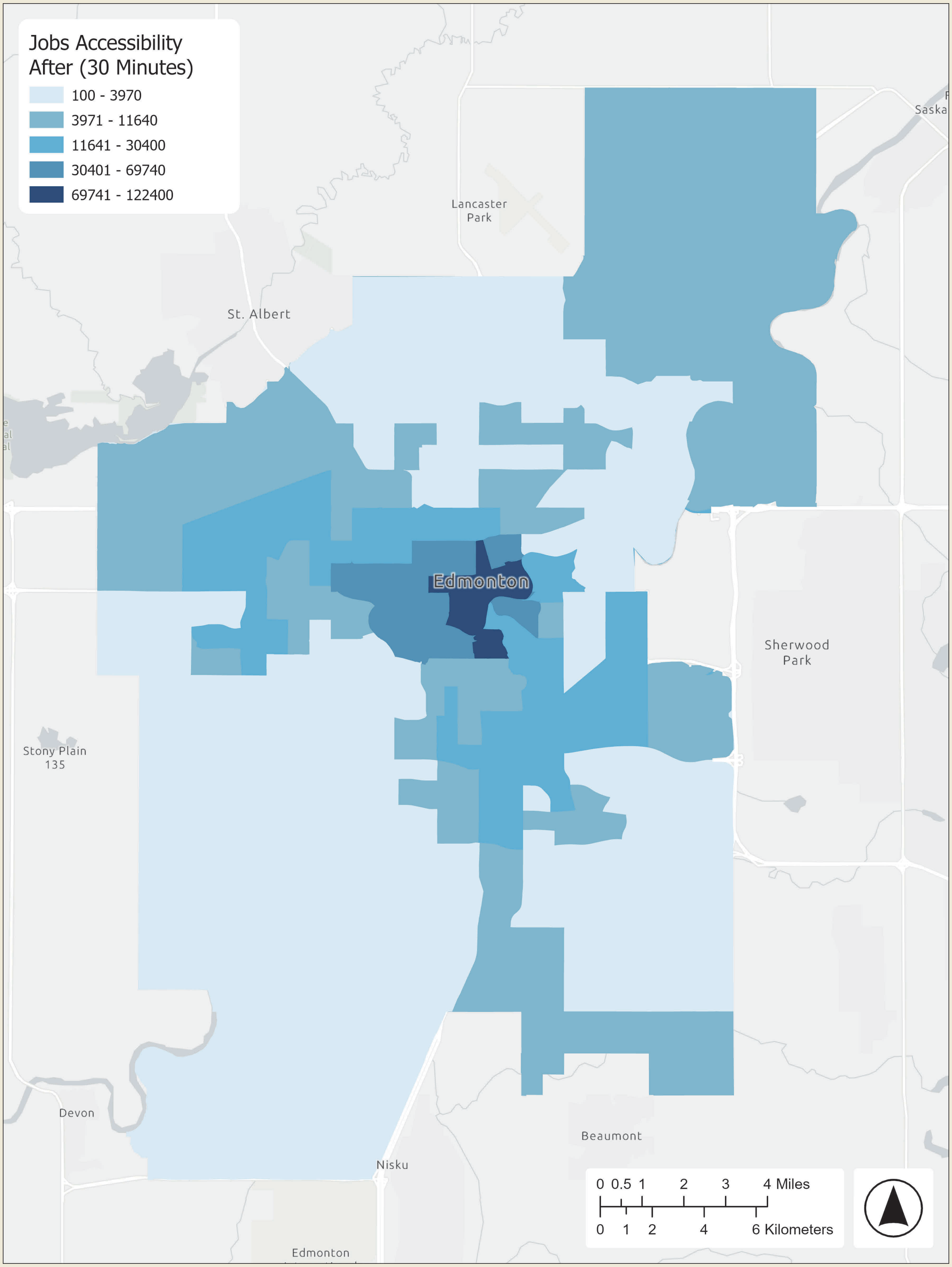

Figure 4. Edmonton, jobs accessibility After redesign, 30-minute threshold

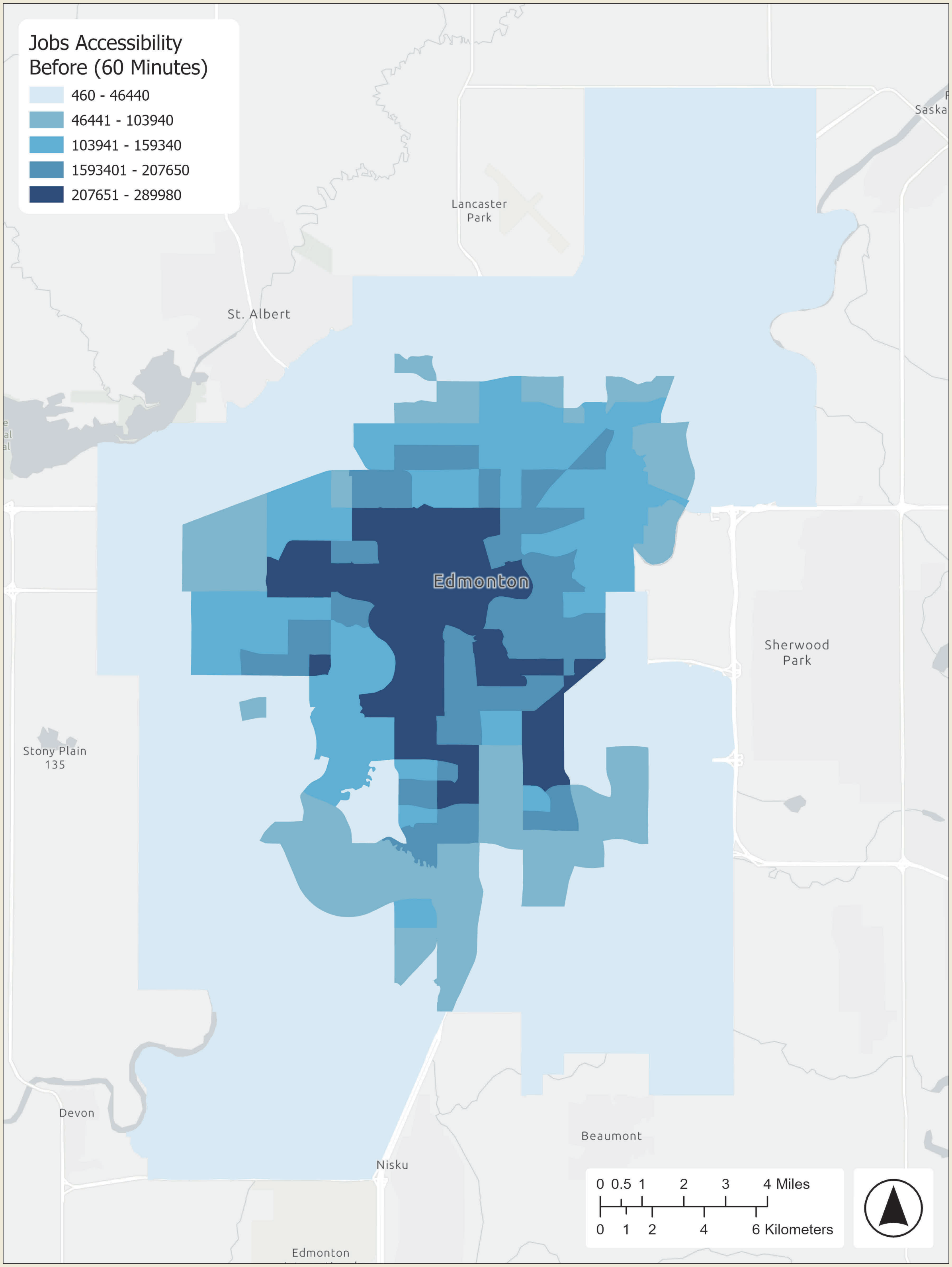

Figure 5. Edmonton, jobs accessibility Before redesign, 60-minute threshold

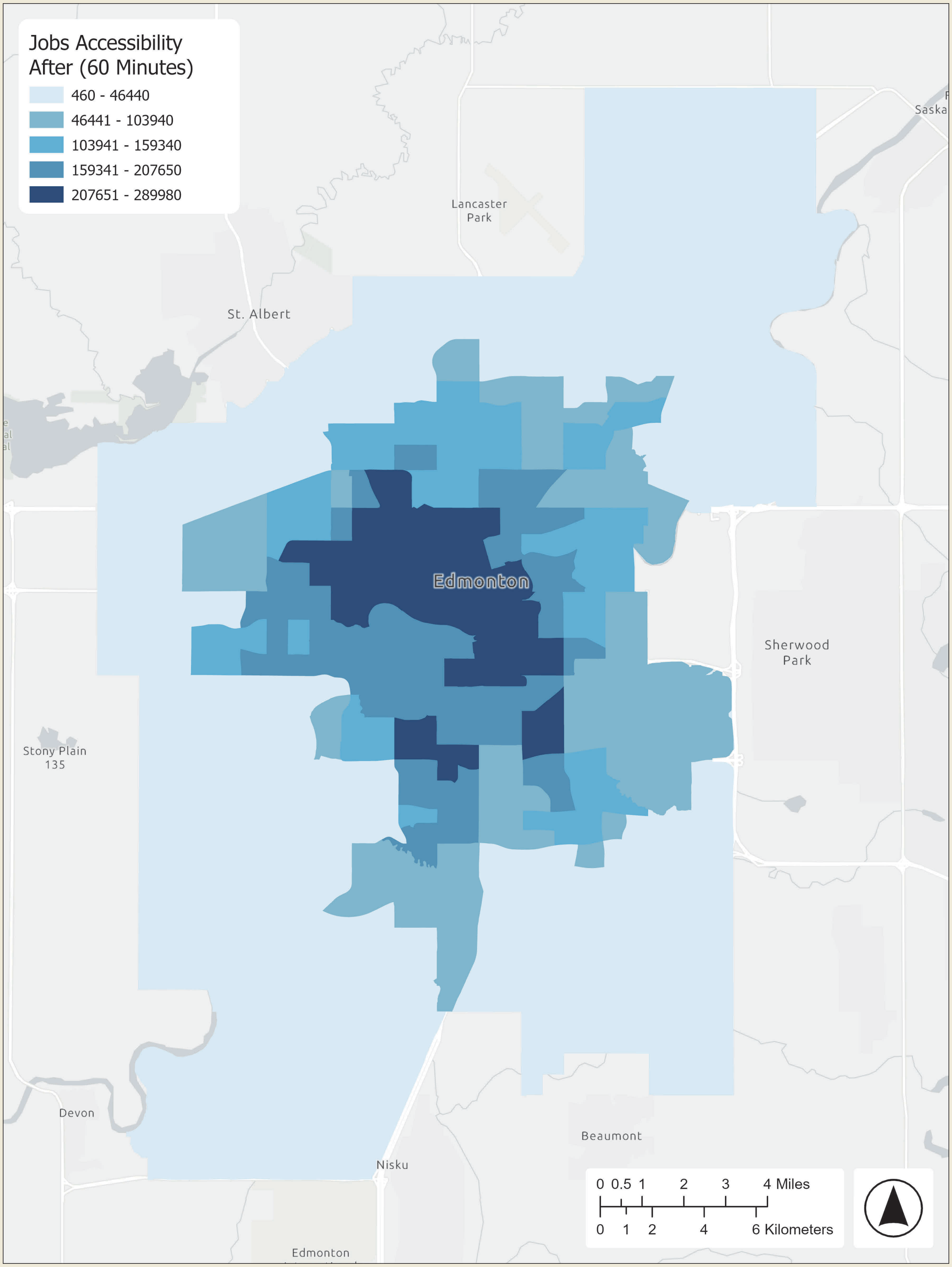

Figure 6. Edmonton, jobs accessibility After redesign, 60-minute threshold

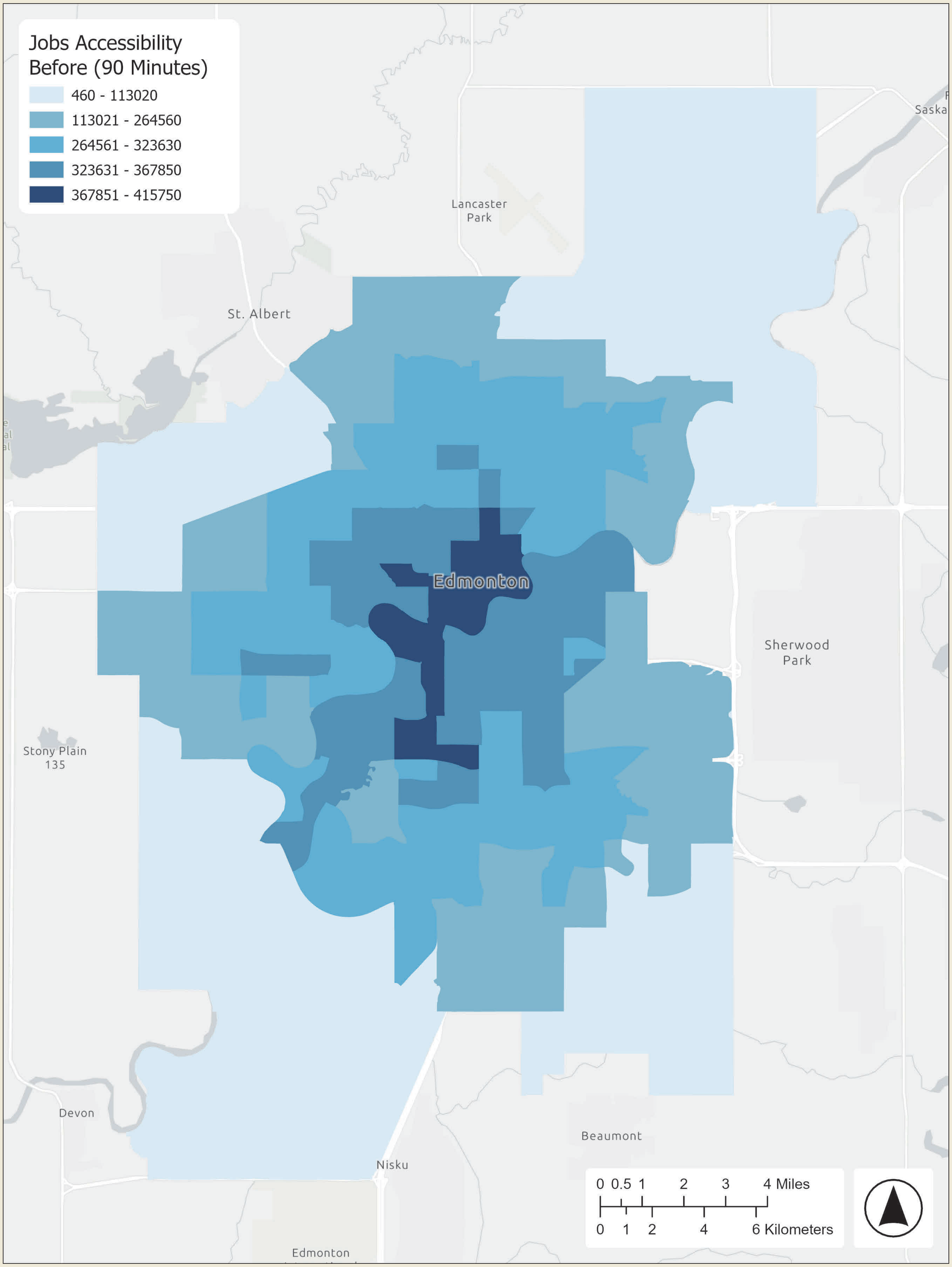

Figure 7. Edmonton, jobs accessibility Before redesign, 90-minute threshold

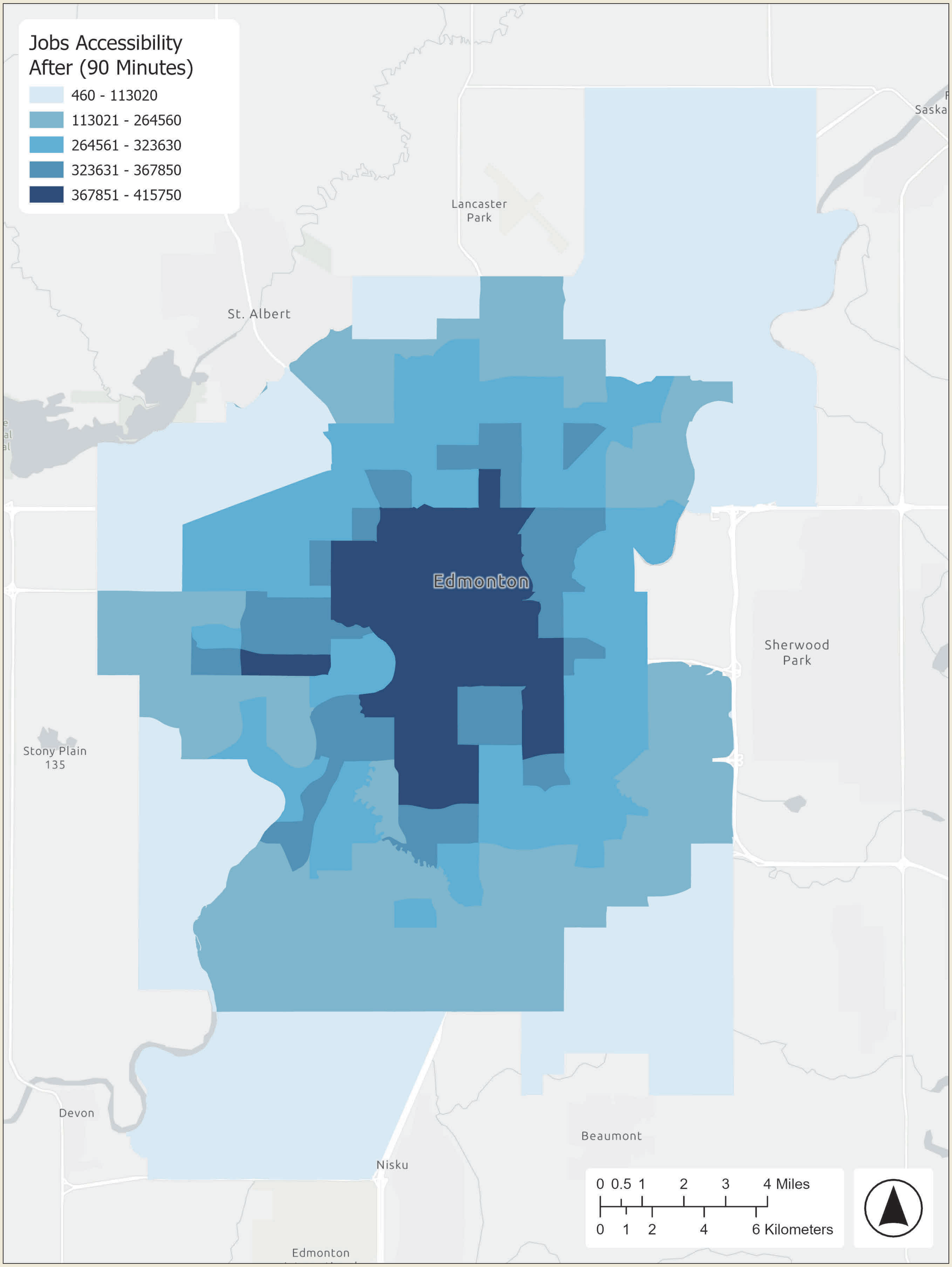

Figure 8. Edmonton, jobs accessibility After redesign, 90-minute threshold

across nearly the entire mapped extent, including the urban core; visible change of either sign is confined to a scatter of small, isolated tracts, with gains and losses appearing in roughly similar numbers. There is no large contiguous zone of gain or loss at this threshold.

At 60 minutes (Figure 10), the pattern becomes far more pronounced. Large gain zones appear in the south and in the east near Sherwood Park, while a substantial loss zone runs through the southwest and west-central part of the city. This is the most spatially structured of the three Edmonton percent change maps, with gains concentrated in the south and east and losses concentrated in the west.

At 90 minutes (Figure 11), gain tracts become dominant across most of the map, including large blocks in the far north and far southeast, while loss is confined to two isolated patches near St. Albert and in the southwest. Read together, the three thresholds show an increasing share of gain tracts and a shrinking, more spatially concentrated set of loss tracts as the threshold lengthens from 30 to 90 minutes, illustrating how the redesign's benefits compound over longer trips.

The percent change summary statistics are consistent with this progression. Median percent change moves from 0 at 30 minutes to 0 at 60 minutes to a positive 3.5 percent at 90 minutes, with the mean following the same direction at a larger magnitude (negative 0.3 percent at 30 minutes, positive 3.8 percent at 60 minutes, and positive 14.5 percent at 90 minutes). That the median percent change reads 0 at 30 and 60 minutes even though the median accessibility level fell at both thresholds is a property of the two statistics rather than a contradiction: the median level compares the midpoint of the Before distribution of tracts with the midpoint of the After distribution and is sensitive to a general downward shift, whereas the median percent change captures the change experienced by the typical individual tract, which here was negligible, with the level decline driven by tracts away from the centre of the change distribution rather than by the median tract itself. The range of outcomes across tracts is wide at every threshold, from a low of negative 93.2 percent to a high of 757.3 percent at 90 minutes, reflecting the substantial tract-to-tract heterogeneity visible in the percent change maps even as the central tendency shifts positive.

6.1.4 Distribution by income

The bivariate equity map (Figure 12) shows large, contiguous blocks of high income paired with low accessibility change across the northern, western, and southern fringes of the city, corresponding to the suburban and exurban tracts that also showed low accessibility in the univariate maps. These high-income, low-gain tracts form the single largest contiguous pattern on the map. Tracts with no income data are concentrated in a north-south band through the east-middle of the city, overlapping with the area that showed the highest accessibility values in the 90-minute After map (Figure 8), a data gap sitting directly on top of the area of greatest analytical interest.

Tracts combining higher income with higher accessibility change appear as scattered, fragmented patches mixed in among other classes in the central and south-central part of the city, rather than as a single contiguous zone. Low-income, low-change tracts are similarly scattered rather than clustered. The dominant visual story is a stark income gradient, high-income suburbs against a mixed-to-data-gap core, overlaid on an accessibility change pattern that does not align cleanly with that gradient: the highest-change tracts are not concentrated in either the lowest- or highest-income areas, but are scattered through the middle of the map alongside the income data gap.

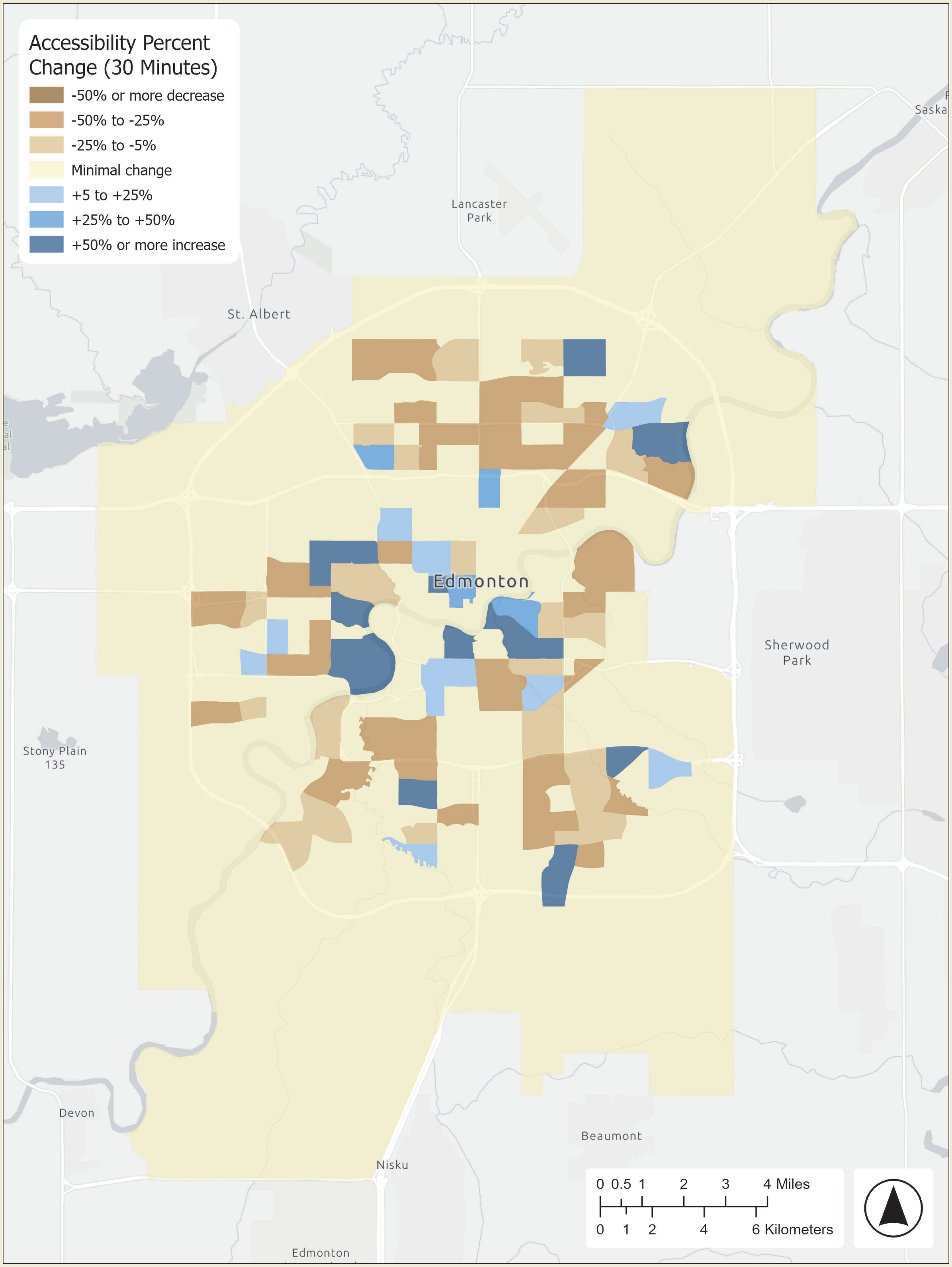

Figure 9. Edmonton, accessibility percent change, 30-minute threshold

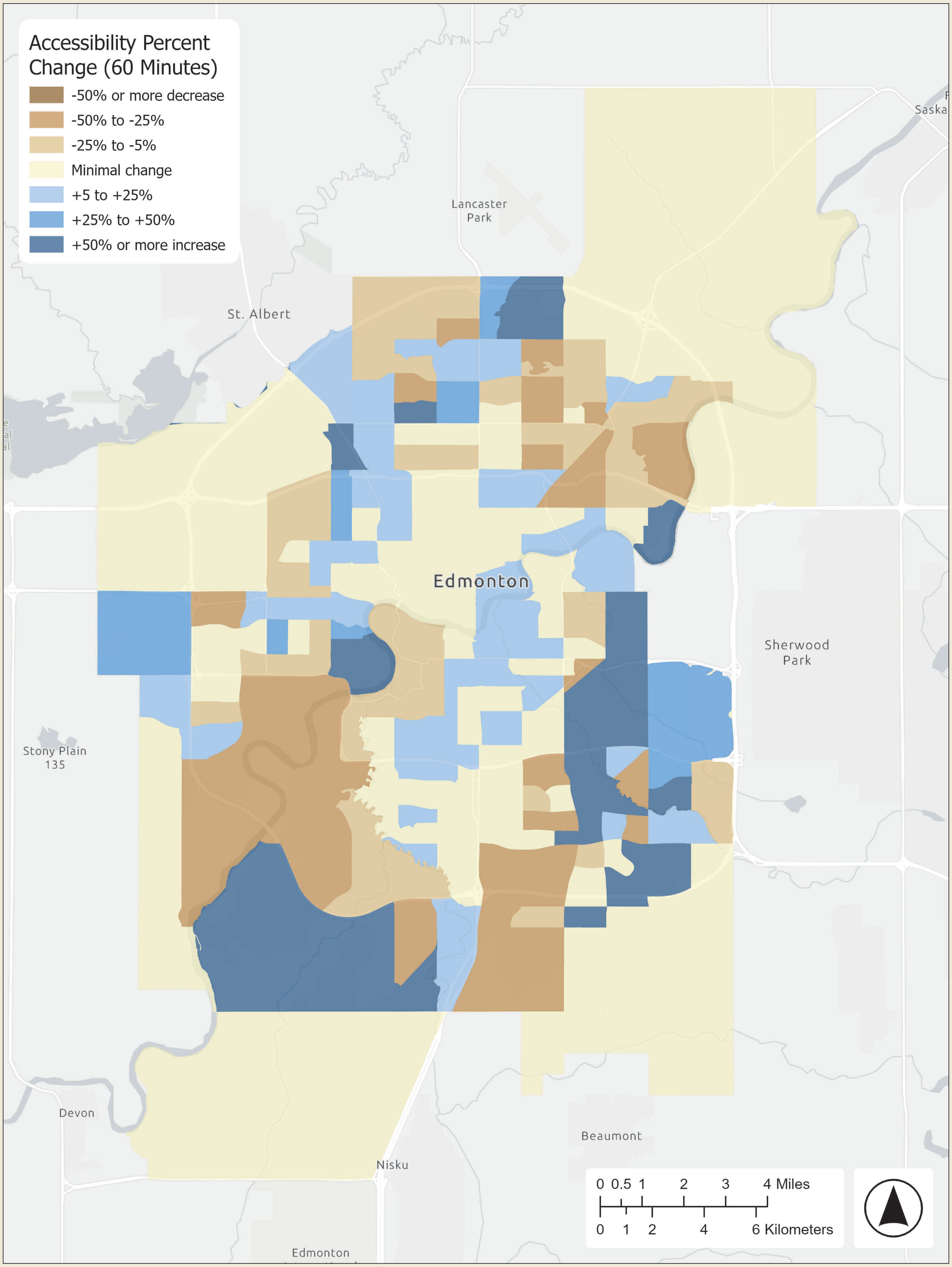

Figure 10. Edmonton, accessibility percent change, 60-minute threshold

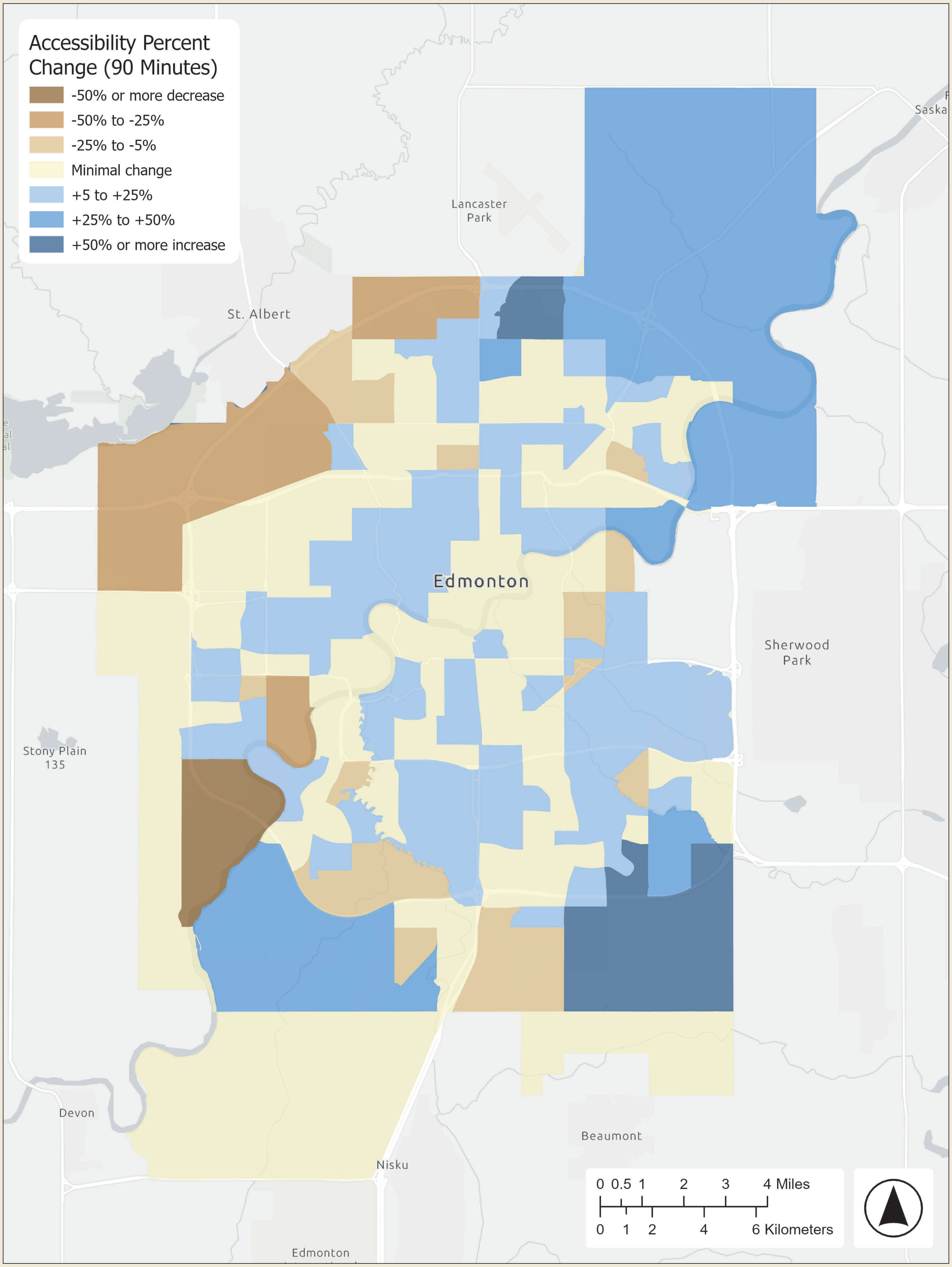

Figure 11. Edmonton, accessibility percent change, 90-minute threshold

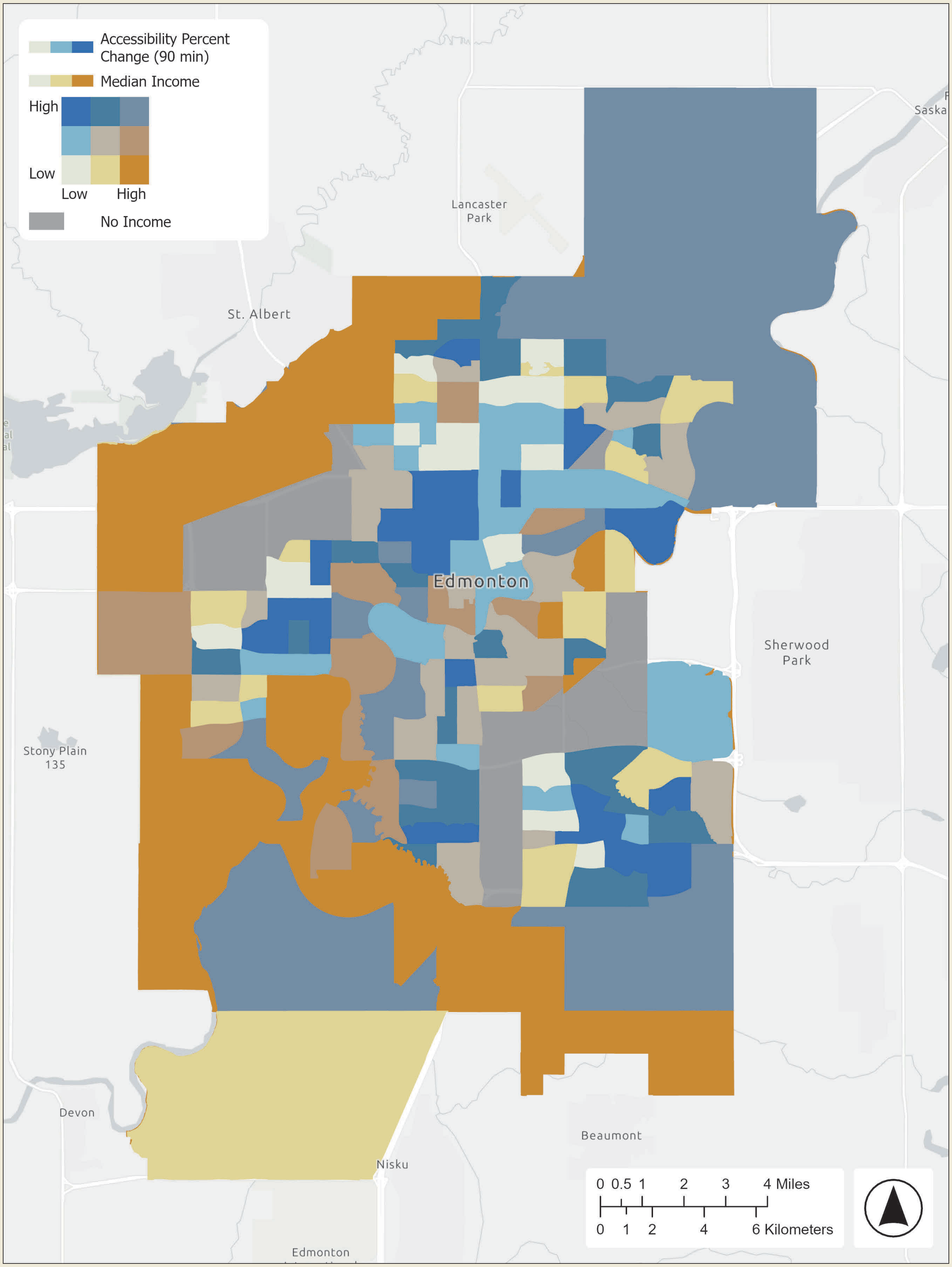

Figure 12. Edmonton, bivariate map of accessibility percent change (90 minute) and median income

6.2 Ottawa

Ottawa's 2025 Bus Route Review was largely budget driven. The combination of limited visible structural change and declining median accessibility, evident across the GTFS service metrics and the accessibility maps alike, distinguishes Ottawa from the other two cities.

6.2.1 Network change

The Ottawa Before and After network maps (Figures 13 to 14) look very similar to each other in overall route density and coverage. The dense downtown core, the Kanata grid in the west, and the eastern arm toward Gatineau's edge all appear essentially unchanged in extent and density between the two maps. The only visible differences are minor: a few short branch segments in the Kanata cul-de-sac area appear slightly less dense after the redesign, a subtle effect confirmed only by close comparison rather than an obvious restructuring of the kind visible in Edmonton.

This reading is consistent with the GTFS service metrics, which show contraction rather than consolidation. Total VKT fell by 7.8 percent (from 136,194.7 to 125,524.1 kilometres), total trips fell by 7.2 percent, and routes operated fell by 9.0 percent (from 200 to 182), while total service hours were essentially flat (a 0.2 percent increase). Ottawa's redesign reduced the volume of service operated without restructuring the network's overall shape, consistent with localized trimming of specific underperforming segments rather than a city-wide consolidation of the kind seen in Edmonton.

6.2.2 Accessibility levels

The three univariate threshold pairs (Figures 15 to 20) cover a wider, more elongated east-west extent than Edmonton or Winnipeg, reflecting the Ottawa-Gatineau urban footprint, including Kanata and Nepean to the west and a long eastern arm toward Orleans.

At 30 minutes (Figures 15 to 16) and 60 minutes (Figures 17 to 18), the spatial structure is very similar between Before and After. The darkest class forms a compact block near downtown Ottawa in both periods, with only marginal differences in its boundary, and the main visible changes are small shifts in class membership at the margins between the second and third classes, particularly along the western band stretching into Kanata.

At 90 minutes (Figures 19 to 20), a clearer difference emerges. The Before map shows the darkest class covering a noticeably larger, more contiguous area, including more of the central swath running east-west through the core, than the After map, where the darkest class appears more confined to two separate masses with a band of the second-darkest class between them. This visible contraction of the highest-accessibility core is the clearest visual signal of decline among the three Ottawa threshold pairs. The lightest class footprint along the eastern arm and in far Kanata looks essentially unchanged, suggesting the decline is concentrated in the core and middle bands rather than at the extremities.

Ottawa is the only city in this study where median jobs accessibility declined at every threshold. The median fell from 4,830 to 4,580 at 30 minutes, from 159,370 to 111,110 at 60 minutes, and from 370,440 to 344,050 at 90 minutes. The mean shows the same direction of change at 60 and 90 minutes (falling from 153,238 to 140,397, and from 320,349 to 303,266, respectively), though at 30 minutes the mean rises slightly (from 22,127 to 22,438) even as the median falls, an instance of the small-denominator divergence noted at the start of this chapter. This consistent median decline across all three thresholds is the central accessibility finding for Ottawa, distinguishing it from both Edmonton and Winnipeg, where the longer thresholds show median gains.

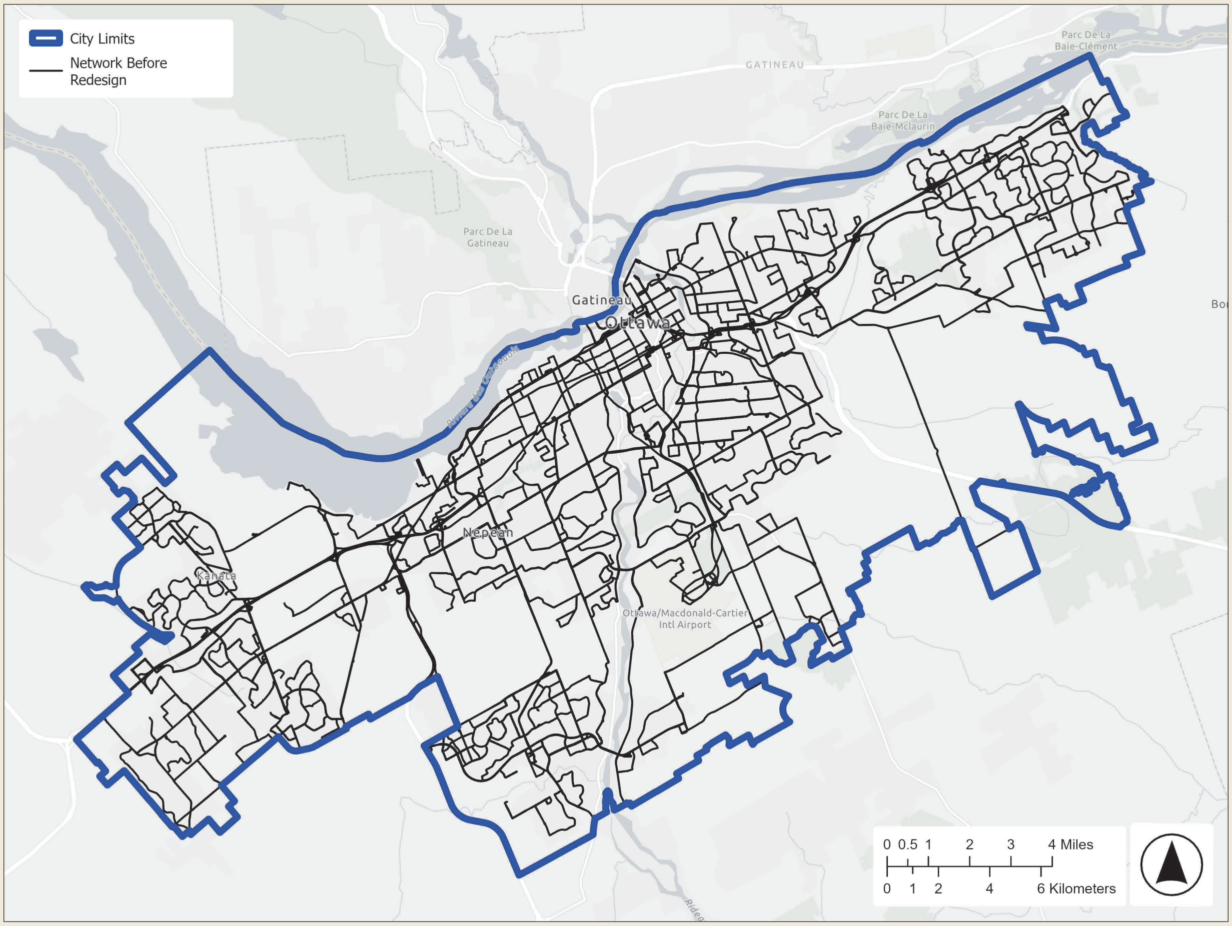

Figure 13. Ottawa, route network before redesign

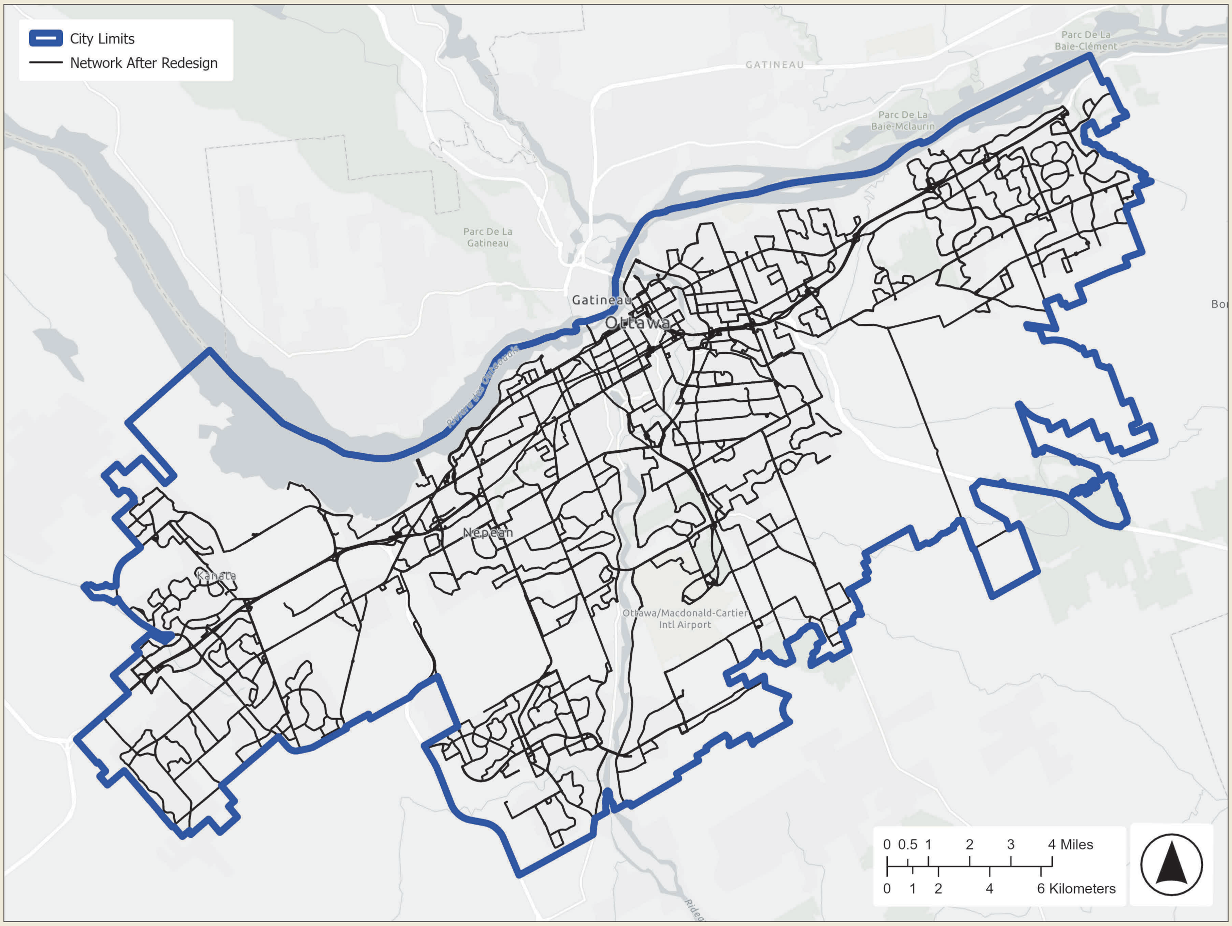

Figure 14. Ottawa, route network after redesign

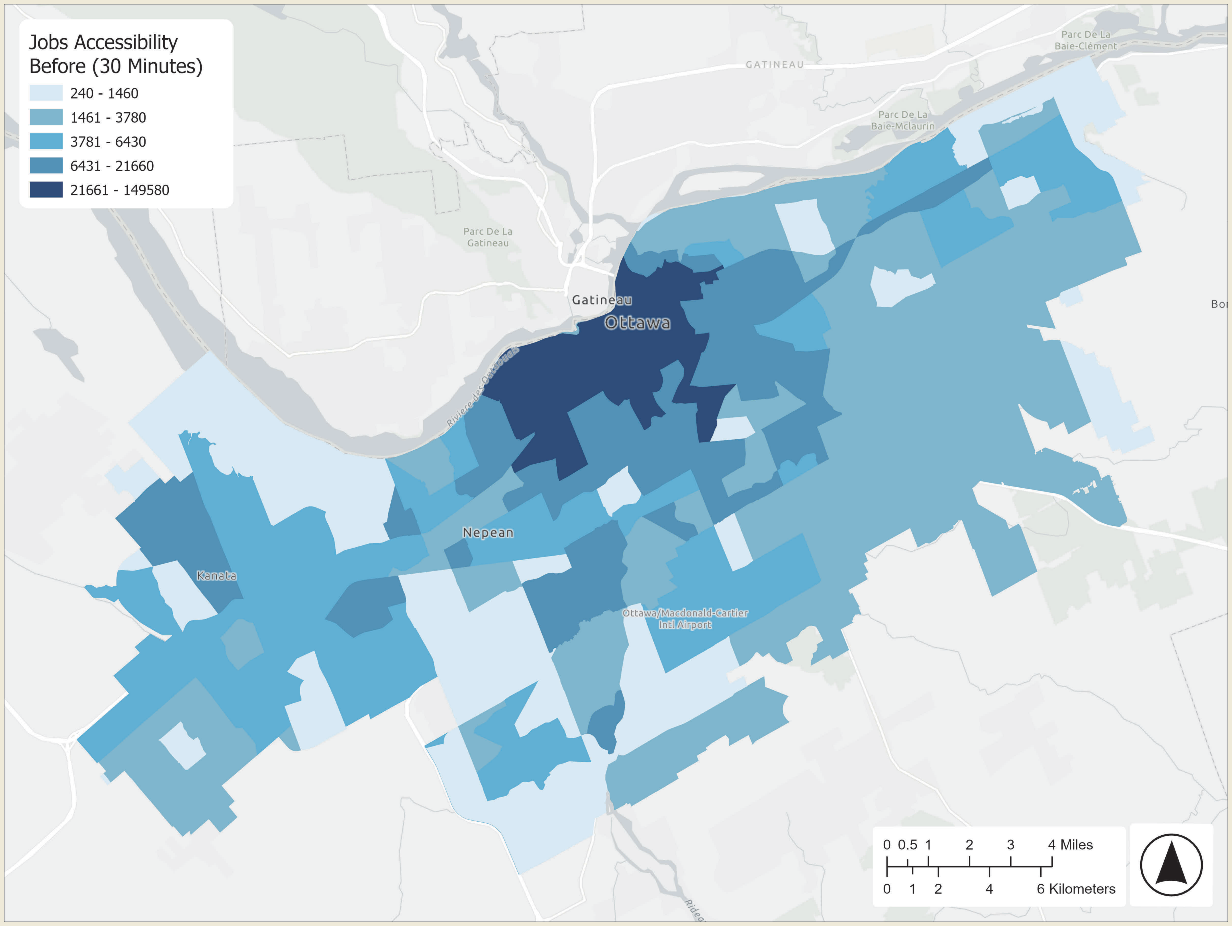

Figure 15. Ottawa, jobs accessibility Before redesign, 30-minute threshold

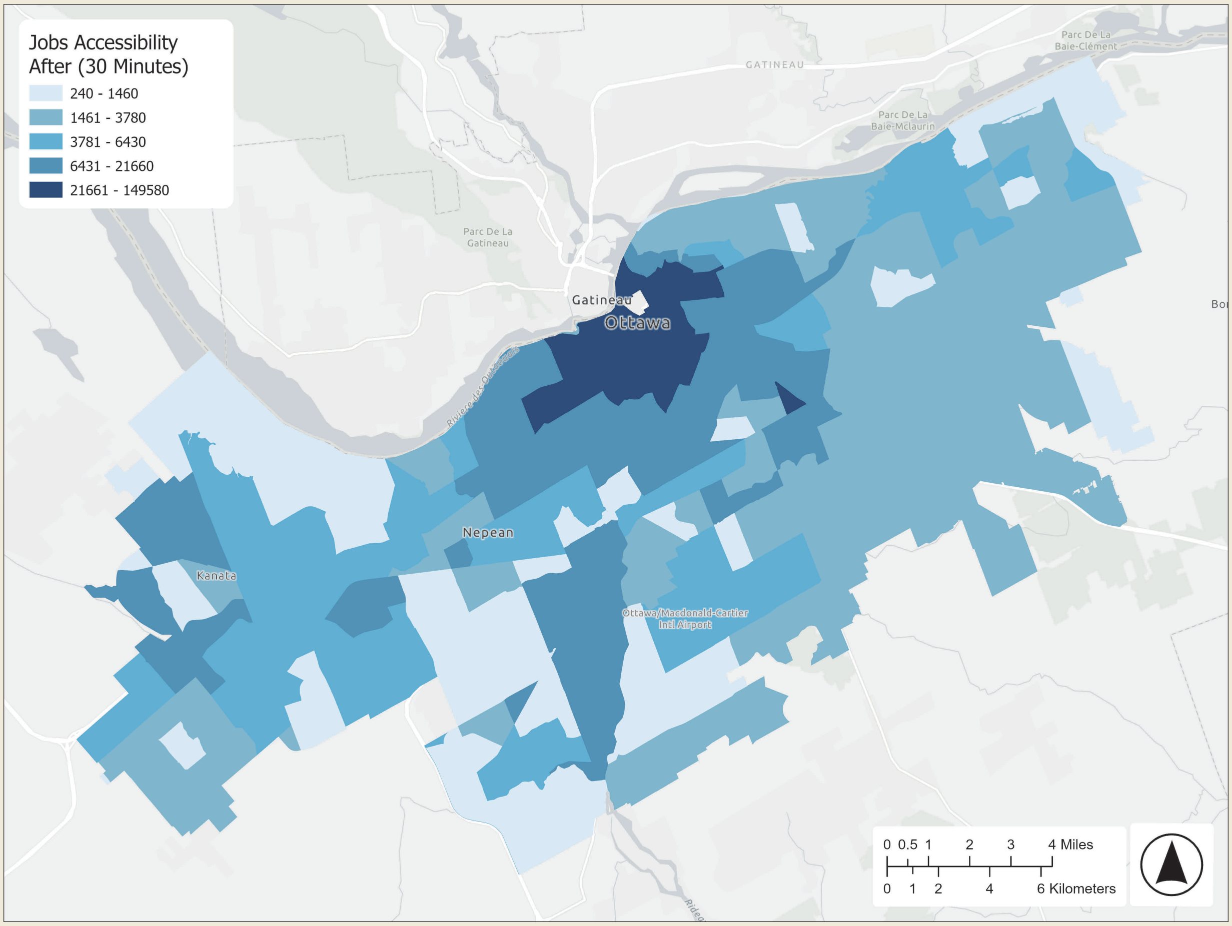

Figure 16. Ottawa, jobs accessibility After redesign, 30-minute threshold

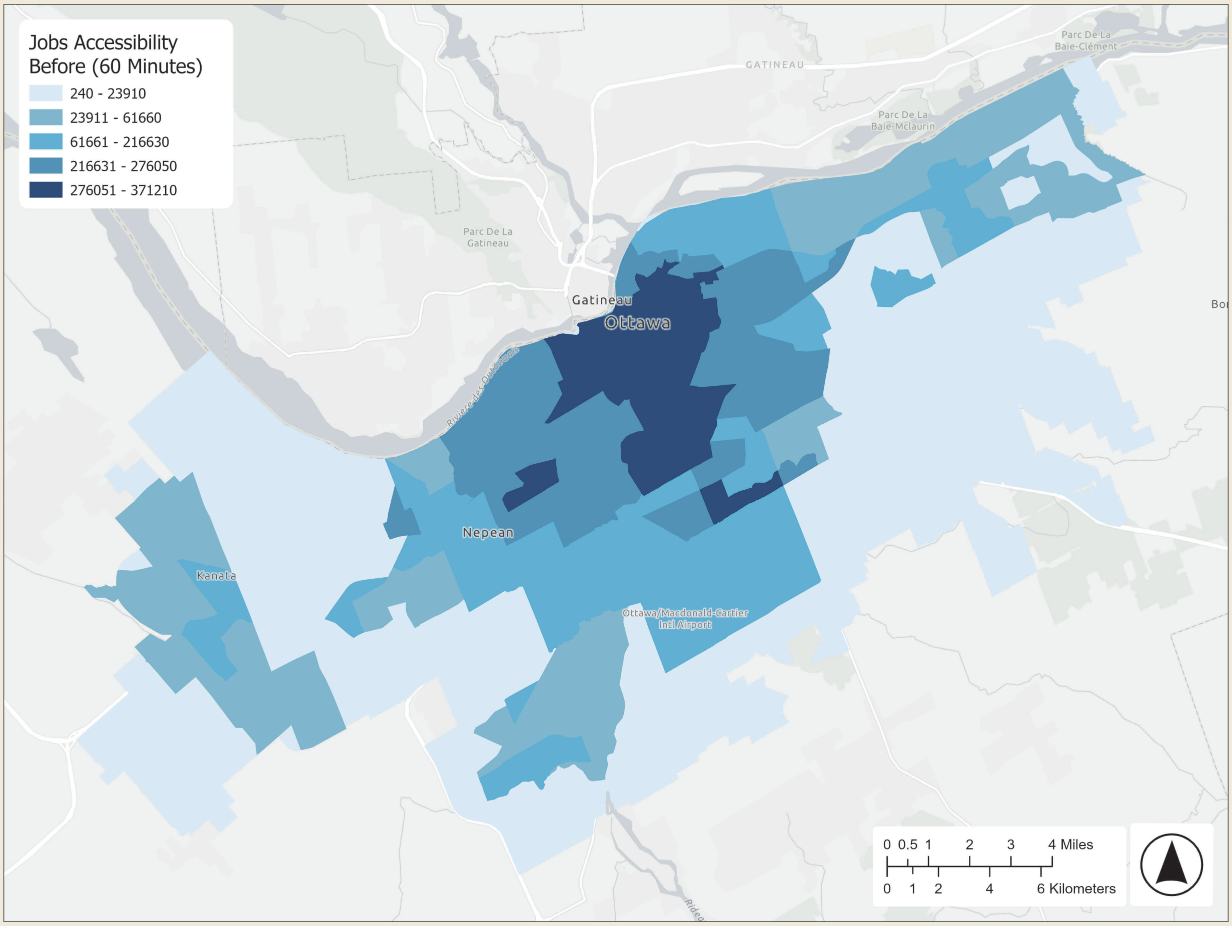

Figure 17. Ottawa, jobs accessibility Before redesign, 60-minute threshold

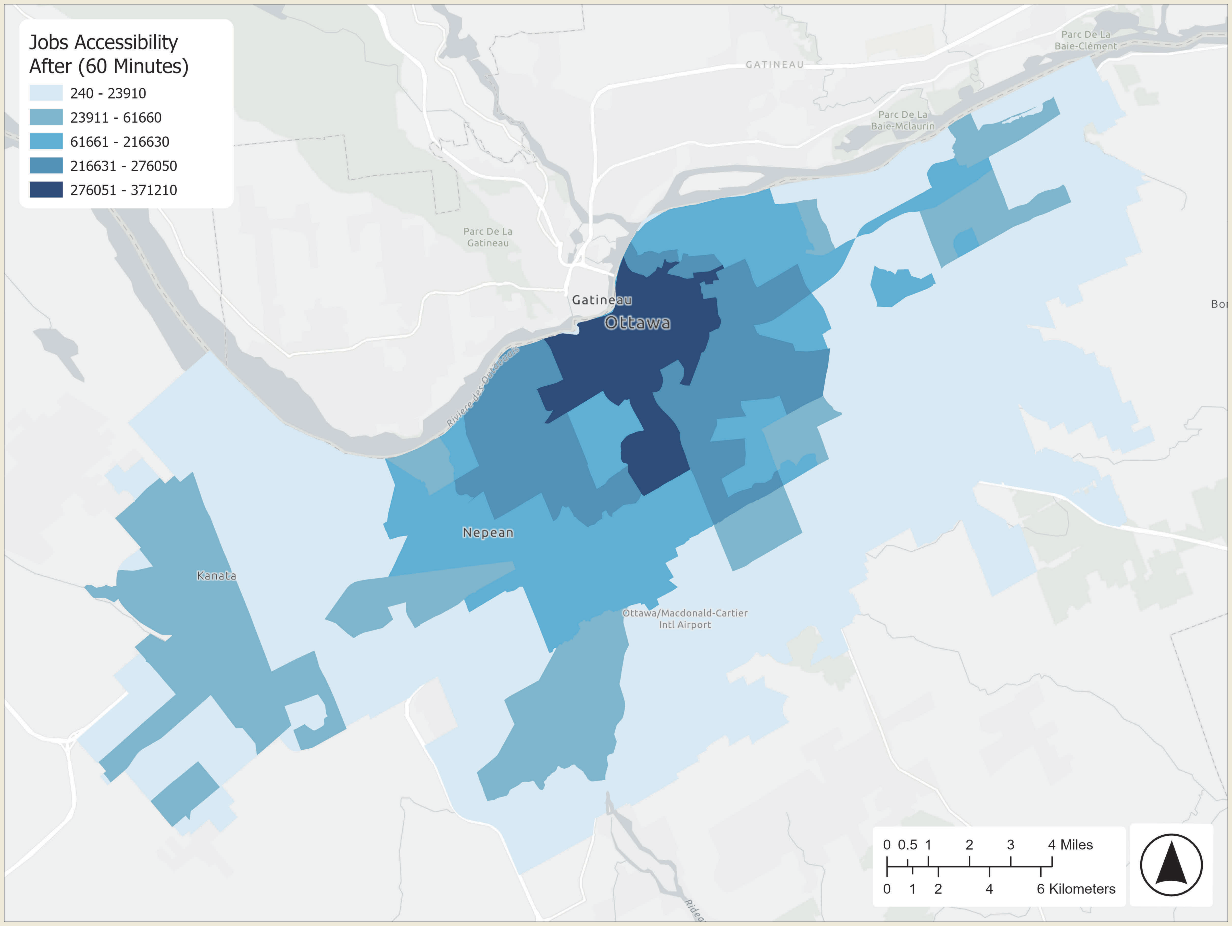

Figure 18. Ottawa, jobs accessibility After redesign, 60-minute threshold

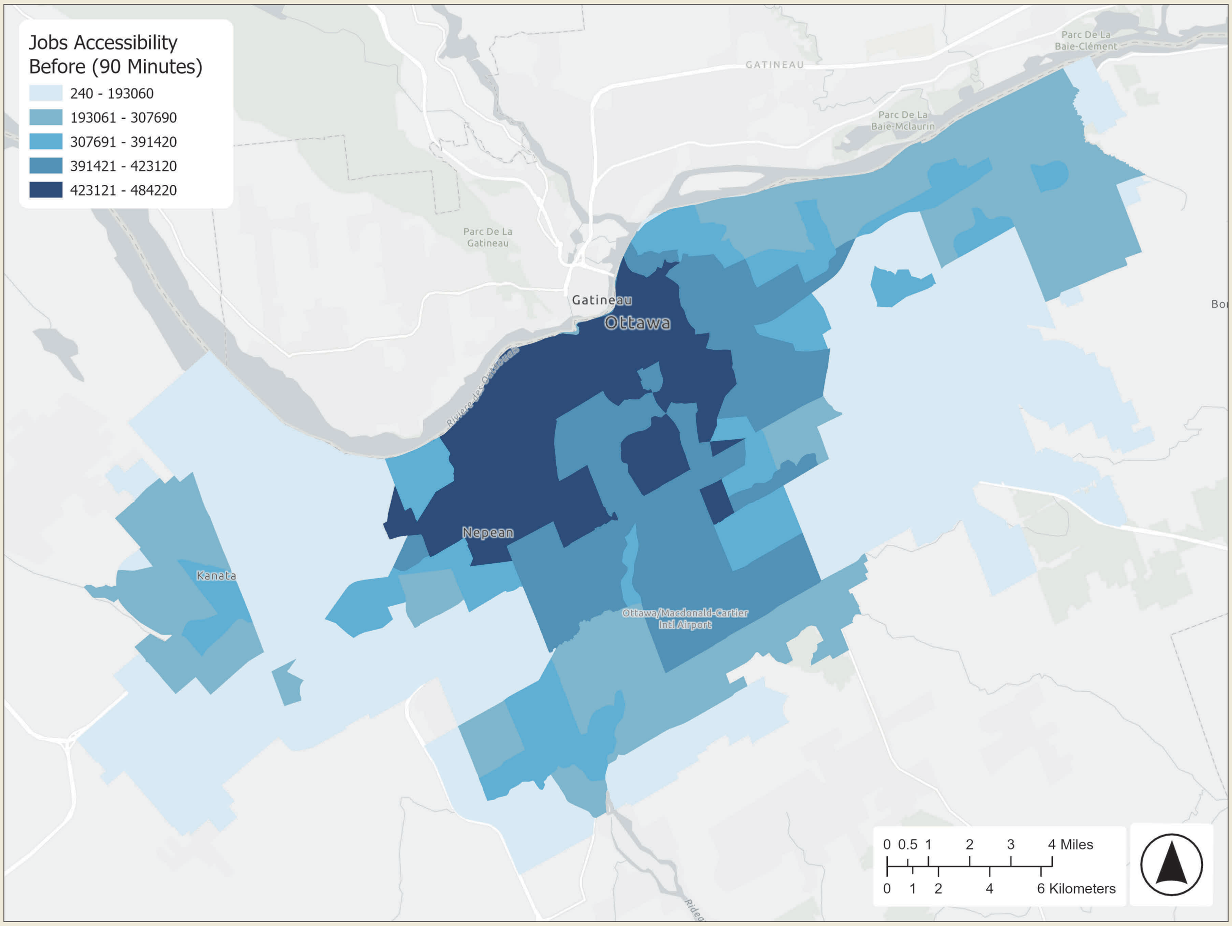

Figure 19. Ottawa, jobs accessibility Before redesign, 90-minute threshold

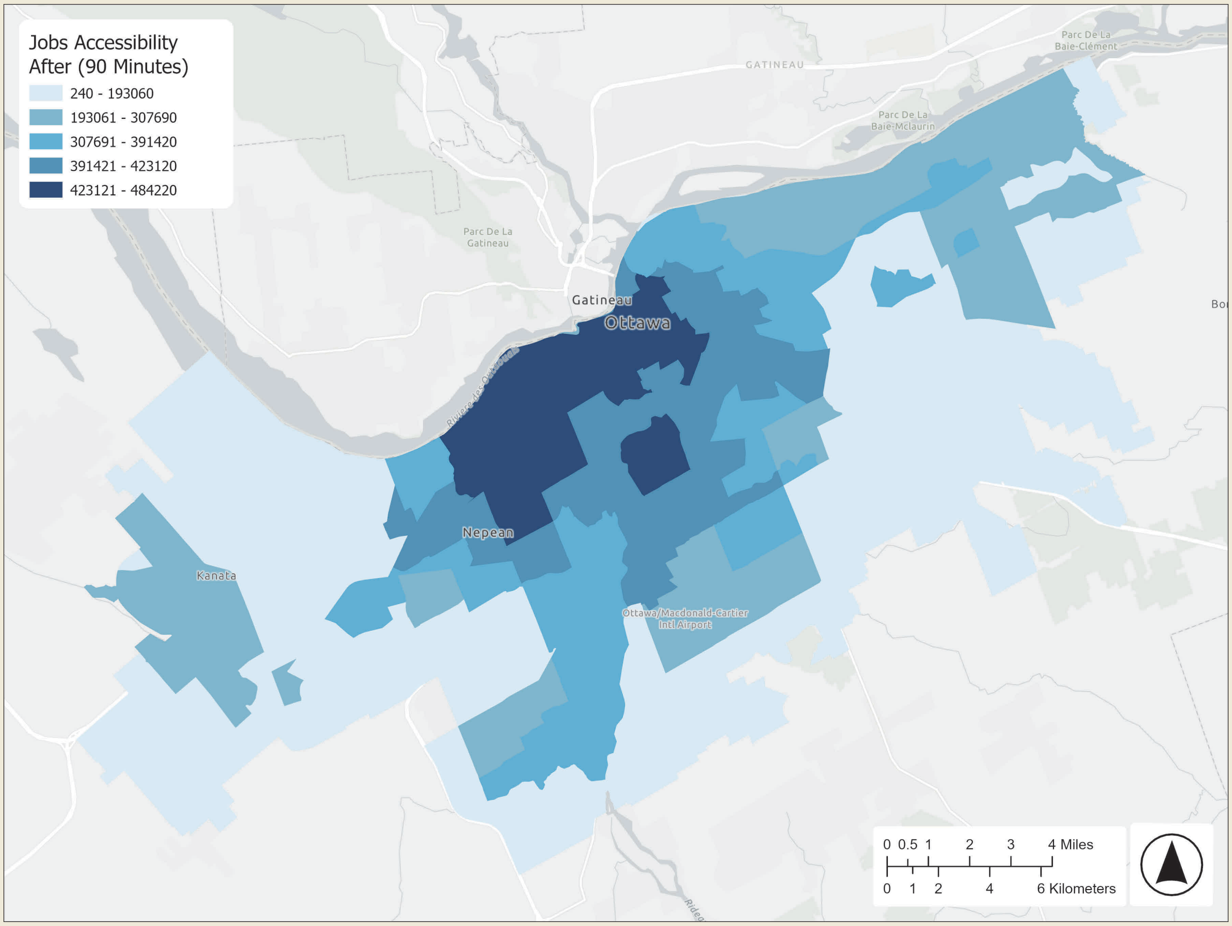

Figure 20. Ottawa, jobs accessibility After redesign, 90-minute threshold

6.2.3 Magnitude and direction of change

The percent change maps (Figures 21 to 23) show a consistent pattern of decline concentrated in one specific area: east and southeast of the airport. At 30 minutes (Figure 21), a dense cluster of loss tracts sits immediately west and southwest of downtown, interspersed with a few gain patches, while separate gain zones appear south of the airport and in Kanata to the west. The core area reads as more volatile, mixing gains and losses side by side, than the urban fringe.

At 60 minutes (Figure 22), a large, solid block of the most severe decline class covers a substantial area east and southeast of the airport, the single largest contiguous patch of severe decline anywhere in the full nine-map percent change set across all three cities. At the same time, a large gain zone appears in Kanata to the west, and the core itself is a fine-grained mix of losses and gains.

At 90 minutes (Figure 23), the decline block east of the airport persists, though in a less severe class than at 60 minutes, while a new severe decline patch appears in Kanata, flipping that area from a gain zone at 60 minutes to a loss zone at 90 minutes. The east-west spread of decline across the southern and western parts of the map at this threshold is the most extensive loss footprint among all nine percent change maps in this study. Across all three Ottawa thresholds, the area east and southeast of the airport declines consistently, and directly corroborating the contraction of the high-accessibility core observed at 90 minutes.

The percent change summary statistics confirm this decline numerically. Median percent change is 0 at 30 minutes, negative 5.4 percent at 60 minutes, and negative 2.9 percent at 90 minutes; the mean follows the same negative direction at 60 and 90 minutes (negative 8.2 percent and negative 6.3 percent, respectively), and is strongly positive at 30 minutes (28.0 percent) only because of the small-denominator effect described earlier, a divergence underscored by the 30-minute high value of 3,285.7 percent, the most extreme value recorded anywhere in this study. Ottawa is the only city where the median percent change is negative at both the 60- and 90-minute thresholds, reinforcing the median-decline pattern already noted in the accessibility level statistics above

6.2.4 Distribution by income

The bivariate equity map (Figure 24) shows a large, contiguous zone of higher accessibility change occupying the eastern third of the map, the long eastern arm toward Orleans, more extensive than any single comparable block in the Edmonton or Winnipeg bivariate maps. Higher-income tracts are concentrated to the west and southwest, in Kanata and the area south of the airport, while lower-income tracts appear in a band running through Nepean and the central-south part of the city.

The downtown core and the area just south of the river show a dense, fine-grained mix of income and change classes packed closely together, more so than in the other two cities, reflecting smaller census tracts and sharper block-to-block contrasts near the centre. Tracts with no income data are few and small, scattered as isolated cells rather than forming a contiguous band, unlike Edmonton's east-centrally located data gap. The large eastern zone of high accessibility change reads as lower-to-middle income in the bivariate legend, suggesting that, unlike Edmonton, a sizeable part of Ottawa's highest accessibility change area does not appear to be concentrated in the highest-income tracts, though the fine-grained mixing near downtown makes a confident read of the core's equity pattern harder than for the eastern arm.

6.3 Winnipeg

Winnipeg's 2025 Primary Transit Network redesign produced the most consistent

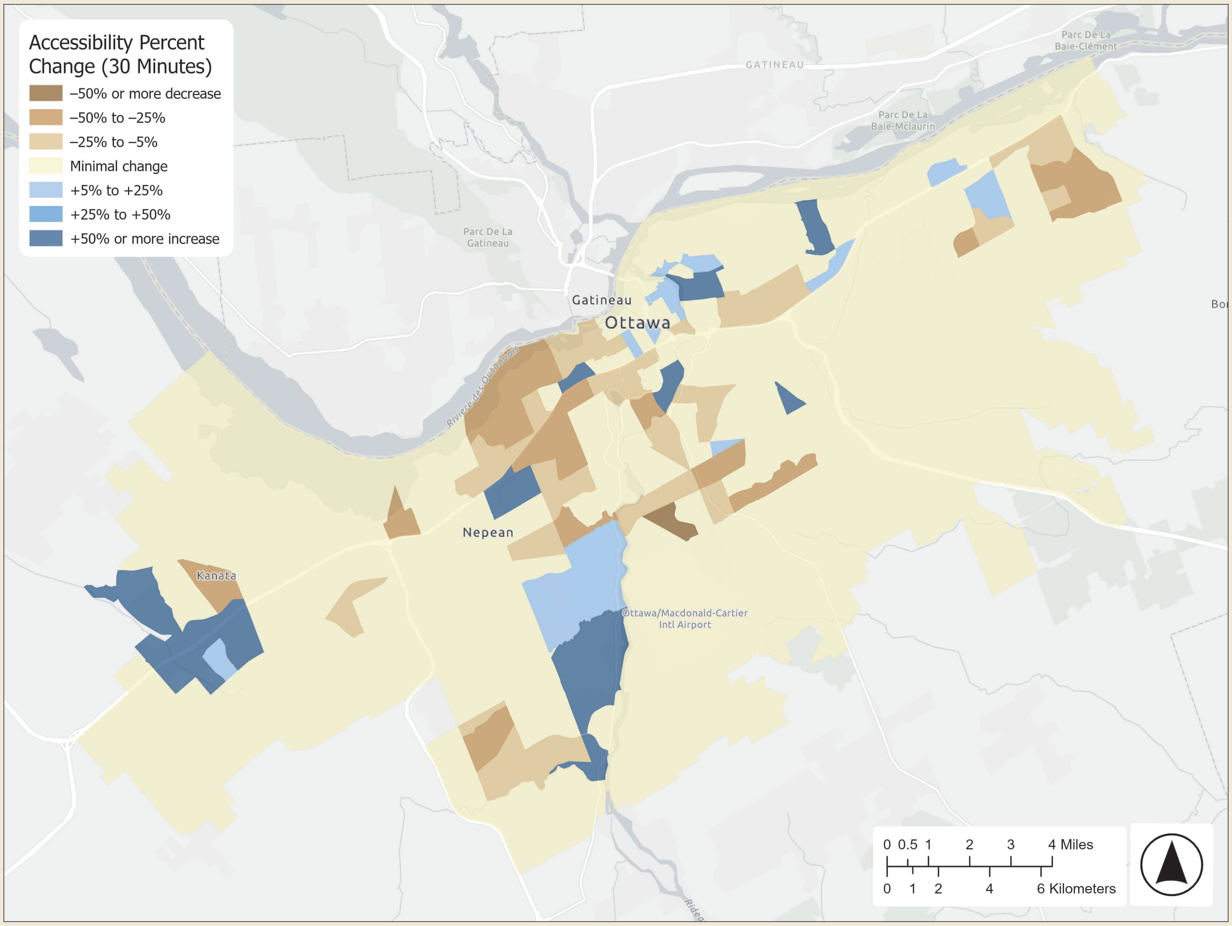

Figure 21. Ottawa, accessibility percent change, 30-minute threshold

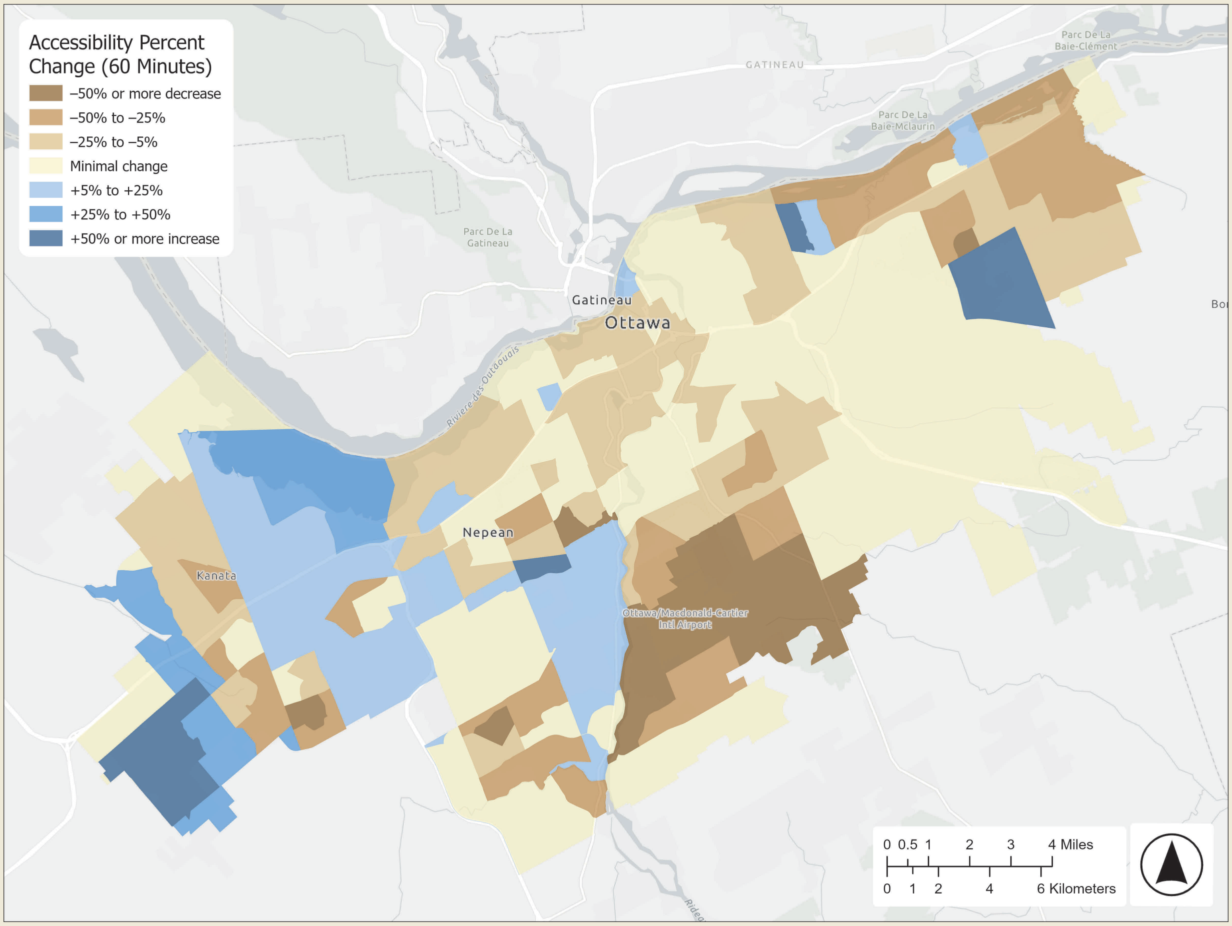

Figure 22. Ottawa, accessibility percent change, 60-minute threshold

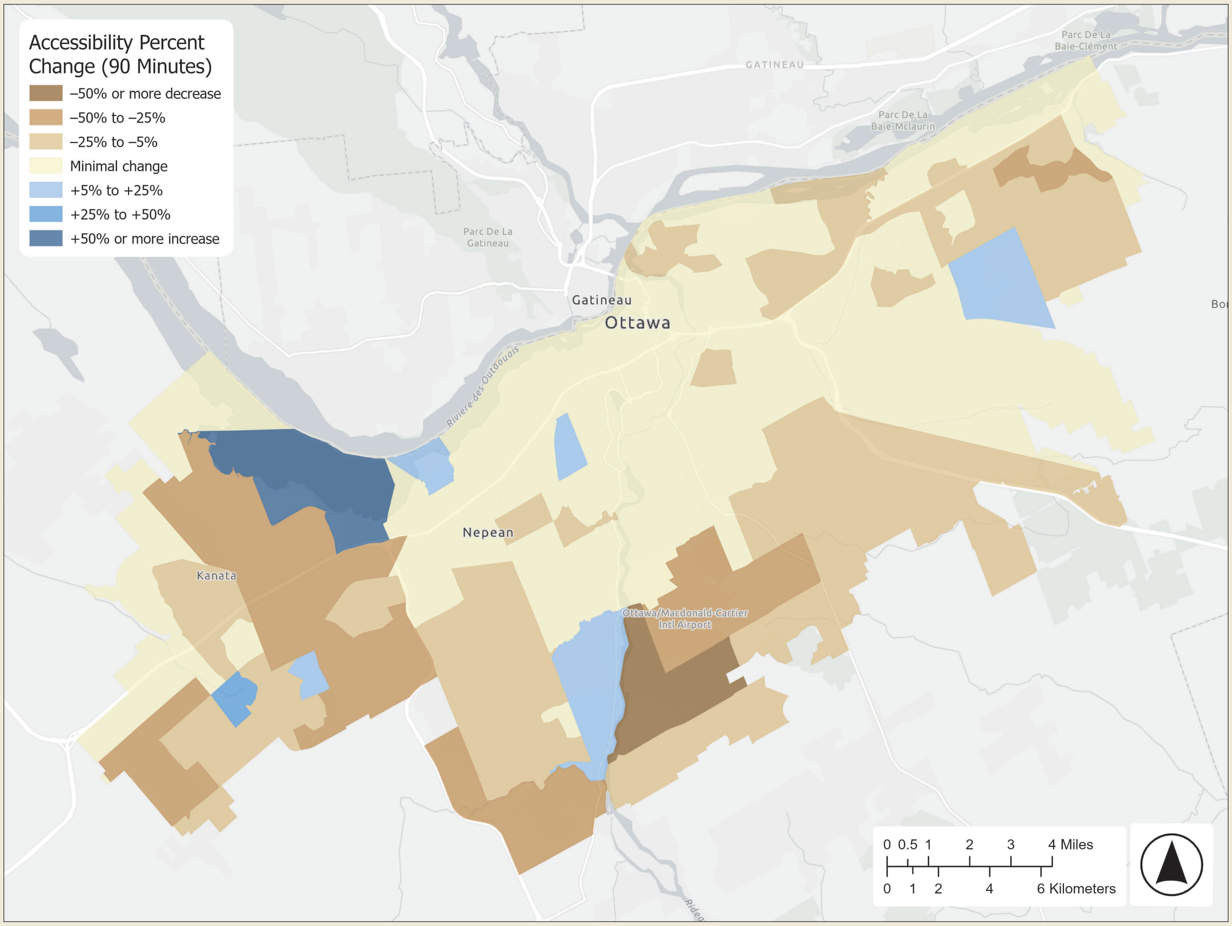

Figure 23. Ottawa, accessibility percent change, 90-minute threshold

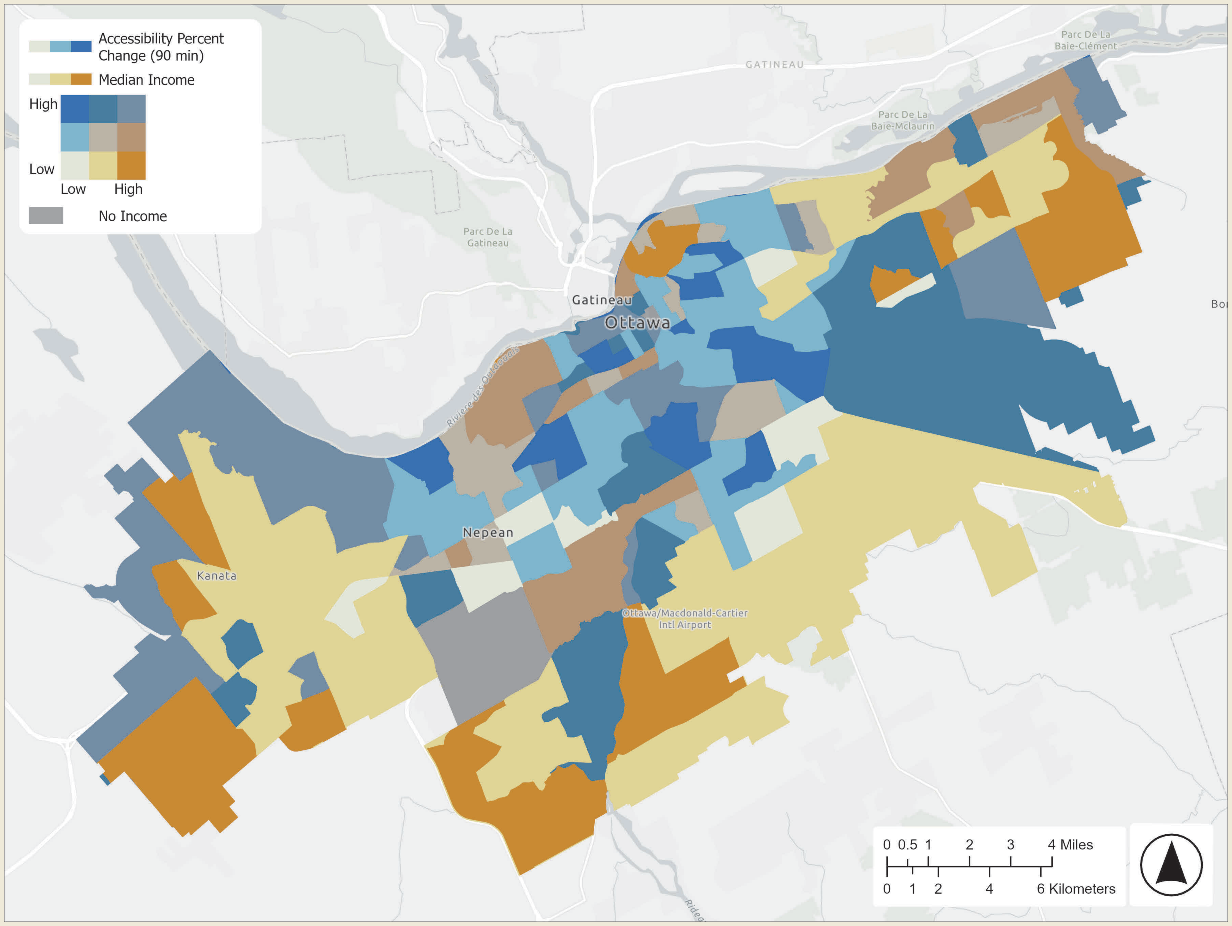

Figure 24. Ottawa, bivariate map of accessibility percent change (90 minute) and median income

gains of the three cities. Notably, this gain is not obviously explained by a denser or more extensive route network, a finding that bears directly on how the mechanism of improvement should be understood in the Discussion chapter.

6.3.1 Network change

Like Ottawa, the Winnipeg Before and After network maps (Figures 25 to 26) look similar in overall route density and coverage. The dense central grid, the long east-west corridor through the airport area, and the southern residential coverage all appear essentially unchanged in extent between the two maps. Only some thinning or consolidation is visible at this zoom level, in contrast to the Edmonton pair.

The GTFS service metrics show a modest net increase in service scale alongside a more selective network. Total VKT rose by 5.1 percent (from 86,677.8 to 91,064.5 kilometres) and total service hours rose by 2.2 percent, while total trips fell by 5.8 percent (from 5,984 to 5,634), unique stops served fell by 24.6 percent (from 5,136 to 3,872), and routes operated fell by 18.4 percent (from 87 to 71). This is the largest proportional reduction in stops and routes among the three cities, even though the route network maps themselves show little visible change in geometry, an apparent contradiction that points toward trunk-line consolidation: fewer, more direct routes serving fewer stops while covering more distance and operating more hours overall. Given how Winnipeg's accessibility gains are in the maps below, this suggests the redesign's benefit came primarily from how the existing routes were arranged, scheduled, or connected, rather than from a visibly leaner or more extensive route map.

6.3.2 Accessibility levels

The three univariate threshold pairs (Figures 27 to 32) show a consistent pattern of moderate, fairly uniform densification from Before to After at every threshold, rather than one dramatic jump concentrated at a single threshold.

At 30 minutes (Figures 27 to 28), both maps show a small darkest-class patch at the city centre with a strong second-darkest band extending west toward the airport and east across the river. The After map shows the darkest-class patch as slightly larger and the surrounding band as marginally more contiguous, but the difference at this threshold is modest, consistent with most of the visible change occurring close to the core rather than across the wider study area.

At 60 minutes (Figures 29 to 30), both maps show a solid dark core at the city centre, slightly larger in position and size between Before and After. The most visible remaining difference is a southern extension: the After map's dark and second-darkest classes reach slightly further south and east of the core, and a second dark patch south of downtown is more distinct in the After map.

At 90 minutes (Figures 31 to 32), the darkest class forms a small, compact patch at the city centre in both maps, with the surrounding area dominated by the second- and third-darkest classes rather than a single large dark block, a more fragmented pattern than the more solid cores seen at 30 and 60 minutes. Across all three thresholds, the pattern is one of consistent, moderate densification, an important characterization for how the strength and uniformity of Winnipeg's accessibility gain should be described.

The tract-level summary statistics confirm this consistency and add precision to its strength. Median jobs accessibility rose at every threshold: from 6,365 to 6,535 at 30 minutes, from 135,710 to 151,795 at 60 minutes, and from 277,185 to 291,070 at 90 minutes. The mean rises by a larger margin at every threshold as well, from 16,214 to 18,596 at 30 minutes, from 126,263 to 140,937 at 60 minutes, and from 243,239 to 261,424 at 90 minutes. Winnipeg is the only city in this study where both the

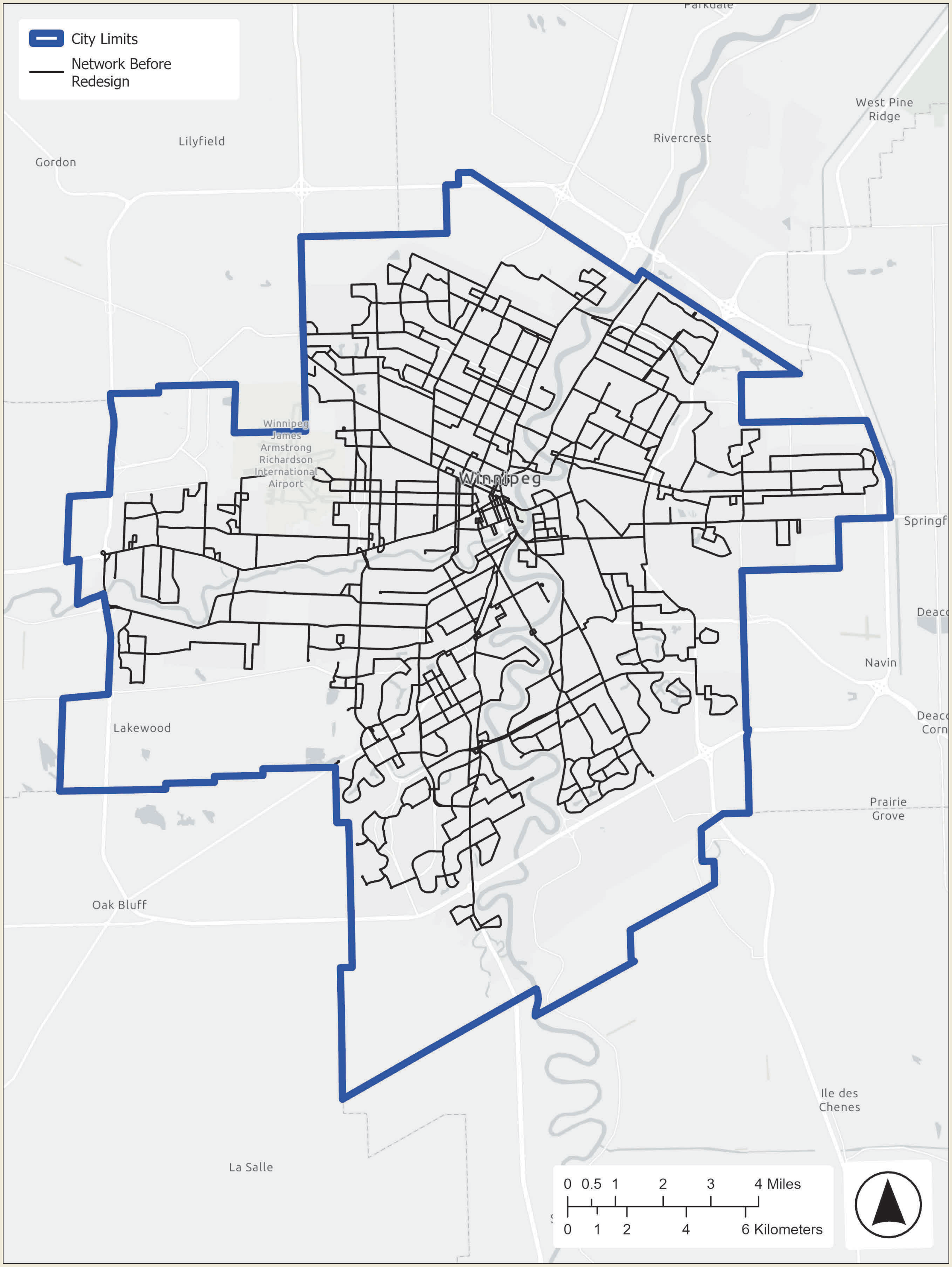

Figure 25. Winnipeg, route network before redesign

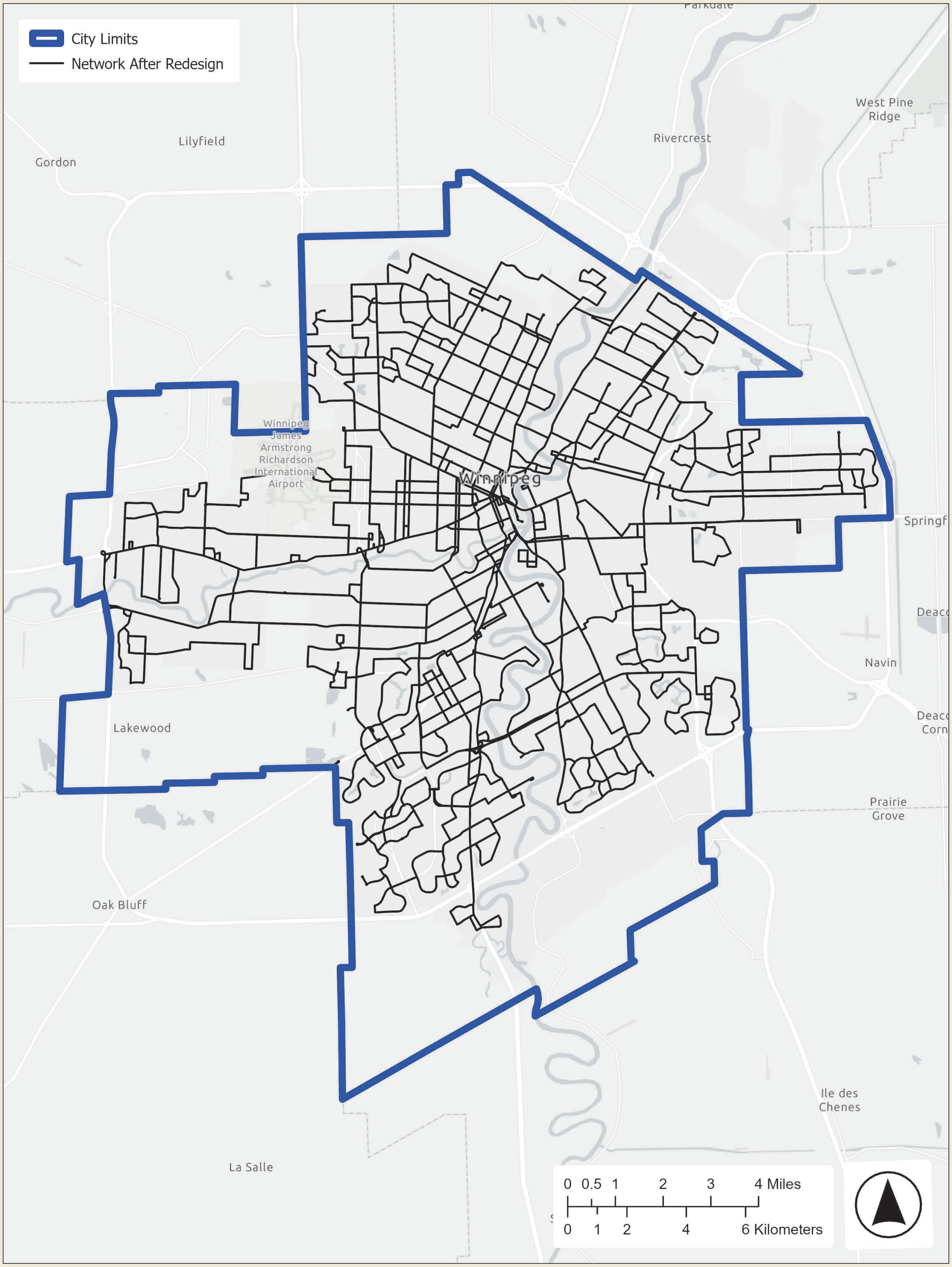

Figure 26. Winnipeg, route network after redesign

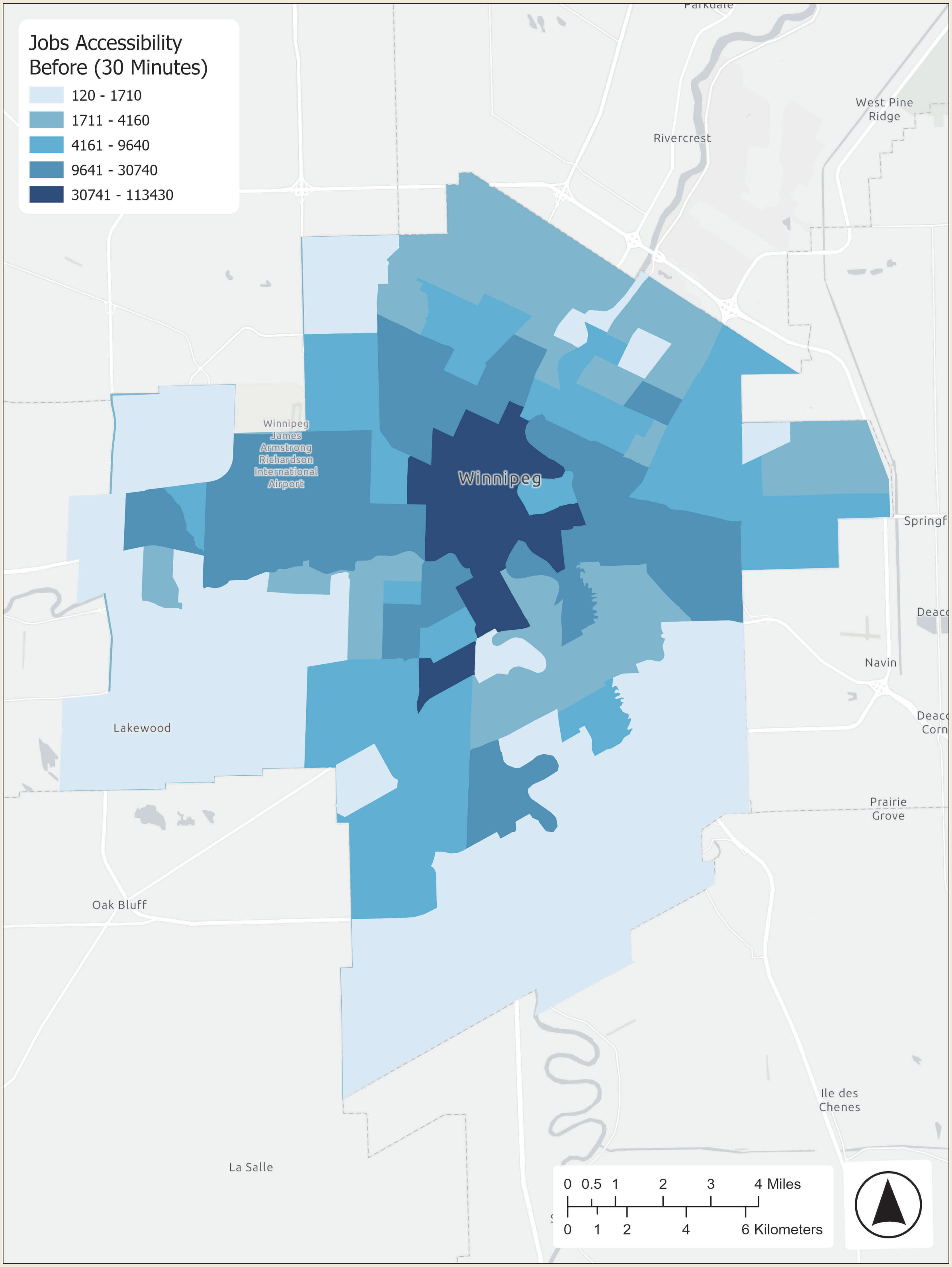

Figure 27. Winnipeg, jobs accessibility Before redesign, 30-minute threshold

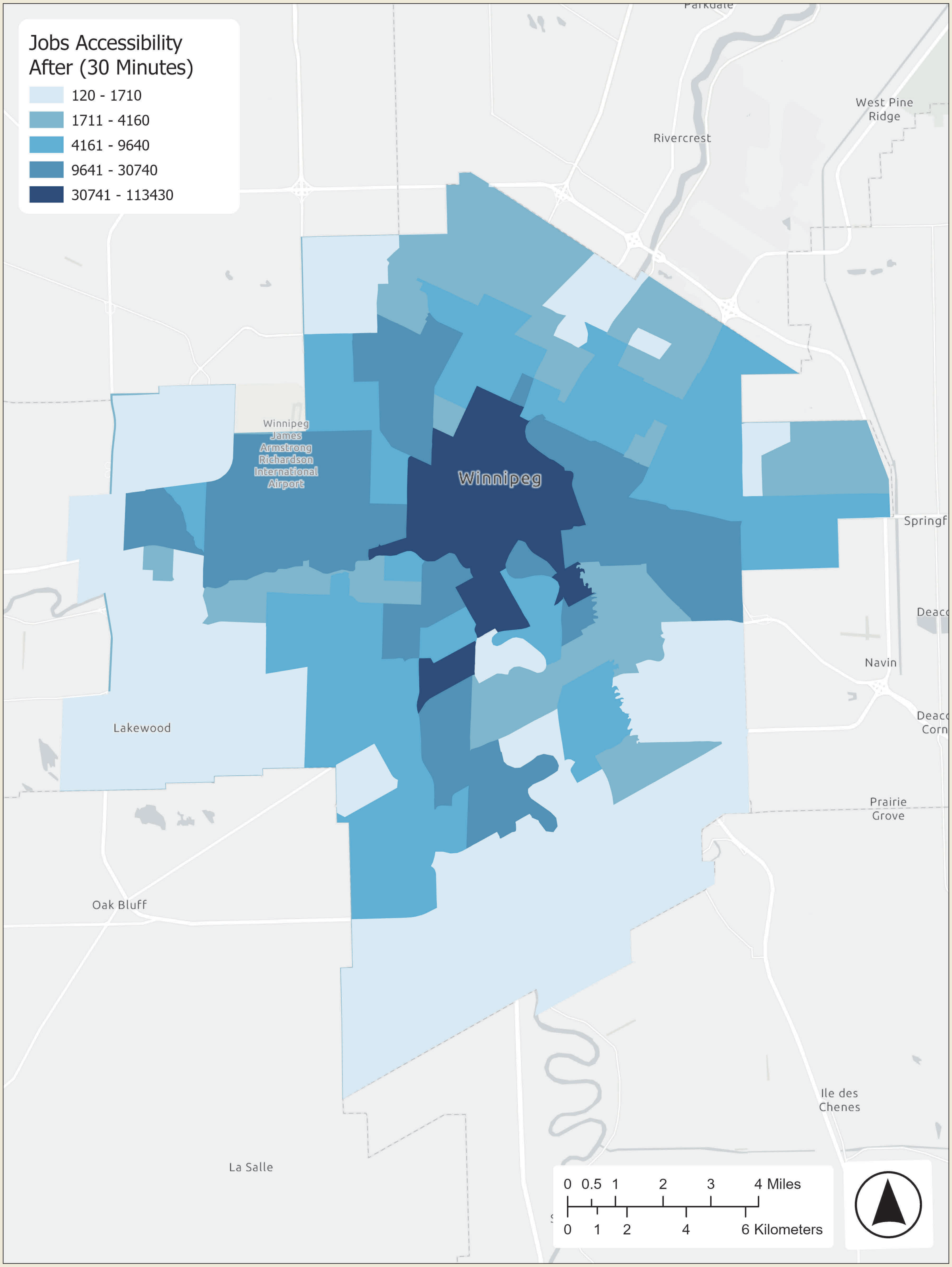

Figure 28. Winnipeg, jobs accessibility After redesign, 30-minute threshold

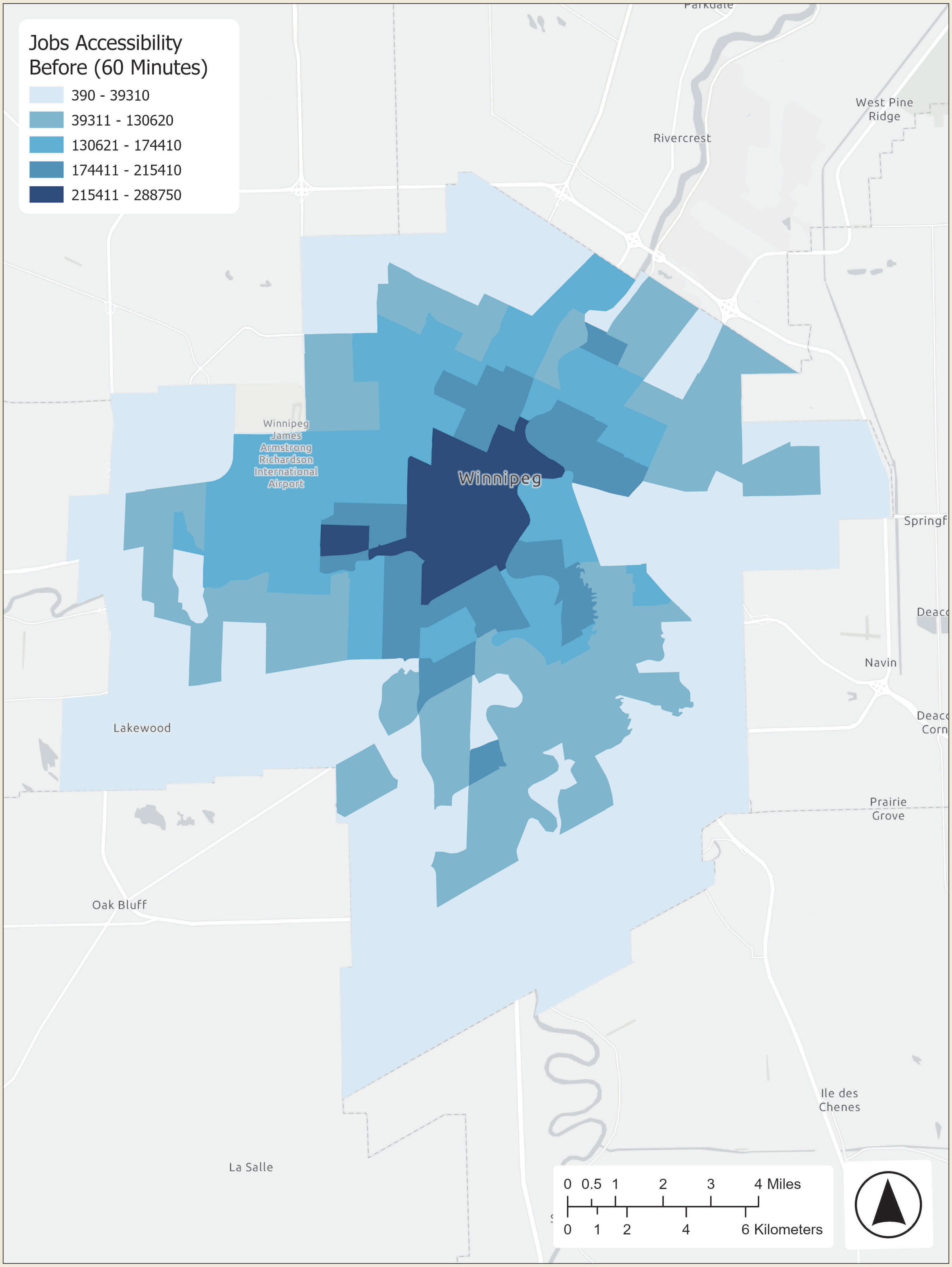

Figure 29. Winnipeg, jobs accessibility Before redesign, 60-minute threshold

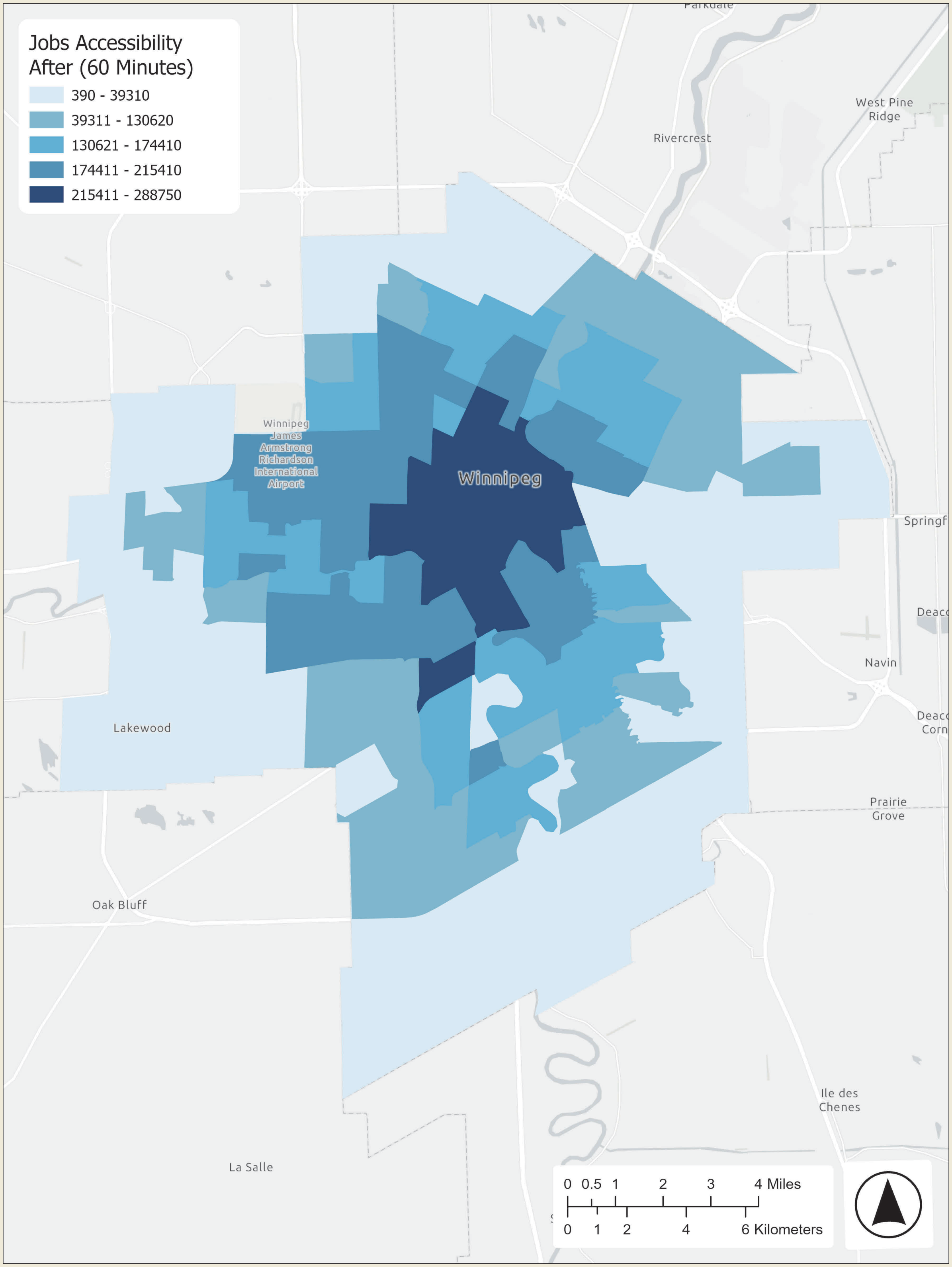

Figure 30. Winnipeg, jobs accessibility After redesign, 60-minute threshold

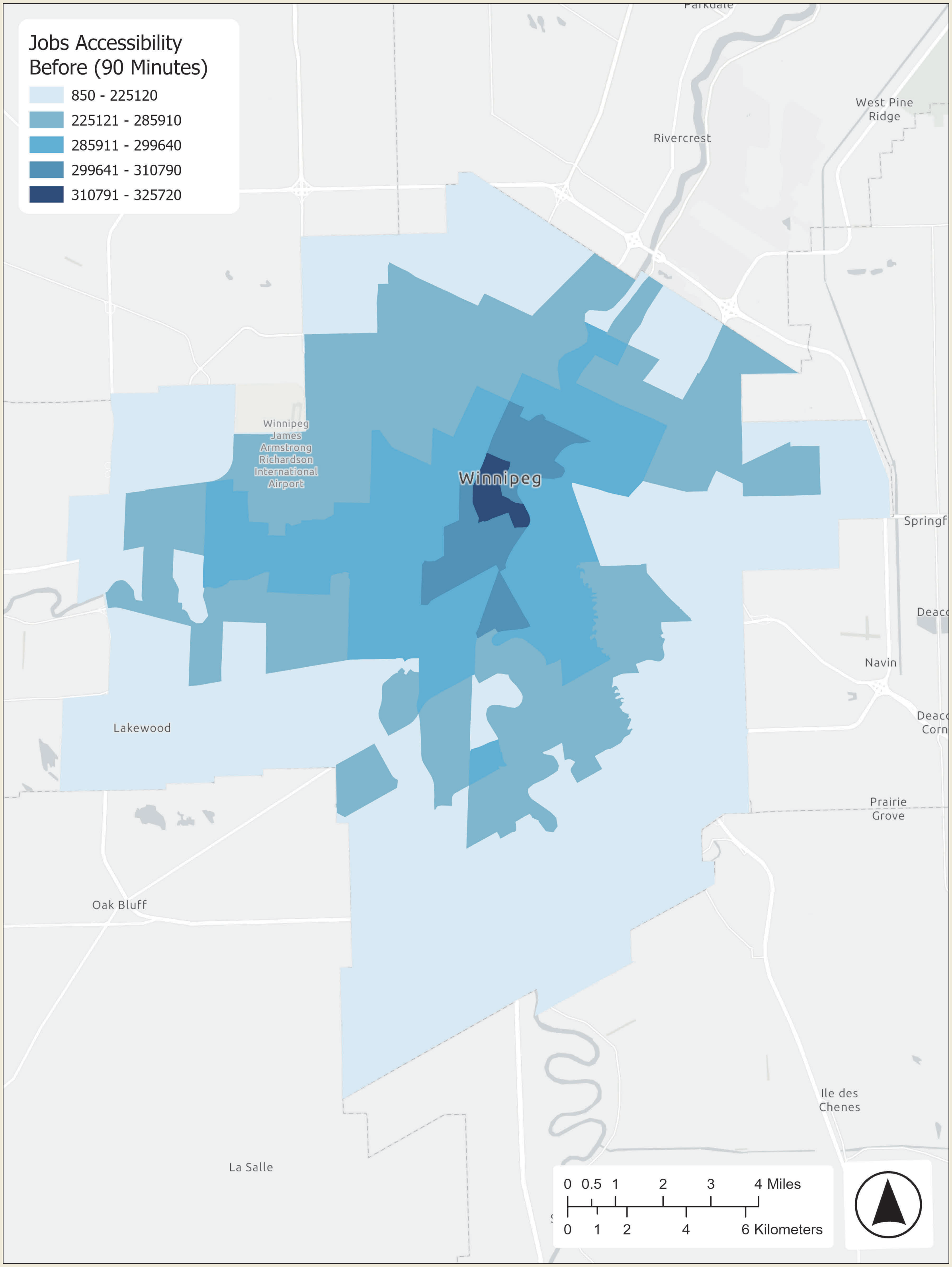

Figure 31. Winnipeg, jobs accessibility Before redesign, 90-minute threshold

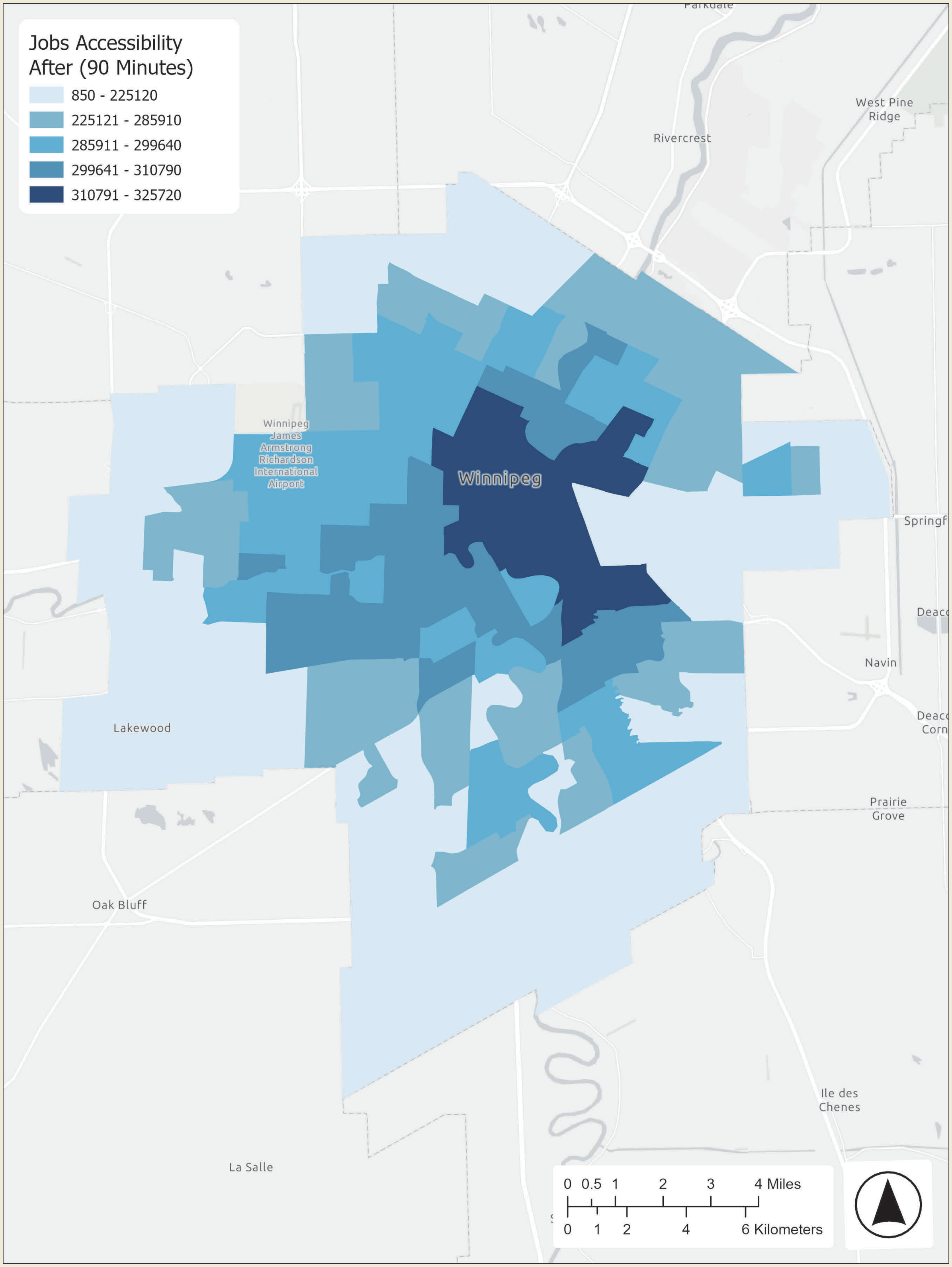

Figure 32. Winnipeg, jobs accessibility After redesign, 90-minute threshold

median and the mean increase at all three thresholds, the numerical counterpart to the consistent, moderate densification described in the maps above.

6.3.3 Magnitude and direction of change

The percent change maps (Figures 33 to 35) provide the most direct visual confirmation of Winnipeg's strong, widely distributed accessibility gain. At 30 minutes (Figure 33), a dense diagonal band of gain tracts cuts through the city from the northwest toward the southeast, with a few isolated loss patches at its edges, already a more extensive gain footprint than Edmonton's or Ottawa's 30-minute maps.

At 60 minutes (Figure 34), gain tracts dominate almost the entire mapped extent, the most uniformly positive map in the full nine-map percent change set, with large solid blocks of strong gain in the north, west, and south and only a handful of small loss patches remaining near the airport and south of downtown.

At 90 minutes (Figure 35), the gain pattern remains strong but slightly less uniform, with large blocks of strong gain in the north, east, and south and a return of minimal-change area through the centre of the city. One area shows consistent loss across all three Winnipeg thresholds: a patch just west of the airport, present in roughly the same location at every threshold, Winnipeg's counterpart to the airport-adjacent loss zone seen in Ottawa. Winnipeg's three percent change maps together show the strongest and most consistent gain pattern of the three cities, with gain tracts outnumbering loss tracts by a wide margin at every threshold, despite the route network showing little visible change

The percent change summary statistics show the largest positive median and mean values recorded in this study. Median percent change is 0 at 30 minutes (again subject to the small-denominator caveat noted above), 9.1 percent at 60 minutes, and 5.1 percent at 90 minutes; the mean is positive at every threshold and substantially larger than the median throughout, at 22.5 percent, 37.5 percent, and 19.5 percent respectively. The high values at 60 and 90 minutes (1,130.4 percent and 1,128.7 percent) are the two largest high values recorded for any city outside the 30-minute small-denominator effect, indicating that Winnipeg's gains include not only a favourable typical-tract shift but also a small number of tracts with very large proportional increases.

6.3.4 Distribution by income

The bivariate equity map (Figure 36) shows a large, contiguous zone of high accessibility change spanning most of the southern half of the city, extending from just south of downtown through Lakewood to the southern edge of the study area, the single largest contiguous block in the Winnipeg bivariate map. Two separate blocks of high income paired with lower accessibility change occupy the southeast corner and the northwest, around Lakewood's northern edge; both are visually separated from the large high-change zone rather than overlapping it.

The area immediately around the city centre and extending northwest toward the airport is dominated by a low-income, low-to-middle change pattern, distinct from the small areas with no income data, which are confined mainly to a patch southwest of the airport and a few scattered slivers near the centre rather than forming a large block, unlike Edmonton's centrally located data gap. The dominant contrast in this map is between the large high-change zone in the south and the two separated high-income zones in the southeast and northwest, with the low-income, low-change area sitting at the centre of the city. On a first colour-level read, the area of greatest accessibility gain does not visually overlap the two largest high-income zones, consistent with the cross-city pattern noted below, though the low-income, low-change area at the city centre

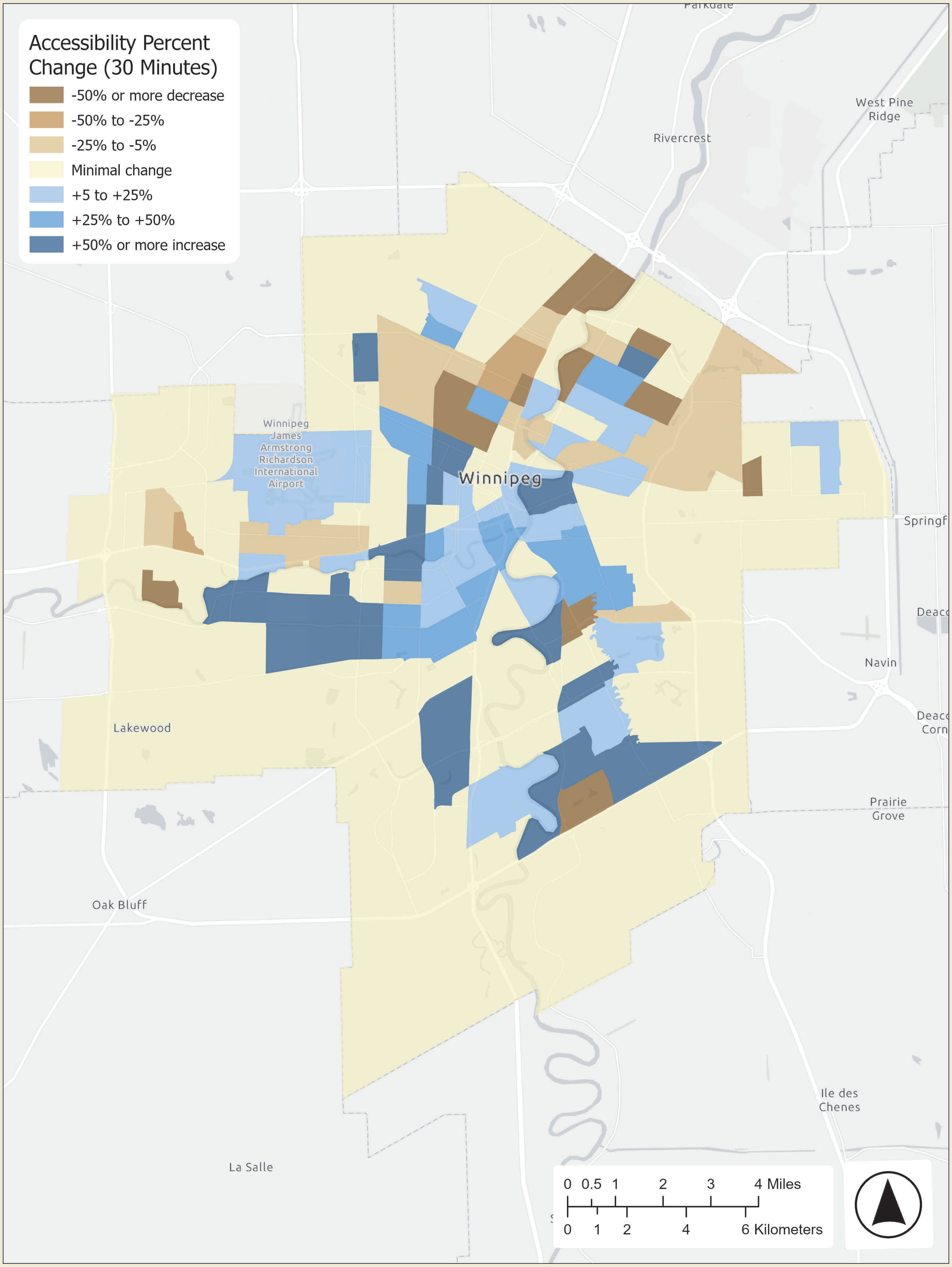

Figure 33. Winnipeg, accessibility percent change, 30-minute threshold

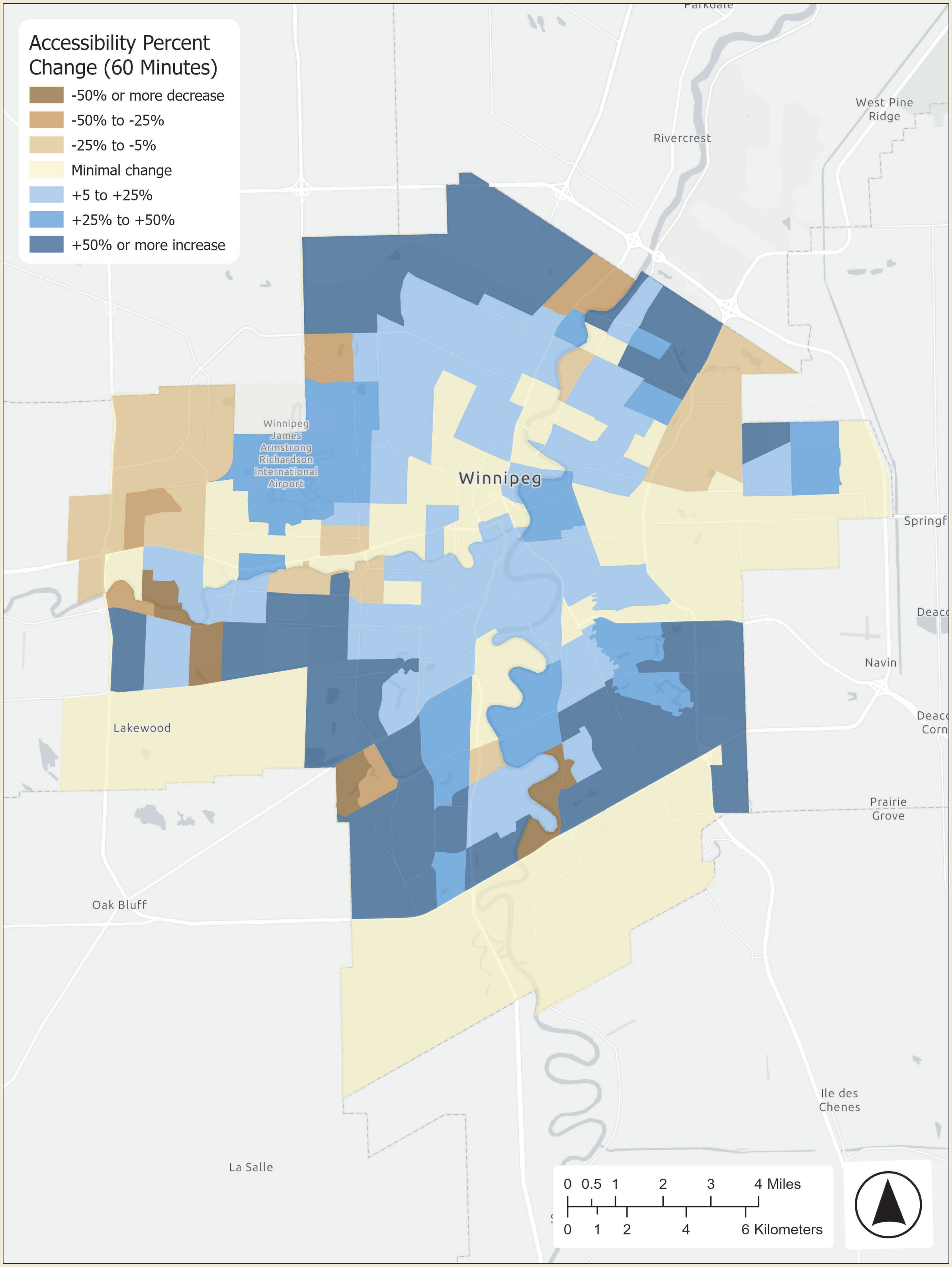

Figure 34. Winnipeg, accessibility percent change, 60-minute threshold

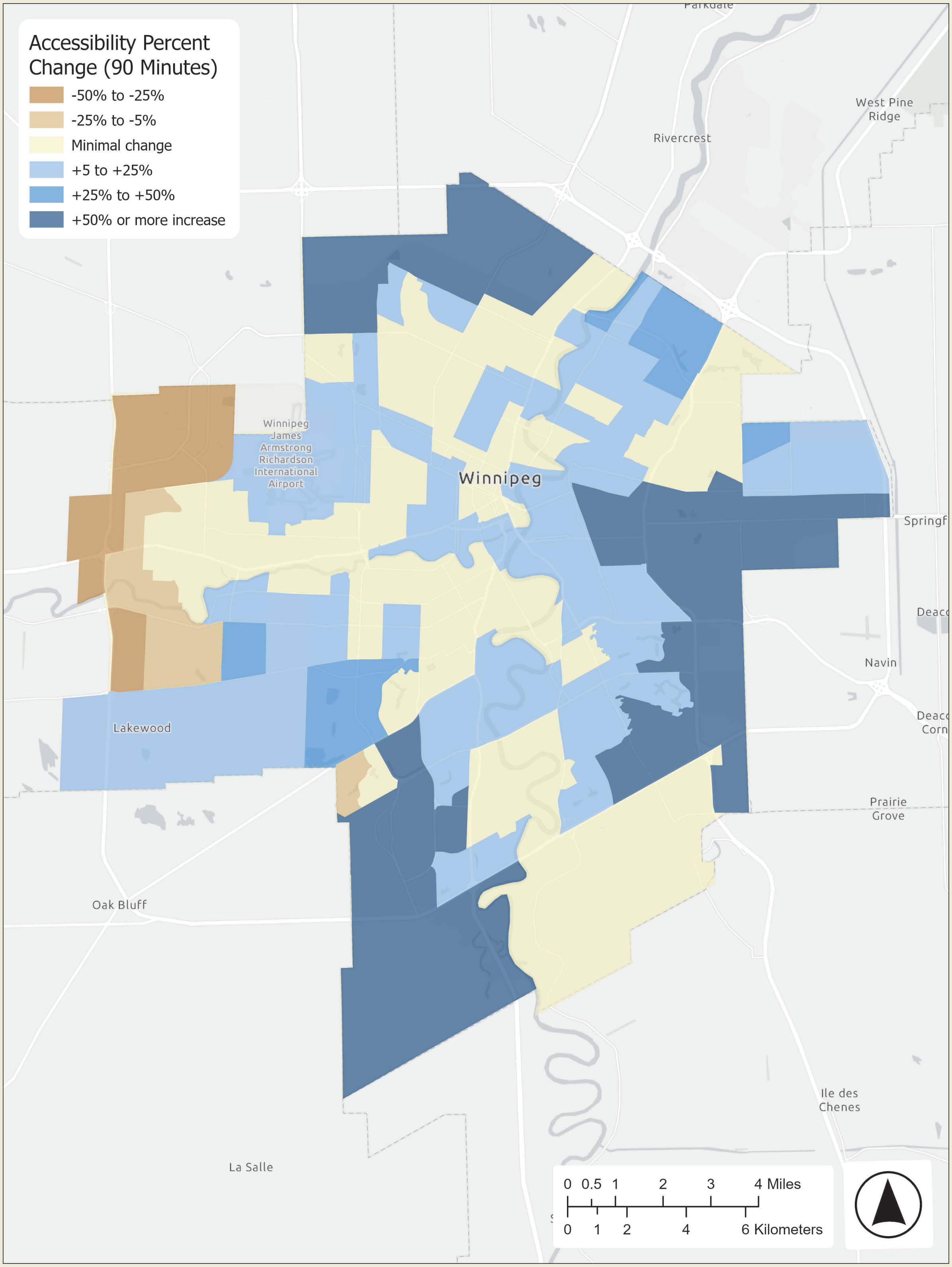

Figure 35. Winnipeg, accessibility percent change, 90-minute threshold

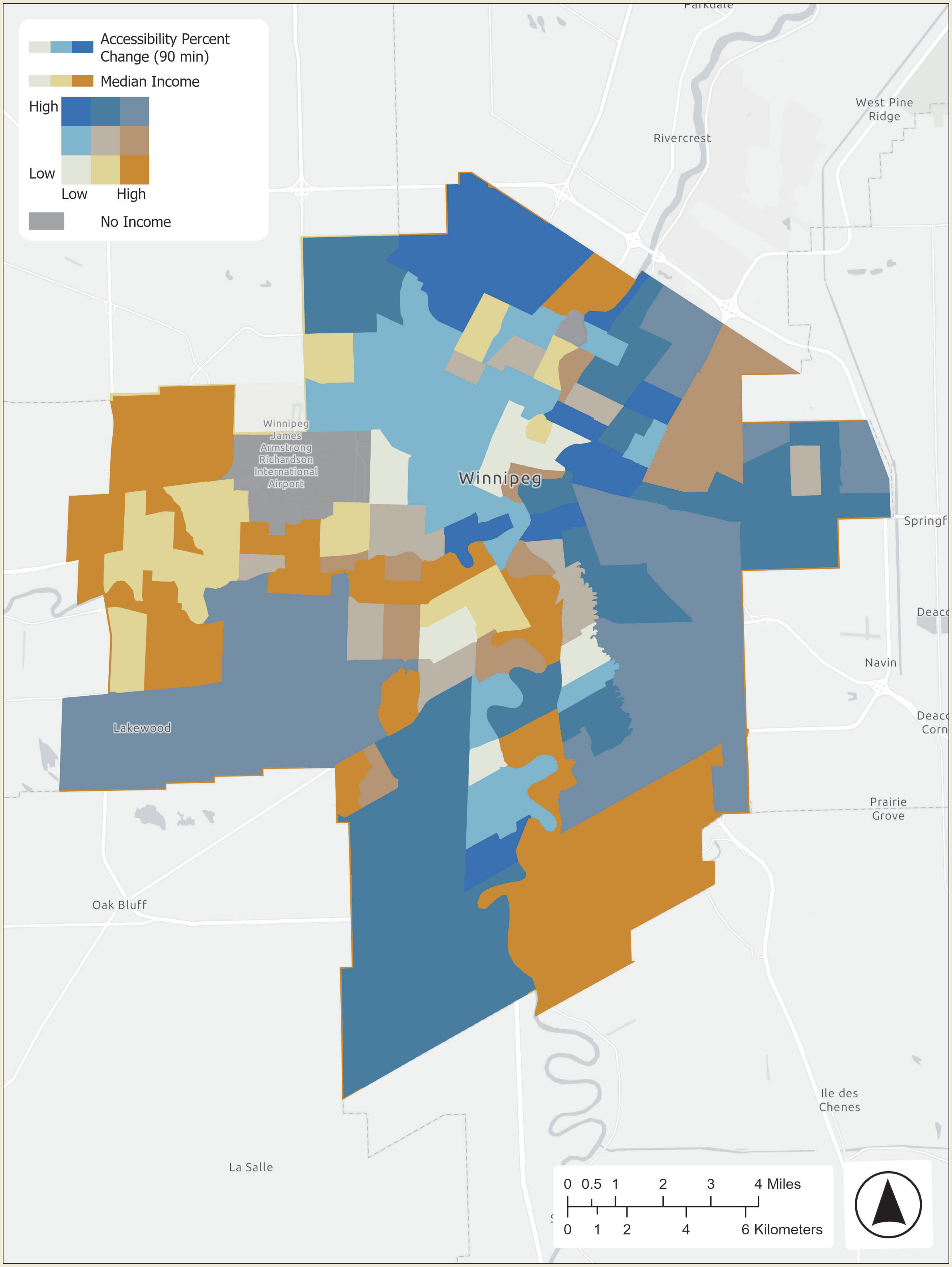

Figure 36. Winnipeg, bivariate map of accessibility percent change (90 minute) and median income

suggests the lowest-income, most central tracts may not be among the biggest gainers either, a point taken up further in the Discussion chapter.

6.4 Cross-city comparison

6.4.1 Network change and accessibility outcome

The relationship between visible network change and accessibility outcome differs sharply across the three cities. Edmonton is the only city with a visibly denser Before network than After, suggesting its accessibility gains came at least partly from route consolidation. Ottawa and Winnipeg both show Before and After networks that look very similar in density and coverage. Winnipeg combines a relatively unchanged route map with the strongest and most widespread accessibility gain of the three cities, an important nuance for the Discussion chapter: the gain mechanism there was not simply more or different route coverage, but something not directly visible in a route-geometry map, plausibly related to scheduling, transfers, or alignment along existing corridors.

The GTFS service metrics summarized in Table 1 reinforce this contrast. Edmonton increased trips and service hours while reducing routes and stops, the signature of consolidation paired with expansion. Ottawa reduced VKT, trips, and routes while holding service hours flat, the signature of contraction without restructuring. Winnipeg increased VKT and service hours while sharply reducing trips, stops, and routes, the largest proportional reduction in stops and routes among the three cities, despite showing little visible change in route geometry. This is consistent with trunk-line consolidation: fewer, more direct routes covering more distance and operating more hours, but serving fewer discrete stops with fewer total trips.

6.4.2 Strength and consistency of accessibility change by city

Comparing the univariate sets across cities, Winnipeg's three threshold pairs show a fairly consistent, moderate Before-to-After densification rather than one dramatic jump. Ottawa's pairs show less visible change of the three cities. Edmonton shows a consistent, moderate densification of its core across all three thresholds.

The tract-level summary statistics sharpen this comparison and reveal a pattern not fully visible in the maps alone. Winnipeg is the only city where the median percent change is positive at both the 60- and 90-minute thresholds (9.1 percent and 5.1 percent), and Ottawa is the only city where it is negative at both thresholds (negative 5.4 percent and negative 2.9 percent). Edmonton sits between the two: its median percent change is essentially flat at 60 minutes (0 percent) and modestly positive at 90 minutes (3.5 percent). At 30 minutes, every city's median sits at or near zero, consistent with the small-denominator caveat described earlier, so this threshold offers little basis for cross-city comparison of typical-tract outcomes. Ranked by median percent change at the 90-minute threshold, the ordering is Winnipeg first, Edmonton second, and Ottawa last, the same ordering implied by the qualitative reading of the percent change maps in each city section above.

The percent change maps independently confirm two findings already visible in the univariate and bivariate sets. First, Ottawa's area east and southeast of the airport declines consistently across all three thresholds, matching both the contraction of its 90-minute high-accessibility core and the lower-income overlap with the high-change zone noted in its bivariate map. Second, Winnipeg's percent change maps show the most extensive and consistent gain footprint of the three cities, matching the strong, widely distributed gain already evident in its univariate and bivariate maps. This convergence across independently constructed map types, levels, change, and

GTFS Service Metrics Summary: Before and After Bus Network Redesign

Edmonton (2021), Ottawa (2025), and Winnipeg (2025). Values are derived from GTFS feeds for a representative weekday.

Metric	Before	After	Change	% Change
Edmonton				
Total VKT (km)	130,583.9	137,967.1	+7,383.2	+5.7%
Total Service Hours	5,783.2	6,229.8	+446.6	+7.7%
Total Trips	10,550	11,656	+1,106	+10.5%
Unique Stops Served	6,494	5,963	-531	-8.2%
Routes Operated	216	207	-9	-4.2%
Ottawa				
Total VKT (km)	136,194.7	125,524.1	-10,670.6	-7.8%
Total Service Hours	5,037.7	5,049.4	+11.7	+0.2%
Total Trips	8,840	8,201	-639	-7.2%
Unique Stops Served	5,813	5,744	-69	-1.2%
Routes Operated	200	182	-18	-9.0%
Winnipeg				
Total VKT (km)	86,677.8	91,064.5	+4,386.7	+5.1%
Total Service Hours	4,167.9	4,258.9	+91.0	+2.2%
Total Trips	5,984	5,634	-350	-5.8%
Unique Stops Served	5,136	3,872	-1,264	-24.6%
Routes Operated	87	71	-16	-18.4%

Note: VKT refers to vehicle kilometres travelled. Change is After minus Before; percent change is relative to the Before value.

Table 1. GTFS service metrics summary

equity, is itself a robustness signal worth noting rather than relying on any single map type alone.

6.4.3 Equity patterns by city

The bivariate maps reveal a distinct distributional pattern in each city. Edmonton's clearest pattern is a large, contiguous high-income, low-change zone in the suburbs, with high-change tracts scattered and not concentrated by income. Ottawa's clearest pattern is a large, contiguous high-change zone in the east that reads as low-to-middle income. Winnipeg's clearest pattern is one very large high-change zone spanning the southern half of the city, separated from two distinct high-income zones in the southeast and northwest, with a low-income, low-change patch at the city centre.

On a first visual read, none of the three cities shows its largest high-change zone overlapping its largest high-income zone. This observation is based on legend-level colour reading rather than underlying tract-level statistical testing. Each city's bivariate map also has a class representing tracts with no income data, and the spatial position of this gap differs in a way that matters for interpretation.

7. Discussion

This chapter steps back from the city-by-city and cross-city findings presented in Chapter 6 to consider what they mean collectively. It is organized around four threads. The first revisits RQ1 and RQ2 together, asking what the pattern of results across the three cities says about whether bus network redesigns (BNRs) in the Canadian context tend toward progressive, neutral, or regressive accessibility outcomes. The second takes up the planning intentions versus outcomes question that Chapter 5 repeatedly noted but deliberately did not pose as a formal research question, asking how each city's stated redesign goals relate to what the accessibility analysis actually found. The third addresses the gap between measured accessibility and rider experience, most visible in Winnipeg but relevant to how accessibility metrics should be interpreted across all three cities. The fourth considers the methodological lessons of this study, including the causality caveat built into RQ1 and the small-denominator limitation identified in Chapter 6, and what they imply for future BNR evaluation research.

7.1 What the Results Say About RQ1 and RQ2

Chapter 3 asked whether this research would find that Canadian BNRs tend toward a consistent distributional pattern, or whether outcomes are highly contingent on local conditions. The results in Chapter 6 point firmly toward contingency. Edmonton, Ottawa, and Winnipeg, despite sharing a country, a post-pandemic fiscal environment, and a broadly similar bus-to-LRT or bus-only service structure, produced three different accessibility outcomes. Winnipeg gained at every threshold, with the largest median gain recorded anywhere in this study. Ottawa declined at every threshold, the only city to do so consistently. Edmonton sat between the two, declining slightly at the shorter thresholds but gaining at 90 minutes. No single answer to "what does a BNR do to jobs accessibility" emerges from these three cases; the answer depends on the city

This contingency is itself a finding worth taking seriously, because it cuts against a temptation that runs through both the planning literature and popular discourse on network redesigns: the tendency to treat the Houston model, or any single successful precedent, as a template whose logic should transfer directly to other cities. Byala et al. (2019) and Pritchard (2015) document real gains from Houston's frequency-oriented redesign, and Bhattacharya et al. (2013) document a comparable net gain in Tallahassee. The Winnipeg case in this study fits that pattern. The Ottawa case does not. The same broad playbook, consolidating routes, concentrating frequency on core corridors, and accepting some loss of coverage, does not guarantee the same outcome, and this research's three-city design exists precisely to surface that variation rather than to assume it away.

Turning to RQ2, the equity picture across the three cities is more consistent than the accessibility picture, though not in the direction that a simple progressive-or-regressive label would suggest. In all three cities, the bivariate maps show that the census tracts with the largest accessibility gains were not the same tracts with the highest incomes. Edmonton's highest-income areas, concentrated in the suburban and exurban fringe, showed low accessibility change; its highest-change tracts were scattered through the income-mixed core rather than concentrated in either the lowest- or highest-income areas. Ottawa's largest zone of accessibility gain, the eastern arm toward Orleans, reads as lower-to-middle income rather than high income. Winnipeg's largest gain zone, spanning the southern half of the city, sits apart from its two clearest high-income zones in the southeast and northwest.

Read at face value, this pattern, gains not concentrated among the already-affluent, leans away from a regressive outcome in all three cities. But this study's own equity framework, set out in Section 4.4, asks a more specific question than "do the rich benefit most": it asks whether low-income tracts experienced comparable or greater gains than higher-income tracts. The bivariate maps, as Chapter 6 repeatedly cautions, support only a legend-level colour reading, not a statistical test of this specific comparison. Winnipeg's bivariate map contains a suggestive complication on this point: the low-income, low-to-middle change area at the city centre indicates that, while the wealthy suburbs did not capture the largest gains, neither did the most central, plausibly most transit-dependent, low-income tracts. A finding that the affluent did not benefit most is not equivalent to a finding that the poor benefited most. Edmonton's data gap compounds this uncertainty in the opposite direction: the area with no income data sits partly over the city's highest-accessibility tracts. Confirming or disconfirming a progressive reading in any of the three cities would require moving from the descriptive bivariate pattern to a direct statistical comparison of mean accessibility change between low-income and non-low-income tracts, the analysis that Section 4.4 specifies but that the map-level evidence in Chapter 6 can only gesture toward.

This combination, real and divergent accessibility outcomes alongside an equity pattern that resists a clean progressive or regressive label, echoes a caution that runs through the equity literature reviewed in Chapter 2. Liu, Rahman, and Karner (2023) observe that a redesign can appear equitable by one performance metric and inequitable by another, and Situ and Karner (2025) similarly argue that proximity-based and accessibility-based metrics can support different equity conclusions about the same redesign. The present findings extend this caution one step further: even within a single accessibility-based framework, a map-level reading of where gains occurred is not by itself sufficient to answer whether those gains were equitably distributed in the specific sense this study's own RQ2 poses. The bivariate maps narrow the space of plausible answers considerably, but they do not close it.

7.2 Planning Intentions and Accessibility Outcomes

Chapter 5 documented, for each city, the gap or alignment between what the redesign was designed to achieve and what the accessibility analysis in Chapter 6 found. This section draws those threads together, not as a formal research question but as the interpretive lens that Chapter 3 set aside for the discussion chapter specifically.

Edmonton's case is the starkest. The 2017 Transit Strategy that underpinned the 2021 redesign never mentions jobs accessibility as a planning metric anywhere in its guiding principles, actions, or performance indicators. Its stated benchmarks, safe, fast, convenient, and reliable, are service-quality attributes, not accessibility outcomes, and its performance monitoring tracks cost recovery, on-time performance, and customer satisfaction rather than the number of jobs reachable from any tract. The redesign was guided by a demand-matching logic: concentrate frequency where ridership and land use density justify it. The accessibility results in Section 6.1, a slight median decline at 30 and 60 minutes paired with a modest median gain at 90 minutes, are therefore not evidence that Edmonton's redesign succeeded or failed against its own goals, because accessibility was never the goal against which the redesign was supposed to be measured. The outcomes documented in this study are, in the language Chapter 5 uses, emergent consequences of a network built around a different logic entirely. This decoupling cuts in both directions: Edmonton cannot be credited with deliberately engineering its 90-minute gains, and it cannot be faulted for its 30- and 60-minute declines, because neither was a tracked objective.

Ottawa's case is different in kind. Its redesign was shaped by acute fiscal pressure on OC Transpo, compounded by LRT-related cost overruns, and the 2023 consultation that preceded it surfaced rider demands for faster, more direct, and more frequent service rather than an accessibility target per se. Here, the accessibility outcome, a consistent median decline at every threshold, is more legible against the stated context: a redesign carried out partly to contain costs, in a system already under financial strain, producing a net accessibility loss is a coherent, if not necessarily inevitable, result of that starting condition. The percent change maps localize this decline specifically to the area east and southeast of the airport, the same area whose bivariate equity map reads as lower-to-middle income rather than high income. If this localized decline disproportionately affected lower-income riders along the eastern arm, a question this study's descriptive maps raise but cannot fully confirm, then Ottawa's case would be the clearest instance in this study of a budget-driven redesign producing a regressive accessibility outcome in fact, even though equity was not a stated obstacle the planning process was built to avoid.

Winnipeg's case is the most analytically interesting precisely because it does not fit either of the other two patterns. The Winnipeg Transit Master Plan and the 2025 Primary Transit Network redesign were explicit about wanting accessibility-adjacent outcomes: more frequent service, simpler and more direct routes, better cross-town connectivity, and a 25 percent capacity increase without additional service hours. Unlike Edmonton, Winnipeg's planning documents gesture toward exactly the kind of network performance this study measures. And unlike Ottawa, the result delivered on that intent: Winnipeg's accessibility gains are the strongest and most consistent of the three cities. Yet the redesign also generated significant rider pushback centred on increased transfer requirements, particularly in lower-density outer neighbourhoods that had previously relied on single-seat rides. This is the clearest case in this study where stated intentions and measured outcomes align on the accessibility metric this research tracks, while still producing a documented gap between that metric and how riders experienced the change. Section 7.3 returns to this gap directly.

Taken together, these three cases suggest that the relationship between planning intent and accessibility outcome in BNRs is not reducible to a single story. A redesign can produce accessibility outcomes nobody was tracking (Edmonton), an outcome consistent with an under-resourced starting position (Ottawa), or an outcome that matches stated intent on the metric this study measures while still falling short on dimensions the metric does not capture (Winnipeg). This variation argues against treating accessibility analysis as a simple verdict on whether a redesign succeeded. It is better understood as one input, among several a planning process might track, that in two of these three cities was not part of the conversation that produced the network at all.

7.3 The Gap Between Measured Accessibility and Rider Experience

Winnipeg's redesign offers the clearest illustration in this study of a finding that accessibility researchers must take seriously: a network can become measurably better at connecting people to jobs while becoming, for some riders, worse to actually use. The cumulative opportunity measure used throughout this research counts jobs reachable within a travel time threshold; it does not count the number of vehicles a trip requires, the cognitive and physical burden of a transfer, the reliability of the connection between two scheduled trips, or the loss of a familiar single-seat ride. Winnipeg's strong, consistent median gains at every threshold, confirmed independently by the univariate, percent change, and bivariate maps in Section 6.3, coexisted with rider complaints specifically about the Feeder Network's transfer requirements in lower-density outer neighbourhoods.

This is not a contradiction in the data; it is a limitation of the metric, one that Section 4.5 acknowledges in general terms and that Winnipeg's case makes concrete. A cumulative opportunity score treats a one-transfer trip and a one-seat trip of the same total travel time as equivalent, because both deliver the same destination within the same threshold. Riders, by contrast, do not necessarily experience them as equivalent. Grise, Stewart, and El-Geneidy (2021) document a similar dynamic in Longueuil, where a shift to a high-frequency, transfer-based network increased accessibility while provoking rider resistance specifically to the transfer burden itself, and note that this resistance is a recurring challenge in transfer-based network design generally. Winnipeg's experience is consistent with that broader pattern rather than an isolated local complaint.

The practical implication is that accessibility metrics of the kind used in this study are necessary but not sufficient for evaluating a redesign's success. They answer the question "can more jobs be reached within a given time" with a precision that rider surveys or anecdotal feedback cannot match, but they are silent on whether the trips that deliver that reachability feel like a service improvement or a service degradation to the people taking them. A complete evaluation framework would pair the accessibility analysis presented in Chapter 6 with transfer counts, reliability metrics, or rider satisfaction data, none of which are part of this study's design but all of which would sharpen the interpretation of cases like Winnipeg's. This is taken up further as a direction for future research in Section 7.5.

7.4 Methodological Reflections

Two methodological points raised earlier in this paper warrant fuller discussion here, because both bear directly on how confidently the findings in Chapter 6 should be interpreted.

The first is the causality caveat built into RQ1 from the outset. Chapter 3 was explicit that this research's before-and-after design identifies associations between a redesign and observed changes in accessibility, not causal effects, because population redistribution, employment change, and updates to the underlying street network data could also shift the cumulative opportunity measure between the two snapshots. This caveat is not a formality. Edmonton's employment geography, for instance, could plausibly have shifted between the March and June 2021 GTFS snapshots for reasons unrelated to the redesign, and the one-month buffer used to avoid transitional service disruptions, described in Section 4.2.1, does not address this concern. The results in Chapter 6 should accordingly be read as what changed alongside each redesign, not as a fully isolated estimate of what the redesign alone caused. This is a limitation common to before-and-after accessibility studies generally, including the methodological precedents this research draws on (Klar et al., 2023; Pritchard, 2015), and it does not undermine the value of the comparison, but it does mean that claims about mechanism, particularly the suggestion in Section 6.3 that Winnipeg's gains came from scheduling, transfers, or alignment rather than route geometry, should be read as plausible interpretation rather than demonstrated cause.

The second is the small-denominator limitation identified in the percent change statistics at the 30-minute threshold, documented in Section 4.5 and applied consistently throughout Chapter 6. Because percent change is calculated relative to the Before-period job count, tracts with very few jobs reachable within 30 minutes before redesign can show extreme percent changes after even modest absolute gains, producing mean and maximum values at this threshold (Ottawa's 30-minute high of 3,285.7 percent being the most extreme instance) that say little about the typical tract. This study addressed the problem by treating the median as the more reliable summary statistic at this threshold and by flagging the issue explicitly rather than silently reporting the inflated means. Future studies using percent change as a tract-level summary statistic at short travel time thresholds, where job counts can be small in absolute terms even when cumulative opportunity measures are otherwise well behaved, should anticipate this issue and consider absolute change or median-based summaries as the primary reporting statistic rather than the mean.

A further reflection concerns the convergence noted across map types in Section 6.4: Ottawa's airport-adjacent decline and Winnipeg's broad gain footprint were each independently confirmed by the univariate, percent change, and bivariate maps for their respective cities. This convergence is a genuine strength of the multi-method visual approach taken in this research, since no single map type is asked to bear the full evidentiary weight of a finding. At the same time, the bivariate equity readings in particular were repeatedly described in Chapter 6 as legend-level colour observations rather than statistical results, a distinction this discussion has returned to more than once. The descriptive cartographic approach used throughout this study is well suited to generating hypotheses about where accessibility changed and how those changes relate to income, but it is not a substitute for the tract-level statistical comparison that a fully quantified answer to RQ2 would require.

7.5 Implications and Future Research

For transit practitioners, the central implication of this research is that accessibility outcomes cannot be assumed from a redesign's stated rationale or even from its visible network changes. Ottawa's redesign looked, on the route network maps alone, like the least disruptive of the three; it nonetheless produced the only consistent accessibility decline in this study. Winnipeg's redesign looked similarly undisruptive on the same kind of map, yet produced the strongest gains. Edmonton's redesign was the only one with an strongly consolidated network, and its accessibility outcome was the most threshold-dependent of the three. Route geometry, in other words, is a poor proxy for accessibility outcome, and agencies undertaking a redesign would be better served by accessibility modelling of the kind performed in this study, conducted before implementation, than by inference from network maps alone. For agencies in Edmonton's position, where accessibility was not part of the original planning framework, this also suggests a concrete addition to future redesign processes: building jobs accessibility, or another accessibility measure suited to local priorities, directly into the performance indicators against which a redesign is evaluated, rather than leaving its outcomes to be discovered after the fact by outside researchers.

For researchers, three extensions follow directly from the limitations discussed above. First, the equity findings in this study would benefit from a direct statistical test of mean accessibility change by income group, moving beyond the descriptive bivariate maps to the comparison Section 4.4 specifies, particularly for Edmonton and Winnipeg, where the bivariate maps raise more specific equity questions than they can answer. Second, the gap between measured accessibility and rider experience documented in Winnipeg points toward pairing accessibility analysis with transfer-burden or reliability metrics in future BNR evaluations, following the kind of comprehensive framework that Situ and Karner (2025) call for. Third, the threshold-dependence observed in Edmonton's results, and the small-denominator issue at 30 minutes observed in all three cities, both suggest that future cumulative opportunity studies should treat the choice of travel time threshold as a substantive analytical decision rather than a robustness check, reporting multiple thresholds in full as this study does rather than collapsing to a single preferred value.

Finally, the contingency at the heart of this study's findings, three cities, three different accessibility outcomes, is itself the strongest argument for continuing this kind of city-by-city, accessibility-based evaluation rather than relying on precedent from elsewhere. Houston's success does not predict Ottawa's outcome, and Tallahassee's equity-neutral result does not predict Winnipeg's. Each Canadian city redesigning its bus network is, in effect, running its own experiment, and only systematic accessibility analysis, of the kind this research has applied to Edmonton, Ottawa, and Winnipeg, can say with any confidence what that experiment actually produced.

8. Conclusion

This research set out to answer two questions: how do bus network redesigns change jobs accessibility in Edmonton, Ottawa, and Winnipeg, and are those changes distributed equitably across income groups. The answer to the first question is that change is real but contingent: Winnipeg gained accessibility at every travel time threshold examined, Ottawa lost it at every threshold, and Edmonton produced a mix of small losses at shorter thresholds and a modest gain at the longest one. The answer to the second is less clean. None of the three cities shows its largest accessibility gains concentrated among its highest-income tracts, but this descriptive pattern falls short of confirming that lower-income tracts gained more than higher-income ones in the specific sense this study's equity framework asks about, and in Edmonton's case a data gap sits directly over an area of great analytical interest. The honest summary is that this study found three different accessibility outcomes and an equity picture that resists a single label.

That contingency is this study's central contribution. Three Canadian cities, operating under broadly similar post-pandemic fiscal and demand pressures and drawing on the same general BNR playbook of route consolidation and frequency concentration, produced three different accessibility results. This finding matters because it pushes back against any tendency, in either the planning literature or in agency decision-making, to treat a single successful precedent as a transferable formula. A redesign that worked in one city does not guarantee the same outcome in the next, even within the same country and the same broad set of constraints. Systematic, city-specific accessibility analysis, rather than confidence drawn from comparable cases elsewhere, is what allowed this study to detect that divergence at all.

A second finding that emerged only through close reading of both maps and summary statistics together is that accessibility outcomes can be sensitive to the travel time threshold chosen. Edmonton's results would look like a straightforward decline if only the 30- or 60-minute threshold were reported, or a straightforward gain if only the 90-minute threshold were reported. Neither framing alone would be wrong, but neither would be complete. Reporting all three thresholds, rather than treating one as primary, was necessary to see this pattern, and it is a methodological choice this study recommends to future accessibility research using cumulative opportunity measures.

A third finding concerns the relationship between what a redesign sets out to do and what an accessibility analysis later finds. Edmonton's 2021 redesign was never evaluated against a jobs accessibility metric by the agency that designed it, which means the gains and losses this study documents were not anticipated by anyone at the time. Winnipeg's redesign explicitly aimed at outcomes consistent with what this study measures, and largely delivered them, yet still produced rider dissatisfaction over transfers that an accessibility score cannot capture. Together, these cases suggest that accessibility analysis is best understood as one input planning processes should track deliberately, rather than a verdict to be discovered after the fact by outside researchers, as happened here for two of the three cities studied.

This study has limitations that should temper how its findings are used. The before-and-after design identifies association, not causation; other changes, in employment geography, population, or the underlying street network, could have contributed to the accessibility shifts documented here alongside each redesign. The bivariate equity maps support a descriptive, legend-level reading rather than a confirmed statistical finding about which income group gained more. And the percent change statistic, while useful, behaves unreliably at the shortest travel time threshold when Before-period job counts are small. None of these limitations invalidate the findings, but they do mean the findings should be read as a rigorous first look rather than a final word, particularly on the equity question this study's own framework poses most directly.

Future work building on this research would benefit from three additions: a direct statistical test of accessibility change by income group rather than a map-based reading of it, rider-facing measures such as transfer counts or reliability data paired alongside the accessibility metric, and continued multi-city comparison as more Canadian agencies undertake their own redesigns in the years ahead.

For the transit planners and policymakers this study is written for, the practical lesson is straightforward even where the findings are not: a bus network redesign does not have a predictable accessibility outcome simply because it follows a familiar playbook, and the only way to know what a redesign actually did to jobs accessibility, and to whom, is to measure it directly, before and after, city by city.

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